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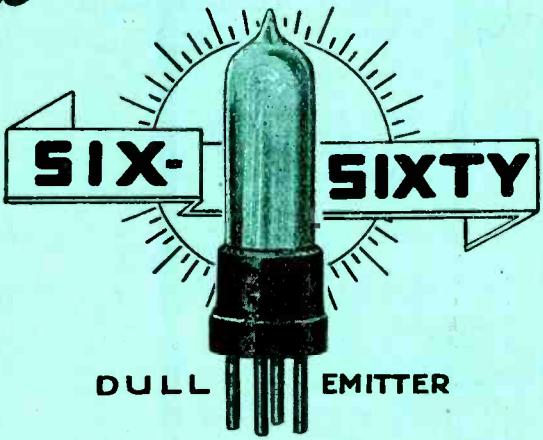

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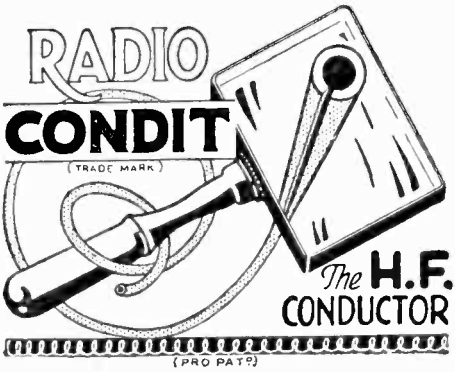

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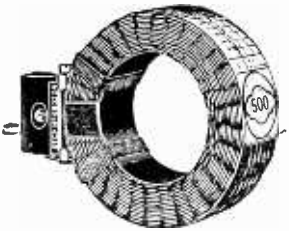

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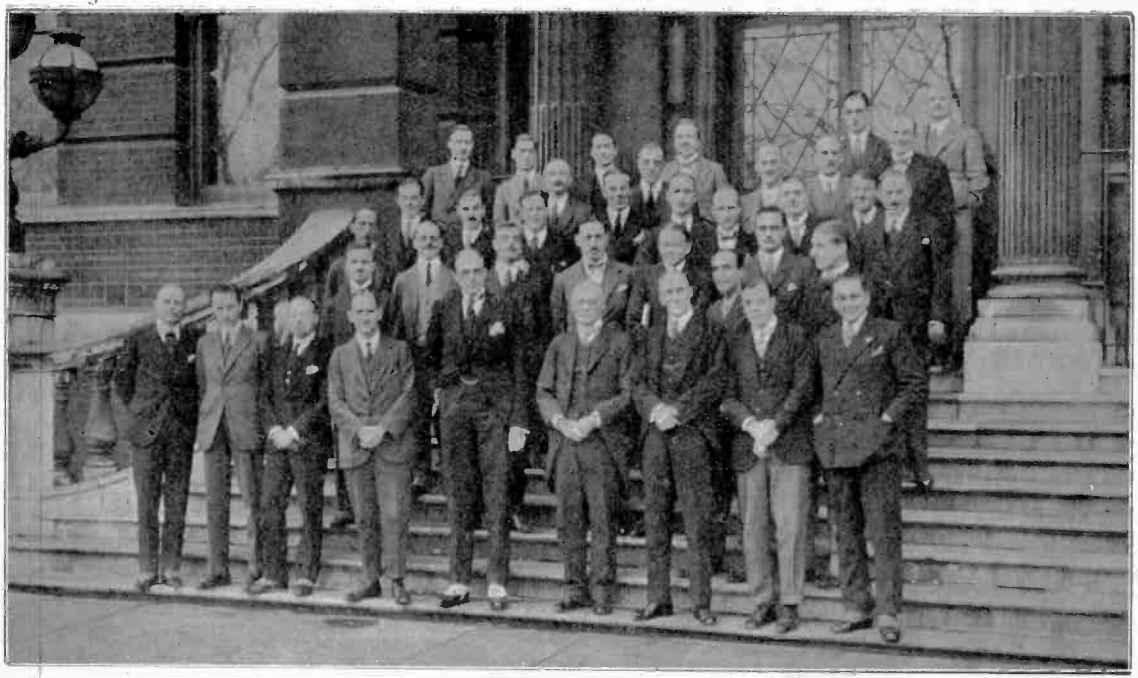

AN INTERESTING RADIO GROUP

A group of Directors and Station Directors photographed at Savoy Hill. In the front row are George Grossmith (Adviser) Mr. J. C. Reith (General Manager); Lord Gainford (Chairman); Capt. P. P. Eckersley (Chief Engineer); Mr. Percy Edgar (Director of Birmingham Station).

THE
RADIO YEAR BOOK

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1926 (Fourth Year)

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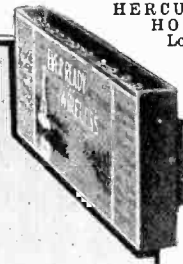

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FOREWORD

A MESSAGE FROM LORD GAINFORD

THE value of broadcasting from a national point of view is now almost taken for granted, and the significance of its international aspect is occupying the minds of thinking people. To-day everyone acknowledges the power of wireless as a barrier-breaker between town and country, province and capital, rich and poor; but men are alive to a more extended field of influence, wherein radio is helping to further the cause of tolerance and peace between nations. Listeners all over the world have recently been enabled to hear programmes of other countries and the utterances of world statesmen at Geneva, and through the ministry of wireless they can better understand and appreciate each other's view-points, and realize the essential kinship of all European peoples in music and other arts.

This widened scope and the steady perfecting of the technical and educational side of the B.B.C.'s work, make us justifiably proud of the past year's record, and keenly hopeful for what the future may yet hold in store.

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PREFACE

TO THE 1926 EDITION

ONE of the most important developments in broadcasting which will take place during 1926 will be the decision of the Government with regard to the future of the British Broadcasting Company. It is impossible at present to forecast with any pretence of accuracy what this decision will be, but there can be no doubt that the interests of the three parties most concerned, viz., the holders of broadcast licences, the British Broadcasting Company, and the Government are all receiving due consideration by the Special Committee which has been appointed for this purpose, and to which reference is made on page 18 of the YEAR BOOK. We feel sure that we shall not be accused of partisanship when we venture the opinion that much excellent work has been done by the B.B.C. during the past year, both as regards the engineering side and in the way of improved programmes.

With regard to the latter, we are in a position which enables us to appreciate very keenly the great difficulty of selecting programmes which will suit the greatest number of people. The compiling of the present YEAR BOOK has many points of similarity. We, also, have to make up our "programme" so that it will interest every broadcast listener. Most listeners will, we think, find many items of interest amongst the photographs which appear between pages 6 and 48. Mr. Thorne Baker's popular article on "Seeing by Wireless" is another feature which will make a very wide appeal. The section on the Children's Corner, which has been specially contributed by the B.B.C., contains a great deal of information hitherto unpublished regarding the Aunties and Uncles at all the main stations. An article which can be read with profit by practically everyone possessing a wireless set is Dr. J. A. Fleming's article, "Amateur Aerials and Earths." This article is a delightful example of the way in which Dr. Fleming can impart practical information on a technical subject so that it can be readily appreciated by anyone who is not technically inclined.

The thanks of the Editor are due to various correspondents for their criticisms and suggestions, which have been of real use in the preparation of the present edition, although it has not in every case been possible to carry the suggestions into effect.

THE EDITOR.

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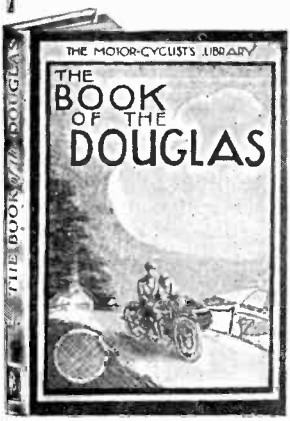

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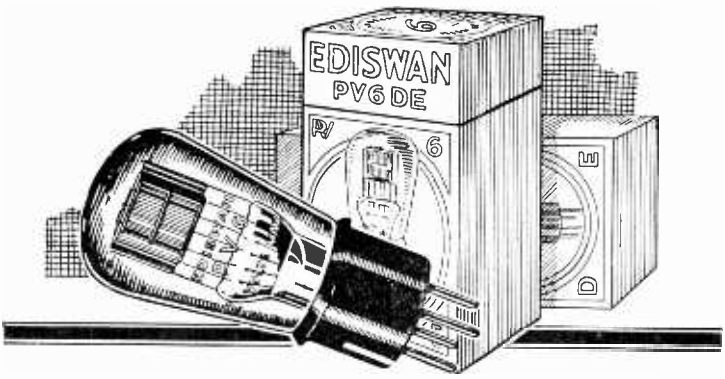

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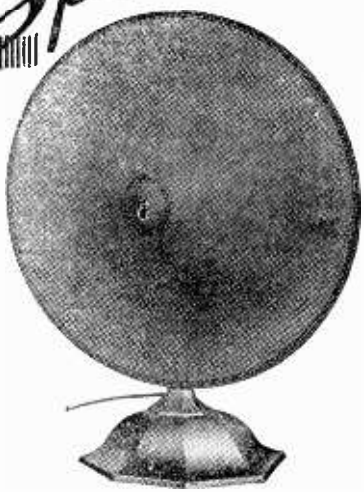

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THE

RADIO YEAR BOOK

THE BRITISH BROADCASTING COMPANY

Retrospect and Prospect

By J. C. W. REITH, A.M.I.E.E.

Managing Director of the British Broadcasting Company

Unflagging Interest.

IN complying with the invitation to make further observations on the activities and prospects of the B.B.C. from our point of view, perhaps the first thing I should remark upon is the extraordinary extent to which wireless has succeeded in holding public interest. In the early days of broadcasting in Britain,

J. C. W. REITH, A.M.I.E.E

there were many who never tired of saying that national interest in wireless would wane very soon when the novelty wore off. Broadcasting was only another " stunt," which would have its day and then rapidly go out of fashion. Those prophets have been disappointed in their predictions. Wireless is steadily becoming as much a part of the daily life of the people as the newspaper. One has not to look far to discover what has been the cause of this. First of all, continuous development has taken place on the scientific and technical side, for which credit is due not only to our own staff, but also to the experts of the wireless industry. The barrier of one month is surmounted and forgotten the next. The high-flown vision of one season is taken for granted as a realized fact within the year. This steady perfecting of the medium has kept alive the zeal of those of our friends who are more interested in reaching out and making far contacts than in receiving entertainment by radio. The maintenance of an infinite variety in our programme service has further ensured that the other section of our listening public will not flag in its interest. New and original features have continually made their appearance in the programmes, and in this sphere all our stations have played their part in contributing to the general stock of ideas.

There has been a steady increase in the number of listeners and licence holders, and the total number must now be very nearly twice what it was when the 1925 *Year Book* was produced. There has also, of course, been a considerable increase in the number of manufacturing members of the company.

New Developments.

The main event of the year has, of course, been the erection of a new high power station at Daventry, and the closing down of Chelmsford. Daventry, it has been estimated, now serves over 23 million listeners, and is an immense boon to countless crystal users. The experiments now being conducted with regard to international broadcasting will enormously extend the field for the users of more elaborate sets, and make possible the exchange of programmes between widely separated lands.

Another improvement in the transmitting service was effected this year in the construction of a distributing board at Leeds for amplifying and correcting transmissions to the northern area by land line. This has had the effect of improving greatly the quality of simultaneously broadcast transmissions for northern listeners.

Considerable changes have been effected with regard to studio accommodation at central office, new studios having been constructed for dramatic rehearsals and the giving of talks, involving the latest acoustic principles and allowing for experiment in this sphere.

The International Side.

In connection with the international aspect of broadcasting, the various visits of our officials to Geneva, the carrying out of European wavelength tests, and the two transmissions of speeches from the Assembly of the League of Nations, aroused widespread interest throughout the country. Believing in the extent of this international outlook among our listeners, we have instituted the publication of a *Radio Supplement*, which gives the Dominion and foreign programmes and editorial matter in connection with broadcasting in other countries, and we believe that the supplement meets a long-felt want.

We are happy to have been able to come to an agreement with associations of theatre managers with regard to the relaying of portions of their productions, and we look forward to further co-operation with them in the provision of good dramatic material for our listeners in a way which will not prejudice their own services.

H.M. Government have introduced a short bill dealing with the wireless service, which, on passing into law, has defined more precisely the terms of the broadcast receiving licence. They have also appointed a committee to inquire into the whole future of broadcasting. We look forward to co-operation with the committee in its inquiry into our stewardship of broadcasting in this country, as well as investigation of the possibilities of its development.

The Educational Side.

The educational side of our work has steadily increased in popular favour. We have ample evidence of the extent to which regular talks are appreciated throughout the country, and the increasing number of schools who are taking our wireless courses transmitted for school children is an encouraging omen for the future.

Looking back over the work of the year, my most encouraging reflection is on the general strengthening of public support for our ideals and standards. Ever since we began to broadcast we declined to limit our programmes to ephemeral entertainment; we took the view that this wonderful new medium should be the means not only of amusing but of instructing and guiding. There is now no doubt whatever that our policy is generally approved.

THE B.B.C. ACHIEVEMENTS IN 1925

THE record of the aims and achievements of the B.B.C., which was given by Lord Gainford, chairman of the company, at the second ordinary general meeting, epitomized the work accomplished and forms a fitting prelude to this summary of the chief events of 1925. It was in the following terms—

1. During the past year there has been an increase of 567,000 in the number of broadcast receiving licences issued throughout the country.

2. The total receipts from the Postmaster-General for licences in two years and a half to the end of March, 1925, were £666,000.

The total expenditure of the B.B.C. on programmes for the same period was £612,000.

The total receipts for the financial year ended 31st March, 1925, were £538,528.

The excess of revenue over expenditure, after deducting dividend for the same period, was approximately £79,000.

Of expenditure, 85·37 per cent was incurred on programmes, 6·38 per cent on administration, and 8·25 per cent on depreciation.

3. The dividend charge under the statutory 7½ per cent absorbed £5,172. The whole of the profits apart from this have been invested in necessary addition to plant as follows—

£59,000 of the surplus had already been spent on extension and improvements.

£50,000 was required to complete the construction of the Daventry station, and to complete payments for the Oxford Street station.

These two items alone more than absorbed £79,000 excess of revenue over expenditure which appeared in the balance sheet.

4. On a conservative basis it was estimated that ten million of the inhabitants of these islands listen to the B.B.C. programmes, either regularly or occasionally. In two years' time British broadcasting may well reach twenty million of the people of this country.

5. As regards the future, the B.B.C. has in hand plans for rapid development. In this connection, even when the number of licensed listeners increases to two millions, the income will barely secure the standard of service at which the B.B.C. is aiming in its endeavour to provide the best available services for the whole of the population of the country.

The outstanding features of the year's work are as follows—

Radio Film.

The first radio film to be screened in this country was " Charlot's Revue," which, in January last, was simultaneously enacted at the Prince of Wales' Theatre, and screened at the Shepherd's Bush Pavilion, the music being broadcast by the B.B.C. For between seven and eight minutes the audience at Shepherd's Bush saw and heard a comedy scene and a dancing and singing scene. A ten-valve set was installed in the picture theatre ; the electrician and cinema operator were provided with head 'phones and, at the right moment, the former switched in and the latter flashed the film. As an experiment, the synchronization of film and music was good, and further broadcasts of a similar nature will be attempted.

The Zoo.

With the assistance of the denizens of the Zoological Gardens, a novel broadcast was accomplished by the engineering department. The proceedings started with " Old Bill," the walrus, who gave an uproarious performance. The " Wireless Pram," a specially designed transmitter, which was pushed round the Zoo, also visited the parrot house, but the piercing shrieks of the birds required considerable modulation for broadcasting purposes. Baboons, chimpanzees, and other mammals, were included in the broadcast, which was strengthened by a talk on the peculiarities of animals and birds.

International Conference.

A conference of the leading European broadcasting authorities, convened by the B.B.C., met in London in March for the purpose of examining ways and means of co-ordinating and developing wireless broadcasting. The deliberations were of a preliminary character, but they had a definite outcome in the establishment of the Office Internationale de Radiophonie at Geneva, to perform the double function of a clearing house of information and an instrument for the adjustment of technical difficulties of an international character.

One of the most important among the early achievements of the Geneva Bureau, which is managed by Mr. A. R. Burrows, formerly Assistant Controller and Director of Programmes of the B.B.C., was a redistribution, in September, of wavelengths throughout the broadcasting stations of Europe.

On the completion of tests on the new wavelengths, an important conference was convened at Geneva, in October, to discuss the results of the experiments. The conclusions arrived at were that Europe has more broadcasting stations than can possibly be

fitted into any waveband coming within the most elastic limits which the Governments of Europe are ever likely to set aside for broadcasting purposes. In other words, Europe has more broadcast stations than can be operated freely and without interference. The matter was not officially discussed; but the feeling of many of the delegates was that instead of having a large number of comparatively low-power stations, Europe will in the future have fewer and more powerful transmitters, that each station will have its separate place in the waveband and that there shall be no duplication of wavelengths.

Meanwhile, the new plan adopted by the conference for allocating wavelengths to each station is based on the following considerations—

Population of a particular country.

The area of that country.

The length of time that a broadcast service has been operating.

Language difficulties (i.e. when two or more languages are spoken in one territory).

The permanent staff at Geneva was responsible for bringing the scheme into operation during November, and the Board met in December to consider the results achieved. The Board then decided that new stations should be given positions below 200 metres, thereby avoiding the infliction of any hardship on existing stations. In this respect the new Dublin station was very fortunate, as the British representative at the Geneva Conference was able to arrange a position for the first station in the Irish Free State inside the coveted part of the waveband.

Railway Broadcast.

A broadcast of particular interest was carried out in June, when conversation and train noises were transmitted to listeners from the footplate of the Scottish express which left King's Cross on that evening. Prior to the departure of the train, one minute's transmission of the characteristic noises at a busy terminus such as King's Cross was followed by a light comedy sketch and three cameos illustrating the progress of travel. One item was a scene in George Stephenson's workshop, where "Locomotion No. 1"—the first engine to draw a passenger train—was constructed. When the engine was ready for service, the hiss of steam was replaced by the sound of the opening of the throttle, the beat of the pistons and the cheers of the assembled crowd as "Locomotion No. 1" set out on its journey, as not only the first passenger train on the old Stockton and Darlington Railway, but also as the first passenger railway train in the world.

The broadcast up to that point had taken place from one of the platforms and the station yard; the B.B.C. then switched over

to the platform whence the Aberdeen express steamed out at 8.25 p.m.

The arrangements from the train were of a novel character, as nothing of the kind had previously been done in this country. Captain Eckersley's reference to the achievement in another page is therefore worth amplifying as briefly as possible. The method employed was a mixture of wireless and wired wireless. The railway company provided a brake van in which to house the train transmitter, which consisted of a choke control telephony set of low power, working entirely off batteries. The aerial (three wires) was run eighteen inches above the roof of the van, and the earth was made to the two bogies of the van and also to the tender and engine. The microphone, which was of an improved carbon type, was suspended by means of rubber bands, to avoid vibration, on the side of the cab, thus enabling the B.B.C. announcer and an official of the railway, who were on the footplate of the Pacific type engine, to conduct a dialogue about the journey, with the noise of the engine as a background.

As regards the receiver, a single wire was chosen from the group of line-side telegraph wires between Potter's Bar and Hitchin. This wire was cut at each end, tapped at Hatfield Station and connected to a loose-coupled wireless receiving set, which comprised several stages of high-frequency detector and two low-frequency valve amplifiers. The transmission, therefore, consisted mainly of wired wireless along this wire, the connection on to the wire being made by a kind of inductive effect from the aerial on the train. The sounds picked up on this wire were transferred over Post Office land lines to 2 Savoy Hill, and then radiated from all stations.

Audience in Studios.

"A public broadcasting studio" is an apt description of a new idea which germinated early in the year for the establishment of psychological contact, not only between artist and audience, but between listener and listener. The aim was to arouse the listener in his home to a consciousness of the response of the audience in a public hall to a broadcast performance. It was recognized that the environment of the studio, with its almost ominous atmosphere of silence and desolation, militated against an artist's best efforts. An arrangement for broadcasting from King George's Hall, London, was, therefore, made, and the public were admitted on several occasions, as they had been to the symphony concerts at Covent Garden Opera House, and the Central Hall, Westminster. Further, for programmes like the "Radio Radiance" revues and the musical extravaganza, "Winners," a certain

number of visitors were allowed to occupy seats in the studio, both to hear and witness the performances.

New 2LO.

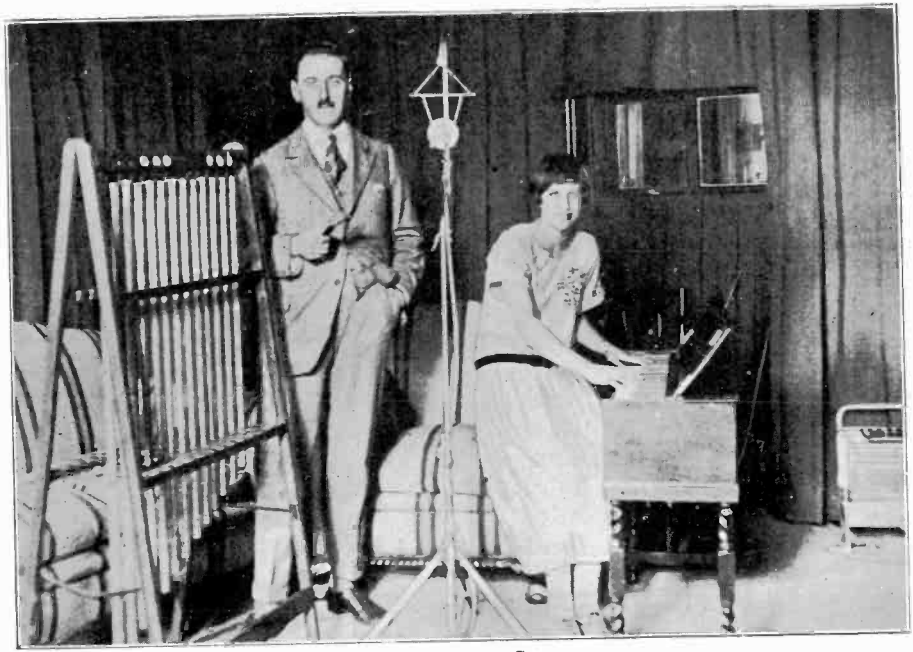
The transference of the 2LO transmitter from Marconi House to Oxford Street was accomplished on 6th April, when the input power of the transmitter was raised to three kilowatts to the anodes of the oscillators, that is, twice the power previously employed at London and the other main stations. The set was specially built, and is in effect equivalent to two main station

FIG. 1.—MR. ALAN COBHAM GIVING A LESSON IN FLYING

transmitters run in parallel. Its effective crystal range is twenty-five miles, whereas previously the crystal range of 2LO was approximately seventeen miles. The immediate effect of the change-over was to increase the strength of the signals in the London area as far as 90 per cent of listeners were concerned.

Flying Lesson.

Instruction and entertainment were combined in a flying lesson broadcast by Mr. Alan Cobham in May. The airman instructed his pupil, who, for this occasion, was Miss Heather Thatcher, in every problem of aeroplane management, his words being transmitted from the aeroplane by wireless to a receiver on the ground, whence they were relayed by land-line to 2LO to be broadcast. The noises connected with the "taking off" of the aeroplane and its landing after the flight, were included in the broadcast.



EDINBURGH RELAY STATION

A. L. Marshall (Director and Uncle Loslie) and Miss Muriel A. Taylor (Aunt Muriel).

Auction Sale.

Listeners were provided with a broadcast auction in May, when the proceedings at the sale of Messrs. Christie's auction rooms in St. James's, London, of pictures belonging to Almina, Countess of Carnarvon, were transmitted. The microphone was placed on the auctioneer's rostrum and the progress of the bidding for the art treasures which were offered, which included a famous Gainsborough, were relayed to 2LO.

FIG. 2.—MISS BEATRICE HARRISON PERSUADING THE NIGHTINGALE TO SING FOR THE MICROPHONE

Nightingale.

The broadcasting of the song of the nightingale, for which the arrangements were rather more elaborate than in 1924, was not an unqualified success on the occasion of the first attempt of the season, on 31st May. This was not surprising ; for the nightingale, as all bird lovers know, does not incline to song on a cold and blustering night ; and all that listeners could hear, besides the soft playing of Miss Beatrice Harrison's 'cello in the beautiful garden at Oxted, was a roaring in the headphones, which told of a gusty night and the effect of the wind on the microphones in Oxted Woods. At about midnight, however, Miss Harrison's 'cello was again heard in an attempt to inveigle a song. Only a faint twittering resulted, and though the engineers at Oxted let out an extra quarter of a mile of cable, and penetrated far into the woods in the pursuit of the elusive songster, the expedition was not successful. Another attempt in June, when the weather

was more favourable, met with fair success and a three minutes' broadcast of the nightingale's song was obtained.

Aldershot Tattoo.

The Aldershot Searchlight Tattoo broadcast was carried out successfully, although, owing to a chapter of accidents, it was not executed according to plan. On the way down from London, the van containing the gear was delayed through a mishap and did not arrive at Aldershot until the first part of the performance was over. In the ordinary course it would, therefore, have been

FIG. 3.—THE ENGINEERS PREPARING FOR BROADCASTING THE NIGHTINGALE.

possible to broadcast only the second part at 11.30 p.m. Fortunately, however, the engineer in charge, who was already on the scene, happened to have left at Aldershot apparatus used three days earlier, during a rehearsal. This apparatus consisted of an amplifier with a microphone over two years old—the very first of its type made, with batteries half run down and no spare valves. There was not even a pair of telephones with which to listen to the music, nor a portable telephone set with which to maintain communication with London. The local post office engineers came to the rescue with a pair of head telephones and a portable set such as the telephone maintenance men use for tapping the lines. By using an overcoat rolled up on which to rest the microphone, and butter instead of the usual vaseline to fix the microphone coil on the microphone, and connecting up with odd pieces of wire, the apparatus was hastily lashed together and got

into position in the arena. The head telephones, which were hurriedly fetched by a boy scout from Aldershot town, three miles away, were not received until after the first item had been transmitted, so that the only check that the engineers had that the apparatus was functioning properly was by telephoning to Savoy Hill and inquiring whether the music was being received satisfactorily. As regards the placing of the microphones, when the proper apparatus finally turned up, a second microphone was brought into service and carried on along with the antiquated instrument, which had survived the first part of the programme satisfactorily. These microphones were run out into the arena at the end of long lead-covered cables, which had to be placed in position and hauled back as opportunity occurred in the pauses between the evolutions of the troops.

R.A.F. Display at Hendon.

The Royal Air Force Display at Hendon may be mentioned in this story of the year's broadcasting activities ; although, unfortunately, the proposed broadcast of part of the proceedings has to be classed among the several disappointments which the B.B.C. engineers have had to contend with during the past year. Arrangements were made for a complete squadron to be put through various evolutions by the commanding officer flying with his squadron. His words of command were to be received by the pilot of each aeroplane on his R/T set ; and to enable the public to hear those orders, they were to be broadcast, as well as the orders given from the ground to the O.C. squadron. The object of broadcasting was to demonstrate to listeners the difficulties of intercommunication by voice between the machines, with the noise of the engines dominating everything. The organization for the broadcast was complete and highly satisfactory results were obtained at the exhaustive preliminary trials. But the broadcast, after the first command had been given, which listeners heard perfectly, was almost completely blotted out owing to an extremely powerful heterodyne. The interference was believed to be deliberate. The incident was the more regrettable, as the R.A.F. had previously announced the wavelength which was used, and had issued an appeal to the public to refrain from interference on it.

Relay Stations.

The relay stations have taken a prominent part in the broadcasting of events which are rather outside the normal programme items, and it fell to the lot of Plymouth to be the first station to bring the sound of the sea to the listener's home. In the early summer, a microphone was placed on the beach in Bovisand Bay,

about four miles from Plymouth on the eastern extremity of the breakwater—in Plymouth Sound, and the noise of the waves was broadcast from all stations. Plymouth, in common with other stations, has two lines to London. On one, the station was taking the London programme, and on the other, which is normally used as a control line, the sea was brought to London. It is a remarkable fact, therefore, that the sounds of the sea at Plymouth went to London and back again to Plymouth before they were actually broadcast from the Plymouth aerial. The sea was " on tap " for the use of London's broadcast for a considerable period, as it was needed at varying times throughout a two hours' programme.

Agreement with Theatres.

An agreement in respect of stage performances was entered into in June between the B.B.C. and the entertainment industry, as represented by the Society of West End Theatre Managers, Limited, the Theatrical Managers' Association, Limited, the Entertainments Protection Association, Limited, and the Provincial Entertainments Proprietors' and Managers' Association, Limited. The heads of the agreement may be summarized as follows—

1. The entertainment associations to endeavour to secure the co-operation of the entertainment industry generally with the Broadcasting Company. They object to any attempted ban on plays, excerpts from which have been broadcast, and do not object to artists being employed for ordinary broadcasting when such artists are not precluded by the conditions of any contract existing at the time of the proposed broadcast.

2. To secure effective co-operation by means of a regular and harmonious interchange of opinions, a committee of six to be established—four members representing the entertainment associations, and two the British Broadcasting Company—and an arbitrator to be appointed should any serious difference of opinion arise.

3. The British Broadcasting Company may broadcast up to twenty-six excerpts from stage performances per annum, if possible at fortnightly intervals, and not more than once in any one week, but repertory grand opera and performances coming under this category as understood, shall not be included in this undertaking. In the event of broadcasting such repertory operas twice in any one week, in that week there shall be no stage broadcast.

4. No first night performances to be broadcast and the British Broadcasting Company to arrange that, as far as possible, Fridays and Saturdays shall be the only nights in the week when stage

broadcasts shall take place and the duration of these excerpts shall not normally exceed thirty minutes.

5. No cabaret performances to be broadcast during theatre hours.

6. The British Broadcasting Company to give preference to members of the associations, without committing itself to exclude all theatres not so associated, and negotiation on all points of detail, including the question of payment, if any, to take place between the British Broadcasting Company and the individual managers. Managers are entitled to decline to broadcast and, similarly, the British Broadcasting Company may decline any excerpts offered.

7. The British Broadcasting Company not to present from its studios, plays touring the provinces during the first twelve months of a tour, unless by agreement, and to endeavour to exclude the broadcasting of excerpts of plays actually being performed on the stage from being relayed to towns where such plays are running, or are expected to come in the near future.

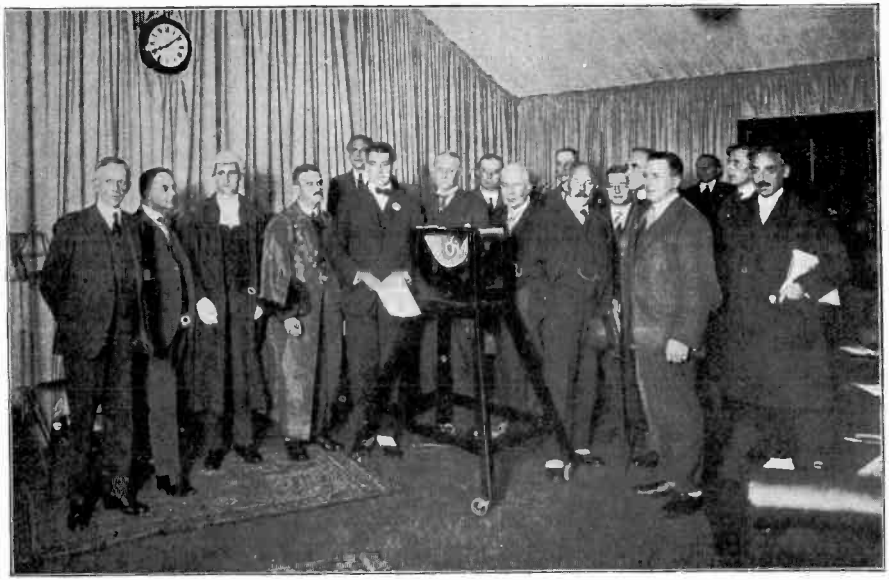
8. The arrangement is in force until 31st December, 1926.

"H.M.S. President."

"An Hour in a King's Ship" was a memorable relay from H.M.S. President, the headquarters of the London Division of the Royal Naval Volunteer Reserve, to 2LO. Three microphones and a hydrophone were installed for the "Man overboard" episode, the most thrilling of the whole broadcast. All these microphones were in operation at once, so that the confusion and medley of sounds might be reproduced. One microphone was placed on the deck to catch the sounds of the launching of the lifeboat, another was located inside the signal school, from which the crew were beaten to quarters, and a third hung over the side to pick up the sounds on the water, while the hydrophone hung beneath the surface of the river to reproduce the under-water noises. An unrehearsed incident, which bade fair to wreck the transmission, occurred during this episode. As the lifeboat was being lowered over the side of the "President," one of the microphones was struck and damaged; but the engineer in charge carried on, and the broadcast was completed successfully.

Daventry.

The opening of Daventry, on 27th July, as the permanent high-power station, referred to in the article on "B.B.C. Feats of Wireless Engineering During 1925," marked the opening phase in the development of the international era of broadcasting. A few days before 5XX was brought into service, conferences had been



GROUP TAKEN AT OPENING OF DAVENTRY STATION

held with Mr. David Sarnoff, Vice-President and General Manager of the Radio Corporation of America, then in London, who discussed with the B.B.C. a scheme for exchanging broadcast programmes with the stations belonging to the Radio Corporation. As the company had already been developing, through the International Union of Broadcasters at Geneva, comprehensive plans for an international exchange, the suggestion that an arrangement should be made with the Radio Corporation as the preliminary step in an exchange with all the leading American organizations was welcomed at the B.B.C. headquarters and a message was sent to America, through Mr. David Sarnoff, announcing that the British organization intended to set up a central receiving station for intercepting and re-transmitting to the ten million listeners in the British Isles the transatlantic programmes.

On 1st September, the B.B.C. was able to announce that its central receiving station had been established at Keston, near Hayes, Kent, on a site thirty acres in extent. At the start two masts were erected, each 60 feet high and 120 feet apart; but directional aerials for picking up the programmes of foreign broadcasting stations are being erected as required. They are of an unusual character, being very little longer than the common or garden broomstick. In conjunction with the short aerials, which will be adjusted according to the station which it is desired to receive, a high-grade selective receiving set is used, capable of picking up the most distant station with practically no " mush " or atmospherics.

Another important function of the Keston station is to discover the identity of any interference which may be causing trouble to the transmissions from any British station and to keep a check on wavelengths, so as to ensure their accuracy.

A third main use of the station is for the carrying out of experimental work of a nature which may be necessary to technical improvement. Ideas are being developed at Keston, and as their practical application is proved, they are incorporated in the apparatus used at other stations. The significance of such a station in the march of wireless science will become more obvious from month to month.

Committee on Broadcasting.

In August the Postmaster-General announced in the House of Commons the appointment of a committee " To advise as to the proper scope of the broadcasting services, and as to the management, control, and finance thereof, after the expiry of the existing licence on 31st December, 1926." The committee, which was expected to begin its deliberations as the *Year Book* was going to press, consists of the following: Earl of Crawford and Balcarres

(Chairman); Lord Rayleigh; Mr. W. Graham; Lord Blanesburgh; Mr. Ian Macpherson, M.P.; Dame Meriel Talbot; Sir Thomas Royden; Capt. Ian Fraser, M.P.; Sir Henry Hadow, and Mr. Rudyard Kipling.

Transmission from Geneva.

The opening of the League of Nations Conference in Geneva on 7th September witnessed an interesting experiment in international broadcasting. An attempt was made to transmit the opening speech of M. Painleve, and although the remarks of the French Prime Minister were intelligible only in parts to British listeners, the experiment was of considerable and immediate practical value, inasmuch as the speech of Mr. Austen Chamberlain on the following day was broadcast with greater success. These speeches had to pass over a long land line from Geneva to Paris. The technical arrangements on the Continent appear to have been efficiently conducted; nevertheless, the change over to wireless link after such lengthy land line transmission resulted in a clipping of words and considerable distortion. The wireless link from Paris worked well, despite the intervention of occasional morse from two telegraph stations near the wavelength of the Eiffel Tower.

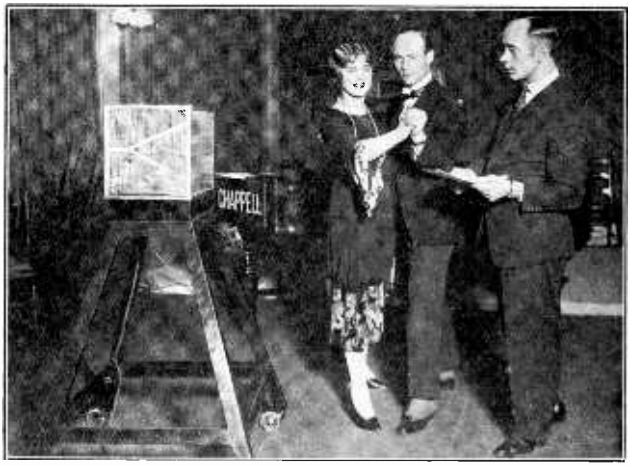
Dance Lessons.

A novel educative effort was the broadcasting of lessons in the French Tango. A dance expert first broadcast a talk on the dance, and in subsequent broadcasts he dealt with the steps in detail, and actually demonstrated his method of teaching by having a partner in the studio whom he instructed to appropriate music.

S.B. Arrangements.

Early in 1925 the simultaneous broadcast arrangements underwent considerable alteration. When broadcasting started, each station, whether main or relay, was connected to London every evening by trunk lines which were in ordinary daily and commercial use. All these lines were concentrated on a board in the control room, where an engineer was kept fully occupied in transferring his voice from Glasgow to Bournemouth and from Cardiff to Newcastle, but with a few seconds' pause between each communication. The new board, which came into operation early in the year, was fitted with signal lights—green, red, and opal—to show the simultaneous board operator what was going on. When a distant station wished to take S.B. he slipped a plug into its hole. When a relay clicked in London, a light glowed on the board and the appropriate amplifier was switched on. Automatic devices thus replaced human effort and relieved

the operator from many and varied operations. Although this method marked an important advance on that originally employed, it was by no means the last word in simultaneous broadcasting, and before many months had passed, simultaneous broadcast underwent another evolution, and a scheme for the reorganization of the land line system was brought into operation in November, when Leeds became the pivotal point for the control of all transmissions relayed between the south and the north. One of the disadvantages which the new scheme avoided was the broadcasting of, say, the Newcastle programme from Manchester,



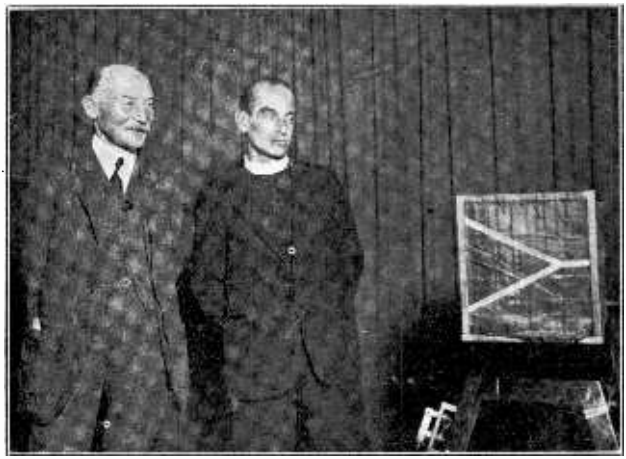
DANCING LESSON BY WIRELESS

through the agency of lines to and from London. It was an unwieldy and cumbersome method, and tended to create delays in the programmes ; whilst the quality of transmissions suffered through the use of several hundreds of miles of unnecessary land lines which produced distortion due to the impossibility of certain telephone lines to work on variable frequencies.

All stations north of Leeds are now linked up by land line to Leeds instead of to London. Between London and Leeds four special lines are set apart by the Post Office for the use of the B.B.C. Generally speaking, only one is wanted, but spares are provided for alternative programmes, control purposes, and emergency use. The arrangements at Leeds to send out the programmes or items to northern stations are much more automatic than they were from London. The engineers in the London

control room no longer feed other stations; but, instead, the stations depending on Leeds help themselves. The distant station makes its own connection to Leeds by the manipulation of a single plug, which also controls the necessary amplifying apparatus.

The chief function of Leeds as a pivotal point is to improve the quality of all the items which it receives from London to the same excellence as when they left London. Distortion and other faults are corrected, and weak signals amplified before they are passed on, with the object of providing listeners with improved



BOY SCOUT AND "WOODBINE WILLIE" AT 2LO
During the Children's Hour recently Sir Robert Baden Powell and the Rev. A. G. Studdert Kennedy broadcasted from 2LO.

reception from many local stations and of accelerating the S.B. part of the programmes.

Mine Broadcast.

For the first time in the history of wireless, a concert was broadcast from the Whitwood Collieries in Yorkshire, at the end of 1924. The programme lasted about one hour, and included a talk from the pit bottom, 1,500 feet below the surface, by a well-known North of England comedian, on his "experiences." The Whitwood Colliery Silver Prize Band also performed "bright musical selections." The programme was relayed to the Leeds-Bradford station and broadcast from there.

The Sheffield station undertook a similar adventure in June,

1925, but on that occasion the actual noises of a mine were broadcast from the Park Gate seam. The sounds transmitted included those of coal cutting, the shock borer, explosion shot, fall of coal, the filling of the tubs, the noise of the train, and signals connected with the working of the cage. This broadcast took place 750 feet below the surface.

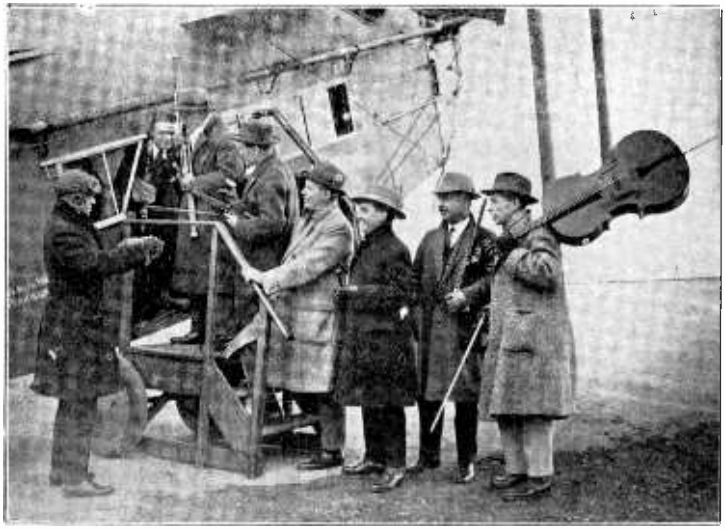
York Minster and Canterbury Cathedral.

Probably the most difficult broadcasts undertaken during the year were those from York Minster and Canterbury Cathedral. They were difficult because of the peculiar acoustic properties of

FROM THE STAGE TO THE MICROPHONE
Mr. Donald Calthrop, the well-known actor-producer, who is now on the staff of the B.B.C. He superintends the production of plays for wireless.

the buildings. The echo in York Minster, for instance, lasts for eleven seconds; not, perhaps, creating an effect which mars singing or speech in the Minster itself, but an obstacle which had to be overcome to make broadcasting successful. In the actual transmission there was no trace of the echo and the music provided by the military band, the prayers read by the Dean of York and the sermon preached by the Bishop of Lewes were received perfectly, not only in this country, but in many parts of the Continent. Microphones had been placed in several positions and, by the introduction of corrector apparatus, echo was introduced or subdued at the will of the engineers. In some churches

the Minster service was picked up and broadcast by means of loud speakers, and in private houses in York itself the broadcast was picked up from Chelmsford. Within the Minster the congregation, seated not more than thirty feet from the pulpit, were only able to catch a word here and there of the preacher's discourse ; this was partly due to the noises of the vast congregation, such as the coughs and shuffling of feet ; whereas two hundred miles away, every word was heard distinctly owing to the efficient broadcast



CONCERT IN MID-AIR
Members of the 2LO Orchestra take a trial flight in an Imperial Airways machine to get their air legs.

arrangements. For the Canterbury Cathedral service special control apparatus was again used in order to eliminate unnecessary echo. In this case also, owing to the peculiar acoustics, speech received by the microphone placed more than seven feet distant from the choir is unintelligible ; special arrangements were therefore necessary for the transmission.

The Prince of Wales' Broadcast.

Arrangements were made on 10th November for the Prince of Wales to broadcast a Poppy Day message in connection with Earl Haig's British Legion Fund. This was the second occasion

on which His Royal Highness's study in York House, St. James's Palace, had been converted temporarily into a broadcasting studio, the first occasion being October, 1922, when the Prince, from his writing desk in his study, addressed the Boy Scouts of the Kingdom. The microphone was on both these occasions connected by about four miles of telephone line through the studio at 2LO to the transmitter.

The Third Birthday.

The B.B.C. signalized the completion of its third year by special birthday programmes, broadcast throughout the week 8th–14th November. In addition to the transmission of the Prince of Wales' Poppy Day message, listeners heard the Archbishop of Canterbury preaching from Canterbury Cathedral on Armistice Day; the Prime Minister, on the occasion of the Banquet at the Guildhall on Lord Mayor's Day; Viscount Cecil of Chelwood; the Rt. Hon. Philip Snowden, M.P.; Sir Oliver Lodge, and Sir Robert Baden-Powell, among others. In the domain of music they had the Hungarian String Quartet; the pianist, Lamond; Mignon Nevada, the operatic soprano; the great violinist, Albert Sammons; the Bands of the Royal Air Force and H.M. Grenadier Guards; Lionel Tertis, the celebrated viola player; the 2LO Wireless Orchestra conducted by Sir Edward Elgar, in works of his own composition; the *Valkyries*, performed by the British National Opera Company, conducted by Mr. Albert Coates, Miss Florence Austral and Mr. Robert Parker taking principal parts. Listeners also heard John Coates, probably the greatest English tenor; Louis Fleury, the flautist; and Mrs. Gordon Woodhouse, who gave a recital on the harpsichord. In the domain of comedy were the names of George Graves, Wilkie Bard, Mark Lester, and Donald Calthrop. There was drama, grave and gay; the trial scene of Bardell *v.* Pickwick, with a cast of famous people, including Sir Edward Marshall Hall, K.C., Mr. A. S. Comyns Carr, K.C., and Mrs. Hilton Philipson, M.P.; a symbolical play by Capt. Reginald Berkeley, entitled *The White Chateau*; a radio revue by Mr. Donald Calthrop; and an excerpt from the "Co-Optimists," then playing at His Majesty's Theatre. Other novelties of the week were a Radio Military Tattoo; the broadcasting of a concert from the aeroplane *Vanguard*, which ascended from Croydon aerodrome with several well-known stage artistes, reinforced by the Savoy Orpheans. The concert which they gave was picked up by the Keston receiving station on 900 metres, and relayed to 2LO and all other stations.

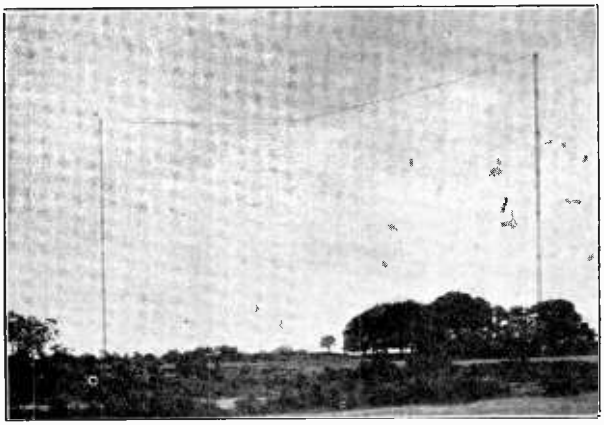
B.B.C. WIRELESS ENGINEERING DURING 1925

By P. P. Eckersley

In reading last year's *Year Book* and seeing an article on B.B.C. stunts, I am complimented by the Editor's request to write something under the above heading for *this* year.

Progress in Face of Opposition.

1925, the period under review, has revealed fewer stunts because we are finding it more and more difficult in face sometimes of real opposition, sometimes of actual physical difficulty, sometimes of necessary restriction, to do what our imagination tells us



The Daventry Aerial

requires to be done. The year 1925, at any rate, has been spent in "consolidating our position" after the advances rendered possible, when the Sykes Committee in 1923 gave us by their decisions munitions and supplies. Thus, if the year has not been spectacular, it has, at any rate, given us a chance to consolidate.

Stand-by Apparatus and Control Room Improvements.

I hesitate to put such an achievement as equipping every one of our main and relay stations with a system whereby every part is duplicated and can be fitted in times varying, at the worst, from half an hour, to the best to three minutes anew, but this is just typically one of the things that has been done.

In 1924 our control rooms were equipped with, I shudder to think, what crudities. The London control room I well remember

was simply a room to contain a number of boxes, the interior of which was lighted with pendulous valves suspended by rubber, cotton wool, and optimism. Now there are four control tables, each equipped with easily understood and easily handled amplifiers ; there are miles of wire neatly held in channel runs, so that a maximum of flexibility and ease of maintenance is achieved.

Instead, again, of the mass of batteries, high, low and grid, that usually disfigure a control room, London has begun the fashion of central battery systems, where the high tension battery has a 10 ampere hour capacity and the low tension will stand a discharge of 100 amperes. In many provincial towns lash-up apparatus, flung together in premises chosen as a nucleus to future building, has been superseded by more modern arrangements. Of all this the listener knows nothing, nor can he hear any difference between the carefully nursed amplifiers, ready to fail at any moment but for constant care, and the real engineering job that has taken its place. If he but knew how some programmes have been sent out he would be amazed, but I doubt if they were greatly different from those as received to-day.

Research for Improving Quality.

Some listeners may have appreciated an improvement in quality here and there, but so far little change has been made. For all this he knows nothing of the painstaking research which, while it may not be spectacular is nevertheless fundamental, has taken place all through this year so that we may have a knowledge to enable us to make the next great advance. No science ever advances until the personal equation is largely eliminated and measurement takes its place. To discover alone a reliable method of measurement is no easy matter, but, once discovered, it has revealed to us many important factors that stand in the way of further progress towards perfect quality. The B.B.C. development section, in close touch with the experts of member firms, has developed methods of measurement which give us data not only for improving simultaneous broadcasting and the quality of existing stations, but also of designing new sets to replace or supplement the old.

The " Wireless Pram."

Among the more spectacular, but probably less fundamental, feats that have been revealed in 1925 is the development of the " Wireless Pram." Certain outside broadcasts cannot be done unless the wire link is dispensed with. For instance, the Zoo animals cannot be led to our studios, nor can a long length of wire be trailed about the gardens. The Wireless Pram, in accomplishing a link between the animals' cages and a little fixed

receiver just outside the Zoo, enabled us both in London and in Manchester to give this broadcast.

Broadcasting from a Locomotive.

The Railway Centenary gave us a further opportunity of showing what can be done with the wireless link, for by equipping the train with wireless we were able to maintain contact between people talking in the cab of the engine drawing the " Flying Scotsman " at 80 miles an hour and our listeners in Britain, and the Continent. This experiment owed its success to combining wireless, wired wireless, ordinary wire telephony, and broadcasting.

BROADCASTING FROM LOCOMOTIVE

The train transmitter, with its fixed aerial parallel to the telephone wires, induced powerful high frequency currents in these wires, a pair of which between Potters Bar and Hitchin formed the gigantic aerial of a wireless receiver. The long aerial acted, in a sense, as a wired wireless link, the true wireless link being over the few yards separating train and " telegraph posts," as they are called. The receiver at Barnet was linked to Savoy Hill by ordinary telephone line, and from Savoy Hill further trunk lines fed each and every one of our main high power and relay stations. The transmission was interesting and something quite out of the ordinary.

The High Power Station.

The article woul l be incomplete if it did not mention how our experimental and temporary high power station at Chelmsford

was crystallized into finality on the top of Borough Hill near Daventry. When it was opened by the Postmaster-General at the end of July, 1925, this station was the largest in the world. A brief description may not be out of place as it, too, represents how during this year temporary expedients have been replaced by real engineering propositions. A building of about 120,000 cubic feet houses the power supply machines, the main transmitter, a local studio, offices, control room, battery room, and instrument room.

Power Requirements.

The power fed at 11,000 volts on an underground cable from Nottingham 12 miles distant on a ring main is transformed to 500 volts in a transformer house a few yards from the main building. The 500-volt supply with several kilowatts behind it is diverted at a switchboard to the various machines designed to convert the 500 volts A.C., 50 cycles, to the requirements of the wireless transmitter. Two 70-kilowatt motor alternators supply the high tension power. The alternators deliver power to the transformers at 1,000 volts, 300 cycles, and the transformers pass this to the rectifiers at 10,000 volts. A spare 70-kilowatt machine is available in case of breakdown, but for 25-kilowatt working (the normal power of the station) one machine would be just sufficient. For working the independent drive or oscillator a 25-kilowatt motor alternator is used, which, with its transformer, delivers to the rectifiers 10,000 volts at 300 cycles. There is one spare 25-kilowatt machine. There are no filament lighting batteries for the main equipment, so three 10-kilowatt motor generators, driven from the mains and giving 400 amps. at 20 volts each, are available—two for working and one for spare.

The wireless set, except that it is larger, differs in no fundamental respect from the transmitters used at other stations. The noteworthy points are that in order to overcome the necessity of designing the enormous speech choke otherwise required, the high tension supply to oscillator and to the controls are separate and are fed through separate windings of a transformer. By opposing the sense of windings there is no d.c. magnetization of the transformer core. Water cooled valves are used practically throughout, each valve being capable of handling a dead loss of about 5 kilowatts.

The aerial of **T** formation and 500 feet high has a calculated radiation resistance of about 7 ohms, a dead resistance of 11, and thus radiates with the 45 amperes of aerial current measured about 14 kilowatts.

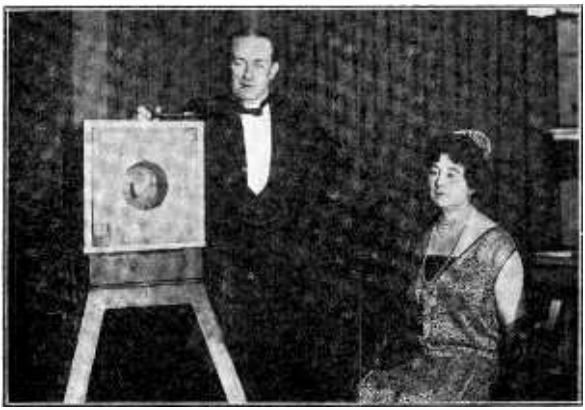
RADIO HISTORY OF 1925 IN PICTURES

In continuation of the policy started in our 1925 edition, we have collected a large number of photographs illustrating important and interesting developments which have occurred in connection with broadcasting during the past year.

Notabilities Before the Microphone.

Mr. Baldwin

Mr. Stanley Baldwin, with his wife and celebrated pipe, is shown in the first picture. This photograph was taken on the



Mr. Stanley Baldwin with his Wife before the Microphone

occasion when the Premier appealed from 2LO for funds for a club for working girls.

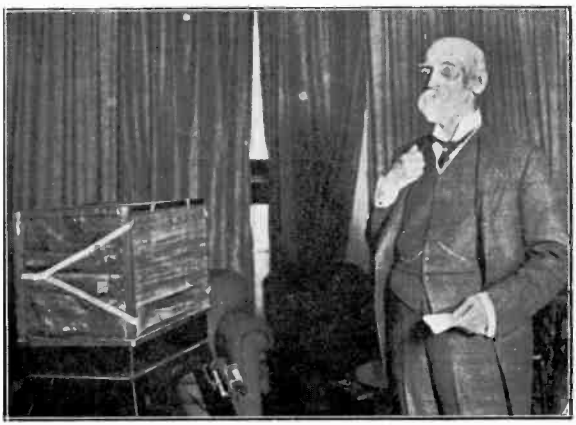
Mr. Ramsay MacDonald

The next picture shows Mr. J. Ramsay MacDonald M.P., giving his talk on the subject of " Open Diplomacy."

It will be noticed that the microphone is enclosed in a fabric case shaped rather like a biscuit tin. It may be remarked in passing that the whole atmosphere of the studio is kept as cheerful as possible, all unsightly wires and apparatus being carefully concealed.

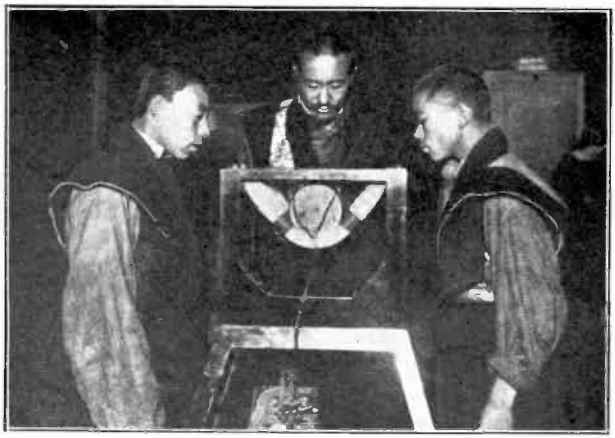
MR. RAMSAY MACDONALD, M.P.

Next, we have a picture showing the founder of Empire Day, namely, the Earl of Meath, making a speech to all stations from 2LO on Empire Day, 1925.



THE EARL OF MEATH

The next picture shows the Tibetan priests who were with the Mount Everest Expedition and who recently visited London.

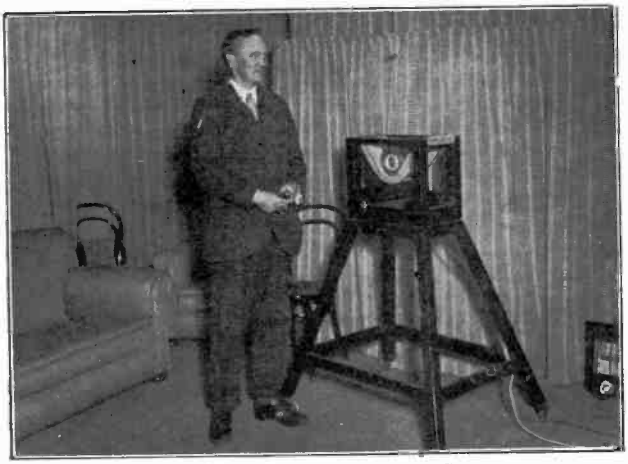


TIBETAN PRIESTS

Their visit to the studio of 2LO formed one of their most interesting experiences. It will be remembered that on this occasion they broadcast several Tibetan chants and instrumental music.

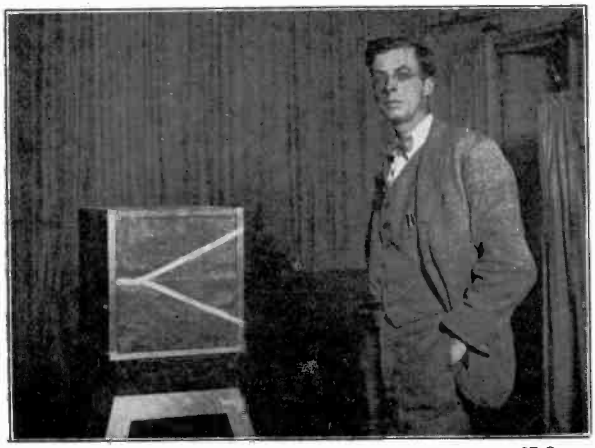
MISS LILIAN BRAITHWAITE

Above is shown a picture of Miss Lilian Braithwaite broadcasting her appeal on behalf of the "Elizabeth Garrett Anderson Hospital Extension."

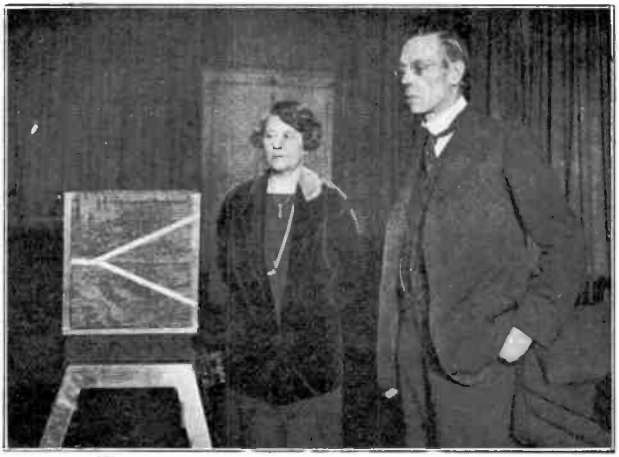


FIRST UNIVERSITY BROADCASTING STATION

At Oxford, the B.B.C. new station, the first University broadcast station in this country, was opened by Dr. A. D. Lindsay, Master of Balliol College. The picture shows Dr. A. D. Lindsay at the microphone.

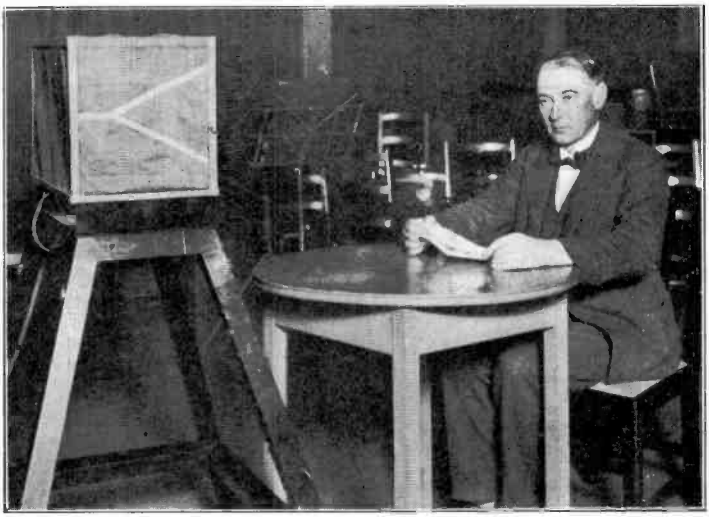


PROFESSOR JULIAN HUXLEY BROADCASTING FROM 2LO



WORK OF THE FOOD COUNCIL BY WIRELESS
WILL IT BECOME A HOUSEWIVES' TRADE UNION ?

Lord Bradbury, accompanied by Lady Bradbury, broadcasted from 2LO on "The Work of the Food Council," of which he is Chairman. Lord and Lady Bradbury at the microphone.



FRENCH LESSON BY WIRELESS

Monsieur Stephan, who broadcasts lessons in French from 2LO

Few readers of the Year Book will need to be told that the next picture shows the celebrated pianist, Paderewski, in characteristic study, at the piano in the studio of 2LO.

PADEREWSKI

The privilege of listening to such a master of pianoforte playing is one which was very highly appreciated by listeners-in all over the country.

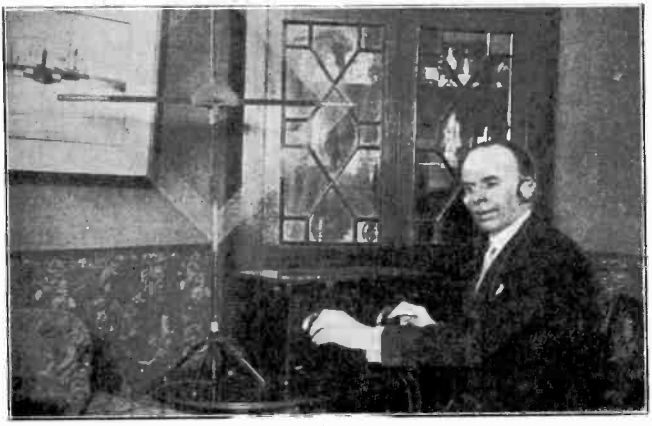
The next picture shows Mademoiselle Lenglen broadcasting her tennis talk from 2LO.

MDLLE. LENGLEN

The next picture shows our old friend, John Henry, with his " better half," Blossom, giving their impressions of London from an aeroplane. The impressions were broadcast from all stations,

JOHN HENRY

and were listened to with considerable interest and amusement all over the British Isles.

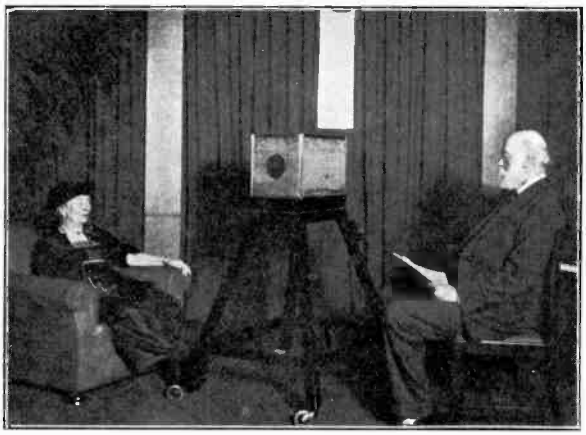


GEORGE GROSSMITH

Mr. George Grossmith, who was recently appointed Advisory Director of Programmes of the B.B.C., is here seen listening-in on his own set which is equipped with a frame aerial.

WELL-KNOWN PEOPLE WHO HAVE BROADCAST DURING 1925

Sir Oliver Lodge is here seen giving one of his talks on wireless which were broadcast from all stations. Lady Lodge is seen on the left of the picture.

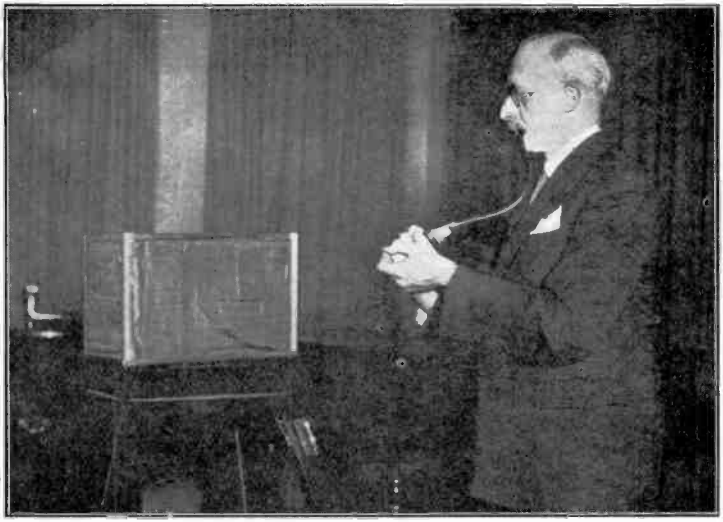


SIR OLIVER AND LADY LODGE

MR. A. E. R. GILLIGAN

Mr. A. E. R. Gilligan, Captain of the English Cricket Team, is here seen broadcasting from 2LO his story of the cricket tour.

TRANSMITTING THE LATE QUEEN ALEXANDRA'S PORTRAIT
The apparatus at Radio House which was used to send across to America the portrait of the late Queen Alexandra.



SIR RICHARD PAGET, BT.
Using the laryngaphone for reproducing the sounds of the human voice.

SOME CELEBRATED ARTISTES

MUSIC lovers will not be likely to forget the occasion on which Madame Tetrazzini broadcast from 2LO. The great prima donna is here seen before the microphone with Mr. Percy Pitt, the famous conductor.

MADAME TETRAZZINI AND MR. PERCY PITT

THE 2LO ORCHESTRA

Mr. Dan Godfrey is shown conducting the 2LO orchestra.

Sir Alexander Mackenzie, of the Royal Academy of Music, is here shown conducting a wireless concert of his own works.

Sir Alexander Mackenzie of the Royal Academy of Music

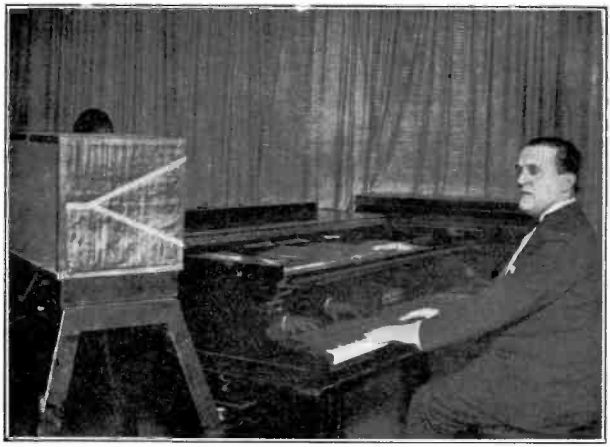
THE LIGHTER SIDE

Our next picture shows the " Radio Radiances," who recently broadcast from 2LO their first musical revue. The pit-pat of the dancing could plainly be heard by listeners-in, but up to now most people have only been able to imagine the charm and grace which, as can be seen from the accompanying photograph, is possessed by all the " Radiances."

The Radio Radiances

FAREWELL BY WIRELESS

From 2LO Norah Blaney and Gwen Farrar, the famous duettists, gave their farewell performance to listeners all over Great Britain, prior to their departure for America.
Norah Blaney at piano and Gwen Farrar making noises into microphone.



DAREWSKI ON THE WIRES

Max Darewski at 2LO plays his own pieces to thousands of listeners.

SOME POPULAR BROADCAST ARTISTES

In the following pages are given some photographs and sketches illustrating many of the artistes whose voices or instrumental music are familiar to broadcast listeners.

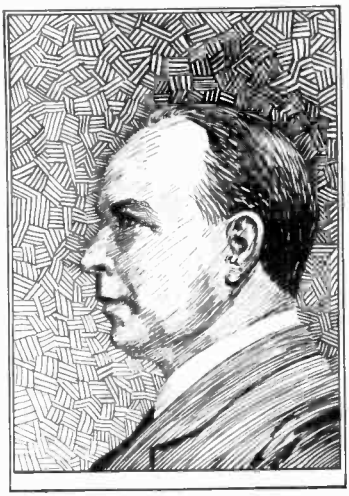
The Gresham Singers (*His Master's Voice.*)

As "seeing by wireless" is not yet an accomplished fact, at least commercially, no doubt many of our readers will find this collection of pictures of considerable use and of recurrent interest during 1926.

ROBERT RADFORD

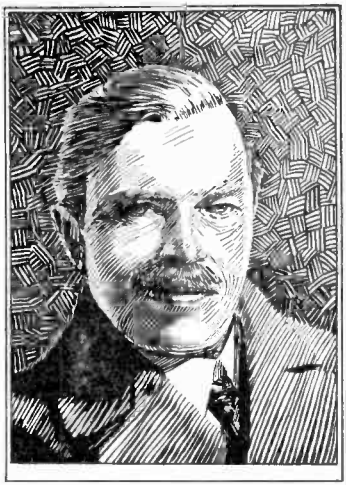
LADDIE CLIFF

MAURICE COLE



JOHN COATES

HAROLD SAMUEL



SAPELNIKOFF

DE GROOT

The conductor of the Piccadilly Orchestra will need no introduction to broadcast listeners. The above is from a recent photograph received from Mr. de Groot.

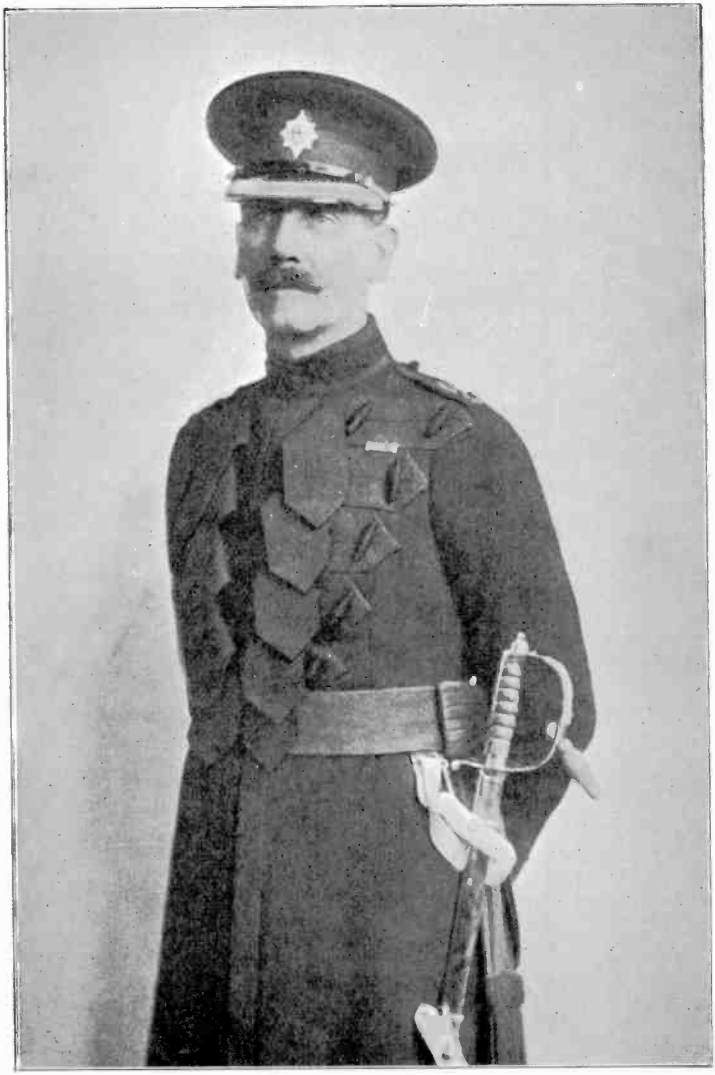
PEGGY COCHRANE

IRENE SCHARRER

MARJORIE HAYWARD

PHYLLIS LETT

The original sketches of the above may be purchased from the Publishers, Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2.

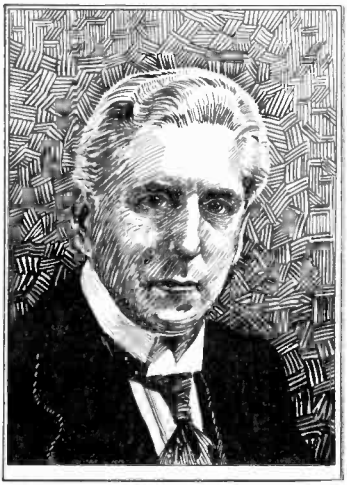


LIEUT. R. G. EVANS
Director of Music, Coldstream Guards.

ALBERT SAMMONS

WILLIE ROUSE

ROY HENDERSON



HORACE STEVENS

ELSIE SUDDABY

WILLIAM PRIMROSE

BRANSBY WILLIAMS

Broadcasts from 2LO before departing for his American tour.

THE WIRELESS LEAGUE

A Notable Movement

It invariably happens that when a new movement springs into being the need is found of some form of voluntary association to control or direct or support its activities. So at the outset of the motoring movement the Royal Automobile Club came into existence, and later the Automobile Association. So now the Wireless League has come to life—obviously not to control the various forms of wireless activity which have suddenly developed as by enchantment—but to support them by all the means in its power and to ensure that they shall serve the highest interests of the community, and indeed, of the whole world.

The first idea of the formation of the Wireless League was conceived in the very able brains of those men who direct the *Daily Express*. They brought their new baby into the world with the flourish of trumpets which should rightly attend the birth of an infant destined to such an exalted and interesting career, and they proclaimed to wireless listeners with justifiable pride its wonderful progress in its cradle.

In the early days of motoring it was necessary for the few motorists to bind themselves together in defence against a hostile public. That was the tie that held the Royal Automobile Club together in the first few years from 1898. Such is not the case with the Wireless League, because they have no enemies. They are hurting no one and every one is on their side. But there are dangers nevertheless, and for that reason it is well to lay down at the outset the outlines of the policy it is intended to pursue. These are as follows—

1. To perpetuate, consolidate, and extend the public service character of broadcasting in the British Isles, and with that object to support centralized executive control.

2. To exercise increasing vigilance to protect broadcasting from any lowering of its standards and ideals.

3. To safeguard the essential public service against any demand for broadcasting facilities, the granting of which would endanger Imperial Defence.

4. To maintain the use of wireless broadcasting for educational as well as entertainment purposes.

5. To assist broadcast listeners in their efforts to secure efficient reception.

6. To bring to the notice of the broadcasting authorities such criticisms as may seem to be constructive, and generally to act as a link between the listening public and the authorities.

7. Generally to do all such things as are conducive to the efficiency of the service and the interests of listeners.

In these days children grow up very quickly and the time soon came for the infant to stand on its own legs. That was the time at which the child was handed over to Sir Arthur Stanley, who became the Chairman of the Wireless League.

The first step was to form a provisional committee. Help was required in many different ways and the committee was formed with that object in view. It consisted of the following—

Sir Arthur Stanley (Chairman), G.B.E., C.B., M.V.O.
Sir Lawrence Weaver (Vice-Chairman). K.B.E.
Lord Montagu of Beaulieu.
Sir Ernest Hodder-Williams. C.V.O.
Sir Frederick Radcliffe.
Sir Frederick Wise, M.P.
Sir Landon Ronald, F.G.S.M.
Sir Harry Brittain, K.B.E., M.P.
Sir Walter Windham.
Major Evelyn Wrench.
Major L. Hore-Belisha. M.P.
Mr. C. G. Ammon, M.P.
Mr. H. W. Lonsdale (Market Harboro).
Mr. H. Munro Nelson (Bristol).
Mr. H. Y. Richardson (Newcastle-on-Tyne).
Mr. J. E. Kemp (Manchester).
The Rev. Tildsley (London. Forest Gate).

It will be seen that excellent representation was secured in the House of Lords and the House of Commons. The League was also well represented in the musical world by Sir Landon Ronald; in the publishing world by Sir Ernest Hodder-Williams, and generally in every direction likely to be interested in the objects of the Wireless League. Satisfactory representation from provincial branches of the Wireless League was also secured.

The services of Professor A. M. Low, who is well known to all wireless enthusiasts, were secured as technical adviser. and the finances will be looked after by those who watched so carefully and so successfully over the £22,000,000 raised by the British Red Cross and Order of St. John during the Great War.

Up to the time of writing over 150 branches have been formed in the United Kingdom and Ireland, and in order to decentralize the work at headquarters as much as possible, the country has been divided into fourteen areas as follows—

London County	Midlands	Northern
South Coast	South Midlands	Scotland
Home Counties	North Midlands	Wales
Western	Yorkshire	Ireland
East Coast	Lancashire and Cheshire	

the branches in each of which form an area committee.

These committees in their turn elect delegates to the General Council, which is the governing body of the League.

The first meeting of the General Council was held in London at the R.A.C. on the 2nd October last when the Executive Committee, and such sub-committees as are necessary, including technical, legal, and rules and constitution committees were elected.

The General Council want to make the Wireless League of real use to its members. It is generally felt that an association of this kind is required, but when one is asked "What are you going to do?" it is rather difficult to answer. One thing that has been arranged is free insurance for members. Third party claims are covered; damage to set due to lightning or any other cause up to a total of £30. Many claims have already been made and have been satisfactorily dealt with. Another is free legal defence. It is hoped that this will not be necessary in the case of many members, as it is an expensive item, and it must be clearly understood that this legal defence is only in respect of litigation arising out of their use of wireless apparatus. The Wireless League has already been able to help several of its members who were in difficulties of various sorts.

Then there is a new item, the granting of certificates to wireless repairers. The whole wireless industry is of very recent growth, and as a result there are a good number of people setting up as wireless experts and repairers who know very little indeed about their job. For the protection of members the qualifications of repairers will be inquired into and a certificate will be given to those who can show that they are properly qualified to carry out the work.

Now the League is settling down to carry out its programme, and all that is required to assure success is a large membership. If the subscription is to be kept at a very low rate of 2s. a year and the above-mentioned advantages given, and others that will undoubtedly occur, the League ought to have 200,000 members at the very least. If all who read this article will help by applying to the Head Office at Chandos House, Palmer Street, Victoria Street, S.W.1, the numbers will very soon be obtained and the League will be able to extend its operations.

SEEING BY WIRELESS

By T. Thorne Baker, F.Inst.P., F.R.P.S.

Radio-television, or transmitting visual images by wireless, may be easily placed amongst the most fascinating problems that are being attacked by science to-day.

To be able to converse with, and at the same time see, some person hundreds of miles away is—for all practical purposes—to annihilate space, and it is not surprising to find that efforts are being made in many directions to accomplish such a result.

On grounds of economy the problem has now resolved itself into one very much akin to kinematography. We have seen how a picture or photograph can be transmitted by wireless. Suppose the picture to be that falling upon the focusing screen of a very large camera, and that as many consecutive pictures a second of that image could be telegraphed by radio as are taken in a motion picture record, and could be thrown upon a similar screen after reception by the distant apparatus. Here we have an ideal system of television that would enable us to watch in our own home a race meeting or regatta, etc., taking place hundreds of miles, possibly thousands of miles, away.

The Present Position.

Our purpose on the present occasion is to see just what obstacles remain in the path of progress in this direction, and to what extent they are being overcome. Two stepping-stones towards a solution have been shown this year which may be placed on record. One is chiefly of historical interest, and is the demonstration given at the Royal Institution by the writer of an apparatus with which simple images, such as figures and letters, could be flashed on to a distant screen by means of a mosaic screen of selenium, or photo-electric, cells. The other is the far more practical demonstration of Mr. Baird, with whose apparatus something in the nature of a real solution of the problem has been accomplished.

It is necessary, in order to grasp the nature of the problem, to realize that a picture cannot be translated *en bloc*, i.e. it *must* be dissected up into many thousands of tiny pieces or units, and each one of these *must* be transmitted by a radio signal of corresponding value in an extremely correct sequence. A telegram containing the words " Come to-day " could be split up into nine letters and one space, or twenty-three Morse signals. By receiving this number of signals, the distant telegraph operator could reconstitute the message and see it plainly.

Problems to be Solved.

Now take the case of a photograph, a very simple portrait, the face alone. How many signals or code units would be required to telegraph a comprehensible facsimile of it? The photo-engraver will tell you that in a coarse half-tone image

MR. T. THORNE BAKER, F.INST.P., F.R.P.S.

such a face could be made recognizable with about 2,000 dots, representing a photograph $1\frac{1}{8} \times \frac{3}{4}$ in. in size, and made with a "50-line" screen (the latter breaks up every square inch of picture into 50×50, or 2,500 half-tone dots).

To see an apparently sustained image with the kinematograph, we know that some sixteen pictures a second must be thrown upon

the screen. Hence for a living, and therefore moving, object to be transmitted by a television apparatus the latter must be capable of radiating and receiving at least 16 × 2,000, or 32,000 distinct signals per second. To "see" a race or a landscape would involve millions of signals a second.

If we resolved the image of the face into the 2,000 units of different brightness, and used 2,000 telegraph lines to connect the sending and receiving apparatus, one line for each unit, the problem would be much simpler. This was, actually, the way in which Professor Ernst Rühmer first tried to solve the problem about a score of years ago.

Practicable But Too Expensive.

Imagine a mosaic "screen" made up of the 2,000 light-sensitive cells, on which the image of the face to be seen at a distance was projected by a lens. Each cell or unit of the screen would thus be illuminated by a bundle of light rays, the intensity of which would be proportional to the brightness of that part of the image from which they emanated. As the resistance of selenium varies in proportion to the amount of light illuminating it, an electric current passed through a cell will be greater the greater the light falling upon the cell, and vice versa. Now imagine further 2,000 currents, each passed through one of the cells forming the mosaic, and we can see these currents collectively carrying the image of the face converted for the moment into electricity.

Suppose, now, that we have a screen at the receiving end, built up of 2,000 small pieces of ground glass, say ¼ in. square, with a tiny electric lamp behind each, and that each selenium cell of the transmitting device is connected, via a suitable battery, with its corresponding lamp. The current supplying this lamp and the light given by the lamp will thus depend on the amount of light falling upon its corresponding cell. The net result will be that each one of the 2,000 lamps will be illuminated with a brightness proportional to the intensity or strength of the image falling upon the corresponding selenium cell of the transmitting device, and—viewed from a suitable distance—the total effect of the lamps will amount to a reproduction of the original image.

Now such a method of television is quite practicable, but the expense involved in putting it into practice is absolutely prohibitive, and it is, moreover, quite unsuitable for wireless transmission.

The radio transmission of an image resolves itself into sending, preferably on *one* wave-length, an excessively rapid succession of signals representing the whole "units" of the image, and sending

a fresh cycle of such signals with sufficient rapidity that the image reproduced is sustained by the eye at the distant station.

The sensitive selenium cell possesses the drawback that, while its resistance is lowered if light falls upon it, when the light is removed or quenched the resistance does not rise again to normal without an appreciable delay. This sluggishness of action would give the effect of the old dissolving view magic lantern, when the two images were seen together for a moment on the screen while the slides were being changed; it would give a succession of fresh images on which the previous ones were still overlapping—a very blurred and indistinct result.

Recent Advances.

A great advance has been made by the advent of the photo-electric cell, which responds to changes of strength in the illumination within about a millionth of a second. The photo-electric cell may be regarded as the "electric eye," which will estimate the brightness of an image and instantly control a wireless radiation in proportionate intensity.

These cells operate by reason of their emission of electrons when illuminated. Such metals as sodium and potassium, when suitably treated within a glass vessel exhausted to a millionth of an atmosphere or less, emit negative electrons when rays of light fall upon the metal, and this emission may be made use of in any of the many ways that at once suggest themselves to the wireless engineer for controlling the output of a radio transmitter.

The Baird System.

In the Baird apparatus a photo-electric cell is illuminated by different small sections of the original image, which are thrown upon it by means of an ingenious arrangement of rotating sectors and spirally arranged apertures cut in a rotating disc. The electric eye is made to "see," one after another, each tiny fraction of the image mechanically analysed. Every portion of the complete image is "seen" by the photo-electric cell several times a second, and flashed to the receiving apparatus.

Similar mechanical devices at the receiving end recombine the dissected parts of the picture. The fluctuations of the electron emission in the photo-electric cell are made to vary the wireless current transmitted, just as in the case of a telegraphed picture, only, of course, with vastly greater rapidity. After reception and amplification they are made to control the brightness of an electric lamp, or illuminated screen, which is viewed by the *human* eye through the radially-slotted disc and spirally-arranged apertures. These discs are driven synchronously with those of the transmitting device by means of synchronous motors.

Mr. Baird's brilliant scheme should be readily developed and should lead at least to a partial solution of the problem of television. Success depends to a large extent upon mechanical ingenuity and the refinements of the instrument maker. If we leave out the question of atmospherics and interference, there can be no medium so suitable as wireless for the transmission of the extremely high speed signals involved in any method of television; there are no effects due to capacity such as one experiences with a cable or metallic conductor which set a strict limit to the rate at which discrete signals can be telegraphed.

Professor Rosing's Apparatus.

One of the most ingenious attempts at a solution is that due to Professor Rosing, of (then) St. Petersburg; although this dates back to 1910, his ideas were so sound that they may yet be found to solve some of the mechanical difficulties not yet overcome, and certainly deserve description in a general article.

Put very simply, his idea was to make the photo-electric cell trace over the image by a spiral path and so record the varying light intensities with one spiral sweep. We can understand it better by imagining the image of a person to be cast by a lens upon a sort of gramophone record, and a photo-electric cell taking the place of the needle in the tone arm; imagine, further, the "tune" to be played in a sixteenth part of a second, and we can grasp the idea of the photo-electric cell recording the light intensities of the entire image in a sufficiently short time to make possible the radio-transmission of one single kinematograph picture. By making the photo-electric cell trace over the image or "record" sixteen times a second, the picture could be "kept going," and the receiving apparatus would cast a representation of the image upon some sort of screen.

The photo-electric cell was directed upon the image, mounted upon a sort of universal joint and actuated by magneto-motive mechanism to trace its spiral path. A similar motion was synchronously accorded to a cathode tube at the receiving instrument; the rays from this tube were focused upon a phosphorescent screen, and as the pencil of rays swept its spiral path over the screen, the phosphorescent light, varying at each instant in intensity according to the brightness of the corresponding spot of the image, reproduced the image of the distant transmitter.

Conclusion.

It will thus be seen that there are more ideas than one about the accomplishment of television, and that however it is finally carried out the ether will be by far the most suitable medium

for transmission owing to the inevitably enormous number of signals that must be radiated.

But in looking ahead we must restrain our dreams, and realize that whatever the method devised, an image must always be dealt with piecemeal, and that to transmit the image of a race-course, a theatre or any such complicated thing very extraordinary progress has yet to be made. We are apt to hear of rather exaggerated claims at times; let us await results with patience and learn to realize the real greatness of the apparently crude results that are already being obtained.

RADIO AND CABLES

By Sir Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E.

Some seventy-five years ago the greatest wonder of the age was the Submarine Cable, by means of which telegraphic communication was successfully conducted between distant continents separated by the sea.

A far wider circle of the community are now struck with the marvels of Radio Broadcasting. Every day an increasing number of even cottages are fitted with it, and before long it will entirely cease to be regarded as a marvel.

The Cable and Radio each have their proper characteristic sphere. As I have often ventured to suggest, this would be better realized if the order of the two inventions had happened to be reversed—as might quite well have been the case.

Radio is admirably adapted to the simultaneous dissemination of information—and what is called "news"—that is open to all, to as many different centres as possible.

Its very suitability for the above implies that it is not adapted to the purposes of communicating anything of a private nature, and here it is mainly that the cable is so invaluable. What the cable does is to confine the transmitted wave to a definite channel from point to point, thus preventing all straying.

Had the order of the two inventions been reversed, the cable would have to-day been thought as great a wonder as radio, in that it achieved something—secrecy—that radio could not.

As it is, the great marvel in most people's minds is that so many of us can simultaneously share what is being wafted forth from a broadcasting station in all directions.

But for the tendency for the latest thing to be always considered the most wonderful, the cable would be probably regarded with about the same degree of wonder.

CHILDREN'S CORNER

LONDON AND DAVENTRY

REGULAR uncles and aunts. Uncle Rex (Mr. Palmer), Uncle Jeff (Mr. L. Stanton-Jefferies), Uncle Caractacus (Mr. C. E. Lewis), Uncle Peter (Mr. Hodges), Auntie Sophie (Miss Cecil Dixon).

(*Hay Wrightson*)
R. F. PALMER
(Uncle Rex)

Auntie Yvette (Mrs. Phillips) is an occasional visitor, and the Wicked Uncle (Mr. Ralph de Rohan).

The object of the London Children's Hour is to provide a recreative programme and to avoid all appearance of education. It includes fairy stories, school stories, adventure, legends and folk-lore, stories of great people and of great achievements.

Miscellaneous.

Informative chats are given on music, books, photography, travel, gardens, railways, astronomy, architecture. It is hoped later to include talks on industries.

The music side includes ballad songs, humorous, piano solos, solos on every instrument, dance music. Recitations are given occasionally from the greatest poets. Special features are the monthly news bulletin for children, a programme of items given exclusively by children, competitions of all kinds, plays, "The Wicked Uncle," humorous dialogue.

The daily composition of the programme is: Some music, a story of some kind, an interesting talk, and, most days, a special feature as above.

The children have a radio circle, which keeps them in touch with one another. Many interesting competitions are run in connection with this, and just now the children are collecting silver paper, which will be sent to the Hospitals Wireless Fund. The children are encouraged to use their own initiative in devising schemes whereby they can make money for the Hospitals Fund. One little listener organized a concert to which she charged 6d. admission—the result was £1, which was, of course, handed over to the Hospitals Fund. Another little girl manufactures a monthly magazine—she writes her own stories, draws her own illustrations, and circulates it herself. Everyone who reads it pays 2d. for the privilege, and in this way she has made quite a lot of money for the Hospitals Wireless Fund.

The success of the Children's Hour depends to a large extent upon the intimate relations between the aunts, uncles, and children; all letters have individual attention and get every consideration. The material is very carefully edited before it is broadcast, so that it shall be acceptable to the largest majority of listeners. The aim is to compile a complete co-ordinated programme, and those responsible for the Children's Hour are endeavouring to get together a properly balanced entertainment so that every child shall be catered for.

MANCHESTER

Previous aunties and uncles. Auntie Rosalind (Miss L. D. Rhodes), Cousin Tom (Rev. T. A. Rearden), Cousin Edward (Mr. E. Whitnall), Cousin Mac (Mr. E. Barton), Uncle Toby (Mr. T. O. Beachcroft).

Present aunties and uncles. Auntie Vi (Miss Violet Fraser, B.Sc., the organizer of the women's and children's transmissions), Auntie Hilda (Miss H. Metcalf), Alice in Wonderland (Miss D. Massey), Auntie Jean (Mrs. Councillor Nix), Uncle Ted (Station Director), Uncle Eric, the Wicked Uncle (Mr. Eric Fogg), Uncle Victor (Mr. Victor Smythe), Uncle Ronald (Mr. R. C. Evans), Uncle Harry, the Singing Uncle (Mr. Harry Hopewell), Uncle Willie, the Scotch Uncle (Mr. William Cochrane), Cousin Bernard

(Father Bernard Butler, S. J.), who gives talks on Natural History, the Sunshine Trio.

The Children's Corner at Manchester aims at providing a bright, cheery and healthy entertainment to the children at the end of their day's work. It is run on family lines. The aunties and uncles are always at home to the children on Saturday afternoons from 3.0 to 4.0 p.m. One of the features of the Children's Corner

(*Hulton*

VICTOR SMYTHE
Manchester
(Uncle Victor)

is the presentation of a musical revue for children on alternate Saturdays and another feature is music for the children from 5.30 to 6.0 on Sundays.

NEWCASTLE

There are six aunties and six uncles at the Newcastle Station.

Auntie Kirsty (Mrs. Latham) is mainly responsible for stories and little plays of her own writing. One of her creations is that of Luck Brownie, a strange little creature, who dwells in the bottom of an earthenware jar, which generally stands in a corner of the studio. He is a young imp who is constantly playing pranks

on the uncles and aunts, but is really quite a good little soul, and fortunately can be controlled.

Auntie Bridget (Miss Agnes Strong) tells children's stories, and helps to prepare and act little plays. One of the features of the Corner is a game of " Characters " conducted by the above two aunties, which is very popular with the children.

Auntie Una (Mrs. Una Rodenhurst), daughter of the celebrated Dr. Walter R. Hadwen, tells the most delightful stories; her work, besides being particularly delicate and charming, is also unobtrusively educative. She is also very good at giving imitations, and in dialect work. Mr. Andrew Fraser is an excellent pianist, although blind and a very good singer of baritone songs. He provides the music for Auntie Una's Corners, and on the spur of the moment can produce at the piano all sorts of beautiful musical effects.

Auntie Julia (Mrs. J. M. Tittle), better known by her maiden name of Miss Sal Sturgeon, tells quaint stories and recites poetry. She sometimes helps in a little play, but she really does not need any help, as she is a play in herself, and, so far as the Children's Corner is concerned, a " comedy."

Auntie Mary is an excellent mimic and tells stories very daintily. Her principal contribution to the Children's Corner is the singing of songs of the light and dainty variety—songs about fairies, and gardens, and such beautiful things.

Auntie Miriam in private life is the Countess of Tankerville; she tells delightful little stories, which generally have a symbolic meaning.

All the uncles, except one, are members of the station staff, including Uncle Bo, Uncle Richard, and Uncle Joe, who are hosts in themselves.

Uncle Nick is responsible for the Children's Corner. In private life he is Lt.-Col. H. C. Millican. He has a choir of small children, who sing choruses in the studio.

Uncle Peter is the Newcastle Station Director. He had during the summer a novel feature called " Tea by Ballot." The names of children are put in a hat and the six lucky enough to have their names drawn out, are invited to tea in the studio on Saturday afternoons: the tea party is broadcast to other children who listen.

The most recent activity in the Children's Corner is a sort of Children's Dramatic Company, called " The 5NO Phantoms." These children, under the direction of Uncle Peter and Auntie Una, bring to life again all the interesting personalities of nursery days and fairy tales.

Recent additions are Uncle Benn, in private life the Earl of Tankerville, and Cousin Jack, who act and sing respectively.

The children's organization in Newcastle is known as "The Fairy League," and its membership is roughly 2,500. Its members are required to develop the love of flowers and all beautiful things in nature, and protect them from destruction. They are also required to care for dumb animals. Every year a picnic is held, which is generally a very exciting and successful affair. Competitions are held from time to time—generally of an educational nature. The standard of work achieved is very high.

Children living in or near Newcastle may become members of The Fairy League by writing to Uncle Nick, c/o the B.B.C., 24 Eldon Square, Newcastle-on-Tyne.

PERCY EDGAR
Station Director, Birmingham
(Uncle Edgar)

(Annan)

CAPT. J. C. S. PATERSON, R.N.
Birmingham
(Uncle Bonzo)

BIRMINGHAM

The uncles are Uncle Edgar (Station Director), Uncle Pat (Mr. Harold Casey), Uncle Joe (Mr. Joseph Lewis, Musical Director), Uncle Jack and Uncle John. Uncle Bonzo (Captain J. C. S. Paterson, R.N.).

The aunties are Auntie Gladys (Miss Gladys Colbourne), Auntie Kitty (Miss Kitty Usherwood), Auntie Phil (Miss Phyllis Richardson), Auntie Elsie (Miss Elsie Wilson), Auntie Dorothy (Miss E. Dorothea Barcroft).

5 IT BIRMINGHAM AUNTIES AND UNCLES

Left to right, standing: Mr. Alan Felham (Uncle Felix); Miss K. Usherwood (Auntie Kitty); Miss D. Barcroft (Auntie Dorothy); Miss Phyllis Richardson (Auntie Phyl); Mr. Percy Edgar (Uncle Edgar), Station Director; Capt. J. C. S. Paterson (Uncle Bonzo), the Announcer.
Sitting: Miss Gladys Colborne (Auntie Gladys); Miss E. Wilson (Auntie Elsie); Mr. Joseph Lewis (Uncle Joe), Musical Director.

The last-named organizes the Children's Corner and has several compositions to her credit, the most popular with the children being a suite entitled "Pixie Music." The Children's Corner has a "Radio Circle," which has 10,000 members. The children subscribe to the circle, and the subscriptions, after defraying the cost of a badge, go to a fund for providing children in hospitals with wireless sets. It is most satisfactory to note that all the children's wards in Birmingham are now equipped, and many

(*MacMahon*)

W. D. SIMPSON
(Uncle Will), Aberdeen

(*Fred Hardie*)

NEIL MCLEAN
Station Director, Aberdeen

other hospitals as well. The members of the Radio Circle have the privilege of actually broadcasting in the concerts, which are arranged once a month during the winter months. In many cases this has led to the discovery of unexpected local talent. The "Corner" includes the usual stories, plays and music.

ABERDEEN

Auntie Win (Miss Winifred M. Manners) organizes the Children's Corner and writes "Sad Poems" in her spare time. As, in addition, she writes plays and produces them, runs a Children's Concert Party and keeps the uncles from treading on

the "Station Guinea-pig's Tail," fortunately there is not much time for the poems. Uncle Neil (Mr. McLean), an authority on Hebridean folk-song and folk-lore. Uncle Harry (Mr. H. Fitch) tells stories, particularly about Brer Rabbit, and takes parties of children in the Radioplane when any of its engines are in working order. Uncle Will (Mr. W. D. Simpson) sings songs and tells stories. Aunt Marie (Miss Marie Sutherland) pianist and accompanist in the Children's Corner. Uncle Jack (Mr. W. Nair) sings songs and duets with Auntie Nan, who also plays the piano and sometimes takes the children rides in her motor boat, which goes best on dry land!

The activities include a series of plays with music, children's choirs. Visits from nursery rhyme characters who relate adventures which do not appear in any fairy tale book. Visits are paid to the studio of birds, beasts, and animals, where information and entertainment are judiciously introduced. There is also Uncle Harry's Radioplane, which has twenty-six engines, and can cover any distance in a fraction of a second. In this, the aunties and uncles are transported to various interesting places abroad, where they hear of the language, customs and music of the country. Scenes from favourite books are given. A series of little fantasies are about to be given, illustrating simple laws of hygiene in an amusing and fantastic form. Music is given a prominent place. Talks are given on "Learning to Listen," the various instruments of the orchestra are explained. Folk-songs and music are played and songs of all kinds. The stories of well-known operas are told and children's songs are frequently sung, while, of course, nursery rhymes, both in traditional and modern settings, are given a worthy place.

CARDIFF

Auntie Bronwen (Miss B. Davies) conducts trips on the magic carpet, during which birds and beasts and every interesting feature of the country and seaside are seen. She also makes a speciality of old folk-songs. Cousin Dorothy (Miss D. Champion) takes the children to Fairyland. Her most appreciated items are "The Old Curiosity Shop," "Songs for the Smallest People." Aunt Lilian (Miss M. King) is in charge of the Letter Box, a new and important feature of the Children's Hour. Mr. W. N. Settle, Uncle Norman, tells animal stories, tales of Arthur's Knights and Bold Robin Hood. Uncle John (Mr. J. B. Clark) tells of strange deeds in stranger countries, and has a great partiality for the water folk at the Zoo. On special occasions Uncle Warwick (Mr. W. Braithwaite) and his orchestra make delightful music for the children. Auntie Vera (Madame McComb Thomas) and Cousin Amy (Madame Bernard Cook) also play to

MISS M. K. KING
(Aunt Lilian)

MR. W. BRAITHWAITE
(Uncle Warwick)

(Hugo & Co.)

E. R. APPLETON
Station Director, Cardiff
(Uncle Felix)

(H. J. Whitlock & Sons, Ltd.)

W. SETTLE
Deputy Director, Cardiff
(Uncle Norman)

the children. Plays are a popular item. "George and the Dragon" (Lyle Cummings), fantasies by Uncle Ivor (Captain I. H. McClure), and humorous dialogues by "Spick and Span" (of the 5WA Players) are well liked. Uncle Ivor was also the instigator of the "Secret Picnic," at which treasure trove was hidden. Clues are given in front of the microphone, and the treasure trove generally finds its way back to the studio.

The whole family of uncles and aunts will be taking part shortly in a fantasy entitled "The City of Someday Soon," especially written by Cousin Dorothy, including Uncle Warwick and his orchestra.

J. B. CLARK
(Uncle John)

Uncle Felix (Mr. E. R. Appleton) is the presiding genius over the "Radio Sunbeams," who promise kindness to animals and unselfish behaviour, to keep parks and public places tidy, and to look for beauty in books, pictures and music. This movement already numbers thousands, and a Radio Sunbeam Eisteddfod is being arranged, which will include all kinds of musical competitions, etc.

BOURNEMOUTH

Uncle Jack (Mr. Bertram Fryer), Uncle Allan (Mr. Allan Franklin), Uncle Pongo (Mr. Irving Byers), Auntie Nan, who prefers to remain anonymous.

Uncle Franklin's speciality is "The History of the Piano, from the Beginning to the Present Age," also an information bureau to answer the questions which are asked every day by children, such as "One sees on a window in a new house a big white blob, why is it there?" Uncle Pongo entertains with songs and witticisms and joy rides in his aeroplane. Uncle Neville (Captain Neville Lawrence) gives talks on stamp collecting. Playlets are given, and talks on adventure. Phil and Jean in rhymeland are enjoyed, as are visits to foreign countries, listening to rhymes of other countries, competitions, Christmas parties, etc. The children have a Fairy Flower League, whose duties comprise visits to hospitals, the sick and the poor. The children do their best to bring happiness to others as far as it is in their power; flowers, vegetables, and toys are distributed, and they have subscribed close on £400 to install a cot in a home. They also subscribed £10 for some children who were left destitute.

GLASGOW

Uncle John (Mr. D. Millar Craig) has wonderful ideas for new competitions which the children never tire of; he sometimes plays the 'cello. Uncle Alex (Mr. A. H. Swinton Patterson) seems to enjoy introducing strange animals into the studio, cats, tame snakes, canaries, mice, etc. Uncle Mungo (Mr. M. M. Dewar) is noted for his inability to see a joke or guess a conundrum in under a week. Uncle Toccers (Mr. E. J. Thomson) was very enthusiastic about gardening until it was discovered that he did not know the difference between a bulb and an onion, and he never knew which side of the bulb should be planted uppermost. He is now devoting his attention to toffee making! Auntie Cyclone (Miss Kathleen M. E. Garscadden) is the "conductress" of the Radio Circle Choir, and during last winter gave singing lessons to the children every week, and held a singing competition.

The Glasgow Children's Hour includes many outside artists, all specialists in their own department. Competitions are held, stamp chats and French talks are given. A series of talks on "Fables and Fallacies of Nature" was given by Mrs. Marion Henderson, who was also the instigator of the Poets' Corner. Piano and vocal recitals have been given by Mr. and Mrs. A. M. Henderson; Mr. Henderson is organist to Glasgow University. Muir Matheson's Boys' Orchestra visited the studio and was a great success. Miss May Gilchrist is also an occasional contributor to the Corner; she writes delightful fairy stories and her stories in "Pinkie in Fairyland" are much appreciated by the children. Mr. McKnight gave some talks on model engines and railways. Granny Don. Miss M. G. McDonald, was a visitor for some time to Glasgow Children's Corner; she had a never-ending

stock of fairy stories. Miss Elizabeth Clarke, who sometimes visits Glasgow, is famous for her "Epiminondas" stories, and the "Old Woman in the Vinegar Bottle," amongst others. Binnie Hale and George Grossmith have also visited the Corner and were much appreciated. The Westerby Children's Trio have also performed at the Corner, and on their last appearance played "The Miniatures" of Frank Bridge very delightfully. On 25th March, the Corner held a Radio Bazaar, when £350 was raised, which was used to equip four large hospitals for children with wireless. Other items included in this Corner are "Toffee Making Talks," by Cousin Margery, Curly Locks and her Brother (Rene and Jim Dunlop), two clever little violin players, the Wireless Quartet, composed of "Uncle Andrew, Uncle Dickson, Uncle Lossie, and Old King Cole." Recently there has been inaugurated the "Counterpane Corner," which is run entirely by the little people who are invalids, but not too ill to write and send messages of cheer to one another through the medium of "Mr. Mike," as the microphone is popularly called by the children.

BELFAST

The regular aunts and uncles are Aunt Eva (Evva Kerr), Uncle Tom (T. O. Corrin), Uncle Will (W. T. Guthrie), Auntie Pauline (Pauline Barker), Cousin May (May Curran), Aunt Marjorie (Marjorie Sinclair), Aunt Muriel (Muriel Childe), Uncle Albert (Albert Fitzgerald), Uncle Jack (J. H. Chambers), Uncle Bill (William Duncan), Uncle Fred (F. C. Hughes).

The great bulk of the music performed is folk music. There has also been instrumental music, namely, piano, harp, violin, and piano trio, the works given being either light and tuneful classical excerpts, e.g. minuets of Haydn, Mozart, etc., or arrangements of well-known traditional airs. The stories broadcast are mostly traditional or classical fairy tales, e.g. Grimm, Hans Anderson. There have also been read a considerable number of original stories especially written by Evva Kerr, H. M. Davis, and others.

At present, on two days a week twenty minutes of the programme is devoted to stories and nursery rhymes for very small children, e.g. four to eight years old, and on three days a week twenty minutes is devoted to talks and music suitable for older children, e.g. ten to sixteen years old.

In winter, about once a month, a play based on some well-known fairy tale has been given, and from time to time, Walford Davies' Rhyme Quartet for mixed voices has been given by Evva Kerr, Muriel Childe, F. C. Hughes, and W. T. Guthrie.

HOW TO OPERATE YOUR NEW SET

HINTS ON GETTING BEST RESULTS

By "MENTOR"

WHEN we first get the new wireless set home from the shop, aerial and earth duly fixed, batteries in place, there comes that first thrilling moment when the set is to be operated and the family delighted with music. This, like the wedding day and the first ride on a bicycle, give a thrill such as we seldom feel in this unromantic age when everything is commonplace.

To describe the method of operating a set, it will be best to divide the wireless problem into its two natural parts—crystal sets and valve sets. Crystal sets will be taken first, so that valve set owners can skip a page to the heading "Valve Sets."

Crystal Sets.

There are three forms of tuning, in a normal crystal set. First of all, there is the cheap, "ready-made" set, which is sold already tuned to operate on a standard 100 ft. aerial. Usually, this type is tuned to 1,600 metres—Daventry's wavelength—but, of course, one could be just as simply made up to receive the local broadcasting station. The next type is that tuned by a coil and one or more sliding contacts (or, alternatively, stud switches), and the third method is variometer tuning.

What we term the "ready-made" set needs no tuning-in—that is to say, adjusting to the broadcasting station's wavelength. All that has to be done is to see that the aerial is 100 ft. long, and that aerial, earth and telephones are all duly and properly connected to their terminals. Then we pick up our telephones, adjust the crystal, and listen for results.

Most crystal detectors are of the type consisting of the crystal and an implement termed, for some mysterious reason, the "cat's-whisker," which reminds one more of a miniature corkscrew than anything else. When adjusting, the cat's-whisker should not be scraped across the surface of the crystal, but lifted clear each time and put down on another spot, different spots being tried until the nearest approach to the ideal is found.

Coil Tuners.

The type of tuner consisting of a coil with sliding contacts needs a little more attention. In this case, the slider (or sliders, when there are two) have to be moved along the surface of the coil until signals are heard. Where there are two sliders, the one

attached to the aerial circuit should be moved first until something is heard. Then fine tuning may be accomplished by moving the other slider until signals are at their best. At the same time, it is, of course, necessary to adjust the cat's-whisker in the same way as with any other crystal set.

Variometer Tuning.

Tuning with a variometer is an easier and more handy method. In this case, the variometer control knob is simply turned until something is heard, then put in the best position for loudest signals and left where it is.

Minor Details.

If an earthing-switch is fitted, that is to say a switch which connects the aerial direct to earth when the set is out of use, care must be taken to see that the switch is in the "off" position when listening. Otherwise the tiny aerial currents will run straight to earth instead of passing to it via the set. Like most of us, electric currents follow the line of least resistance.

Apart from these matters, the operation of a crystal set is not a very difficult matter, the most irksome part of the process being to find a good point on the crystal. When one is found it should be kept. Continual searching for a better spot wastes a great deal of time, and it is far better to find a reasonably good spot and be content with it.

A crystal set gives excellent results, provided it is within reasonable range of a broadcasting station, and the sole disadvantage is that its signals are not loud enough for most of us. For that reason, and perhaps because its working is rather simple, we all, sooner or later, fall to the craving for a valve set —a set which will work a loud speaker or give really loud signals on the telephones.

Valve Sets.

Tuning-in a valve set is naturally a more complicated process than merely tuning-in a crystal set. There are more parts concerned and consequently more adjustments needed.

The first thing to be done is to see that aerial, earth, telephones and batteries are all duly connected to their right connections. In the case of the batteries, it is always safer to connect the low-tension battery first (the accumulator or battery which lights the valves). The reason for this is that if it is accidentally connected to the wrong terminals no harm will result. When this battery has been connected, the valves should be switched on. If they light up, well and good. If they don't, it probably shows that the battery has been connected to the wrong terminals. In this

case, matters can be quickly put right by putting it to the right terminals. But if the high-tension battery had been connected to the low-tension terminals by mistake, the voltage it contains would have burnt out the valve filaments immediately—rendering the valves useless, of course. For that reason, it is always safer to connect the low-tension battery first.

Tuning In.

Then, when everything has been connected up safely and properly, it is safe to don the telephones and switch on both batteries. The correct coils should be inserted in the coil-holders. In the case of ordinary broadcasting stations, these will be coils numbered about 50 or 75, according to the circuit and capacity of the set, and, in the case of Daventry, perhaps 150 or 200. But the actual coils to use can be easily ascertained from the agent who supplies the set and the numbers noted.

The objective to be aimed at is as follows: When a broadcasting station sends out waves of a given wavelength, its aerial circuit is tuned to a certain frequency. Consequently, to receive this given wavelength, the aerial circuit of the receiving set must be tuned to exactly the same frequency.

"Tuning" a circuit is accomplished by means of two things, capacity and inductance, both of which are variable. To receive longer wavelengths, therefore, we insert larger coils, and then obtain finer tuning by turning the variable tuning condenser until signals are at their loudest.

In tuning in, the first step is to insert the correct coils. Then the variable condenser control knob should be turned until signals are heard, and finally left in the position that gives best results. During this operation the coils should be placed at an angle of, say, 90°. When the tuning condenser has been placed in its final position, the coils may then be gradually moved together until signals are at their loudest strength and clearness. But at the first sign of any fluffiness in the tone they should be slightly separated again, even though it does mean sacrificing a little loudness. In wireless, as in other things, quality is preferable to mere quantity.

The one thing to be avoided when working a wireless set is oscillation, or "howling," as it is more commonly called. The cause of this is using too much reaction, and to avoid it the reaction coil must never be moved too near its neighbours. The crime of howling spoils not only one's own music, but mars the pleasure of all other listeners within a mile or so, for when howling takes place the aerial re-radiates waves which cause squeaks and howls in other sets.

Often when listening, you may have heard these annoying

squeals and howls, and it may be taken for granted at once that someone else is howling. So please don't do it. It's criminal, selfish and unnecessary, apart from the distorted music the howler himself has to listen to.

The "Howling" Test.

And how to tell when one's set is howling? When the set is working merrily, touch the aerial terminal with the finger. If a click is heard in the telephones, it is a sign that the set is howling. The reaction coil should then be moved away from the other coils until the clicking sounds cease. If this does not stop them, the high-tension current should be lowered (by means of the wander plug in the high-tension battery) or the valve filaments turned down slightly. When the adjustments cause the clicks to cease, then things may be safely left as they are without fear of interference with your neighbours.

Final Hints.

When tuning to a given wavelength, better results are obtained by using the largest coils practicable. That is to say, if a station can be received by using a smaller coil and the condenser reading near 180°, or alternatively by using a larger coil and the condenser reading near 0°, the latter alternative is far more efficient.

The valve filaments should be burned as low as possible. The rheostats which control the amount of current passing through the valves should therefore be turned down as low as possible, consistent with good results. This not only saves current, but lengthens the lives of the valves.

As a final hint, do not strain the set into giving loudest possible signals. It is more pleasant to be content with signals of the set's normal power: if these signals are unduly amplified, distortion sets in and the quality of the music is ruined. Normal, clear and distinct signals are always preferable to a distorted blare.

FIRST AID TO THE SET

TRACING AND CURING TROUBLES

By "MENTOR"

WIRELESS troubles may be divided into two broad classes—those which completely stop signals and those which merely weaken them. Probably the former type is easier to trace, as it denotes that something serious has gone amiss—a wire dropped off its terminal, or some other fault equally tragic. When signals are merely weaker than normally, it is often difficult to trace the exact cause, as there are so many little items which, in their small way, can ruin results if they are not working perfectly.

Crystal Set Troubles.

To take crystal sets and their troubles first covers much of the ground of valve-set faults, as many of these troubles are likely to happen to valve sets also. Troubles such as the aerial collapsing, telephones falling off their terminals, and such like obvious trials need not be considered at length here, as the trouble and cure are so obvious that it is rather a waste of time to read about them.

If nothing at all can be heard on a crystal set, the following points should be examined. Aerial, earth, telephones and all other visible connections on the set should be examined for good contact. While making all tests, it is an advantage to keep the telephones on the head, so that it will be noticed at once if the fault is accidentally put right.

The sliding contact of the tuning-coil should be examined to make sure it is making proper contact all along the coil, making contact with bare wire, and not merely touching the insulated part of the coil. If a small fixed condenser is fitted across the telephone terminals, it should be disconnected, to make sure that it hasn't short-circuited internally. Though this is not a frequent trouble, it is a possible one if the set has been roughly handled or jarred.

If signals are audible, but weak, examine the crystal. If its surface is greasy-looking, the trouble may be that the film of grease is forming an insulating material. In this case, it should be cleaned with a little petrol. If the cat's-whisker is rusty it will not make good contact ; the cure is to cut the end, slantwise, with a pair of scissors.

If the crystal is worked in conjunction with a potentiometer, it may be found that the battery has run down. The cure is a new

battery, or an ordinary pocket-lamp battery will temporarily take its place fairly efficiently.

Valve Set Faults.

When the set is quite " dead," and not a note can be heard, it usually denotes a complete break in some circuit of the set, generally a battery circuit. It may be merely a question of a wire dropped off its terminal, or some wire broken in a spot where it cannot be seen.

Supposing you were shown a strange wireless set and told that it " wouldn't work," and invited to get it going, the following method would be a systematic way of tracing the trouble—

See that aerial, earth, and telephones are all duly connected to their right terminals, and make sure that the earthing-switch is in its " off " position. The next step would be to see that the low and high tension batteries are duly connected to their right terminals, and not connected up wrong way round. The set should then be switched on. If the valves light up, it may be taken for granted that they are all right, and that the low-tension battery is not exhausted. If a distinctive click is heard in the telephones when the high-tension battery is switched on, it may be taken for granted that that is in working order also.

If one valve refuses to light up, it may have fused, or it may be merely loose in its socket. It should be moved and if the valve leg points seem rather close together, they should be separated with the blade of a penknife, so that they will make efficient contact in their sockets. The rheostat should be examined to make sure that it is making proper contact. If still one valve won't light up, it is almost certain that the filament has broken—either through fusing, or through its being broken by jarring. In this case, the only cure is to fit a new valve in place of the old one. (It is always advisable to keep a spare valve in stock for emergencies of this sort.)

But if everything has gone well so far and the valves appear to be all right, the trouble must be pursued elsewhere. It is possible that the windings of the transformer may have " burnt out," and, if this is the case, the only reliable cure is to dismount the offending part and return it to its maker with a request for repair. A trouble of this nature shows itself by signals suddenly weakening and strengthening, owing to the fact that the broken ends of the wire only make occasional contact. When they touch, signals are heard ; when they don't, naturally nothing happens.

Crackling Noises.

When crackling noises occur in a set, similar to those set up by atmospherics, it is often a sign that the high-tension battery is

running down. If a voltmeter is handy, it is as well to test each cell of the battery in turn. Usually one cell will be found to be defective; this stage should be short-circuited with a short length of wire and the crackling noises will then usually cease.

Another cause of crackling noises is that the insulation of the telephone leads has worn through in places. If no spare pair of telephones is available, it is better to take the leads off altogether and fit the telephones temporarily with electric light flex, or even ordinary wire, until some fresh leads can be obtained.

Condenser Troubles.

Condenser plates occasionally get out of alignment and touch when the condenser is turned to a certain position. It is a difficult matter to get them back into alignment, and this is usually a fault which occurs only with cheap condensers. If it occurs at a moment when there is not time to dismantle the set and readjust the plates, it is often possible to insert different sized coils from those normally in use, so that the same wavelength may be tuned in at a different condenser reading, where possibly the plates do not rub together.

Fixed condensers are liable to short-circuit internally, and often cause a complete cessation of signals. The best test is to dismantle one connection from the condenser. If the condenser is as it should be, no difference will be made, but if it is faulty, signals will probably improve, though they may not be of full strength.

Fixed condensers of incorrect value anywhere in the set cause weak signals, but as this is a fault of design in the first instance, it can hardly be classed as a genuine trouble, but it is an item worth bearing in mind when a new set is accused of giving weak signals.

Grid-leaks.

If the grid-leak is of incorrect value, signals will be faulty. If its value is too high, howling will probably take place; if it is too low, signals will be weak. Where it is suspected that the leak is of too high a value, it is often possible to remove it altogether and still receive good signals, especially if the set concerned is an old and dusty one. Where the value of the leak is too low, one of higher resistance should be fitted, or, again, removing the leak altogether may improve matters. Removing the leak is, of course, merely a temporary cure; a leak of correct value should be fitted at the first opportunity.

Howling.

As mentioned already, one cause of howling is a grid-leak of

too high a resistance. Another cause may be that the reaction coil is too large. To test this, remove the coil and short-circuit the coil-holder prongs. If the howling then ceases it may be taken that the coil was too large and a smaller one should be tried in place of it.

Too much high-tension current is also inclined to encourage howling, as is also too much low-tension current, which has the additional disadvantage of shortening the lives of the valves while giving no better results. Wires running parallel, especially those carrying high-frequency currents, occasionally cause oscillation.

Dust and Damp.

Dust, damp and dirt are all enemies of wireless sets, and so a set which is overburdened with any of these three items can never be expected to give first-class results. Therefore, a set which is not working up to its normal standard will often be improved by a thorough spring-cleaning.

But by far the best way to cure troubles is to prevent them in the first place, so to speak, by periodically looking over the set and righting any fault, however trivial, the moment it is noticed. Only by doing this can one be assured that the set will always give results when wanted.

LIST OF STATIONS

OF SPECIAL INTEREST TO BROADCAST LISTENERS

Name of Station	Wave-length(s)	Call Sign
B.B.C. (Main)		
LONDON	365	2 LO
DAVENTRY	1,600	5 XX
ABERDEEN	495	2 BD
BELFAST	440	2 BE
BIRMINGHAM	479	5 IT
BOURNEMOUTH	386	6 BM
CARDIFF	353	5 WA
MANCHESTER	378	2 ZY
NEWCASTLE	404	5 NO
GLASGOW	422	5 SC
B.B.C. (Relay)		
BRADFORD	310	2 LS
LEEDS	346	2 LS
EDINBURGH	328	2 EH
HULL	335	6 KH
LIVERPOOL	315	6 LV
NOTTINGHAM	326	5 NG
PLYMOUTH	338	5 PY
SHEFFIELD	301	6 FL
STOKE-ON-TRENT	306	6 ST
DUNDEE	331	2 DE
SWANSEA	48	5 SX
FRANCE		
RADIO PARIS	1,750	SFR
ECOLE (PARIS)	450	PTT
EIFFEL TOWER	2,650	FL
"PETIT PARISIEN"	347	——
AGEN	318	——

Name of Station	Wave-length(s)	Call Sign
GERMANY		
BERLIN	505 576	——
KOENIGSWUSTER-HAUSEN	2,450	LP
BREMEN	277	——
BRESLAU	416	——
CASSEL	273	——
DORTMUND	288	——
DRESDEN	280	——
ELBERFELD	289	——
FRANKFORT	470	——
HAMBURG	395	——
HANOVER	297	——
KOENIGSBERG	463	——
LEIPZIG	452	——
MUNICH	485	——
NUREMBERG	321	——
STUTTGART	446	——
HOLLAND		
AMSTERDAM	2,125 1,050	PCFF PA 5
HILVERSUM	1,050	NSF
SPAIN		
BARCELONA	324 300	EAJ 1 EAJ 18
RADIO CATALANA	460	EAJ 13
OVIEDO	400	EAJ 19
MALAGA	400 325	EAJ 26 EAJ 25
MADRID	392	EAJ 6
CADIZ	360 330	EAJ 3 EAJ 10
VALENCIA	360 400	EAJ 24 EAJ 14

Name of Station.	Wave-length(s)	Call Sign
SEVILLE	350 300	EAJ 5 EAJ 21
ASTURIAS	345	EAJ 12
SAN SEBASTIAN	345	EAJ 8
SARAGOSA	325	EAJ 23
BILBAO	300	EAJ 9
SALAMANCA	290	EAJ 22
BELGIUM		
BRUSSELS	262	SBR
DENMARK		
COPENHAGEN	308	——
LYNGBY	2,400	OXE
RYVANG	1,150	——
HJÖRRING	1,250	——
ODENSE	950	——
SWEDEN		
BODEN	1,250	SASE
FALUN	370	SMZK
GOTENBURG	286	SASB
MALMOE	470	SASC
STOCKHOLM	428	SASA
SUNDSVALL	545	SASD
ITALY		
ROME	434	JRO
RUSSIA		
MOSCOW (CENTRAL)	1,450	RDW
,, (SOKOLWIKI)	1,010	——
WARSAW	385	PTR
LENINGRAD	920	——
REVAL	425	——
AUSTRIA		
GRAZ	404	——
VIENNA	530	——

Name of Station	Wave-length(s)	Call Sign
SWITZERLAND		
GENEVA	1,100	HB 1
LAUSANNE	850	HB 2
ZURICH	515	——
AMERICA		
SCHENECTADY	380	WGY
EAST PITTSBURG	309 64	KDKA
NEW YORK CITY	492 405 455	WEAF WJY WJZ
WESTINGHOUSE	536	KWY
OAKLAND	312	KGO
SPRINGFIELD	331	WBZ
OMAHA	526	WOAW
JOHN WANAMAKER	508·2	WOO
AMERICAN TEL. CO.	492	WEAF
RADIO CENTRAL	467	KFI
AMERICAN RADIO CO.	394	KFQX
WILLARD STORAGE BATTERY	389	WTAM
KANSAS CITY STAR	365·5	WDAF
RADIO LIGHTHOUSE	286	WEMC
AUSTRALIA		
MELBOURNE	1,760 1,720	7 ZL 3 LO
PERTH	1,250	6 WF
SYDNEY	350	2 BL
CANADA		
MONTREAL	411	CNRM
AFRICA		
CAPETOWN	375	WAMG
DURBAN	450	——
JOHANNESBURGH	400	JB
INDIA		
BOMBAY	375	2 FV

BROADCASTING IN THE UNITED STATES IN 1925

By MARTIN P. RICE

Director of Broadcasting for the General Electric Company

High Power Stations.

BROADCASTING in the United States entered the super-power stage of development on 26th July, 1925, when WGY of Schenectady, New York, transmitted a programme on 50 kilowatts of power.

This test, as well as others which followed in August and September, conclusively proved that high power, if skilfully handled, results in increased volume, reduced static, less fading, and reliable reception over a much greater territory. Several tests were conducted at the request of the United States Department of Commerce, for the purpose of determining whether high-power would blanket the air and prevent reception of stations using lower power, as had been predicted by some engineers and feared by many listeners. The entire country became a great laboratory, and every set-owner was asked to report on reception. A survey of the letters received showed that the 50 kilowatts signals were sharp, of good quality and volume, and easily detuned, even within a five mile radius of the transmitter.

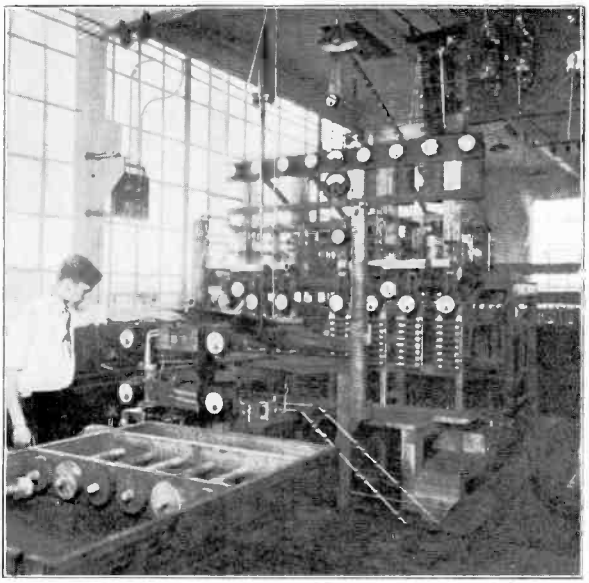
The super-power transmitter of WGY is located at the 54 acre transmitter laboratory of the General Electric Company, probably the largest laboratory in the world devoted exclusively to the problems of radio transmission. It is provided with equipment for determining the transmission characteristic of wavelengths from 5 metres to 3,000 metres, at powers from 5 watts to 100 kilowatts. In addition, there are many antenna structures, so that the best type of radiator can be determined for the various wavelengths.

From this laboratory the programmes of WGY have been broadcast daily, except Sunday, on 41·88 metres, 109 metres, and 1,560 metres. Listeners on the 41·88 metres signals have reported reception in Pretoria, South Africa, and Auckland, New Zealand, during daylight hours.

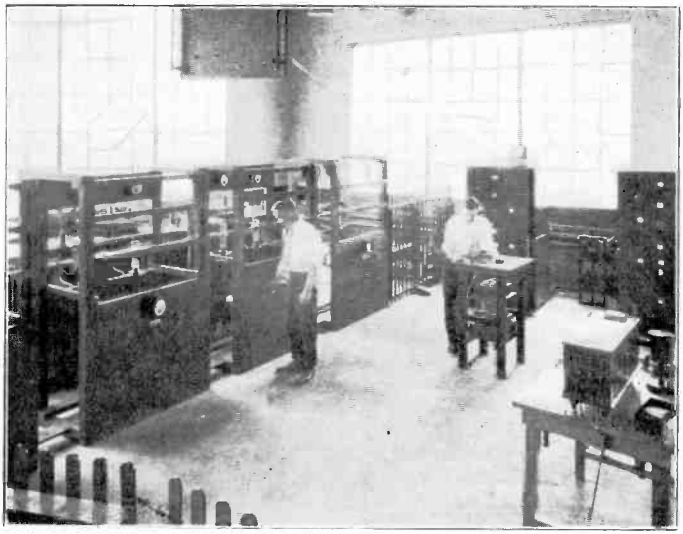
The Radio Corporation of America opened a 50 kilowatt broadcasting station late this year. In addition to the super-power stations of the Radio Corporation of America, and the General Electric Company there are twenty-three stations licensed to operate on from 1½ to 5 kilowatts.

International Broadcasting.

International broadcasting has always held a great fascination for the listener, and when in March, 1925, WGY of Schenectady



DEVELOPMENTAL 50 KW. TRANSMITTER OF 2ZY
GENERAL ELECTRIC CO.'S STATION, NEAR SCHENECTADY, N.Y.



MODULATOR UNIT 2ZY'S SUPER-POWER TRANSMITTER

and WJZ of New York rebroadcast the signals of the British Broadcasting Company's station at Chelmsford, England, and crystal set owners near those American stations were privileged to hear the tone of Big Ben, and the music of the Savoy Band, interest in the foreign stations was quickened. This coming winter and spring, it is expected that 5XX of Daventry, and the German station at Herzogstand, Bavaria, will both be rebroadcast in the United States.

The Crowded Ether.

In the United States to-day the greatest problem is the assignment of wavelengths to all those who believe they have something to offer in the already crowded ether. Herbert Hoover, Secretary of the Department of Commerce, under which broadcasting matters are administered, called a conference for the purpose of threshing out these difficulties in a way that will be fair to all concerned.

On 31st August, 1925, there was a total of 563 licensed broadcasting stations in the country, divided as follows: Class A, 453; Class B, 107; Class C, 1, and Class D, 2. 31st December, 1924, there were 538 stations divided into class A, 423; Class B, 68; Class C, 45, and Class D, 2. During 1924 199 new stations were licensed and 174 were discontinued.

Under regulations prevailing during 1925, broadcasting was confined to a waveband from 545 to 200 metres. A separation of ten kilocycles is preserved between stations in the same time-zone, but with 563 stations in operation it has been necessary to give two or more stations the same wavelength. Confusion is avoided, to some extent, by assigning the same wavelength to stations widely separated, geographically.

In connection with investigation in radio relay, engineers of the Westinghouse Electric & Manufacturing Company succeeded in rebroadcasting signals of KDKA of Pittsburg, by KFKX of Hastings, Nebraska, using the same frequency on the relay as on the original signal. It is proposed, by this method, to avoid the use of wire lines between stations and also conserve wavelengths.

How the Wavelengths are Controlled.

Because of the large number of stations on the air it becomes increasingly important that stations hold closely to their assigned wavelength, as deviations frequently cause interference. Engineers of the General Electric Company and the Westinghouse Company have developed the Piezo crystal as a means of holding radio-frequency constant. WGY was the first broadcasting station in the United States to adopt the crystal as part of its transmitter equipment.

During the past year there has been a wide expansion of wire networks. The American Telephone & Telegraph Company has connected from twelve to fifteen broadcasting stations by wire, and conveyed programmes from WEAF, New York, to each of the connected stations. Among the best known networks is that of WJZ, New York, WRC, Washington, and WGY of Schenectady. Feature events, originating in or near any of these stations, are broadcast by all of them. This fall, WGY increased its programme territory by connecting its Schenectady studio by wire with Buffalo, Rochester, Syracuse, and Utica, all populous New York State cities.

Notable Events of the Year.

From the standpoint of the listener, the leading programmes of the year were the summer concerts of the New York Philarmonic Orchestra, United States Marine Band, United States Army Band, special programmes by artists of the two leading recording companies, Victor & Brunswick-Balke-Collender Co. Among the outstanding events were the world series baseball games, a report from a motor-boat of the inter-collegiate regatta at Poughkeepsie, New York, a report from airplane of the race of a speed boat against the running time of the Twentieth Century, a crack train of the New York Central, between Albany and New York, a distance of 150 miles. Descriptions of leading football games were also broadcast.

There has been a general refinement in studio appointments. The condenser microphone has come into much more general use, being preferred to the carbon type of pick-up because of its freedom from hiss and its superior production on all frequencies.

Marked improvement was made this year in the lines of receivers available to the listener. The super-heterodyne receiver continues to be most sought after, and a leading company has introduced sets which operate from the lighting mains, requiring no batteries. Of particular note was the introduction of a new loud speaker constructed on the cone principle. This speaker provides distortionless reproduction at volume equal to that of an orchestra, and gives an acoustical range never before attained by a loud speaker.

20,000,000 Listeners.

Broadcasting begins its fourth year in the United States with unabated popularity. The Department of Commerce estimates that there are now 20,000,000 listeners in the country, and that 5,000,000 homes are equipped with radio receivers. Radio is only just beginning to gain popularity on the farm. A survey of farming sections of the country shows that nearly half a million sets are in use, and that this number is growing rapidly.

PERIODICAL LITERATURE

Below are given particulars of various publications, all of which publish articles or information of interest in connection with wireless work, either professional or amateur. Several of these journals are devoted exclusively to wireless, but each views the subject from a different angle.

Amateur Wireless. Weekly. Price 3d. Published by Messrs. Cassell & Co., Ltd., La Belle Sauvage, Ludgate Hill, E.C.4. This deals with the subject of wireless reception from the point of view of the amateur who takes a keenly practical interest in wireless, or who is engaged in experimental work.

The Broadcaster and Wireless Retailer. Monthly. Price 1s. a copy. Twelve months' subscription, 7s. 6d., post free. Trade Paper. Subscription only. *Publishers*: Odhams Press, Ltd., 85-94 Long Acre, W.C.2.

Electrical Industries. Every Wednesday. Price 2d. 13–16 Fisher Street, London, W.C.1. Covers the whole of the electrical industry. Has a monthly supplement entitled *The Broadcasting Trader*. Published the first week in each month.

Electrical Times. Weekly on Thursday morning. Price 3d. Sardinia House, Kingsway, London, W.C.2. All branches of electrical engineering, including wireless.

The Electrician. Thursday afternoon for Friday. Price 6d. 6–8 Bouverie Street, London, E.C.4. Electrical engineering in all its branches. Special attention is paid to wireless developments in the second issue each month. The paper with an up-to-date news service on all electrical matters.

The Electrical Review. Weekly. Price 6d. Deals with the whole of the electrical industry, and contains both articles and news of special interest to radio engineers and traders.

Electricity. Every Friday. Price 2d. 36 Maiden Lane, London, W.C.2. All branches of electrical engineering, including telegraphy, telephony, and wireless.

Experimental Wireless. Monthly. Price 1s. Watergate Press Ltd., 19 Surrey Street, Strand, W.C.2. Of special interest to amateurs of all grades.

Irish Radio Journal. Fortnightly. Price 3d. 34 Dame Street, Dublin. The official organ of the Radio Association of Ireland.

Irish Radio Review. Monthly. Price 4d. 179 Great Brunswick Street, Dublin.

Irish Radio Trader. Monthly. Annual subscription 3s. 34 Dame Street, Dublin.

Modern Wireless. First of the month. Price 1s. Bush House, Strand, W.C.2. Wireless.

Nature. Dated Saturday of each week ; published on Friday of each week. Price 1s. St. Martin's Street, Leicester Square, W.C.2. The whole field of scientific work and progress, including both biological and physical sciences, the philosophy of science, technology in its scientific aspects, and the application of scientific methods to all public affairs.

Popular Wireless. *Editor :* Norman Edwards, M.Inst.R.E., F.R.S.A., F.R.G.S. Every Friday. Price 3d. The Fleetway House, Farringdon Street, E.C.4. The policy of the paper is to present to the reader an accurate, light, and not unduly technical survey of wireless in general, with practical constructional articles, essentially inexpensive to construct. The social side of broadcasting is also an important feature, as is also the "humour" of wireless. The scope may be said to be infinite and varied. Sir Oliver Lodge is scientific adviser to this journal.

Post Office Electrical Engineers' Journal. Quarterly : April, July, October, and January. Price 2s. Engineering Department, G.P.O., West, E.C.1, and 4 Ludgate Hill, E.C.4. The organ of the Institution of P.O. Electrical Engineers. Deals with British Post Office practice in all forms of signalling communications—telegraphy, telephones, and wireless—and electrical engineering generally.

The Radio Times. Every Friday. Price 2d. Messrs. George Newnes. Ltd., 8–11 Southampton Street, Strand, W.C.2. The official organ of the B.B.C. ; a non-technical magazine for "listeners," containing advance official programmes for the week.

The Radio Supplement. (Dominion and Foreign programmes.) Published every Friday. Price 2d. Messrs. George Newnes, Ltd., 8-11 Southampton Street, Strand, W.C.2. A companion journal to the *Radio Times* : devoted to the publication of programmes broadcast by stations throughout the world. This journal is intended to foster public interest in international broadcasting.

Telegraph and Telephone Journal. About first of month. Price 4d. G.P.O. North, London, E.C.1. Deals with the work, progress, and development of the telegraph and telephone (including wireless) services.

Wireless. Tuesday of each week. Price 2d. Bush House, Strand. W.C.2. Wireless.

The Wireless Dealer. Twelfth of the month. By subscription only. 7s. 6d. per annum, 1s. per single copy. Bush House, Strand, W.C.2. Wireless trade journal.

The Wireless Constructor. Fifteenth of the month. Price 6d. Bush House, Strand, W.C.2. Wireless.

The Wireless Magazine. Twenty-fifth of the month. Price 1s. Published by Messrs. Cassell & Co., Ltd., La Belle Sauvage, E.C.4. For the broadcast listener and the non-technical man who is interested in wireless : deals mainly with wireless as a form of entertainment. Contains articles and stories of general wireless interest and makes a feature of giving its readers particulars of all the latest developments.

The Wireless Trader. Incorporating *The Wireless and Allied Trades Review.* Weekly. Price 6d. post free. The Trader Publishing Co., Ltd., 139-140 Fleet Street. E.C.4. Everything for the wireless retailer, wholesaler, and manufacturer.

The Wireless Export Trader. Monthly. Price 1s. post free. The Trader Publishing Company, Limited. 139-140 Fleet Street, E.C.4. For the radio trade and industry all over the world.

Wireless Weekly. Every Wednesday. Price 6d. Bush House, Strand. London, W.C.2. Wireless.

Wireless World and Radio Review. Every Wednesday. Price 4d. Iliffe & Co., Ltd., Tudor Street, E.C.4. A journal devoted exclusively to wireless telegraphy and telephony, devoting special attention to the requirements of the amateur and experimenter.

B.B.C. STATION ADDRESSES

MAIN

Aberdeen. 15 Belmont Street. *Tel. No.* 2296.
Belfast. 31 Linenhall Street, Belfast. *Tel. No.* 5870–1.
Birmingham. 105 New Street. *Tel. No.* Midland 209–10.
Bournemouth. 72 Holdenhurst Road. *Tel. No.* 3460–1.
Cardiff. 39 Park Place. *Tel. No.* 2514–5.
Glasgow. 21 Blythswood Square, Douglas. *Tel. No.* 1192–4.
London. 2 Savoy Hill, W.C.2. *Tel. No.* Regent 6727.
Manchester. Orme Buildings, The Parsonage. *Tel. No.* City 9646–7.
Newcastle. 24 Eldon Square. *Tel. No.* Central 5865.

HIGH-POWER

Daventry. Borough Hill. *Tel. No.* Daventry 77.

RELAY

Edinburgh. 87 George Street. *Tel. No.* Central 9746.
Hull. 26–27 Bishop Lane. *Tel. No.* Central 6138.
Liverpool. 85 Lord Street. *Tel. No.* Bank 5018.
Plymouth. Athenæum Chambers, Athenæum Lane. *Tel. No.* 2283.
Sheffield. Castle Chambers, Castle Street. *Tel. No.* Central 4029.
Leeds-Bradford. Cabinet Chambers, Basinghall Street, Leeds. *Tel. No.* 28131.
Stoke-on-Trent. Majestic Buildings, Stoke-on-Trent. *Tel. No.* Hanley 1970.
Nottingham. 4 Bridlesmith Gate, Nottingham. *Tel. No.* 6944 and 6945.
Dundee. 1 Lochee Road. *Tel. No.* Dundee 5209.
Swansea. Oxford Buildings, Oxford Street. *Tel. No.* Swansea 3107.

BROADCAST RECEIVING LICENCES

On the 1st July, 1924, the new type of Wireless Receiving Licence became available on sale at a fee of 10s. per annum.

This licence will be issued to new applicants on and from that date, and will take the place of the existing broadcast, constructor's, and "Interim" Licences as they fall due for renewal. It will cover the use of any receiving set, provided that the set or parts are of British manufacture. In the case of existing "Interim" Licences it will also cover any apparatus—whatever its origin—which the holder of such licence was entitled to use. Heavy penalties are prescribed by the Wireless Telegraphy Act, 1904, on the conviction of the offence of establishing a wireless station without the Postmaster-General's Licence.

By command of the Postmaster-General.

LIST OF RADIO SOCIETIES

PRACTICALLY all the societies mentioned below are now affiliated with the Radio Society of Great Britain. Societies marked with an asterisk were affiliated prior to January, 1923. An examination of the list will show the strides which have been made since that date. Secretaries of those societies which are not already affiliated are invited to communicate with the Honorary Secretary, the Radio Society of Great Britain, 53 Victoria Street, London, S.W.1.

Radio Society of Great Britain. *Patron*, H.R.H. Prince of Wales. *Pres.*, Sir Oliver Lodge, D.Sc., LL.D., F.R.S. *Hon. Treas.*, Prof. E. Wilson, M.Inst.C.E., M.I.E.E. *Hon. Sec.*, Philip R. Coursey, B.Sc., A.M.I.E.E., F.Inst.P.

Aberdeen and District Wireless Society, 22 Gray Street, Aberdeen.
Ackworth School Wireless Society, Ackworth School, nr. Pontefract.
Aldershot and District Wireless Society—Queen's Avenue, Aldershot.
Appleby and District Radio Society, Appleby, Westmorland.
Aquarius Radio Society, 173 Rosebery Avenue, E.C.1.
Ashington and District Radio Society, 57 Seventh Row, Ashington, Northumberland.
Associated Equipment Co., Radio Club, Blackhorse Lane, E.17.
Aylesbury and District Radio Society, "Laburnham," Stoke Mandeville. Aylesbury, Bucks.
Ayr and County Radio Society, 23 Woodfield Avenue, Ayr.
Barnet and District Radio Society, "Sunnyside," Stapylton Road, Barnet, Herts.
Barnsley and District Wireless Association, 28 Park Grove, Barnsley.
Bath Radio Club, 6 Pierrepont Street, Bath.
Battersea and District Radio Society, 31 Holden Hill, Lavender Hill, S.W.11.
Bedford Physical and Radio Society, 48 Goldington Avenue, Bedford.
Belvedere and District Radio and Scientific Society, 110 Bexley Road, Erith, Kent.
Bergens Radio Amateur Club, Bergen, Norway.
Berkhampstead Wireless Society, 19 Lower King's Road, Berkhampstead.
Bermondsey Radio Society.
Berwick-on-Tweed Wireless Society, 24 Bruce Gate, Berwick.
Birkbeck College Radio Society, Bream's Buildings, E.C.4.
Birkenhead Radio Society, 24 Shrewsbury Road, Birkenhead.
Birmingham Experimental Wireless Club, c/o Lancaster Bros. & Co., Shadwell Street, Birmingham.
Bishop's Stortford and District Amateur Wireless Association, Halfacres, Bishop's Stortford, Herts.
Blackburn Radio and Scientific Society, Spring Bank, Limefield, Blackburn.
* Blackpool and Fylde Wireless Society—*Hon. Sec.*, C. Sheffield Doog, 7 Seventh Avenue, South Shore, Blackpool.
Bolton Wireless Society—*Hon. Sec.*, O. Stott, Moss Bank House, Smithills, Bolton.
Boots Radio Society, Welfare Department, Station Street, Nottingham.
* Borough of Tynemouth Y.M.C.A. Radio and Scientific Society—*Hon. Sec.*, "Eynesbury," Cleveland Road, N. Shields.

Bournemouth and District Radio Society, Canford Hall, St. Peter's Road, Bournemouth.

Bournemouth and District Radio Club—*Hon. Sec.*, T. H. Dyke, 2 Iris Road, Winton.

Bournville Radio Society, c/o Cadbury Bros., Ltd., Bournville, Birmingham.

* Bradford Wireless Society, 14 Bankfield Drive. Shipley, Yorks.

Bradford-on-Avon Wireless Society—*Hon. Sec.*, H. Helps, 4 Ivy Terrace, Bradford-on-Avon, Wilts.

* Brighton Radio Club—*Hon. Sec.*, D. F. Underwood, 68 Southdown Avenue, Brighton.

Brighton and Hove Radio Society, 68 Southdown Avenue, Brighton.

Bristol and District Radio Society, 6 Wood Leaze, Sea Mills, Bristol.

* Bristol and District Wireless Association—*Hon. Sec.*, 10 Priory Road, Knowle, Bristol.

Bristol and District Radio Society, 46 Cotswold Road. Bedminster, Bristol.

Bromley Radio and Experimental Society, 73 Masons Hill, Bromley, Kent.

B.T.H. Radio Society, The B.T.H. Recreation Club, The British Thomson Houston Co., Rugby.

Buckman Radio Society, 2/4/6 Whitechapel Road, E.1.

Burnham, Highbridge and District Wireless Society, 52 High Street, Burnham-on-Sea.

Burnley and District Radio Society, 13 Park Avenue, Burnley, Lancs.

Burton-on-Trent Wireless Society—*Hon. Sec.*, 66 Edward Street, Burton-on-Trent.

Brussels Radio Club, 26 Rue de la Croix de Fer, Brussels.

Cambridge and District Wireless Society, 102 Burrell's Walk, Cambridge.

* Cambridge University Wireless Society—*Hon. Sec.*, Gonville and Caius College, Cambridge.

* Cardiff and South Wales Wireless Society—*Hon. Sec.*, 37 Colum Road, Cardiff.

Carmarthen and District Radio Society, 9 Hall Street, Carmarthen.

Caterham and District Radio Society, Doddington, Caterham Valley.

Cheltenham and District Wireless Association, "Netherseal," Winstonian Road, Cheltenham.

* Cheltenham Wireless Association—*Hon. Sec.*, Winchcomb Street, Cheltenham.

Chesterfield and District Radio Society, Beetwell Street, Chesterfield, Derby.

Cirencester Wireless Society, X-Ray Department, Memorial Hospital, Cirencester.

* City and Guilds Wireless Society—*Hon. Sec.*, Exhibition Road, London, S.W.7.

Cornhill Radio Club, 54 Leadenhall Street, E.C.3.

County of London Electric Supply Co., Ltd.. Wireless Society, 126 Hill Street, Peckham, S.E.

Coventry and District Wireless Association—J. E. Bolus, 14 Coundon Road, Coventry.

Cowes and District Radio and Research Society, Llangollen, Alexandra Road, Cowes, Isle of Wight.

* Cowes and District Radio Society—*Hon. Sec.*, 1 Mill Hill Road, Cowes, I.O.W.

Cricklewood and Brondesbury Radio Society—*Hon. Sec.*, C. N. Green, 213 Fordwych Road, Cricklewood, N.W.2.

* Croydon Wireless and Physical Society—*Hon. Sec.*, c/o H. T. P. Gee, 51 Chancery Lane, W.C.2.

* Dartford and District Wireless Society, 146 Station Road. Crayford. Kent.

Darwen Wireless Society, 8 Hawkshaw Avenue, Darwen.

Denton and District Wireless Society, 7 Westminster Avenue, Reddish, Stockport.

* Derby Wireless Club, 26 Curzon Street, Derby.
Derby Railway Institute Radio Society, Derby Railway Institute, Derby.
Devizes Radio Club, Woodhayes, Parrs Lane, Devizes.
Dewsbury and District Wireless Society, 1 Ashworth Place, Dewsbury, Yorks.
Dick Kerr Wireless Society, Ashton Park, Ashton-on-Ribble, Preston.
Doncaster and District Radio Society, 18 Strafford Road, Doncaster.
Dorking and District Radio Society, High Street P.O., Dorking.
Dublin Wireless Club, 29 South Anne Street, Dublin.
Dumfries and District Radio Society, 41 English Street, Dumfries.
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Holy Trinity Meccano and Radio Clubs, 15 Thornhill Houses, Thornhill Road, N.1.
Hornsey and District Wireless Society, 188 Nelson Road, Hornsey, N.8.
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Huddersfield Radio Society, Glen Avon, Cottingham Road, Huddersfield.
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Malvern Wireless Society, The Laboratory, Worcester Road, Malvern.

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North West Manchester Radio Society, "Newholme," Albyn's Avenue, Cheetham Hill, Manchester.

Northampton and District Amateur Radio Society, 51 College Street, Northampton.

Northampton and District Amateur Radio Society, 79 Knight's Lane, Kingsthorpe, Northampton.

North Lincolnshire Wireless Society, 323 Cleethorpes Road, Grimsby.

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Southend and District Radio Society, Eastwood House, Rockford, Southend-on-Sea.
South Hams Radio Society, The Ropewalk, Kingsbridge, Devon.
South London Wireless and Scientific Society, St. John's Institute, S.E.17.
* South London Wireless and Scientific Society—*Hon. Sec.*, St. John's Institute, Larcom Street, S.W.17.
South Shields and District Radio Club, 66 Salmon Street, South Shields.

Southampton and District Radio Society, "Grimston," Wood Mill Lane, Bitterne, Southampton.

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Stockport Wireless Society, 30 Gt. Portwood Street, Stockport, Lancs.

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St. Bride Radio and Experimental Society, 15 Larkhall Lane, S.W.4.

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St. Pancras Radio Society, 7, Eton Villas, Haverstock Hill, N.W.3.

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* Sunderland Wireless and Scientific Association—*Hon. Sec.*, Westfield House, Sunderland.

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Swansea and District Radio Experimental Society, 100 Bryn Road, Swansea.

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Trowbridge Radio Association, Bridge House, Trowbridge, Wilts.

Tunbridge Wells and District Wireless Society, Ovenden House, Tenterden, Kent.

Tynemouth (Borough of) Y.M.C.A. Radio and Scientific Society, Y.M.C.A. Buildings, Bedford Street, North Shields.

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Workington and District Radio Society, 21 Belle Isle Street, Workington.
Wrexham and District Wireless Society, Maesgwyn Cottage, Maesgwyn Road, Wrexham.
Yeovil and District Radio Society, "Kismet," Sherborne Road, Yeovil.
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AMATEUR AERIALS AND EARTHS

By Dr. J. A. Fleming, F.R.S.

As one travels about in train or tram in the neighbourhood of large towns it is impossible not to notice the immense number of wireless aerials attached to houses. Whole rows of semi-detached villas or terrace houses in the suburbs of London one after the other display this sign that within resides one or more eager listeners-in. It gives one a very enhanced sense of the degree to which telephonic broadcasting has become a factor in modern life, relieving the monotony of labour and affording the opportunity of hearing interesting speeches by celebrities or music which would never otherwise fall on ears oppressed with the din of city life.

What the Aerials Show.

It is clear, however, from the manner in which these aerials are arranged that the majority of their owners know very little about radio work as a science. All they are interested in is to pick up as best they can what is passing over them, and they care very little about the processes by which this modern marvel of broadcasting is performed.

The Functions of Aerial and Earth.

Nevertheless, whether the proprietor of the receiver is the owner merely of a home-made crystal set, or of an expensive multi-valve apparatus made by some eminent firm, he ought to desire to obtain the best results from it. This he cannot do unless he pays a little intelligent attention to his aerial and earth, and understands what are their functions.

Generally speaking, the impression given by most amateur aerials is that their arrangement is determined far more by that of the chimney pots on the house or the convenient position for the pole in the back garden than by the strict requirements of theory. Whilst one can often see at a glance the defects of the aerial it is not possible to inspect those of the "earth," which are too often quite as important. Even the entirely unscientific amateur should therefore take some trouble to understand what the best or desirable arrangements of aerial and earth are, and then approximate to them as closely as circumstances allow.

In the first place it should be clearly understood that the duty of the aerial is to catch and absorb a certain kind of radiation or

waves sent out from the broadcasting station called electric waves. With ut entering on any abstruse discussion as to the nature of these waves, we can say that when they strike the aerial they produce in the wire very rapid to and fro but feeble electric currents in it which are called electric oscillations. In order that these currents or movements of electricity may take place, there must be some place into which they can flow both at top and bottom of the aerial.

Why an Earth Connection is Necessary.

Electricity behaves just like an incompressible fluid such as water, and water cannot move in a pipe unless that pipe ends in some cistern, reservoir or vessel into which the water can flow. Hence, the aerial wire is connected at the bottom to the earth and at the top to what is called the capacity. The vertical part of the aerial wire is therefore the chief wave-catching part, and the horizontal part at the top is the capacity.

The Importance of "Proportion."

It is, therefore, important to so arrange the aerial that these two parts are in proper proportion. One often sees an aerial constructed of a very long horizontal wire stretched at a low height over a garden to a pole at the end, and a very short vertical part close to the wall of the house. This is quite wrong.

Isolation.

Then, again, another common defect is as follows: If a wire has in it high-frequency electric currents, and if it is placed near to another conductor such as a metal pipe or to damp brickwork, then the currents in the wire create other induced or secondary currents in the conductor, and this absorbs energy and tends to damp out or weaken the currents in the aerial wire. Accordingly, no part of the aerial, whether the horizontal or vertical part, should be very close to a wall or roof. In constructing his aerial the amateur should therefore keep all the wire at least a yard or more away from walls or roofs or trees, except just where it enters the house.

The Most Suitable Form of Post Office Aerial.

The horizontal part of the aerial should not exceed in length the vertical part if possible. The user has 100 ft. of wire, by Post Office rules, and the amount of vertical height he can command is limited by the height of chimneys or poles which he can erect. The most suitable form is a T aerial in which the flat top of the T is formed, say, of two wires in parallel and about 4 ft. apart, and the vertical part of a single wire connected to both of them at the

centres. Suppose that 40 ft. of vertical height can be obtained, then the aerial might be formed of 40 ft. vertical wire and two horizontal flat tops of 30 ft. each.

Location of Aerial.

Another matter, not without importance, is the direction in which the broadcasting station lies which it is desired to pick up. It is desirable that the aerial should be erected on that side of the house which faces the broadcasting station, as in that case there will be less absorption of wave energy due to pipes, wires and steel joists in the house itself.

The Earth Connection.

Next, with regard to the earth, it is not a good plan merely to attach a bit of wire to the nearest water tap ; since water pipes are screwed together and joints made with red lead or some such material, the resistance to earth from the tap is far from negligible. It is better to form a good private earth, if possible, by burying a large plate of zinc in damp ground. This may best be done with a 4 ft. length of zinc rain-water pipe with two turned-up ends at right angles. A dozen holes are bored in both sides of the tube and it is buried in the earth a couple of feet underground with the middle part horizontal. Water can then be poured in at the turned-up ends, which protrude above ground, and this runs out at the holes and keeps the earth round the zinc tube damp. A good connection should be made with this plate by stranded tinned copper wire soldered to the zinc tube, and this should be brought into the house through an ebonite or porcelain tube let into the wall. It is also necessary that the lead-in wire of the aerial should be well insulated from the house and brought in through an ebonite tube, not too thin in the walls.

It is possible to test the resistance of an " earth," but only when we have three similar " earths " not too near to each other.

Summary.

We may sum up the conditions to be complied with, as far as possible, as follows: Assuming the amateur wishes to pick up one of the British broadcasting stations which, with the exception of Daventry, have wave-lengths approximating to 400 metres, the best results would be obtained with an aerial having a natural wave-length of about 120 to 150 metres.

If a single vertical wire could be employed this would require a wire 30 metres in length, but as this is not generally practicable, the next best way is to divide the available 100 ft. of aerial wire into three parts, one 40 ft. long for the vertical part and two of 30 ft. each. Use the two 30 ft. lengths in parallel for the flat top,

keeping them about 4 ft. apart by wood spreaders, and connect them at their middle points to the 40 ft. length as down lead.

Support the flat top by insulators at least 3 yards above any roof, and bring the down lead into a window through an ebonite tube let into the window-frame. Bring in the earth lead through another tube, and do not forget a short-circuiting switch which shoul be placed outside the house to connect the aerial directly to earth when not in use, and so protect from damage by lightning.

WORKSHOP RUST

By J. SWINBURNE, F.R.S.

An Amazing Figure.

IT has been estimated that the world's loss is £500,000,000 a year through the rusting of iron.

A small portion of this goes on in the amateur's workshop, where tools, work, screws, and nails get rusty. If tools could be kept very dry they would not rust. The only workshop I have ever seen that was quite dry belonged to the late Mr. Samson Fox, of the Leeds Forge. It was kept warm by hot pipes, but it may have been damp in summer.

The Causes of Rust.

The chief enemy seems to be organic matter. If a polished tool, such as a saw, is left out for some time it will rust on the upper face, while the lower may be quite untouched. The rust on the upper face has been started by the dust that settled on the steel. Again, a watch will go for years even at sea without getting rusty. The steel parts are covered by a very thin film of oil; but steel, slightly greased, will rust if left out in an ordinary workshop. The steel parts of a watch are also generally highly polished, and that seems to be a great protection.

Preventive Methods.

The effects of organic matter, especially cellulose, are very familiar in the rusting of a needle, in spite of its polish, when left in calico. Tools should therefore not be put away in drawers resting on wood, or still worse, paper, unless it has been paraffined. Screws should be taken out of the brown paper packings. It is a good plan to collect small tins, or better, wide mouth bottles, such as the screw-top honey or jam bottles, and to store screws and nails in them.

There are two problems: to keep tools from rusting, and to restore them when rusted.

If the surfaces are continually being rubbed by the fingers, or by the work, merely greasing with petroleum jelly is of little use. Petroleum jelly is very disappointing as a protection even if not rubbed off. Varnishes and lacquers soon come off. The best method I know is to boil the articles in phosphoric acid dissolved in plenty of water. After some time the surface gets greenish black. It is then washed well, dried, and heated well above 100° C., and then coated with boiled oil, or any adherent varnish.

A Varnish Recipe.

As a protection to surfaces that are not rubbed, there are many varnishes. Celluloid, for instance transparent handles of tooth brushes dissolved in ten times their weight of equal parts of acetone and amyl acetate, makes a fair varnish, which is generally useful.

Proprietary Varnishes.

There are many special varnishes on the market, but I have tried very few of them. "Noxidise" and "Sozal" are both better than celluloid. Sozal has a good record, as it was used by the Air Board. They dipped aeroplane engines into it. It comes in tins, and should not be bottled. It is said to be lanolin dissolved in trichlorethylene. Some time ago I used trichlorethylene kept in a bottle, for cleaning the oil out of some watches on which I was experimenting, and three of the hair-springs rusted afterwards. I found that light decomposes the liquid, and sets hydrochloric acid free. All the same, I use Sozal very dilute for watches, but it is not left exposed to light.

A polished surface does not rust so quickly. A new surface, as left by the file or emery paper, rusts easily.

Removing Rust.

When steel or iron articles are rusty they can be cleaned with acid or alkali. Sulphuric acid soon removes rust, and, after washing, the last remains of the acid can be killed with a little barium hydrate. But the surface is very apt to rust; in fact, it is nearly impossible to dry it without rust. I generally put them while wet into paraffin with a little heavy oil in it, and fry them up to 140° or so, so as to get the water out thoroughly, and to fill the "pores" with oil. Screws treated this way do not rust again easily. One might suppose that the rusting is due to traces of acid, or salts. For that reason I avoid hydrochloric acid, and barium sutelpha can hardly be a rust producer. Rusty iron can

be cleaned in caustic soda with some bits of zinc or aluminium to set up local action ; but cleaned this way it is just as ready to rust.

Other Destructive Agents.

The moral is that all tools should be kept under cover, not because drawers or boxes are drier inside than out, but because dust does not settle on them. Paring chisels ought to be locked up in a thick safe to keep off women-kind. They are as difficult to keep off as white ants in India. No one knows what they do with a chisel ; most likely they turn screws to the right to open a box, or they try to prise nails out of packing cases, or weeds out of a crazy pavement.

If a little rust has to be removed, glass-paper is better than emery, as it is hard enough to scratch the rust, but does not grind off much steel.

Rusting is not only a question of polish, of organic dust, or of moisture. In organs iron or steel in the wind trunks is apt to rust. The screws that hold the covers on to wind-chests are rusted where the wind leaks past them.

Those who do chemical work in their workshops know that the least trace of hydrochloric acid, or chlorine in the air, will start up rust. But sulphuretted hydrogen, or sulphur dioxide are nearly as bad. In many country places the gas has enough sulphur to cause rust, especially if much is used without a chimney, as in a large blow-pipe, or an injector furnace.

AMATEUR TECHNICAL PROGRESS

By THE EDITOR OF *Popular Wireless*

The Super-Heterodyne.

THE surprising thing about radio in 1925 is that the super-heterodyne is not so popular as was generally anticipated. At the moment of writing—when 1925 is entering on its last phase—the super-heterodyne is regarded with a certain amount of suspicion and distrust by the vast majority of amateurs in this country.

Of course, there are a few hundreds of amateurs who have built super-heterodynes, but the number is infinitesimal compared to those who have built Reflex, Unidyne, "straight," and other types of sets.

And, although prophecy in radio is a dangerous thing, I would venture to forecast that the super-heterodyne will still hang fire in 1926, unless some radical alterations concerning it are made.

First, the price of even the six-valve super-heterodyne is beyond the means of thousands of amateurs, and second, the super-heterodyne (rightly or wrongly) has a reputation for being very cantankerous in the hands of the average amateur.

When they are handled skilfully, there is no doubt that super-heterodynes are extraordinarily satisfactory—but for general broadcast use they will never command a really big market until their operation is considerably simplified, and their cost lowered.

Reflex Circuits.

In the meantime, Reflex circuits still retain a larger amount of popularity than I expected at this stage in the development of amateur radio work, while on the other hand, I cannot help feeling glad to note that there is a steadily increasing interest and ever-growing band of amateurs who swear by the Unidyne circuits, or H.T.-less circuits.

The Unidyne.

In October, 1925, the inventors of the Unidyne—Messrs. Dowding & Rogers—designed a new circuit for H.T.-less reception, a diagram of which is shown in Fig. 1. This circuit has many advantages over the original Unidyne circuits, and is both powerful and selective.

A Super-Selective Circuit.

Writing of selective circuits, reminds me of a most interesting American circuit which came to my notice a few months back.

Space will not permit a discussion of its merits, but I unhesitatingly recommend it to amateurs who are troubled by interference, and who want a really selective one-valve.

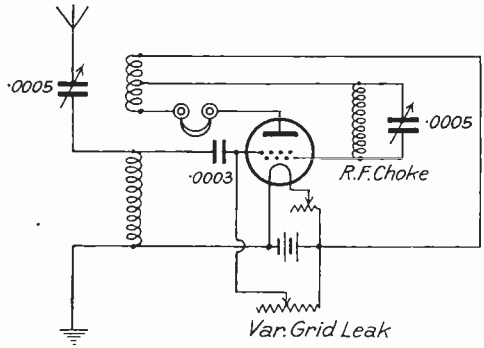


FIG. 1.—THE UNIDYNE CIRCUIT FOR H.T.—LESS RECEPTION

Perhaps it is only fair to say that this "super-selective" set is rather tricky to handle, but I am confident that the average amateur could master its "funny ways" by spending a patient

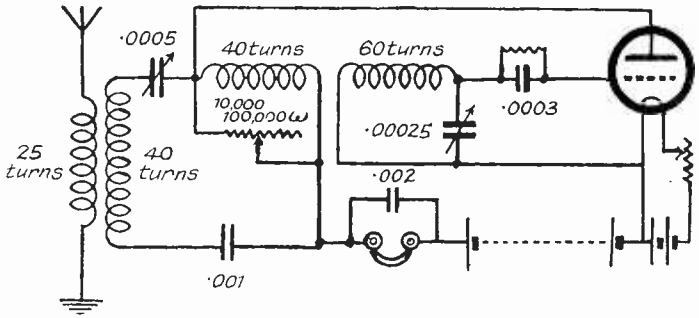


FIG. 2.—THE SUPER-SELECTIVE CIRCUIT

hour or two in studying its control. I myself have worked this set within one mile of 2LO; have cut out that station by a movement of a vernier condenser, and have brought in Bournemouth without a trace of interference from 2LO. What more can one say in praise of its selective properties? (*See* Fig. 2.)

During 1925 the practice of naming various sets with distinctive

names has spread widely, and indeed, one would have to keep a day-by-day diary to note all the circuits, old, rehashed, modified, new, partly new, etc., which have been given publicity in 1925.

Nevertheless, the variety of circuits now open to the constructor to choose from is not a bad thing: it offers, for example, a never failing source of interest and acts as a very great stimulant to amateurs who are always out to "go one better."

"Low Loss" Components and an Amusing Error.

Perhaps the chief craze in 1925 has been the "low loss" craze. This became a slogan, which was quickly taken up by the radio trade, until the words "low loss" looked like becoming the be-all and end-all of amateur radio.

One go-ahead advertiser even went so far as to boost a low-loss rheostat! The square low condenser had a vogue, but a much more sedate one than the low-loss campaign, and, in fact, seems to have taken a more permanent place in amateur radio technique.

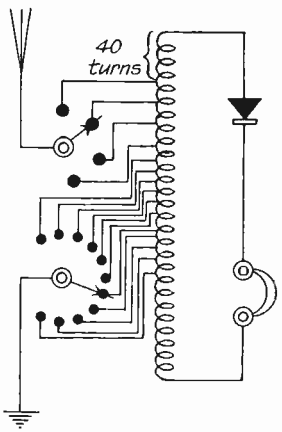


FIG 3.—THE ULTRA CRYSTAL SET

Progress in Valves.

As regards valves, 1925 saw a sudden cut in prices of both dull and bright emitters, and the advent of a whole host of new types for detection, H.F., L.F., and power amplification work, with the result that to-day the amateur has a most varied list of various makes, types, etc., of valves to choose from. The "surprise" of 1925 valve progress is not a very outstanding one: the best I can think of is the progress made in the ·01 volt types of dull emitters.

Crystal Sets.

Crystal circuits have, of course, retained a very large measure of popularity, owing to the permanent erection of 5XX at Daventry. A circuit which has proved extremely popular is shown in Fig. 3.

As for crystals themselves, they continue to enliven the advertisement pages of the radio journals, but, one is glad to note, super-extravagant claims are seldom made for even crystals with the most attractive of names. For quite a long time I have not seen

a crystal advertised to " receive all the B.B.C. stations." This is a good sign.

Loud Speakers.

Loud speakers are going to prove more and more popular in 1926. Messrs. Amplions, Brown's, Celestion, Brandes, T.M.C., Sterling, and many others, continue to produce new models, each an improvement on the last and a credit to the designers, while equally good progress has been made in the design of L.F. transformers and condensers.

Amateur Work on Short Waves.

To attempt to outline, however briefly, the " DX " and other records set up by British amateurs would take up many pages, but mention must be made of the excellent work done by Marcuse, Simmonds, Goyder, and others, in transmitting speech and morse over great distances on low-power and short wavelengths. Mr. Simmonds especially deserves mention for his record in establishing two-way telephony communication with Australia.

METHODS OF COUPLING VALVES IN AMPLIFIERS

By Prof. G. W. O. Howe, D.Sc., M.I.E.E.

The Meaning of Efficiency.

The efficiency of any piece of apparatus is defined as the ratio of the useful output to the total input; it is necessary to say "useful" output because all the input ultimately comes out in some form or other. In a transformer the power is put in as alternating current and the useful output comes out in the same form, but smaller in amount, the difference appearing as heat in the copper and iron. In an electric lamp the input is in the form of electric power, whereas the useful output is that portion of the radiated heat which happens to be of a frequency capable of giving the sensation of light. In a loud speaker the input is in the form of an alternating current of audible frequency and the useful output in the form of sound waves in the air. No scientifically trained person ever expected to get more energy out of a piece of apparatus than is put into it; such a result would be contrary to the principle of the conservation of energy. At first sight, however, the valve amplifier appears to accomplish this feat, since a very small amount of power put into the grid circuit in the form of alternating current produces in the anode circuit a relatively large amount of power in the form of an alternating current of the same frequency. The valve differs radically from a transformer, however, in having other sources of power, viz., the filament and anode batteries, and, strictly speaking, the anode battery should be regarded as supplying the input to the valve. The valve converts the continuous current power supply into alternating current power to an extent depending on and controlled by the potential changes of the grid. The valve is therefore a converter rather than a transformer, but a converter in which the frequency and amplitude of the output are controlled by the frequency and amplitude of the potential applied to the grid. It is desirable that, when used as an amplifier, the alternating current output should follow faithfully the variations of the control, so that the voltage impressed on the grid of the succeeding valve should bear a fixed ratio to that impressed upon its own grid, irrespective of amplitude and frequency; it is also desirable that this ratio should be as large as possible with the smallest possible supply of power either to filament, grid, or anode.

To Avoid Distortion Due to Valves.

So far as the valve itself is concerned, faithful reproduction without distortion is easily ensured by adjusting the grid and anode voltages so that the normal steady anode current is at the mid point of the straight portion of the characteristic curve. The valve should be so designed that this can be done with such a negative potential on the grid that no current is taken by the grid beyond the very small alternating current taken to charge the capacity of the grid. If the amplitude of the alternating current superposed upon the steady anode current is excessive, then the resultant current will approach zero at one end and the saturation current of the valve at the other end and the reproduction will be no longer proportional.

A valve may be used as an amplifier of the radio-frequency currents before their rectification by the detector, or it may be used to amplify the audible-frequency currents produced by the detector. The principles are the same in either case, but the numerical details necessarily differ.

Conditions for Good Amplification.

An amplifying valve may operate a telephone receiver or loud speaker, or it may be followed by another amplifying valve, the grid of which takes no current. In the former case the anode circuit must supply alternating current power to the device which is being operated, whereas in the latter case the anode circuit has merely to supply an alternating voltage to the grid of the next valve. As a matter of fact, there is little distinction between these two cases, since the alternating voltage can only be produced across some power-absorbing device inserted in the anode circuit.

The valve of an amplifier may be regarded as an alternating current generator in the anode circuit, producing in this circuit an E.M.F. of the same frequency as the P.D. applied to the grid, and equal in amount to m times this P.D., where m is a constant called the amplification factor, depending on the characteristics of the valve. The alternating current produced in the anode circuit will be inversely proportional to the total impedance of this circuit which is made up of the internal resistance of the valve itself, and the resistance or impedance of whatever external device is inserted in the circuit. To obtain as large a fraction as possible of the alternating E.M.F. generated in the valve, across the external apparatus, it is necessary that the resistance or impedance of this external apparatus should be large compared with the internal resistance of the valve.

Classification of Amplifiers.

Amplifiers are usually classified according to the apparatus inserted in the anode circuit with the object of coupling the successive valves, that is, of causing the variations of anode current of one valve to impress variations of potential on the grid of the next valve. The usual types are—Resistance ; Reactance : Tuned Reactance ; and Transformer.

Resistance Coupling.

In a resistance coupled amplifier a non-inductive resistance is inserted in the anode circuit, and the variations in the P.D.

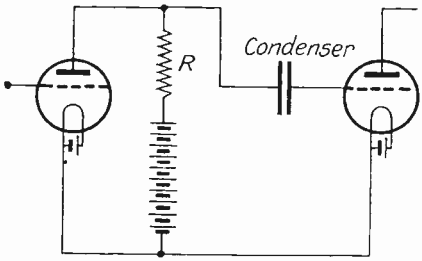


FIG. 1.—RESISTANCE COUPLING

across it are impressed upon the grid of the next valve. Strict proportionality and independence of frequency are obtained so long as the frequency is not so high that the small capacity between the metal connected to the two ends of the resistance causes the capacity currents to become comparable to the currents through the resistance itself. One disadvantage of the method is that to obtain a large variation of P.D. the resistance must be great compared with the internal resistance of the valve, which may be of the order of 20,000 ohms. This means, however, that to maintain a given steady anode current, a greatly increased voltage must be employed in the anode battery. Even if the external resistance is made equal to the internal resistance of the valve so that half the generated alternating E.M.F. is lost in the valve, the voltage of the anode battery must be doubled. To enable the alternating voltage to be applied to the grid without raising its normal steady potential, a condenser is inserted in the grid connection, and to enable the filaments to be supplied from the same battery, the arrangement shown in Fig. 1 is usually adopted ; the alternating voltage actually applied to the grid through the condenser is that across the resistance and the battery.

Although giving distortionless amplification this method is inefficient because of the practical impossibility of using sufficiently high resistances in the anode circuit. The alternating output of the valve is entirely wasted in heating the resistance, since the grid of the succeeding valve requires no power supply but merely an alternating potential. This suggests the possibility of transforming the alternating output by means of a step-up transformer.

Transformer Coupling.

In electrical engineering transformers are employed to convert a current of, say, 1,000 amperes at 500 volts into a current of

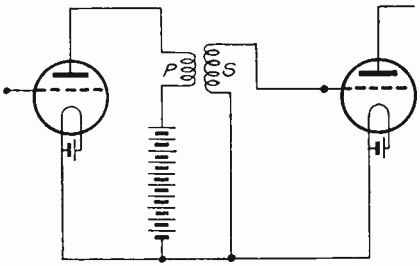


FIG. 2.—TRANSFORMER COUPLING

10 amperes at 50,000 volts. The smaller the secondary current required, the higher the secondary voltage can be made, the power remaining the same. In transformer-coupled amplifiers the primary winding of the transformer is connected in the anode circuit, and the secondary between the grid and filament of the succeeding valve as shown in Fig. 2. For amplifying currents of radio-frequency the transformers are usually free from iron and consist merely of two coils wound very close together, whereas for audio-frequency currents, iron-cored transformers are employed. Transformers have the advantage of a low resistance to steady currents, thus avoiding the necessity of an increased anode battery voltage.

Although a greater amplification is usually obtained with transformer coupling than with resistance coupling, a limit is soon reached if an attempt is made to obtain a very large step-up of voltage. This limitation is mainly due to the capacity between the parts of the winding and between the parts of the valve. A further disadvantage of transformer coupling at audio-frequencies, is the difficulty of avoiding resonance effects at certain frequencies due to the inductances and capacities of the windings.

In the case of telegraphy, as distinct from telephony, the possibility of pronounced resonance effects at certain audible-frequencies is an advantage, as it may be utilized to give greater selectivity for the desired signal, by working at a note of a given pitch.

In radio-frequency amplifiers, resonance effects, even in telephony, are not usually disadvantageous, since by suitable tuning by means of variable condensers, resonance may be made

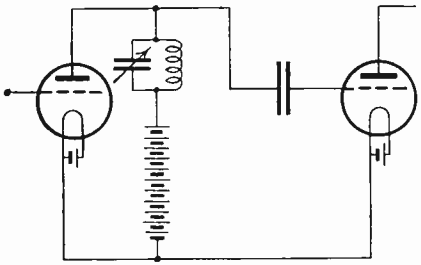


FIG. 3.—TUNED ANODE COUPLING

to occur at the frequency of the received waves, thus increasing the freedom from interference due to other transmissions at a different wave-length.

The Tuned Anode Method of Coupling.

In the resistance coupled amplifier, the resistance may be replaced by an inductive coil of low resistance to continuous current but of high impedance to alternating current. This gets over the necessity of an increased anode voltage, but it suffers from the disadvantage that the impedance, and therefore also the amplification, depends on the frequency. This is not of great importance at radio-frequencies, since the received wave has a definite frequency; the effective impedance can be increased by shunting the inductive coil with a variable condenser as shown in Fig. 3, and tuning the combination to the frequency of the received wave. Such a tuned circuit offers an extremely high impedance to alternating current of the resonant-frequency. Such an arrangement is obviously quite unsuitable for audible-frequency amplification in radio telephony as it would unduly respond to the note of the resonant pitch whenever it occurred. Hence, except for telegraphy where signals can be adjusted to have this resonant pitch, such tuned anode circuits are only suitable for radio-frequency amplification.

HOW TO TELEGRAPH PICTURES BY WIRE AND WIRELESS

By T. Thorne Baker, F.Inst.P., F.R.P.S.

The day has come when the telegraphed picture has ceased to excite astonishment. We have seen telegraphed photographs in the Press, and already begin to accept them as a matter of course. A picture, in fact, is little different from a long sentence or telegraphic message—it can be split up into elementary units or fragments just as a sentence is split up into letters and Morse signals.

The simplest type of picture is that of a sketch in which all of the lines are of the same thickness. If we can imagine these lines drawn in an ink composed of some insulating material such as shellac, and drawn upon some *conducting* medium such as copper or tin foil, it is easy to see that the lines of the sketch would interrupt the passage of an electric current passing from the metal foil to a metal needle as the needle was traced over the surface.

If such a sketch were wrapped round a metal drum, with a metal needle tracing a spiral path, photograph fashion, over the surface, it could be made to take the place of a Morse key in a transmitting circuit, each shellac line as it comes under the needle interrupting the telegraph current.

Now a photograph can be split up into a series of insulating lines in a similar way by a means well-known to photo-engravers, and these lines vary in thickness at every point of the picture according to the degree of light and shade. This is clearly seen in Fig. 1. If we imagine this line photograph mounted on the metal cylinder, we can see that the current will be not merely interrupted as the needle traces over its surface, but will be interrupted for periods corresponding at each instant to the density in the photograph.

In other words, a photograph built up of these parallel lines can be made to act as a controller of the output of a wireless transmitter. If we can receive the signals and utilize the received energy to record a mark of corresponding intensity upon a photographic film attached to a synchronously revolving drum, the problem of transmitting a photograph by wireless will have been accomplished. High speed telegraphic messages are recorded, as we know, in many systems, either by some form of inker or by photographic means, so that to record an actual photograph is merely to adapt a well-known means of telegraphic recording to a new problem.

We know, of course, that two clocks, accurately adjusted, would keep perfect time in two different countries. It is easy to imagine a powerful clockwork mechanism driving the two telegraph instruments, the drum of each being thus made to travel at precisely the same rate. But when we come to work such

FIG. 1

instruments at a sufficiently high speed for practical picture telegraphy various mechanical difficulties arise. Synchronous electric motors have come to our aid as a substitute, and these have been employed in the trans-Atlantic transmissions that have been recently made.

The first step in working out any system of telegraphing a picture has been to have the sending and receiving instruments coupled together, i.e. working side by side with the drums mounted on a common shaft. Methods of synchronizing two

widely separated machines are after all mechanical problems and not wireless. A great deal of fascinating experimental work may be done on these lines, and in order to stimulate interest in the purely practical side of the question a brief description of such an experimental apparatus will now be given.

The transmitting and receiving apparatus have each a cylinder or drum of a convenient size, say 2 in. diameter and 5 in. length.

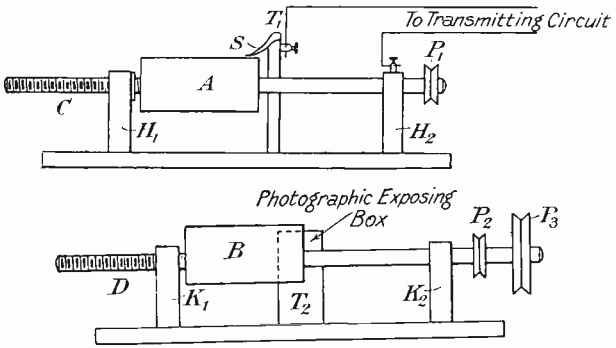


FIG. 2

One of these may be of wood (for the receiver), but the transmitter drum should be of metal, a 5 in. length of 2 in. brass tubing fitted with metal ends accurately bored to take a $\frac{3}{8}$ in. or $\frac{1}{2}$ in. shaft.

In Fig. 2, the upper sketch represents the transmitter, A being the 5 in. brass cylinder, mounted on a shaft at least 16 in. in length. Along one end of the shaft (c) a thread must be turned, preferably 35–40 to the inch pitch, and the bearing H_1 must be threaded with the same pitch, so that as the cylinder revolves, the shaft works its way *through* the bearing, and the cylinder works forward from left to right. If the distance between the upright bearings H_1 and H_2 be 10 in., the cylinder A will work its way from the position shown to the dotted position when revolved for a number of times equal to $\frac{\text{length of cylinder}}{\text{pitch of thread}}$; the right-hand bearing is plain, not threaded; P_1 is a grooved pulley wheel. The receiving instrument is constructed in an exactly similar manner, except that the drum B may be of wood if desired, and a small pulley wheel, P_3, is fitted at the extreme end of the shaft. The two machines can then be coupled together by a string of gut belt of any practicable length, and one of them driven by a small clockwork or electric motor M (Fig. 2a), so geared that

the rate of revolution of the cylinders is about one in five seconds. Of course, if the two instruments are to be run each at a different place, each one must have its own driving motor and some special synchronizing device must be employed, such as is described in the various books dealing with photo-telegraphy. But as

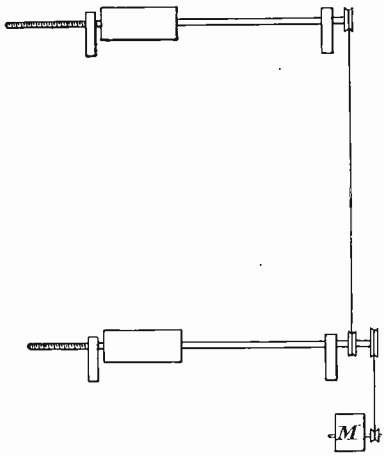


FIG. 2*a*.—SHOWING SYNCHRONIZER DRUMS

already stated, much initial work of a fascinating nature can be done at first with the two instruments under one control.

So far we have merely the two cylinders which, as they revolve, travel from H_1 to H_2 and K_1 to K_2 respectively. Upon A must be mounted the sketch or picture (or writing) drawn with a clean pen upon very thin *smooth* copper foil (about No. 40 gauge), in ink, made as follows—

Shellac	1 ounce
Methylated spirit . . .	6 ounces
Gentian violet . . .	30 grains

(or other spirit-soluble aniline dye).

Screwed to the baseboard on which the apparatus is mounted is a brass upright of the shape shown in Fig. 3, U, to the top of which is soldered a hard brass spring, S, tapered down to a point as shown at K. This spring or stylus presses lightly on the surface of the drum, D, and makes contact with the copper foil as it revolves, *except when a shellac line of the picture interrupts the current.*

The transmitting instrument thus operates like the reverse of a simple Morse key, the shellac lines of the picture or drawing interrupting a current flowing through the metal bearing, cylinder, copper foil and spring stylus to the wireless transmitter.

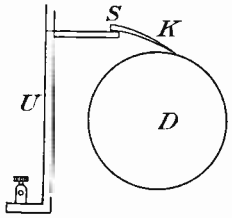


FIG. 3

The receiving instrument is little more complicated, but one simple photographic pattern may be made as shown in Fig. 4.

Here *D* represents the drum of the instrument, around which is attached a sheet of photographic paper (bromide) or sensitive

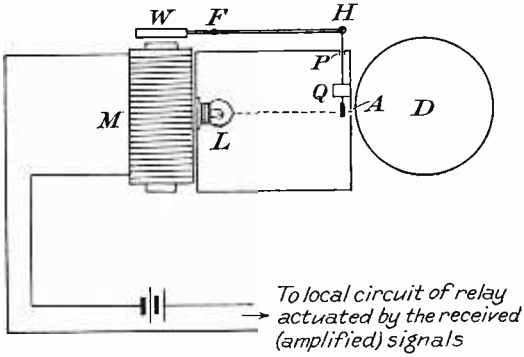


FIG. 4

celluloid film. A small wood or metal box about 3 × 3 × 1½ in. is made and mounted so that a small aperture $\frac{1}{64}$ in., *A*, comes just in front of the central line of the drum and in the position of the stylus in the transmitter at the beginning of a transmission. *L* is a small electric lamp, one of the better quality 3½ volt, or, better still, a 4 volt high efficiency lamp, fixed in a " Baby " baton holder so that its filament is exactly opposite the aperture *A*. *Q* is a small shutter about ½ in. square, attached to one end of a

brass rod hinged at H to another rod WFH pivoted at F, W being a small flat iron armature and M a small horse-shoe electro-magnet. The rod HS is made to work in one hole at P and another, Q, made in a small support, so that when the magnet M attracts W, the shutter rises in an accurate vertical path and allows the light from the lamp L to fall upon and expose the sensitive film. Some form of loose light-tight cover must be made to place over the receiver to protect it from the light while a transmission is in progress, but this can be made very simply with a little ordinary ingenuity.

The magnet M is excited by a local dry battery or accumulator, the circuit being made by means of a relay, which is in turn actuated by the signal received from the transmitter. In this way it will be seen that, each time the transmitting instrument sends out a signal, denoting a line in the picture, the shutter is raised by the magnet and a corresponding spot of light falls upon and exposes the sensitive film on the receiving drum.

The transmitter, as we have seen, acts as the Morse key, or control, of a transmitting wireless circuit. It can be made either to actuate a cheap form of relay, which switches in the primary circuit of a wireless transmitter, or it can be used to short-circuit a condenser in the aerial circuit. Very little power is required, of course, if the two instruments are used in the same room directly connected.

As regards receiving apparatus, any fairly sensitive type of telegraph relay can be worked with two-valve amplification; the receiving circuit comprises the relay in place of the telephones or loud speaker, and the local circuit of the relay is connected via a battery of a couple of dry cells to the magnet of the exposing apparatus.

We can now turn our attention to the more general problem of the commercial "wirelessed" photograph. The method evolved by the American Telegraph and Telephone Co. makes use of a transparent photograph printed on celluloid; this picture is attached to a glass cylinder, and a fine pencil of light is directed *through* it, as it revolves, on to a photo-electric cell. As the different parts of the photograph, and therefore different densities, intervene between the pencil of light and the cell, the *amount* of light falling on the latter varies in corresponding intensity, and the properties of the cell are such that electrons are liberated in corresponding proportion from its metal electrode (potassium or sodium usually, converted into hydride and "sensitized" by bombardment with cathode rays). The electron stream is used in a manner similar to that of the ordinary valve, and the degrees of light passed by the spirally revolving photograph are thus made to control the radiation from the wireless transmitter.

At the receiving machine these impulses of varying strength are utilized, after great amplification, to operate an inker, or else a photographic exposing device, and a reproduction of the original is obtained. The sending and receiving instruments being far apart, some method of synchronizing the two has to be employed, and the means adopted has been the use of synchronous motors, which can be kept in step with a high order of accuracy. Photographs have been transmitted from New York to this country in about twenty minutes in this way, and the excellent results most of us have seen. So far only simple portraits have been transmitted, but to obtain pictures with a greater amount of detail is a mere matter for mechanical construction.

Wireless transmission offers many advantages, though it has the drawback of interference and disturbances and the limitations due to the great demands on the ether. The instantaneous character of the signals is distinctly preferable to the sluggish discharges of a long cable ; this feature of line picture telegraphy has, indeed, so far proved one of the most serious drawbacks in its commercial application, and for this reason alone radio-telegraphic photography is likely to make great strides in the future.

DEVELOPMENTS IN MARITIME WIRELESS

By Lt.-Col. Chetwode Crawley, M.I.E.E.

The developments in wireless communication between ships and between ships and the shore during the last year has been considerable, but a great deal of what has been shown to be possible from the technical point of view has not yet reached the stage of commercial practicability.

Wireless Telephony.

This applies in a marked degree to wireless telephony. In this country during the last year the Marconi Company, in co-operation with the Post Office, has continued experiments in telephoning between ships and the shore. Not that such experiments are anything new, as the practicability of telephoning between ships up to a range of 50 miles was demonstrated ten years ago by Mr. Marconi, long before the valve had reached anything approaching its present state of development as a transmitter or receiver of the continuous waves which are necessary for telephonic communication. Indeed, it was five years ago that members of the Empire Press Union when in the Olympic, over 100 miles from shore, conversed quite comfortably by one-way wireless telephony with Government officials in Newfoundland.

The success of broadcasting has made it obvious to all that there are now no technical difficulties in carrying on one-way communication by wireless telephony with comparatively small power over great distances, but until recently there have been technical difficulties to overcome in arranging for duplex communication, similar to that provided by the ordinary line telephone, and in arranging for the linking up of the wireless to the land lines. Both of these problems have been engaging the close attention of wireless engineers since the beginning of 1922, when a demonstration of combined wireless and line telephone working was given by the Marconi Company between London and Amsterdam. The wireless stations were at Southend and Zandwoort, from which the ordinary trunk lines were used for passing on the communications to and from London and Amsterdam respectively.

In this demonstration the wireless transmitting and receiving stations were well separated at the two wireless points in order to facilitate duplex communication, an arrangement which is not of course possible in the small space available on shipboard.

During the last year, however, this problem has been satisfactorily solved, reliable duplex communication being obtained between Southampton and a ship at sea up to a range of 100 miles, and reliable simplex communication up to 200 miles. It seems, too, that under good conditions, these ranges could certainly be doubled. When, however, the wireless was linked up with long land lines, such as a trunk line from Southampton to London, the ranges were about halved.

It may be said then that it has now been shown that from the technical point of view it would be possible to connect up a telephone subscriber in any part of the country to a ship within a couple of hundred miles of the shore.

But there is often a troublesome gap between technical possibility and commercial practice. The main point in this case is whether the service that could be offered would be worth the cost involved in installing and maintaining the necessary apparatus. This, of course, is a question for shipowners as regards facilities in ships, and the Government as regards facilities on shore.

There is no doubt that wireless telephone communication with ships will develop in the future, but the established efficiency and comparative cheapness of wireless telegraphy will undoubtedly act as a brake on the rapidity of this line of telephonic development.

At present the only use being made of wireless telephony for maritime purposes is for communication between light ships and the shore. This system was tried out practically two years ago with the light vessels based on Ramsgate, and has been considerably extended during this last year, so that now about thirty ships and harbour authorities' offices are equipped and working satisfactorily.

Spark versus C.W.

Wireless communication with ships may be divided into two sections; first, communication on the service of the ship, and, secondly, communication on the service of the passengers, that is, social communication. In both sections considerable advances have been made during the last year.

The bulk of ships' service communication is conducted on the old established spark system, and the bulk of social communication on the more up-to-date continuous wave system. The two systems cannot intercommunicate and the former is used principally because it is already so widely established all over the world that a change to the more modern system must be gradual for financial considerations. It has, too, one advantage over the modern system for life saving purposes, and that is that accurate tuning for reception is not essential, a fact which is obviously

advantageous in the case of a distress signal being made for reception by as many ships as possible.

D.F. Apparatus in Ships.

The greatest improvements made during the year in the ships' service arrangements are those relating to navigation. The number of ships with direction finding sets, that is, apparatus for indicating their bearings from coast wireless stations, or from other ships, has increased considerably, and over 200 British ships are now fitted. This is not, of course, a great proportion out of about 3,300 British ships, which are now equipped with wireless apparatus, but it is a very considerable increase on the number which were fitted a year ago.

The chief advance made during the year has, however, been more in the efficiency of the apparatus than in the number of ships equipped. Until considerable practical experience had been gained, the design of ships' directional apparatus was a most difficult problem, as the data required could only be obtained by a study of practical results, and until the designs did give accurate results, shipowners naturally fought shy of spending money in installing apparatus which might not only be useless, but even a positive danger, if reliance were placed on the bearings given.

This difficult preliminary stage was successfully passed during the last year, and the number of ships fitted will no doubt increase more rapidly as soon as it becomes generally recognized that there is now no technical difficulty in installing directional apparatus which may be relied upon to give results sufficiently accurate for all ordinary navigational purposes.

D.F. Apparatus on Shore.

It has been recognized for some time that reliable directional receiving apparatus could be easily installed at stations on shore, and during the last year it has been proved in practice that such installations can be successfully operated from coast stations in addition to their ordinary ship and shore communication, provided that such stations were suitably situated.

The Post Office coast stations at Niton and Cullercoats have been available for this work since the beginning of the year, and, in addition, a Post Office station at Flamborough Head and an Admiralty station at the Lizard have been used solely for direction finding purposes. The total number of bearings given to ships during the year was about 500 a month, more in the winter months and less in the summer, and no complaints of the accuracy of bearings given have been received.

It is proposed to increase the number of stations capable of giving bearings, and indeed all Post Office coast stations will

probably be fitted with directional receiving apparatus, though only those which are suitably situated from the technical point of view will be available for giving bearings to ships.

Ships fitted with reliable directional receivers have the advantage of being able to take useful bearings from any wireless station either on shore or at sea, but as comparatively few ships are so fitted, and as the cost of the equipment is a serious deterrent in the case of the smaller ship, there is a great advantage in coast stations being able to give bearings when required. Bearings given by suitably situated coast stations are more reliable than those obtained by ships, as it is much easier to ensure accuracy in a fixed station, which is carefully calibrated and operated by a highly trained staff, than in a ship station where all conditions are much more variable. Nevertheless, the experience gained in ships goes to prove that, given careful fitting and intelligent operation, the reliability of directional receivers can be all that is desired.

It is essential that the site of the coast station should be suitable for obtaining accurate bearings, and for this reason all coast stations fitted with directional receivers will not be available for giving bearings to ships, but will use the apparatus for reducing interference in the reception of traffic from ships. This arrangement has been used at some of the stations during the last year with marked success.

Arrangements are now in hand for the erection of two new coast stations, which will also be suitable for directional work, one at Linney Head at the entrance to the Bristol Channel and one at Mablethorpe, the latter to replace the present coast station at Grimsby and the direction finding station at Flamborough.

Radio Beacons.

Little, as yet, has been done in this country with radio beacon stations, which have proved useful elsewhere, especially in the United States of America, but, during the last year, Trinity House has had an experimental beacon working in the Scilly Islands. This station transmits its call signal continuously on an interrupted continuous wave of 1,000 metres, so that ships with directional receivers can obtain a bearing from it up to a range of about 50 miles or even more. Further beacon stations will no doubt be erected as the number of ships fitted with directional receivers increases.

The Marconi Company have now two beacons of a special design under trial, one at Inchkeith in the Firth of Forth, and the other on the South Foreland.

The aerial structure in this design is arranged to rotate continuously and to transmit signals which indicate the direction in

which the aerial is pointed. The signals are projected in a narrow beam of about 15 degrees and a different Morse signal is transmitted as the beam points to different selected points of the compass.

The special receiver fitted in a ship to receive this beam is very simple and can be used by persons without any knowledge of wireless telegraphy.

Automatic S. O. S. Apparatus.

Great strides have been made in perfecting apparatus for automatically registering an alarm signal which could be used to precede a signal of distress in order to call an operator to the wireless instruments in all ships within range. Definite requirements for Government approval of such devices have now been issued. The devices are to be operated by a series of three dashes, each of from three to five seconds' duration separated by a space of from one-tenth to two seconds duration, the percentage number of effective calls required, and of false calls allowed, under certain test conditions, being specified.

None of these instruments has as yet been approved and fitted in ships.

Lifeboat Set.

During the year it has been laid down that all our foreign-going passenger steamers which carry more than ten lifeboats must have at least one of them fitted with wireless telegraphy, and if there are more than fifteen, or more than twenty lifeboats, at least one or two, respectively, shall be motor boats fitted with wireless. Transmission must be on a 600 metres spark wave, giving a minimum metre-ampere figure of 15, and the normal receiver must be a valve, with a crystal as alternative.

Weather Forecasts.

In addition to the weather forecasts, broadcast by wireless telegraphy to ships at specified times by Government stations, arrangements have been made for the B.B.C. to broadcast weather forecasts by wireless telephony from their stations at Daventry, Liverpool, Bournemouth, and Newcastle, so that even ships without operators can now obtain forecasts by fitting simple wireless receiving sets.

Social Communication.

Such then are the advances made during the year in the most important aspect of maritime wireless communication, what we have called ships' service communication, and we have now but

to state shortly what improvements have been made in the other aspect, that of social communication.

Spark Sets.

A great deal of this social traffic is conducted by spark installations, though the tendency is to transfer it as far as possible to continuous wave installations, and this has already been accomplished in the case of large passenger ships.

Damped wave installations are, however, fitted by international agreement, in all ships which are compulsorily equipped with wireless telegraphy, and it is only in the passenger liners that the expense of fitting continuous wave sets, in addition, is justified under present conditions.

The substitution of valve for crystal reception has been continued during the year in ships; at coast stations which are so small in number, the crystal has, of course, long since been discarded. Ships' transmitting sets have also been brought up to date when opportunity offered, and the use of wireless telegraphy in small ships, such as trawlers, which are not compelled by law to be equipped, has been greatly extended.

At the coast stations, the principal advance has been in the trial of directional aerial equipment for assisting in communication through interference, and, as already mentioned, it has been decided, as a result of this trial, to install the arrangement at all stations.

At the Land's End station, where jamming on the 600 metres wave is very bad indeed, watch is now kept on the 800 metres wave, as well as on 600 metres, between 9 a.m. and midnight, either wave being available for transmission, an arrangement which has proved very helpful in dealing with the heavy traffic.

Arrangements are being made, as already mentioned when dealing with direction finding stations, for the erection of new coast stations for ordinary traffic at Linney Head and Mablethorpe.

Continuous Wave Sets.

The number of ships fitted with C.W. sets has increased considerably, but for the reasons already stated, the sets are almost wholly confined to large ships.

Short Waves.

The phenomenal advances made in short wave working has not been lost sight of in connection with maritime communication, and experiments with a view to development on these lines were put in hand during the year, and are still in progress.

HOW TO MAKE A CABINET FOR YOUR WIRELESS SET

By "MENTOR"

THE type of wireless set neatly contained in a cabinet is rapidly taking the place of the untidy jumble of wires which comprise so many wireless sets. The ordinary type of box cabinet, with one side omitted and a wireless panel substituted for it, has the great disadvantage that the set is left entirely unprotected from dust, apart from its unsightly appearance. Dust forms little unofficial grid leaks between the terminals on the panel, with the result that signals are weakened and the current from the batteries is allowed to leak slowly between the terminals.

Fig. 1 shows a neat type of cabinet which can be easily made by anyone with an inclination to carpentering. Being in appearance somewhat similar to the type of gramophone popular in drawing-rooms, it is tolerated as an ornament of furniture. And having a lid to it, it keeps the set dust-free, and keeps loud speaker, batteries and the multitudinous odd wires out of sight.

For the sake of bringing down the measurements to some standard, the following description and measurements would apply well to a three- or four-valve set mounted on a panel 14½ in. square. The loud speaker referred to is the Brown 21 in. standard type. If the reader has a panel of different dimensions, or a loud speaker of another make, it will not be a very difficult matter for him to adjust the measurements to suit his particular requirements.

General Measurements.

A front view, or "elevation," as we must technically term it, of the set, showing the doors open, is shown in Fig. 2, giving the principal measurements of the cabinet. The framework may be made of deal, oak, mahogany, or any wood suited to the amateur's pocket, and the panels of three-ply wood, all being stained to the desired shade.

The overall measurements of the front, excluding the legs, are 33½ in. high by 16½ in. wide, so that the first stage is to make a framework of wood 1 in. square of the exact dimensions shown in Fig. 3. The measurements shown are inside dimensions and so 1 in. must, of course, be allowed in each case for the 1 in. thickness of the wood.

The two sides of the cabinet consist of two pieces of three-ply wood, each cut to exactly 14½ in. by 31½ in., and glued into the sides of the frame. The front, as shown in Figs. 1 and 2, has

four doors. The two upper doors, which open on to a platform on which telephones, etc., may be laid, are 3 in. by 7 in., with the

FIG. 1

½ in. space between them filled in by the small 3 in. by ½ in. upright shown. The two lower doors, which are to be opened or closed as required, screening the loud speaker, are 10 in. by

7 in., also with a 10 in. by $\frac{1}{2}$ in. support between them. Two hinges are necessary for the larger doors, while two smaller hinges are advisable for each of the smaller ones.

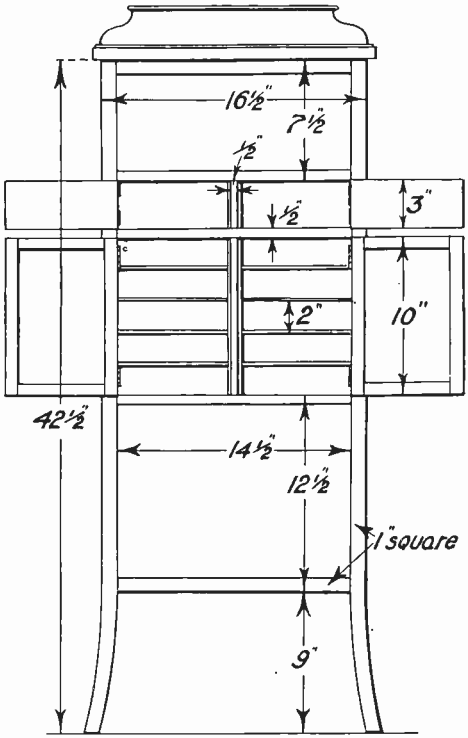


FIG. 2

The spaces above and below the doors are filled in by three-ply wood, sizes $6\frac{1}{2}$ in. by $14\frac{1}{2}$ in. and $11\frac{1}{2}$ in. by $14\frac{1}{2}$ in. respectively.

The Back.

The back of the cabinet, as shown in Fig. 5, has two doors, each size $21\frac{1}{2}$ in. high by $7\frac{1}{4}$ in. wide. There must be no central partition between these doors, as the full width is required to take the loud speaker in or out and so the doors must be made to overlap, on the style of cupboard doors. a small step being placed on the floor to prevent their closing too far inwards.

While the appearance of the cabinet is greatly improved by making the doors of a framework of 1 in. wood, filled in with three-ply, this is not essential, and solid wooden doors may be

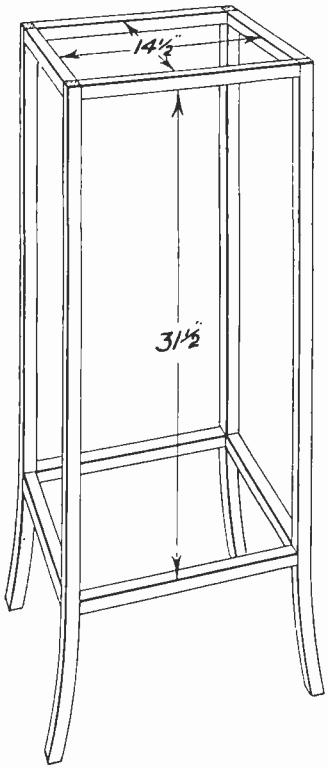


FIG 3

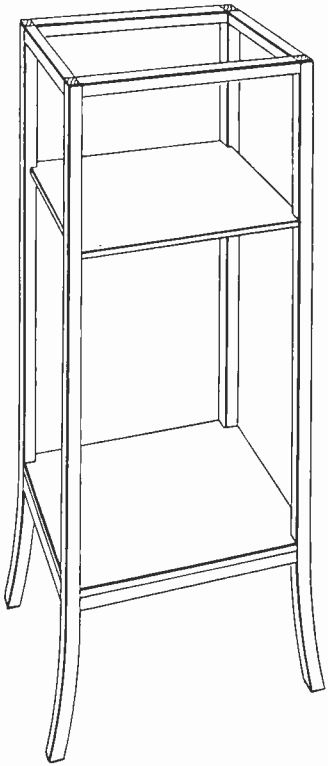


FIG. 4

used, though trouble may be encountered later on through the wood warping if it is not thoroughly seasoned.

Loud Speaker Laths.

The next step is to fit the laths behind the loud speaker doors. These laths hide the loud speaker, allowing the sound waves to get through audibly, while considerably improving the appearance of the cabinet. The quickest way of doing the work is to make a

frame of $\frac{1}{2}$ in. wood, $13\frac{1}{2}$ in. by 10 in. internal measurement, first of all. Then the laths, five in number, $13\frac{1}{2}$ in. long, 2 in. wide, and $\frac{1}{2}$ in. thick, can be fitted into the frame and the whole glued into position inside the doors, so that the appearance will be as

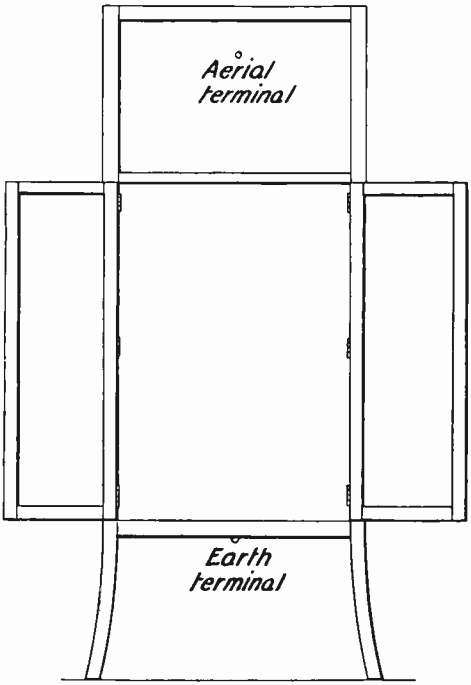


FIG. 5

shown in Fig. 2. An additional refinement can be indulged in by fitting the laths so that they swivel in their frame, but this is not essential.

A platform should be fitted to the framework, as shown in Fig. 4. This comes below the two smaller doors and above the larger ones. This forms a convenient shelf, on which telephones, spare valves, and any other odds and ends which it is desired to keep out of the way in a safe place may be stored. Another shelf, the same size, $14\frac{1}{2}$ in. square, should be fixed at the base of the cabinet ; this is the shelf on which the loud speaker will stand.

Mounting the Panel.

The panel, on which the valves and other wireless components are mounted, must be exactly 14½ in. square, and rests in the top of the cabinet, as shown in Fig. 1. A ledge, consisting of strips of wood ¼ in. square, should be firmly fitted inside the case, 3½ in. below the top, or the panel may be fitted with a hinge at the back, so that it may be raised if required. The latter is more convenient if alterations to wiring, etc., are ever likely to be necessary. Otherwise, the only access to the underneath side of the panel is via the two upper doors in the front of the cabinet.

The lid of the cabinet, shown in Figs. 1 and 2, is domed, and is the most difficult part to make neatly. For this, four pieces of moulding 4½ in. wide are used. They should each be cut exactly to the dimensions shown in Fig. 6. A piece of three-ply wood, 12¼ in. square, forms the top of the lid. The whole should then be firmly glued together, and the lid attached by two hinges to the back of the cabinet.

A support is then needed for the lid, to avoid strain on its hinges. Any type of elbow-shaped support (Fig. 1) will serve for this purpose.

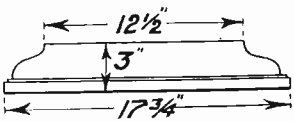


FIG. 6

Valves and holders are normally about 4 in. high, so that the dome of the lid will give ample clearance. The tuning-coil holder may be fitted to one side of the cabinet, above the panel.

As there is a space 22½ in. deep below the platform, there is plenty of room to stand a Brown 21 in. loud speaker, and amount of space occupied by the laths corresponds to the opening of the loud-speaker horn. The space on the floor, on each side of the loud-speaker base, gives room for the accumulator and high-tension battery. A hole should be drilled at the back of the cabinet (Fig. 5), for the aerial terminal, and another hole in the floor for the earth terminal. Holes should be drilled in the upper platform, and leads run connecting batteries and loud speaker to the set. Leads to the telephones, of course, run direct from the underneath side of the panel, the telephones resting on the upper platform and being taken out of the small doors when required.

With this style of cabinet everything is out of the way and out of sight, except the necessary aerial and earth connections.

The cabinet may then be stained dark oak, or whatever colour is required to tone with the rest of the furniture in the room, and the wireless set then presents an enviable appearance.

LOUD SPEAKER EXTENSIONS

WIRING A HOUSE FOR WIRELESS

By "MENTOR"

THOSE who possess loud speakers often feel the disadvantage of being more or less tied to one room whenever it is desired to listen in. Then usually a lead is run from the "wireless room" to wherever it is wanted, and, as time goes on, untidy extensions take place to other parts of the house. This is one of the causes of the unpopularity of wireless amongst wives.

In wiring a house for wireless there are two obvious alternative methods. The aerial and earth are fixed, as a rule, in one spot. So there is the possibility of running leads about the house and moving the set bodily from room to room, or, alternatively, keeping the set in a fixed spot and taking leads for the telephones or loud speaker to wherever they are likely to be wanted. The former idea may be deservedly dismissed at first sight, for it is impracticable. The tiny aerial currents have not the strength to run through the house-wires efficiently, in the first place; the entire capacity of the aerial circuit is being continually altered, and the wear and tear on the set and possibility of damage occurring to the valves during removals make the system a cumbersome one.

On the other hand, the low-frequency currents of the loud-speaker circuit scarcely suffer at all in being transferred to distant points, within reason. And so this system is by far the better one to pursue.

The Chief Difficulty.

In wiring up a house, as in most things, there is a right way and a wrong one. The chief difficulty is, of course, to obtain consent of the mistress of the house to anything of this nature, but if you can persuade her that the job can and will be done neatly and almost invisibly, reluctant consent can usually be extracted.

This obtained, we may set to work. The first thing to do is to settle on a permanent spot for the wireless set itself. This settled, wiring should work from the set to the points required, and not vice versa, as is sometimes attempted. Only by working in this way can a minimum of joints be used.

A plan of campaign should be thought out beforehand on the lines of that given in Fig. 1, which shows the ground floor of a certain house and the design followed. In this the wires are kept away from the wall for the sake of clearness. In practice this is not essential, of course.

The Central Points.

A double wire should be run from the set to the foot of the stairs, and this point made the central distributing station for all the leads on the ground floor. From this point a lead should be run upstairs to another central point on the landing, from

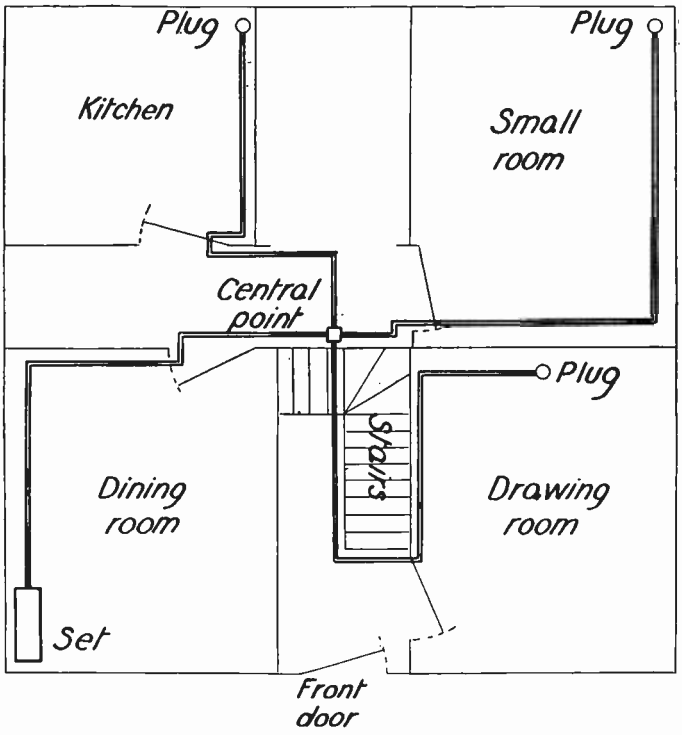


FIG. 1

which upstairs rooms will be supplied. In this way, one central joint on each floor is used, and, if this joint is soldered and well covered with insulating tape, efficient results can be assured for years of wear. Then leads should be run to the various rooms on each floor in which it is ever likely that the wireless will be wanted.

On the upper landing, leads can be taken to each bedroom, as required; bathroom is not recommended, as steam is bad for

loud speakers. In this way, the whole system is thus wired up " in parallel," so that the loud speaker and/or telephones may be connected to any one or more points at once.

Hiding the Wires.

For the work to be really efficient, the floor-boards should be taken up and the wires run underneath, as is often done in the case of electric-bell wires. When the wires have to run in the same direction as the beams, or " joists," as they are technically called, the work becomes a comparatively simple matter. To persuade the wire to run under the entire floor, and so save removing many boards, one of those long flexible canes which are used for cleaning flues is useful. They can be obtained from most oil shops for a few pence. Where the wires have to run in the same direction as the floor-boards, i.e. through the joists, a hole must be bored in each joist with a gimlet or bradawl. This is rather a long process, though not a difficult one, and does the job efficiently.

An easier and quicker system is to run the wires above the surface of the floor. Where all the floors of the house are covered with linoleum, they may be neatly laid underneath it, but this method is not to be recommended, as the wires necessarily get wet when the floor is washed, their insulation thereby deteriorating and the wires rusting. Alternatively, the wires may be neatly laid round the wainscoting, or taken up the wall, and run along the picture rail. In the latter case, invisibility can be secured if the wires can be run up the wall behind a sideboard, wardrobe, or other tall article of furniture.

Type of Wire.

The idea of the " central point " system is to avoid joints as far as possible. It involves using a little extra wire, but saves possible trouble through joints corroding or breaking. Wires of this nature, when put down, usually remain for years, and so a little extra trouble in the first place is amply repaid.

Insulated wire only should be used. Ordinary double-cotton covered electric-bell wire is quite suitable and to be recommended. Special covered twin bell wire is specially suitable, and saves the trouble of laying the two wires separately. Care must be taken to see that the insulation is not cut by the staples. Ordinary electric-lighting " flex " may be used, but its bulky nature causes an annoying ridge to form if it is laid under linoleum.

Loud Speaker Fittings.

The most convenient type of fitting to use is a plug and socket, similar to that used in an electric reading lamp. One plug only

is needed (for the loud speaker) and separate sockets required for each room. These should be of a different size (preferably smaller) than those for the ordinary reading lamp, or sooner or later someone will acccidentally insert the loud speaker plug into an electric light socket, with disastrous results.

The sockets may be conveniently fitted in the wainscoting, in similar manner to reading-lamp sockets, and in some rooms it may be found convenient to fit more than one socket for the loud speaker. In any case, the loud speaker plug should be connected by at least 6 ft. of flex, so that the loud speaker will not be confined to within a few feet of the socket.

A little comfort for visitors is to fit up an extra pair of telephones (or even an additional loud speaker) in the spare bedroom, so that, if they wish, they may listen as well as other people. But the unwary and indiscreet must remember that if one is speaking in a room where there is a loud speaker and the visitor is listening on his telephones, he has the benefit of hearing most of what is said. And so, as a final warning. don't criticize the occupants of other rooms when the house is wired up for wireless in this way.

SPEAKING FILMS

By C. F. Elwell, Fell.Inst.Rad., Eng.

Almost from the inception of the motion picture the thoughts of inventors were turned towards the problem of making the characters speak, and thus heighten the illusion. The ability to make the film speak would in itself carry with it the ability to record and reproduce music, or, in fact, most forms of sound.

Early Attempts.

The most obvious method two or three decades ago was to synchronize the film with the sounds from a phonograph record. Much inventive ability was expended in obtaining and keeping the very necessary synchronization between the sound emitted by the phonograph and the movements of the lips or hands of the speaker or musician, as the case might be. The most successful inventor along these lines was Thomas A. Edison, and the novelty of the results obtained by him with his " kinetophone " gave it a brief, but profitable, life. But the operative difficulty of keeping the sounds from the phonograph record exactly in step with the pictures projected on the screen finally prevailed to force this method into disuse. Many attempts were made to revive the method, but all ended in failure.

How the Wireless Valve Has Helped.

The advent of the three electrode valve amplifier, with its ability to faithfully amplify very small electric currents, opened up the field for the truly synchronized talking motion picture. The inventor of the three electrode valve, Dr. Lee de Forest, has himself been the pioneer of perfectly synchronized talking motion pictures, or " phonofilms," as he calls them. Others were quick to realize the possibilities of the method and the rich harvest to be obtained from a successful solution of the problem. Only two systems have yet reached anything like a commercial stage, and these will now be described.

The De Forest System

Dr. de Forest laid down as the first essential for a commercially successful talking motion picture that it should be made on standard film. The commercial reason is obvious, and that is that such " phonofilms " could be projected by means of any of the tens of thousands of motion picture projectors now in

use. Having adopted standard 35 mm. film with standard punching, it was necessary to record the sound on as narrow a strip as possible, and de Forest employs one-tenth of an inch for his sound record, and nine-tenths of an inch for the picture. Fig. 1 shows a piece of a "phonofilm."

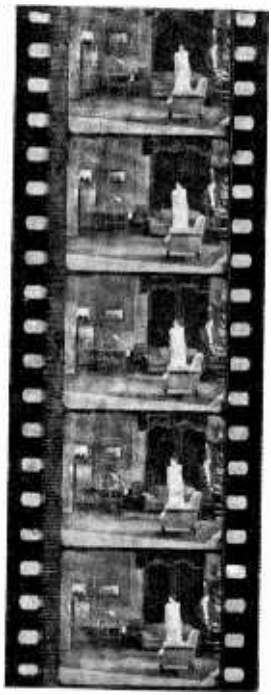


FIG. 1

The Sound Record.

The sound record, which consists of a large number of horizontal lines, each one-tenth of an inch in length, may be seen to the left of the picture. Such a sound record depends upon the varying density of the record. It is also possible to make a sound record which depends upon the varying amplitude of a sinuous record, but such methods necessitate a wider sound record, which in turn unduly reduces the size of the picture.

The Method of Recording.

The method of recording the sound is simple enough to describe, but considerable care must be taken in actual practice if the sound record is to be really faithful. The picture is taken by means of an ordinary cinema camera, but in order to record sound this camera must be driven by a motor at practically constant speed. Then the sound must be recorded on the film at a point where the film is in continuous motion, and not beside the picture (see Fig. 2). The momentary stoppages of the film in order to take each individual picture would spoil the sound record. Fig. 3 shows the

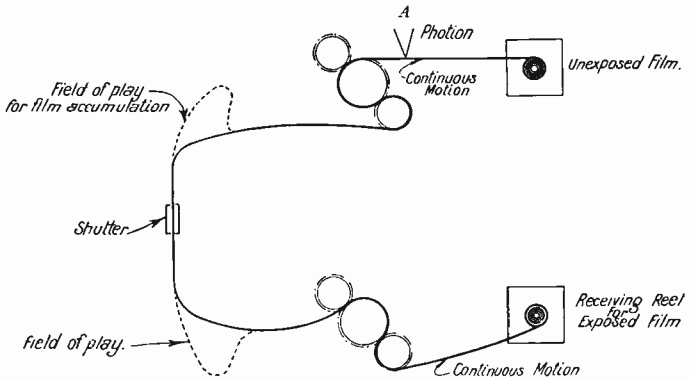


FIG. 2

interior of a "phonofilm" camera. The picture is taken at *A*. where the film is moving continuously prior to being rolled on the spool. A holder contains a two electrode gas-filled lamp, the light from which varies proportionally with changes of current between the two electrodes. The light from this lamp (which may be seen in my hand in Fig. 3, and which is called an Aeo light by the inventor, Mr. T. W. Case) passes through a very fine slit, which may be arranged close up to that portion of the film destined for the sound record. Or the light may first pass through a slit, a reduced optical image of which may be thrown on to the film. The sounds to be recorded may be picked up by one of several types of microphone, such as the Western Electric Co.'s "push-pull" microphone shown in Fig. 4. The microphone serves to transform the sound waves into small electric currents. These small currents are then amplified by means of a powerful amplifier, such as the 8A and 9A amplifier of the Western Electric Co., shown in Fig. 5. The amplified currents are now sufficiently

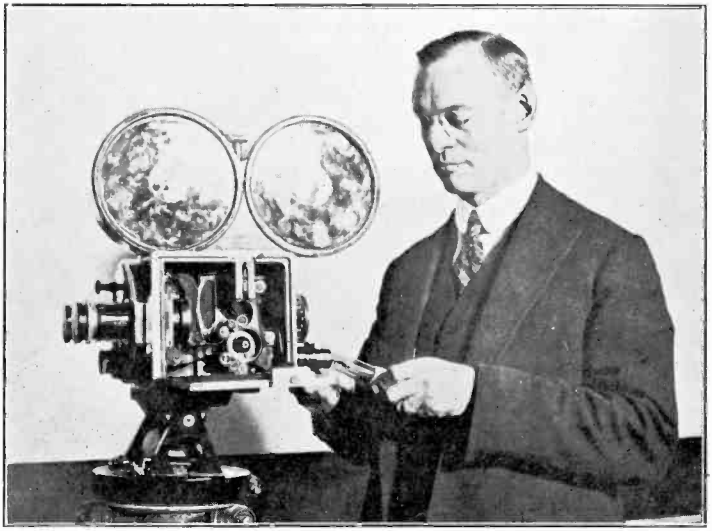


FIG. 3.—THE "PHONOFILM" CAMERA

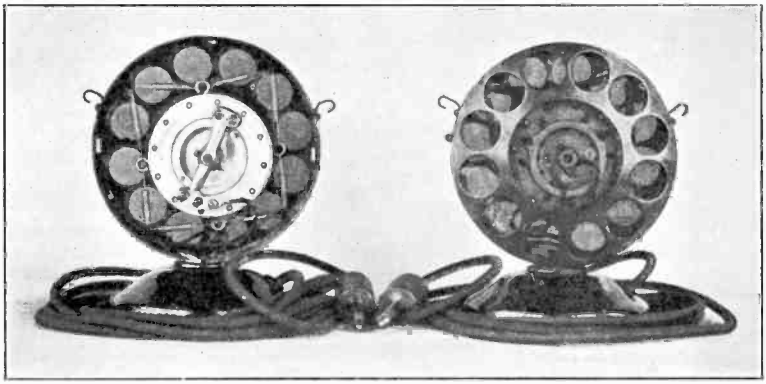


FIG. 4.—WESTERN ELECTRIC MICROPHONE

large in order to affect the luminosity of the Aeo light. The variations of light from the Aeo light follow the variations of current in the microphone, which in turn represent the sound variations to be recorded.

The image of the slit is recorded upon the sensitized film, and after development can be seen as the horizontal lines shown in

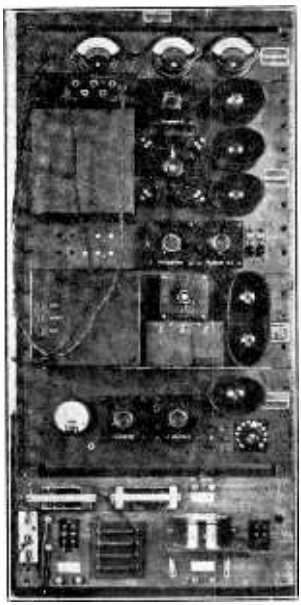


FIG. 5.—WESTERN ELECTRIC AMPLIFIER

Fig. 1. From this negative, containing both picture and sound, any number of positive prints may be made.

How the Sound is Reproduced.

The reproduction of the photographically recorded sounds is also quite simple, and is shown schematically in Fig. 6. The " phonofilm " is placed in an ordinary projector, to which a sound reproducing attachment, as shown in the hands of Dr. de Forest in Fig. 7, is attached between the film magazine and the picture projecting mechanism. This attachment consists of a small

incandescent lamp, shining through a fine slit, which may be placed close to the sound record portion of the film, or have its reflected image thrown upon it, just as is done in the recording camera. The rapidly moving film allows more or less light to pass through the more or less opaque film, depending upon the number and thickness of the lines on the sound record. This fluctuating beam of light then falls on to a light sensitive cell, which serves to transform it into small fluctuating electric currents. These small currents are again amplified until strong enough to operate a loud speaker in which they are again transformed into sounds.

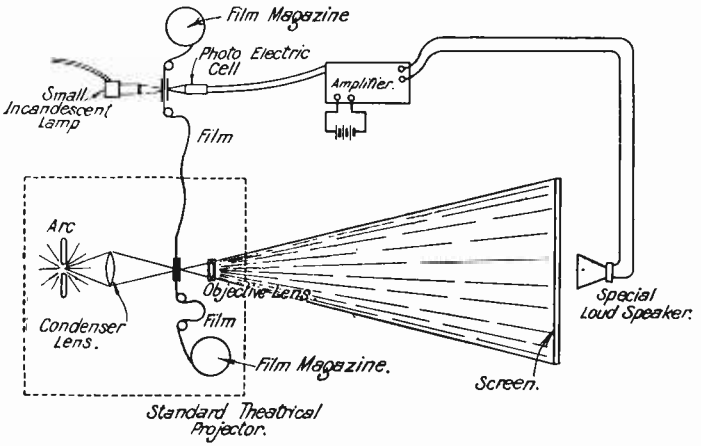


FIG. 6.—DIAGRAM SHOWS HOW THE SOUND IS REPRODUCED

The sounds emitted by the loud speaker synchronize absolutely with the picture being shown on the screen, and the illusion is perfect.

Many forms of light sensitive cells are available. The best known, or Selenium cell, is the least useful on account of the delay in its response to change of light. One of the best cells for reproduction of " phonofilms " is the T. W. Case Thalofide Cell, shown in Fig. 8. The light sensitive material, consisting of thallium and sulphur, is fused on to a quartz disc, to which suitable non-microphonic connections are made. The response to variations in the intensity of light falling upon it is almost instantaneous.

Dr. de Forest has made " phonofilms " in colour without any

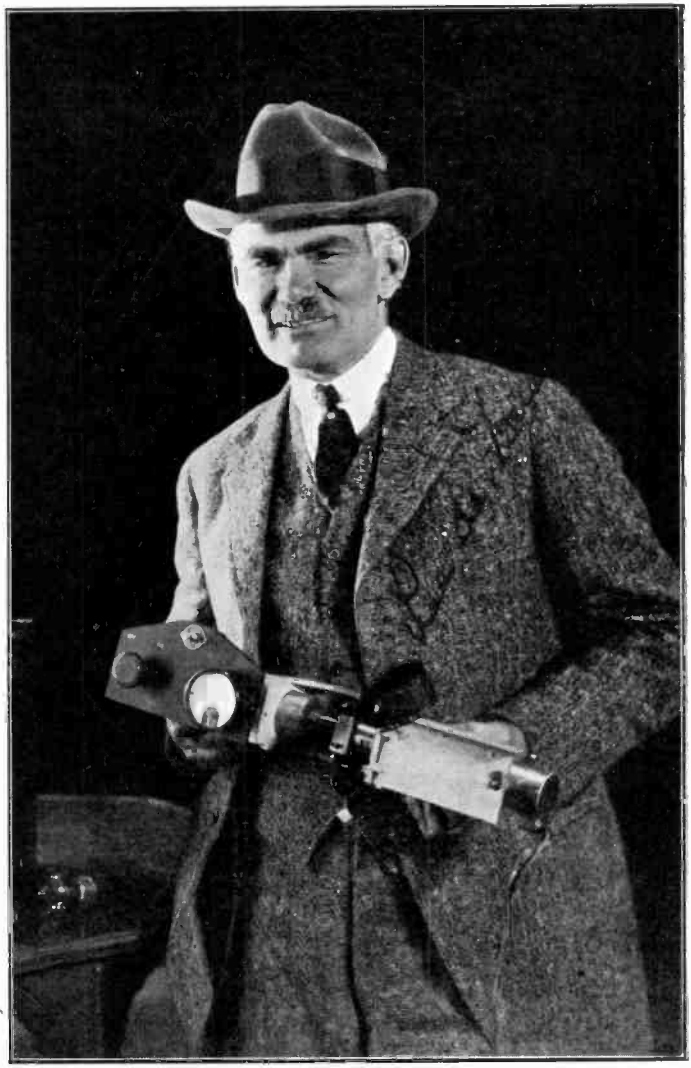


FIG. 7.—MR. LEE DE FOREST WITH SOUND REPRODUCER

depreciation of the perfection of the recorded sound. The only problem left to be solved is thus that of making the motion picture stereoscopic.

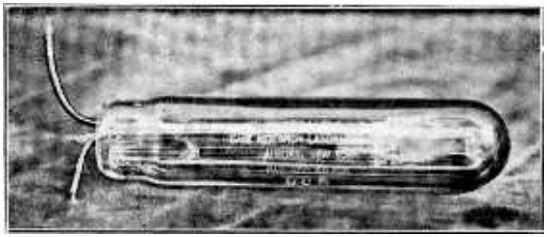


FIG. 8.—THE "CASE" THALOFIDE CELL

THE TRIERGON SYSTEM

Another system worthy of mention on account of the excellence of the results obtained is that of the inventors Vogt, Engl, and

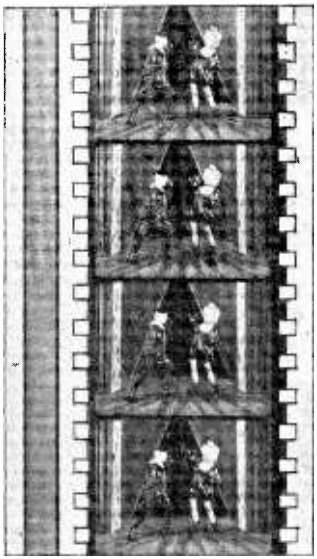


FIG. 9.—TRIERGON POSITIVE

Massolle. The system is known as the Triergon system—a Greek expression, meaning " the work of three." This system does not

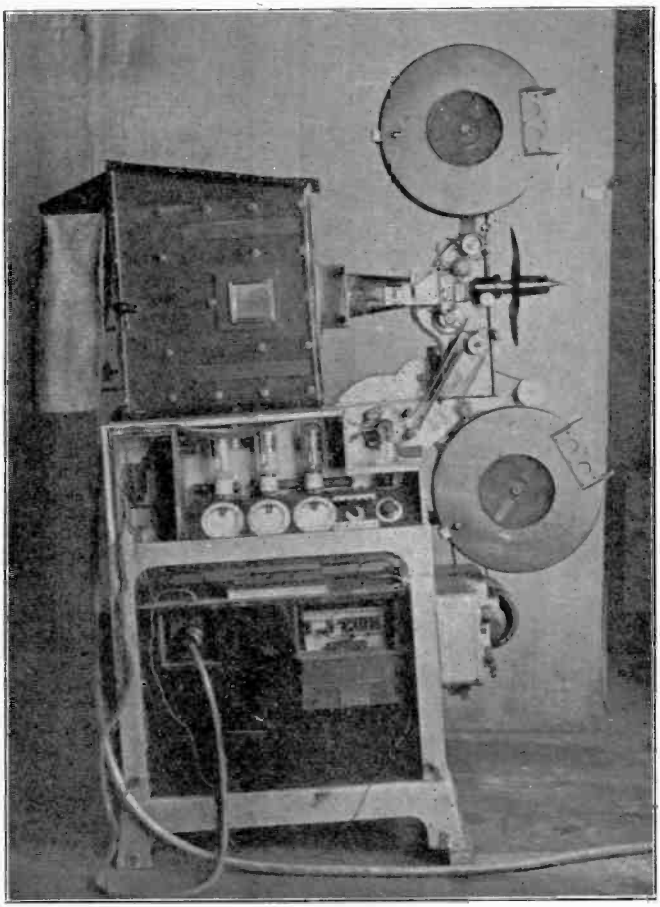


FIG. 10.—" PHONOFILM " PROJECTOR

employ standard 35 mm. film, but special film 42 mm. in width. Fig. 9 shows a piece of Triergon positive, on which the sound record is outside the holes for guiding the film through the projector.

It will be noted that the sound record is about double the width of the de Forest sound record, and the picture is full width, but against this advantage is the disadvantage that the film is of special width—special punching—and hence must be passed through a special projector for reproduction. The projector, as shown in Fig. 10, and the system of reproduction is practically the same as in Fig. 6. The cell used for transforming light fluctuations into electric currents is of the potassium variety, and is shown in Fig. 11.

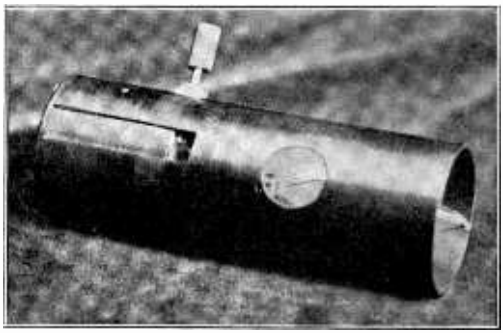


FIG. 11.—CELL FOR TRANSFORMING LIGHT FLUCTUATIONS INTO ELECTRIC CURRENTS

The recording of sound is carried out similarly to the scheme shown in Fig. 2, except that one 35 mm. film is used for the picture and another for the sound record. The two films are then developed separately and printed by means of a special printer on the 42 mm. positive already described.

The talking picture in a commercially perfect form is about to be placed before the public for the increase of its pleasure, and, let us hope, also its education and welfare.

SHORT-WAVE SIGNALLING

RECENT DEVELOPMENTS

THERE has been a noticeable tendency during the last two years for the centre of interest in wireless development to move steadily towards the use of shorter and shorter wavelengths. This is not so much the opening-up of a new field as a reversion to a type of wave associated with the very early days of the art.

In his original experiments, Hertz manipulated wavelengths of the order of two or three metres. As wireless telegraphy developed into a commercial proposition, the necessity for covering long distances, efficiently and reliably by the methods then in use, necessitated the employment of greater input powers at the transmitting end. This, in turn, involved greater aerial capacity, and consequently radiation on longer wavelengths, until the use of 10,000-20,000 metres became the recognized standard for long-distance commercial transmission.

Limits to Long-wave Transmission.

A halt must soon be called in this direction for several reasons. In the first place, there is an upper limit, fixed by the fact that beyond a certain wavelength the actual high-frequency impulses, when translated in the telephones, fall within audible range and therefore mask any superposed signal.

In the second place, the ether congestion, or overlap, between the numerous high-powered stations at present transmitting wavelengths between 6,000, and 20,000, is already sufficiently pronounced to make any large addition to their numbers a matter of practical impossibility from the point of view of mutual interference. Finally, the recent results achieved by the use of low-powered short-wave radiation, indicate clearly that the high-powered station is no longer an economical proposition, and that the future of commercial radio communication lies rather in an opposite direction.

Work of the Amateurs and Others.

To some extent the introduction of the new short-wave technique, and the investigation of certain important factors concerning the handling and propagation of this type of energy, is due to the pioneer work of amateur experimenters. Forced by official regulations to confine themselves to the short-wave end of the scale, the amateurs succeeded in due course in establishing two-way communication with the farthest ends of the earth on wavelengths ranging from 100 to 20 metres, although restricted to

input powers that were insignificant by comparison with those employed in commercial practice.

The sole credit is not, however, theirs. Some years before the outburst of amateur short-wave enthusiasm, Mr. C. S. Franklin, of the Marconi Company, succeeded in transmitting telephony on 10, 15, and 20 metre wavelengths across the Irish Sea, the Bristol Channel, and between London and Birmingham—a distance of roughly 100 miles. Nevertheless the recent record ranges of from 6,000 to 12,000 miles on low-powered non-directional radiation, undoubtedly rests with the amateurs.

Ultra Short-wave Working.

Short though such waves may appear by comparison with those more commonly used, even in broadcasting, they do not by any means represent the limits attainable in this direction. Transmission on wavelengths of five metres is at the present day practically commonplace in the hands of skilful experimenters; whilst in the laboratory, Sir Oliver Lodge, Captain Round, and many other investigators are handling wireless waves only a few centimetres long. In short, the gap between the so-called radio frequencies, and those similar ether vibrations which we recognize as light waves, is being rapidly filled in.

As the size of wavelength is reduced, its frequency (and that of the currents it induces in a receiving aerial) is correspondingly increased. A wavelength of 100 metres, for instance, gives rise to three million impulses per second in an aerial, and creates oscillating currents of this frequency in the associated receiving circuits. Similarly, a 10 metre wavelength induces currents which alternate at the rate of thirty million per second.

High-frequency Problems.

High-frequency energy of this order involves certain special difficulties when it has to be passed through various electrical components such as inductance coils, condensers, and valves, as in the processes of transmission or reception. A particular difficulty arises from its tendency to treat any capacity as a short-circuit. For example, it prefers to skip across the capacity existing between adjacent layers of an inductance coil, instead of flowing through the length of the windings, and so creating voltages that can be detected or made to do useful work in a valve.

Manufacturers are already recognizing the future importance of short-wave development, as is shown by the increased production of "low-loss" coils, condensers, and other components, as well as low-capacity valves specially designed to prevent high-frequency leakage losses. Ingenious circuit arrangements, such as

the balanced Neutrodyne receiver, and the frequency-changing system known as the Super-heterodyne, are also peculiarly adapted for the purpose of handling waves of ultra high-frequency, and will no doubt be more widely utilized for this purpose in the near future.

A Remedy for Broadcast Congestion.

In these circumstances there is much to be said in favour of the proposal to relieve the present congestion in the broadcasting system, by altering the existing wavelength band to one much higher up the frequency scale—say, between 50 and 150 metres. Provided that a serviceable broadcast receiver can be designed, capable of receiving short-wave transmission of this order, the whole problem of interference and overlap will largely disappear. That there is no insuperable difficulty involved in such a change is proved by the successful broadcast service already provided by the American station KDKA, on wavelengths between 40 and 70 metres.

The present broadcast band, say 200-600 metres, translated into frequencies, becomes 1,500,000 and 500,000, or an interval of one million cycles. On the other hand, a band of 50-150 metres corresponds in frequencies to 6,000,000 and 2,000,000, or a difference of four million cycles. As the selectivity of any receiving set depends ultimately upon the frequency-gap between adjacent signals, it will be seen from the above figures that the present number of broadcasting stations could be doubled, and at the same time the difficulty of separating-out any one programme from its nearest neighbour on the wavelength scale would be reduced by half.

Wireless and Light Waves.

It has previously been mentioned that the shortest radio wavelengths are rapidly approaching the dimensions of those ether waves which give rise to the sensation of light. The connection between the two is, in fact, already apparent when certain aspects of recent developments on short-wave radio technique are considered.

In the well-known Marconi beam transmitter, the radiated waves are reflected and focused by a background of metallic rods, in much the same way as light is acted upon by a parabolic mirror. In order to secure any effective concentration, the focusing surface must be at least several times the length of the waves upon which it acts. It is obviously impracticable to construct a metallic reflector which shall be several times the size of the ordinary 300 metre wavelength used, say, in broadcasting. But by generating wireless energy having a wavelength of only

six metres, as in the wireless lighthouse recently installed at the South Foreland, Marconi is able by means of a rotating background of wires, some 90 feet wide, to send out a focused " beam " of signals. The beam revolves once every two minutes, like the ray from a lighthouse, and conveys a wireless warning signal to all ships within a range of 20 miles or upwards.

Beam Transmission.

A somewhat similar " grid-iron " reflector was employed in the successful beam transmission tests made between this country and Australia, Canada, and South America, during the course of last year, and is a further illustration of the peculiar value of short-wave radiation for economical long-distance signalling. Comparatively low-powered beam stations for trans-oceanic commercial work are already in course of erection, and promise to render obsolete the standard high-powered transmitter, in which thousands of kilowatts are expended in covering the same range of distance.

True " Space Waves."

A further parallel with light-rays lies in the proved tendency of short-wave radiation to travel in a direct path through space, instead of being " earthbound," as is the case with the longer waves. This being so, it is evident that the part played by the so-called Heaviside layer becomes of outstanding importance in short-wave transmission, particularly in connection with those mysterious fluctuations of signal strength, called " fading," to which this type of energy is peculiarly subject.

After leaving the transmitting aerial, short-wave radiation travels upwards as a true " space-wave " towards the Heaviside layer. Here it must be deflected down towards the earth, as otherwise the transmitted signals would be merely lost in inter-stellar space. Various theories have been advanced from time to time regarding the precise deflecting action of the Heaviside layer, though none of them can be said to be completely satisfactory in every detail.

Effect of Heaviside Layer.

According to one theory, the incident waves are reflected downwards from the upper ionized surface in much the same way as light is reflected from a mirror. Another theory states that as the ionized stratum is electrically dense, due to the presence of free electrons, the incident wave-front is " refracted " or bent by a process similar to the action of an optically dense medium upon a ray of light, the refraction being sufficient to turn the incident waves right round and back towards the earth.

Meissner, in fact, suggests that this refraction process may be gradual and cumulative throughout the whole of the atmosphere, the electric density of which, he considers, varies sufficiently to produce a bending-back effect, irrespective of the existence of any definitely-localized area such as the Heaviside layer.

Fading.

Whatever may be the true explanation, it is certain that the waves are deflected in the higher atmospheric regions, and in this fact modern investigation has found a clue to those puzzling fluctuations of signal strength which at present constitute the main obstacle to the more extensive use of short-wave systems for commercial purposes. It is obvious that " fading " must be due to some dissipation or absorption of wave-energy occurring in the ether between the transmitter and receiver. The Heaviside layer, being a conducting medium, is the most likely point at which to look for such an effect

Polarized Waves.

On this assumption, the use of polarized waves has been suggested as a practical remedy for fading. Although polarization is a familiar phenomenon in optical science, it appears at first sight to be a novel conception in radio technique. Stated briefly, all ether waves, whether of the dimensions used in light, or those used in wireless signalling, consist of two components. One is an electrostatic vibration, the other is electro-magnetic. Each of these components vibrates at right angles to the other, and both vibrations take place in a plane at right angles to the forward direction of the actual wave front.

Under ordinary conditions the radiation from a transmitting aerial consists of waves which are not definitely arranged in any particular order. In some of the waves the electro-magnetic component is vibrating vertically to the earth's surface, whilst in others it is horizontal, or parallel to the ground. In the case of long-wave transmission, where the waves travel more or less along the surface of the ground, the former type of wave (with a vertical magnetic component) is, in practice, rapidly wiped out. The earth is a conductor, and the vertical magnetic fluxes cut into it ; in so doing, they are gradually converted or dissipated into earth eddy-currents. This action does not, however, affect those waves in which the magnetic component is set parallel to the ground.

Automatic Polarization.

The residual energy is accordingly orientated or polarized, i.e. all the waves have a horizontal electro-magnetic and a vertical electro-static component. This automatic polarization effect can

be tested by means of a frame aerial, which will be found to pick up no signals when its plane is held parallel to the ground (because there is no vertical magnetic flux passing through the windings), whilst it will give strong signals when held in a vertical position, pointing towards the incoming wave, because then the horizontal magnetic component threads through the frame windings at maximum strength.

Bearing in mind that the Heaviside layer is also a conducting medium, it will be seen that when an unpolarized stream of short-wave energy is reflected from it, absorption losses will occur in the case of those waves which strike the layer with their electro-magnetic component " end on," whilst those waves in which the magnetic component is vibrating parallel to the layer will lose no energy from this cause.

A Remedy For Fading.

If, therefore, the original radiation can be polarized as it leaves the transmitting aerial, so that all the waves are set with horizontal magnetic and vertical electro-static components, absorption losses at the Heaviside layer will be largely eliminated. The wave reflected back from the layer will preserve the whole energy of the incident-wave, and the principal cause of fading will disappear.

Experiments have recently been made by Dr. E. F. W. Alexanderson, of the Radio Corporation of America, and by M. Lucien Levy, the well-known French radio engineer, in the production of short-wave polarized radiation of this type. A special flat-topped aerial is employed, consisting of a network of tuned units, which are impulsed so as to form the seat of a standing or stationary wave system, from which the polarized waves are radiated outwards.

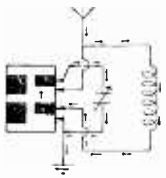
SOME NOVEL COMPONENTS

FROM amongst many novelties which have been brought to our notice during the past year, we have selected the following as being of special interest to readers of the *Year Book*—

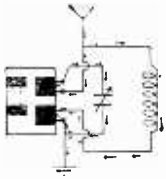
Condenser for Series or Parallel Working.

An aerial condenser used in series with the tuning coil serves to shorten the wavelength. The same condenser, if used in parallel with the tuning coil, gives a range of longer wavelengths. The condenser illustrated below is provided with a device which

SERIES-PARALLEL CONDENSER



(*a*) Series Arrangement.



(*b*) Parallel Arrangement

DIAGRAM OF CONNECTIONS

connects the tuning coil in series during the first 180° of rotation and in parallel during the remaining 180° through which the condenser knob is turned. The arrangements of the connections are shown on the two small diagrams.

This condenser is obtainable from Messrs. Falk Stadelmann & Co., Ltd., 83-87 Farringdon Road, E.C.1.

A Neat Micro-Condenser.

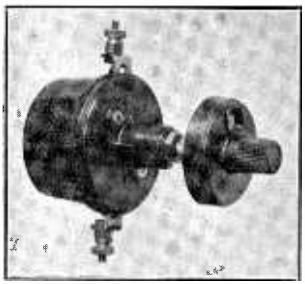
This instrument is primarily intended as a means of vernier tuning when used in conjunction with an ordinary variable condenser. It may, however, be used for all other purposes in a radio receiver in which a minutely variable capacity is required.

It consists of a small variable condenser, having stout brass vanes of conventional shape, but of small dimensions, and has a maximum capacity of approximately ·00004 mfd., and an

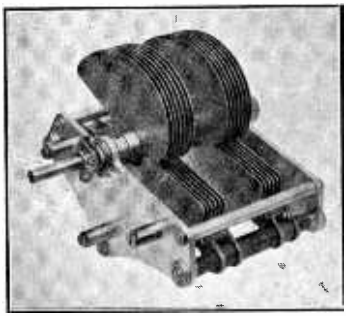
exceedingly small minimum capacity. It will be found highly efficient in use, electrical losses being practically negligible.

Low Loss Dual Variable Condenser.

This comprises two separate sections, the fixed vanes in each section being thoroughly insulated from each other, while the movable vanes in each section are mounted upon a common spindle, and are, therefore, electrically connected. The two



IGRANIC MICRO CONDENSER



IGRANIC LOW LOSS DUAL VARIABLE CONDENSER

sections are accurately matched, and the complete instrument is particularly suitable for tuning two oscillatory circuits simultaneously, such as two stages of high-frequency coupling.

Its electrical features include : extremely low electrical losses, accurate square law characteristics, and adequate screening, ensuring high efficiency and preventing objectionable noises when tuning.

A Hornless Loud Speaker.

In last year's edition we illustrated the " Climax " type of loud speaker ; below is illustrated another novel type, viz., " Edison Bell " speaker. In this type the front of a large double cone of special paper acts as main diaphragm. The front cone is driven by an armature operated by the electro-magnetic receiving system to which the back cone is attached. It is claimed that this speaker is absolutely free from resonance effects.

This speaker is obtainable from Messrs. J. E. Hough, Ltd., Edison Bell Works, Glengall Road, London. S.E.15.

Another very popular type is the B.T.H. type " E " loud speaker, illustrated below, in which a large conical diaphragm

sets into motion a large surface of air which is not enclosed as in the horn type, so that perfect audition is possible in any position.

Compared with the orthodox design of loud speaker, an increased input will be required to produce an equal volume of sound. On the other hand, the instrument gives really faithful reproduction combined with satisfactory volume, providing that the received signals are of good headphone strength and free from distortion.

Construction.

The vibratory unit has been specially designed for this instrument and particular care has been taken to enclose all parts of

EDISON BELL LOUD SPEAKER

THE B.T.H. HORNLESS LOUD SPEAKER

the magnetic circuit as far as possible, with a view to the exclusion of dirt and foreign matter.

The diaphragm is of conical form, light in weight, and is unsupported at its periphery. At the apex it is rigidly attached to a vibrating reed in such a way as to give maximum support; the reed provides not only a robust construction eminently suited to support the conical diaphragm, but also supplies the restoring force necessary when using a combination of high magnetic flux with the small working air gap essential to obtain a satisfactory volume of sound.

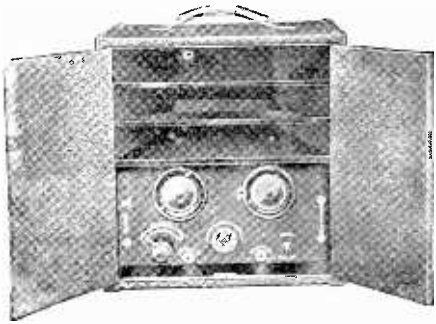
Cobalt steel magnets provide a concentrated field of magnetic flux, which greatly increases the efficiency of the unit.

The volume of sound is controlled by means of the knurled knob at the back of the instrument. The design of this adjustment is such that it is impossible to force the pole pieces on to the

reed. The risk of injuring the latter is, therefore, avoided. Adjustment should be made only when the loud speaker is in operation.

A Portable Receiver.

The new B.T.H. portable receiver is a very compact piece of apparatus. Three B 5 valves are used, with a total consumption of 0·18 watts. The filaments of these valves are heated by a low-tension dry battery fitted into the case of the receiver, which is thus completely self-contained. A special circuit, on the super-heterodyne principle, is employed, giving a remarkable degree of power and selectivity.



B.T.H. Portable Receiver

The supersonic-heterodyne principle consists in reducing the frequency of the incoming carrier wave, amplifying the current at the reduced frequency, and then rectifying to obtain audio-frequency. The process of frequency reduction is carried out by means of an oscillating valve, of which the frequency can be approximated to that of the incoming frequency, the two being then combined and rectified to give a third frequency equal to the difference between the two primary frequencies. The process has decided advantages. The great selectivity and improved amplification of this circuit is due to the fact that the set is constructed on the super-heterodyne principle.

Excellent telephone reception is given by the B.T.H. portable receiver within 40 or 50 miles of any broadcasting station. A frame aerial is contained within the case of the receiver, and this, of course, makes the set directional. The tuning is extremely simple, and absolutely constant, the condenser settings for a given station being always the same, irrespective of distances or other variable conditions.

COMMERCIAL SECTION

PATENT ROYALTIES AND LICENCES

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"Why not make your Wireless knowledge pay your Wireless Bills?

" Wireless is a boon and a blessing—but it's EXPENSIVE.

" Why not make it less so by service to your wireless friends?

" A few shillings outlay on tools and a Licence fee of Two Guineas will place you in a position to manufacture—in your own home—a patented component with a **certain** sale among users of Wireless Sets . . . . if you can't sell the goods yourself the company will purchase your output . . . .

" What's that—why, write the England-Richards Co., 8c King's Lynn, Norfolk—enclose 1½d. stamp for postage—full particulars will reach you in plain cover by return. Just the thing for you, old man—

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PATENT ROYALTIES AND LICENCES

By H. T. P. GEE

Patent, Trade Mark and Design Agent

THE grant of a British patent confers on the patentee, his agents, or licensees, the exclusive right to make, use, exercise and vend the invention, within the United Kingdom of Great Britain and Ireland, and the Isle of Man, for the full term of sixteen years, subject to any question affecting its validity and the payment of the renewal fees, and also subject to certain provisions against any abuse of the patent monopoly.

A patentee is therefore at liberty to manufacture and sell the invention on his own account, or to assign his complete interest therein, or to grant licences in return for the payment of agreed sums or royalties.

Licences to make, use, exercise and vend an invention may be adapted to the particular circumstances of each case and may be general, exclusive, or restricted.

General Licence.

A general licence confers on the licensee the right to " make, use, exercise and vend " the invention, subject to the agreed conditions, and does not debar the patentee from granting other licences on the same or different terms.

Exclusive Licence.

An exclusive licence confers on the licensee the sole right to " make, use, exercise, and vend the invention," on the agreed terms, during the term of the licence, and may operate against the patentee himself using the invention, unless he reserves the right to do so. An exclusive licence is therefore almost equivalent to an assignment of the patent, for the period covered by the licence, as it confers on the licensee what is, in effect, a monopoly in respect of the control of the invention against competition.

Restricted Licence.

A restricted licence may be restricted in a variety of ways, according to the particular circumstances of each case, such, for instance, with regard to time, area or production.

It must be borne in mind that if a licensee makes, uses, or sells the invention in a way other than provided for in the licence, he renders himself liable to infringement proceedings.

In view of the complex and highly technical nature of the various points involved in connection with the payment of royalties and the granting of licences, it behoves both the patentee and the licensee to proceed very warily, and to seek professional assistance in such matters, as there are many pitfalls to be guarded against. For instance, unless the licensee stipulates, in the licence, that the licence shall terminate in the event of the patent being declared invalid, he may render himself liable to pay to the licensor the royalties payable under the licence for the full term for which the patent would have continued but for its revocation, whereas others would be at liberty to use and sell the subject of the patent without the payment of any royalties.

It is a well-settled principle of patent law that a licensee is not at liberty to question or attack the validity of the patent in respect of which he is liable for royalties, unless he has made any such provision in the licence.

It is customary and advisable for licences to provide for the payment of the agreed royalties on certain dates, and for the licensee to keep proper accounts in respect of all transactions and sales relating to the patent for inspection by the licensor at any time, and for all such particulars to be confirmed or verified by a statutory declaration, if required, and, further, for the licensor to stipulate for the termination of the licence, unless the sales by the licensee are sufficient to justify the continuation of the licence, or to terminate the licence in the event of the royalties not being paid, but without prejudice to his right to sue for the recovery of royalties due on any such determination of the licence.

With the object of preventing any unauthorized use of the patented article, and assisting in the detection of any infringement, and to facilitate the recording of sales of the licensed article, it is customary and advisable, where possible, for each patented article, made or sold under the licence, to be marked with a number or distinguishing mark.

It is very important for the licensor and the licensee to arrive at a clear understanding with regard to the payment of the renewal fees on the patent, otherwise the patent might expire, with the result that the licensee might still be held liable for the payment of the royalties, unless he took the precaution of ensuring the insertion of a proviso exempting him from the payment of any royalties after the patent had been allowed to lapse through the omission to pay the prescribed renewal fees.

In the case of *Cummings* v. *Stewart*, the plaintiff sought to recover royalties under a licence agreement, but failed, owing to his having allowed the patents to expire, the court holding that he was bound by the agreement to keep the patents in force, and his failure to do so released the defendant from the contract.

Conditions regarding the price at which the patented article is to be sold is also another consideration for the parties concerned, and in this respect it is necessary and advisable for the parties concerned to enter into the arrangement with a "give and take spirit"; otherwise, if onerous or too restrictive conditions are imposed by either party, such, for instance, as making the price for the sale of each article unreasonably high, both are likely to suffer, mainly by reason of sales not being effected, and which otherwise might, and probably would, lead to a much larger turnover in the sales, and consequently prove more beneficial to all concerned.

Further points for consideration and determination between the licensee and the licensor are the questions of prosecuting or defending any infringement actions or proceedings for the revocation of the patent.

In the case of the grant of a licence in respect of a patent owned by two or more persons, it is necessary for each co-owner of the patent to be a party to the licence, otherwise the licensee may be successfully sued for infringement by the co-owners who were not parties to the licence, as in the case of *Whitehead & Poole, Ltd.*, v. *Sir James Farmer & Sons, Ltd.*

A licence to manufacture or use a patented invention is required by the Patents and Designs Acts (Section 71) to be registered, otherwise it will not be admitted in evidence in any court, unless the court otherwise directs.

INTERNATIONAL MORSE CODE

The following table shows the signals employed in working—

INTERNATIONAL MORSE CODE SIGNALS

LETTERS

a	– ——	n	—— –
ä	– —— – ——	ñ	—— —— – —— ——
á or å	– —— —— – ——	o	—— —— ——
b	—— – – –	ö	—— —— —— –
c	—— – —— –	p	– —— —— –
ch	—— —— —— ——	q	—— —— – ——
d	—— – –	r	– —— –
e	–	s	– – –
é	– – —— – –	t	——
f	– – —— –	u	– – ——
g	—— —— –	ü	– – —— ——
h	– – – –	v	– – – ——
i	– –	w	– —— ——
j	– —— —— ——	x	—— – – ——
k	—— – ——	y	—— – —— ——
l	– —— – –	z	—— —— – –
m	—— ——		

FIGURES

1	– —— —— —— ——	6	—— – – – –
2	– – —— —— ——	7	—— —— – – –
3	– – – —— ——	8	—— —— —— – –
4	– – – – ——	9	—— —— —— —— –
5	– – – – –	0	—— —— —— —— ——

Spacing and length of signals—

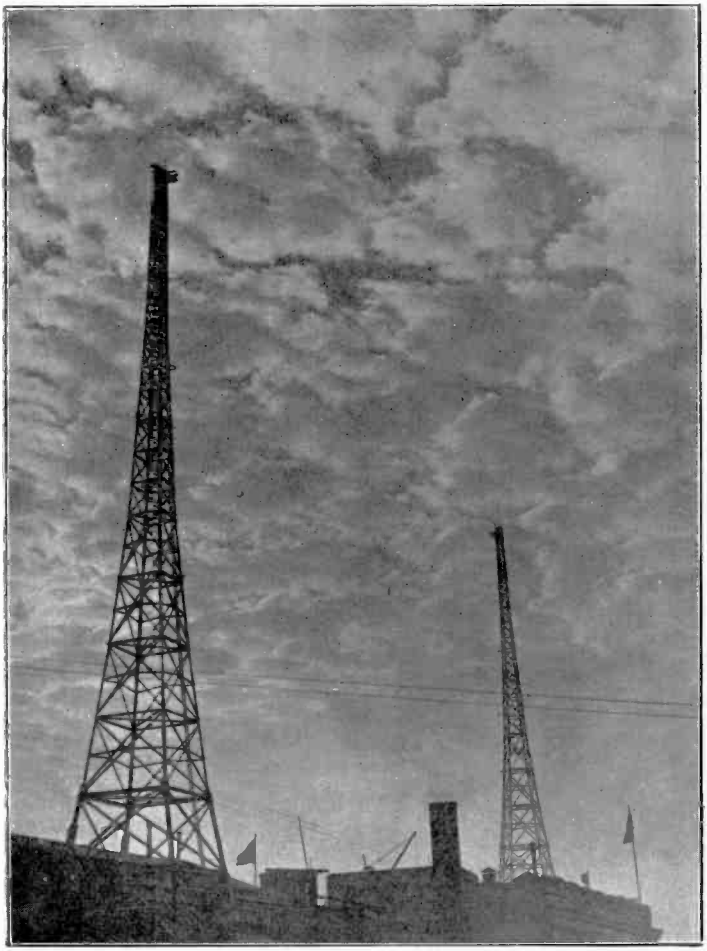
1. A dash is equal to 3 dots.
2. The space between the signals which form the same letter is equal to 1 dot.
3. The space between two letters is equal to 3 dots.
4. The space between two words is equal to 5 dots.

The following signals may also be employed to express figures, but only in official repetitions and in the preamble, and in the text of telegrams written entirely in figures—

1	– ——	6	—— – – – –
2	– – ——	7	—— – – –
3	– – – ——	8	—— – –
4	– – – – ——	9	—— –
5	– – – – –	0	——

PUNCTUATION AND OTHER SIGNS

Full stop	(.)	· – · – · –
Comma	(,)	– – · · – –
Note of interrogation, or request for the repetition of anything transmitted which is not understood	(?)	· · – – · ·
Hyphen or dash	(-)	– · · · · –
Bar indicating fraction	(/)	– · · – ·
Parentheses (before and after the words)	( )	– · – – · – –
Inverted commas (before and after each word or each passage placed between inverted commas)		· – · · – ·
Call (preliminary of every transmission)		– · – · –
Double dash (=) (signal separating the preamble from the address, the address from the text, and the text from the signature)		– · · · –
Understood		· · · – ·
Error		· · · · · · · ·
Cross (end of transmission) (+)		· – · – ·
Invitation to transmit		– · –
Wait		· – · · ·
" Received " signal		· – ·
End of work		· · · – · –



2LO Aerial on the Roof of Selfridges

TRADE DIRECTORY

ABBEY INDUSTRIES, LTD., Abbey Wood Works, Abbey Wood, London, S.E. 2. *T.N. :* Woolwich 538. *T.A. :* "Abbindries," Abwood, London.

Directors : H. Melville Smith, C.B.E., H. McL. Melville Smith, M.A., Mrs. A. H. Melville Smith, M.B.E., Major W. F. Soames, O.B E.

THE ACME PRODUCTION CO., LTD., Britannia Works, Rolfe Street and Engine Street, Smethwick, Birmingham. *T.N. :* 151 Smethwick. *T.A. :* Multum, Birmingham.

Directors : W. J. Allen, W. D. Vick, W. H. Fulford, W. K. Coxon. *Secretary :* W. J. Allen. *Manufactures :* "Acme" Crystal and Valve Sets, Amplifiers, Parts and Components, Automatic Flashers and Signs, Electrical Specialities.

ADAMS BROS. (LONGTON), LTD., Sutherland Road, Longton, Staffs.

Members of B.B.C. Accumulator makers.

A. J. STEVENS & CO. (1914) LTD., Radio Branch, Wolverhampton. *T.N. :* 1748 (7 lines); London, 122–124; Charing Cross Road, W.C.2. *T.A.:* "Reception, Wolverhampton." *Radio Call Signal :* 5 RI. *Joint Managing Directors, Wireless Branch :* H. Stevens and C. W. Hayward. *Manufactures :* Wireless Instruments and Accessories.

All Wireless Crystals. Wholesale only. Sole manufacturers of "Amaxite."

AMERICAN HARD RUBBER CO. (BRITAIN), LTD., 13A Fore Street, London, E.C.2. *T.N. :* Central 2751. *T.A. :* Eboniseth, Ave., London.

Managing Director : S. B. Edmonds. *Secretary :* V. C. Edwards. *Manufactures :* Ebonite-Vulcanite Sheets, Panels, Rods, Tubes, and Mouldings for all classes of Wireless work.

Also sole manufacturers of "Radion" Insulating Material.

AMPLIFIERS, LTD., 49 and 50 Parliament Street, S.W.1. *T.N. :* Victoria 2121.

ASHDOWN, H. E. (BIRMINGHAM), LTD., Aldridge Road, Perry Bar, Birmingham. *T.N. :* Northern 859. *T.A. :* "Segment," Birmingham.

Directors : H. E. Ashdown and H. G. Ashdown. *Secretary :* M. W. Fleming.

ASHLEY WIRELESS TELEPHONE CO., LTD.. 69 Renshaw Street, Liverpool. *Manufactures :* "Claritone" Loud Speakers.

ATTWATER & SONS, Hopwood Street Mills, Preston. *T.N. :* 1045. *T.A. :* Attwaters.

Directors : Richard Attwater, Frederick Attwater, and Christopher Attwater. *Secretary :* Ernest Attwater. *Manufactures :* Bakelite in all forms, Ebonite in all forms, Mica and Micanite in all forms, and all Electrical Insulating Materials.

AUTOMATIC TELEPHONE MANUFACTURING CO., LTD. *Head Office and Works:* Liverpool—Milton Road, Edge Lane. London—Norfolk House, Norfolk Street, Strand, W.C.2. *Agencies:* Manchester—Orme Buildings, Parsonage; Glasgow—260 St. Vincent Street; Birmingham—9 Livery Street; Cardiff—1 *Western Mail* Chambers; Newcastle—33 High Bridge; Dublin—17 Crow Street; Belfast—11 King Street; Leeds—Basinghall Buildings, Basinghall Street. *T.N.:* Old Swan 830. *T.A.:* "Instrument."

Directors: Sir Alexander Roger (Chairman), Sir Harmood Banner, Mr. James Taylor, Mr. D. Sinclair, Sir Andrew Ogilvie, Mr. Eric Taylor, Sir Max Muspratt, Bart., and Mr. E. A. Mellinger. *Secretary:* Mr. A. R. Dodd. *Manufactures:* Wireless Apparatus, including "Claritone" Headgears and Loud Speakers, and Complete Receiving Sets.

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Managing Director: Capt. C. R. Cook. *Directors:* A. E. Chapman, S. H. Martin, L. B. Felton. *Secretary:* E. W. Dilley.

Manufacturers, Radio Engineers and Contractors. Members of B.B.C. and N.A.R.M.A.T. *Radio Call Signal:* 5 BJ.

Sole Proprietors of: H.F. Relay, Clix, Radio Condit, Bridge Condenser, and many other leading patented Radio Specialities. Distributing Agents for entire products of all leading British Radio Manufacturers. Specialists in Hire Services of the Western Electric Public Address System.

BEATON, V., 45 Chalk Farm Road, N.W.1. *T.N.:* Willesden 2688. *Manufactures:* All types of Experimental Apparatus. Has had many years' experience in this branch.

BELDAM TYRE CO. (1920), **LTD., THE,** Windmill Road, Brentford, Middlesex, also at 83 Piccadilly, W. *T.N.:* Ealing 125. *T.A.:* Beldalite.

Manufactures: Crystal Sets, Valve Sets, Amplifiers, and Components. Ebonite mouldings for the trade of the highest grade possible.

BELLING & LEE, LTD., Queensway Works, Ponders End, Middlesex. *T.N.:* Enfield 498. *T.A.:* Belling & Lee, Ponders End.

Directors: C. R. Belling, M.I.E.E., E. M. Lee. B.Sc. *Secretary:* E. M. Lee, B.Sc. *Manufactures:* Wireless Apparatus, Indicating Terminals, Plug and Socket Terminals.

BENNETT, MACKENZIE & CO. *London Office:* 11/12 Finsbury Square, E.C.2. *Works:* Brockley, S.E.4. *T.N.:* Clerkenwell 2410.

Sole Proprietor: B. C. Bennett. *Manufactures:* Crystal Sets—"Benmaco" Junior and Senior Valve Sets—One, Two, Three, Four, and Five Valves, all component Parts excepting Valves, Accumulators, and Batteries.

Registered on King's Roll for employing Ex-service Men. Members of the British Broadcasting Co. All Sets manufactured approved by P.M.G.

BISHOP, W. J., & CO., 1 King's Parade, High Street, Croydon. *T.N.:* Croydon 40.

Manufactures: Wireless Instruments and Components. *Radio Call Signal:* 6 CL.

B.N.B. WIRELESS, LTD., 65 Renshaw Street, Liverpool. *T.N.:* Royal 806. *T.A.:* Aerial, Liverpool.

Directors: J. McCurdy, H. D. Bloomfield. *Secretary:* W. H. Jones. *Manufactures:* Crystal Sets, Components, Gramaphix.

BOWYER-LOWE CO., LTD., THE, Radio Works, Commerce Avenue, Letchworth, Herts. *T.N.:* Letchworth 246. *T.A.:* Bowyer-Lowe Co., Letchworth.

Directors: A. E. Bowyer-Lowe, M.J.I.E., H. W. Widgery. *Secretary:* H. W. Widgery. *Manufactures:* Complete Receiving Sets, Components, Wavemeters, Variometers, Variocouplers, Variable Square Law Condensers, Measuring and Testing Instruments for Wireless, etc.

BRENNAN'S & BRENNAN'S, 8*a* Hackford Road, Brixton, London, S.W.9. Member of British Broadcasting Co., Ltd. *T.N.:* Brixton 1911.

Manufactures: Wireless Crystals, every kind known dealt with. Importers and Exporters. We specialize in Crystals—all kinds in boxes, labelled, customers' own name, etc., also by weight. Sole Distributors of Dr. Cecil's Genuine Hertzite.

BRITANNIA RUBBER AND KAMPLUTICON CO., LTD., THE. Head Office, 7 Newgate Street, London, E.C. *T.N.:* Central 2168. *T.A.:* "Britannia, London." Works, Devons Road, Bow Common, London, E.

India-rubber and Ebodite Manufacturers, established about 1850. *Manufactures:* Speciality—Ebonite for Wireless work, Sheets, Matt surfaces, all thicknesses kept in stock ·010 in. to 2 in. thick, Rods and Tubes, every size. Panels cut, no limits for size. Silver Medal for EBONITE awarded Electrical Exhibition, Crystal Palace, 1892, etc., etc.

BRITISH EBONITE CO., LTD., THE, Nightingale Road, Hanwell, W.7. *T.N.:* Ealing 1560. *T.A.:* "Ebonitical," Han., London.

Directors: John Hughes, J. J. Moore. *General Manager:* E. J. Long. *Director:* Ralph G. Scott. *Secretary:* Richard Kellerman. *Manufactures:* Ebonite Rods, Tubes, Sheets, and Mouldings.

The only British makers of Red and Black-grained Ebonite exclusively engaged in production of high-class Ebonite.

BRITISH RADIO CORPORATION, LTD., Elm Grove Road, Weybridge, Surrey. *T.N.:* 593. *T.A.:* "Astraphone, Weybridge."

Manufactures: High Grade Wireless and Electrical Instruments for Aircraft, Commercial, Broadcasting. *Radio Call Signal:* 5 PI.

BRITISH THOMSON-HOUSTON CO., LTD., THE. *Head Office and Main Works:* Rugby. *London Office:* Crown House, Aldwych, W.C.2. *T.N.:* Rugby 286. *T.A.:* "Asteroidal," Rugby.

Directors: H. C. Levis (Chairman), W. C. Lusk (Managing Director), The Rt. Hon. Earl Buxton, The Rt. Hon. Lord Carmichael, E. A. Carolan, C. A. Coffin, A. W. Burchard, Major-General A. de Lotbiniere, F. Fraser (Secretary), E. W. Rice, O. H. Smith, H. N. Sporborg (Chief Engineer), G. Swope, J. M. Woodward. *Secretary:* F. Fraser. *Manufactures:* Wireless Apparatus for reception of Broadcasting. *Radio Call Signal:* 2 ZI.

This Company is a director of the British Broadcasting Co.

BROADCAST WIRELESS CO., LTD., THE, 2 Tower Royal, Cannon Street, London, E.C.4, and Southfields, London, S.W.13. *T.N.:* City 8482. Putney 2572. *T.A.:* "Adorners," Phone, London.

Managing Director: Gordon O. Tutton. *Director:* Capt. C. D. Rutter. *Secretary:* Allan Somerville Young. *Manufactures:* Wireless Receiving Sets of every description, Component Parts, etc.

Registered Trade Mark: "Broadco."

"BROADWAY" RADIO WORKS, THE, Devonshire Road, Bexley Heath, Kent.

Proprietor: H. L. Lidington. *Manufactures:* Crystal Sets, Valve Sets, High- and Low-frequency Amplifiers, Precision Air Di-electric Condensers, Filament Rheostats, etc., etc.

BROWN, S. G., LTD., Victoria Road, North Acton, W.3 (*Works and Head Office*); 19 Mortimer Street, W.1; 15 Moorfields, Liverpool; 67 High Street, Southampton (*Showrooms*). *T.N.:* Chiswick 312/3, 2626. *T.A.:* "Sidbrownix, London."

Directors: Sidney George Brown, F.R.S. *Secretary:* Mrs. S. G. Brown. *Manufactures:* Radio Telephones and Loud Speakers, and Relays (Microphone Amplifier, etc.); also Brown Gyro Compass and Cable Instruments.

BURNDEPT, LTD. *Head Office:* Aldine House, Bedford Street, Strand, W.C.2. *Factories:* Aerial and Eastnor Works, Blackheath, S.E.3. *London Showrooms:* 15 Bedford Street, Strand, W.C.2. Leeds: 12 Basinghall Street, City Square. Cardiff: 67 Queen Street. Northampton: 8 The Drapery. *T.N.:* Gerrard 9072, Private Line to Works, Blackheath. *T.A.:* "Westrand, London."

Directors: W. W. Burnham, Fel.I.R.E., A.I.E.E., G. E. Duveen, M.A., F. Phillips, M.I.R.E., A.M.I.E.E., J. E. Monins, J.P., M.A. *Secretary:* P. J. Chaplin, A.C.A. *Manufactures:* Wireless Apparatus. *Radio Call Signals:* 2 FQ—2 QQ—2 YH—2 VK—5 MW.

BURNE-JONES & CO., LTD., "Magnum House," 296 Borough High Street, S.E.1. *T.N.:* Hop 6257.

Directors: David Burne-Jones, Frank Foulger. *Secretary:* C. H. Highmore. *Manufactures:* "Magnum" Super-hets, "Magnum" Tapped Coils, "Magnum" Transformers, "Magnum" Valve Holders, "Magnum" Variometers, and all Components for Receiving and Transmitting Apparatus. *Radio Call Signals:* 200 metres—2 FP New Cross; 2 PB Kennington; 6 CW Streatham; 2 CT Lambeth.

BURNS, J., LTD., Wangye Works, Chadwell Heath, Essex. *T.N.:* Ilford 400 and 1594. *T.A.:* "Wangye," Chadwell Heath.
Managing Director: H. Baines. *Manufactures:* Vulcanized Fibre, Sheets, Rods, Tubes; special shapes Turnings, Stampings, etc.; Wireless Telephone Parts and Complete Receiving Sets.
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Managing Director: H. D. Butler. *Manufactures:* Wireless Apparatus and Component Parts.

C.A.C. RADIO, LTD. (late **City Accumulator Co.**). 10 Rangoon Street, E.C.3; 79 Mark Lane, E.C.3; 10 Rupert Street, W.1; 79 Old Christchurch Road, Bournemouth; and Central Street, Leeds. *T.N.:* Royal 4300–1; Gerrard 3063; Leeds 26296; Bournemouth 3546.
Managing Director: G. E. Ward. *Chief Engineer:* Alan L. M. Douglas, M.I.Rad.E. *Secretary:* J. S. Ballance.
Manufactures: C.A.C. Valves, Sets and Accessories.

CARROLL, PARSONS & CO., 12 Verney Road, London, S.E.16. *T.N.:* Hop 6779.
Partners: C. A. Carroll, S. Parsons, W. Parsons. *Manufactures:* "Audiolax," "Dulcivox" Radio Instruments.
Radio Instrument Makers to the trade. Inventors' ideas worked out. Electrical Engineers.

CARY, HALLEWELL & CO., LTD., New Era Engineering Works, Brentfield Road, Willesden, N.W.10. *T.N.:* Willesden 2918.
Directors: A. L. Cary, W. Hallewell, E. L. Stacey. *Secretary:* E. L. Stacey. *Manufactures:* Receiving Sets, Switchboards, etc.

CASTAGNOLI, GORDON, Castaphone Radio Works, Braintree, Essex. *T.A.:* "Castagnoli, Braintree."
Principal: Gordon Castagnoli, A.M.I.Radio.E. *Manufactures:* Radio Apparatus and Accessories. *Radio Call Signal:* 2 ZV.

CENTRAL AIRCRAFT CO., LTD., 179 High Road, Kilburn, N.W.6. *T.N.:* Hampstead 4403 and 4404. *T.A.:* "Aviduction, Phone, London."
Manufactures: Wireless Cases and Cabinets.

CHELMSFORD RADIO ENGINEERING CO., THE, 76 Duke Street, Chelmsford, Essex. *T.N.:* 376.
Partners: Douglas C. Clark, Harold J. Hawkes. *Manufactures:* Complete Receiving Sets of all descriptions. *Radio Call Signal:* 5 DY.
Wholesale and Retail Business.

CHLORIDE ELECTRICAL STORAGE CO., LTD., THE, Clifton Junction, near Manchester. Also Branches at 58 Dale End, Birmingham; 219/229 Shaftesbury Avenue, London; 1 Bridge Street, Manchester; 22 Victoria Street, Bristol; and 40–44 Tureen Street, Glasgow. *T.N.:* Pendleton 481. *T.A.:* "Chloridic, Pendlebury."
Secretary: D. P. Dunne, F.C.I.S. *Manufactures:* Accumulators.
Makers of the well-known Exide Batteries for Wireless, etc.

CINECHROME INSTRUMENTS, LTD. *Offices:* 8/9 Long Acre, W.C.2. *Showrooms:* 16 Garrick Street, W.C.2. *Works:* Cecile House, Crouch Hill, N. *T.N.:* Gerrard 8877. *T.A.:* "Cinechrome, Rad," London.
Manufactures: Wireless Apparatus and Scientific Instruments.

CLIFFORD & SON, CHARLES, LTD., Fazeley Street Mills, Birmingham; also at Dog Pool Mills, Birmingham. *T.N.:* C. 3634 (4 lines), S.O. 172. *T.A.:* "Clifford, Birmingham."
Directors: Thomas Ratcliff (Chairman), Charles H. Barwell, Arthur H. Wolseley (Managing). *Secretary:* E. H. M. White. *Manufactures:* Copper, Brass, Phosphor Bronze, and other non-Ferrous Metals in Tubes, Rods, Strip Sheets, and Wire. Established 1776.

C. T. COLBERY & CO., LTD., 8 St. James' Walk, Clerkenwell Green, London, E.C.1. *T.N.:* Clerkenwell 2425.

Manufactures: Wireless Instruments and Accessories, Scientific Instruments.

COOKE & WHITFIELD WIRELESS, LTD., St. Paul's Buildings, 24 St. Paul's Square, Birmingham. *T.N.:* Central 7780. P.B.X. *T.A.:* "Stancap," Birmingham.

Directors: Howard Seymour Cooke, Horace Henry Whitfield, F.R.S.A. *Secretary:* H. S. Cooke. *Manufactures:* Wireless Parts; Dealers in Complete Instruments. Aerials erected complete. Accumulator charging. *Radio Call Signal:* 2 LG and 5 GH.

Mr. H. H. Whitfield was a winner in the recent Transatlantic Amateur Reception, and was awarded a special prize for the best design of circuit.

COOPER-STEWART ENGINEERING CO., LTD., THE, 136–7 Long Acre, London, W.C.2. *T.N.:* Gerrard 5131 (3 lines). *T.A.:* "Speedistic," London.

Manufactures: Receiving Sets.

COSSOR, A. C., LTD., Aberdeen Works, Aberdeen Lane, Highbury Grove, London, N.5. *T.N.:* North 4340. *T.A.:* "Amplifiers," Phone, London.

Directors: W. R. Bullimore, B. M. Bullimore. *Secretary:* A. A. E. Corbett. *Manufactures:* Wireless Valves, Apparatus and Accessories.

COUBRO & SCRUTTON, LTD., 37 Mark Lane, E.C.3; 11 West India Dock Road, Limehouse, E.14. *T.N.:* East 5467/8/9, East 592. *T.A.:* "Coubro, Fen, London."

Directors: Charles Linder, Campbell I. Scrutton. *Secretary:* A. King. *Manufactures:* Wireless Masts, Spreaders, etc.

CROXSONIA CO., 10 South Street, E.C.2, and 27 Bermondsey Street, London Bridge, S.E.1.

Principals: H. W. Croxson, A. E. Croxson. *Manufactures:* Radio Sets, "Croxsoniaphone," and Radio Panelling "Croxite." (Regd. No. 446286.)

CUNNINGHAM, LTD., 169/171 Edgware Road, W.2. *T.N.:* 5173/4 Paddington.

Managing Director: R. N. Cunningham. *Manufactures:* Wireless Receivers and Parts. *Radio Call Signal:* 5 HP.

General Electrical Engineers.

DAVENPORT, G. (Wireless), LTD., 69 and 70 Dean Street, Oxford Street, W.1. *T.N.:* Regent 1368 (two lines). *T.A.:* Coaction, Westcent, London.

Directors: John Henderson, D.Sc., M.I.E.E., F.R.S.E. (Chairman), Gilbert Davenport (Managing Director), Cyril G. Davenport, B.Sc., John A. Robertson, R. A. Croston. *Secretary:* H. F. Vaughan. *Manufactures:* "D.W." Receiving Sets, Components, and Accessories.

Members of British Broadcasting Co. and National Association of Radio Manufacturers. Manufacturers of Wireless Receivers.

DAVIS & TIMMINS, LTD., 34A York Road, King's Cross, N.1. *Works:* Brook Road, Wood Green, N.22. *T.N.:* North 580. *T.A.:* "Conductivity, London."

Managing Director: G. E. Timmins. *Directors:* Wm. Negus, Esq., J.P., D.L. (Chairman), Sir Henry C. Mance, C.I.E., Arthur E. Perret, W. E. Stewart. *Secretary:* W. Constant. *Manufactures:* Metal Thread Screws and Turned Parts in all Metals. Studs, Nuts, Spacing Washers, Valve Legs, Terminals.

DAY, WILL, LTD., 19 Lisle Street, Wardour Street, London, W.1. *T.N.:* Regent 4577. *T.A.:* "Titles Westrand, London."

Directors: Wilfred E. L. Day, Horace L. V. Day. *Manufactures:* Wireless Accessories of all kinds. Crystal and Valve Sets.

DAYZITE, LTD., 18/19 Lisle Street, Wardour Street, London, W.1. *T.N.:* Regent 4577. *Manufactures:* Portable Supersonic Sets, wholesale only.

DENT & CO. & JOHNSON, LTD., Linwood Works, Linwood, near Paisley. *T.N.:* 109 Johnstone. *T.A.:* "Dentcompa, Linwood."

Managing Director: C. H. Johnson. *Secretary:* D. A. Wallace. *Manufactures:* "The Linwood" Wireless Receivers and Loud Speakers.

DIAMOND FIBRE CO., LTD., THE. *Head Office :* High Road, South Tottenham, London, N.15. *Works :* Bridge Mills, Tovil, Maidstone. *T.N. :* Tottenham 2261/62. *T.A. :* "Dymofyber, Tolcross, London."

Managing Director : Fergus N. Macechern. *Directors :* Edward M. Taylor, A. Dykes Spicer, John M. Taylor, Chas. H. Wright, William H. Taylor. *Secretary :* F. M. Toole. *Manufactures :* Condensite Celoron and Vulcanized Fibre in Sheets, Rods, Tubes, and all Component Parts. Trunk Fibre.

DICKINSON ELECTRICAL MANUFACTURING CO., LTD., THE, Graham Road Works, Bexley Heath. *T.N. :* Bexleyheath 74.

Manufactures : O'Keefe Law Capacity Inductance Coils.

DUBILIER CONDENSER CO. (1925), **LTD., THE,** Ducon Works, Victoria Road, North Acton, W. *T.N.:* Chiswick 2241, 2242, 2243. *T.A.:* "Hivoltcon, Phone, London."

Directors : Sir Arthur Lowes Dickinson, M.A., F.C.A., T. A. Evans, W. H. Goodman, J. E. Hyde, A. Mikellatos (Greek), G. C. Hans Hamilton. *Chief Engineer :* P. R. Coursey. *Secretary :* Mr. F. W. Hollings. *Manufactures :* Electrical Condensers for all purposes. *Radio Call Signal :* 5 AT.

EAGLE ENGINEERING CO., LTD., Eagle Works, Warwick. *London Depot :* Eagle Wireless Supply Co., Ltd., 8 Great Russell Street, W.C.1. *T.N.:* 126 and 127 Warwick; London: Mus. 2848. *T.A.:* "Eagle, Warwick."

Managing Director and Chairman : R. G. Palmer. *Directors :* E. Bradley, F. C. Bradley, H. B. Palmer. *Secretary :* J. W. Mason. *Manufactures :* "Chakophone" Broadcast Wireless Receiving Sets, Accessories, and Equipment.

EAST HAM WIRELESS SUPPLIES, 429 Barking Road, East Ham, E.6. *T.N. :* East Ham 1038.

Proprietor : Henry H. Lassman. *Manufactures :* Wireless Apparatus. *Radio Call Signal :* 2 PX, Duplex, Telephony, and C.W., 150 to 200 metres and 440 metres.

EASTICK, J. J., & SONS. *Head Office :* Eelex House, Bunhill Row, London, E.C.1. *Works :* Eelex Works, 26/36 Lamb's Passage, Chiswell Street, London, E.C.1. *T.N. :* Clerkenwell 9282/9283. *T.A. :* "Eastick, Dalston 1912, London."

Manager : J. C. N. Eastick, F.C.S., A.I.C., A.I.E.E. *Manufactures :* Variometers. Condensers, Knife Switches, Lead-in Tubes, Wireless Parts and Sets.

Have been making small Electrical Wireless parts since 1909 and specialize in goods to customers' requirements.

EBONESTOS INSULATORS, LTD., Excelsior Works, Rollins Street, Canterbury Road, London, S.E.15. *T.N. :* New Cross 1913 (5 lines). *T.A. :* "Ebonestos, Phone, London."

Manufactures : Moulded Ebonestos Insulators suitable for all classes of Electrical Work. Fire and Acid-resisting Grades a speciality.

ECONOMIC ELECTRIC CO., LTD., THE. *Registered Offices :* 10 Fitzroy Square, W.1. *Showrooms :* 303 Euston Road, N.W.1. *Branch : Showrooms and Works :* Twickenham. *T.N. :* Museum 1055 (Private Branch Exchange). *T.A. :* "Econectric, Eusroad, London."

Directors : Albert Holt, Cyril Holt, Reginald Holt. *Manager :* B. S. Varnals. *Secretary :* Herbert Donlin. *Manufactures :* Thermionic Valves. The "Xtraudion" Synthetic Crystal, "Rectarite." Complete Radio-receiving and Transmitting Sets and Components.

Patentees and Manufacturers of the "Xtraudion" Three-electrode Valve, Valve Bridge, and "E.E.C." Oxcillator.

EDISON SWAN ELECTRIC CO., LTD., THE, 123/125 Queen Victoria Street, E.C.4. *Works :* Ponders End, Middlesex. *T.N. :* City 9881 (7 lines). *T.A. :* "Ediswan, London."

Directors : C. F. Spencer (Chairman), A. F. Berry, John Cross, C. H. Cox, George Berry, H. J. C. Johnston, J. W. Drake, E. A. Gimingham (Technical).

Secretary : F. V. Hasemore. *Manufactures :* Valves, Dry Batteries (H.T.), Accumulators (H.T. and L.T.), Switches, Sets and Components, etc. Royal "Ediswan" Gasfilled, Vacuum and Carbon Filament Lamps.

EFANDEM CO., LTD., THE, Fallings Park Works, Wolverhampton; 11 Fitzroy Square, London, W.1; and 28 Queen Street, Albert Square Manchester. *T.N. :* Wolverhampton 1123/34; Museum, London, 2265; City M/C 2014. *T.A. :* "Efandem, Wolverhampton"; "Efandem Eusroad, London"; "Efandem, Manchester."

Manufactures: High-tension Batteries for Wireless Receiving Sets.

EGGINTON, A. G., & SON, Hope Road, Brooklands, Sale, Cheshire. *T.N. :* Sale 352

Partners : A. G. Egginton (Senior), A. Gerald Egginton (Junior). *Manufactures :* "Ageophone" Receivers, Variable Condensers, and Component Parts. *Radio Call Signal :* 6 SP.

ELECTRON CO., LTD., THE. Triumph House, 189 Regent Street, London, W.1. *Works :* 22–23 Allsop Street, Upper Baker Street, London, N.W.1. *T.N. : Office.* Regent 5336. *Works :* Padd. 6611.

ELECTRICAL SUPPLY STORES, 70 Crown Street, Halifax, Yorks. *T.N. :* 1062. *T.A. :*

Proprietor : R. Palmer. *Manufactures :* Specialists in Wireless Apparatus and Terminals. Established 1913.

ELSTON, A. J., 82 Devonshire Road, N.7. *Works :* 391 Hornsey Road, N.19. *T.N. :* Hornsey 2847.

Sole Proprietor : A. J. Elston. *Manufactures :* "Telsophone 'C'" Receiving Sets (B.B.C.), Wireless Components.

ELWELL, C. F., LTD., 138 Gordon Road, Peckham. *T.N. :* New Cross 1397.

Managing Director : C. F. Elwell. *Directors :* J. Herbert Scrutton (Chairman), B. Binyon, O.B.E. *Manufactures :* Designers and Manufacturers of Receiving Sets for Broadcast Reception. *Radio Call Signal :* 2 XQ.

Elwell-Poulsen Arc Transmitters installed in first stations of Imperial Chain at Leafield (Oxford) and Abu Zabal (Egypt). Also at Northolt, Rome, Lyons, Eiffel Tower, etc.

ENGLAND-RICHARDS FLUID-FREE CELL CO., THE. 97 High Street, King's Lynn, Norfolk. *Sole Agents and Distributors :* Messrs. The Stalham Engineering Works, Ltd., Stalham, Norfolk.

ESSEX ACCUMULATOR CO., THE, 499 Grove Green Road, Leytonstone, E.11. *T.N. :* Wanstead 749.

Managing Director : A. J. Sheldrake. *Manufactures :* Wireless Accessories and Accumulators.

ESTLER BROS., South Molton Road, Victoria Docks. *T.N. :* Albert Dock 1871. *T.A. :* "Isolable, Canning, London."

Directors : E. P. B. Estler, H. P. C. Estler. *Manufactures :* Lightning Arrestors.

General and Electrical Engineers; Iron, Gun Metal, and Aluminium Founders; Sheet-metal Workers.

EVANS, E. M. & SON, LTD., 1 and 5 Lever Street, Manchester; 1 Queen Street, Burslem, Staffs. *T.N. :* City, Manchester, 4250; Central, Stoke, 939. *T.A. :* "Cymric," Manchester. "Evans, Electricians, Burslem."

Governing Director: Joseph H. Evans, A.M.I.E.E. *Secretary:* U. C. Tinker. *Manufactures:* "Eventone" Valve Sets, Crystal Sets, Spare Parts for Amateurs.

EVER-READY CO. (GREAT BRITAIN), LTD., THE, Hercules Place, Holloway, London, N.7. *T.N. :* North 3300. *T.A. :* "Eveready, Holway, London."

Directors : C. H. C. Moller (Chairman), Magnus Goodfellow (Deputy-Chairman and Managing), A. H. Sheppard, C. H. Dade, L. P. Lightstone. *Secretary :* F. S. Johnson. *Manufactures :* Portable Electric Lamps, Dry Cells and Batteries, Accumulators, and Motor-car Accessories.

FALK STADELMANN & CO., LTD., 83–87 Farringdon Road, E.C.1. *Manufactures :* Accessories of all kinds.

FELLOWS MAGNETO CO., LTD., Cumberland Avenue, Park Royal, N.W.10. *T.N. :* Willesden 1560. *T.A. :* "Quixmag," Phone, London.

Managing Director : D. V. L. Fellows. *Wireless Manager :* C. S. Harding. *Secretary :* H. C. Sawyer. *Manufactures :* Wireless Apparatus. *Radio Call Signal :* 2 ZZ and 5 CP.

GAMAGE, A. W., LTD., Holborn, London, E.C.1. *T.N. :* Holborn 2700. *T.A. :* "Gamage, Holborn, London."

Directors : A. W. Gamage, E. M. Gamage, J. Dunn, W. A. Vincent, J. S. Parker. *Secretary :* E. W. Malvern. *Manufactures :* Wireless Apparatus.

Have been Wireless Manufacturers since 1908. Contractors to H.M. Government during the War.

GAMBRELL, BROS., LTD., 76 Victoria Street, S.W.1. *Works:* Merton Road, Southfields, S.W.18. *T.N.:* Putney 3461. *T.A.:* "Gambrell, Putney, 3461."

Directors: T. E. Gambrell, C. T. Gambrell, A. Onwood, R. Annan. *Manufactures :* "Efficiency" Inductance Coils, L.F. Transformers, Heutrodyne Condensers, Anti-capacity Switches, Coil Holders, Complete Receiving Sets, Transmitting Apparatus and Electrical and Scientific Instruments.

GASKELL & GROCOTT, Whitehall Works, Longport, Stoke-on-Trent. *T.N. :* Central 388. *T.A. :* "Insulator, Longport."

Proprietors : R. T. Grocott's sons—Tom Grocott, Will. Grocott. *Manufactures :* Porcelain Insulators.

GENERAL ELECTRIC CO., LTD., THE. *Head Office :* Magnet House, Kingsway, London, W.C.2. Branches throughout the United Kingdom and in all the Principal Markets of the World. *T.N. :* Regent 7050 (50 lines). *T.A. :* "Electricity Westcent, London." *Cablegram :* "Polyphase, London."

Manufactures: Everything Electrical, including Wireless Apparatus, Telephone Equipments, Measuring Instruments, Insulating Material, etc., etc.

GENERAL RADIO CO., LTD. *Head Office:* Radio House, 235 Regent Street, London, W.1. *Works:* Radio Works, 22/23 Allsop Street, Baker Street, N.W.1. *T.N.:* Mayfair 7152/3 (Private Branch Exchange). *T.A.:* "Algenrad, London."

Directors: W. S. Stephenson, A. Morphy, W. E. S. Wissler, B. H. Morphy. All types of Wireless Apparatus, X-ray and Electro-medical Apparatus, and Scientific Instruments.

GENT & CO., LTD., Faraday Works, Leicester. London : 25 Victoria Street, S.W. Newcastle-on-Tyne : "Tangent" House, Blackett Street. *T.N. :* Leicester 151. *T.A. :* "Gents, Leicester."

Managing Director : I. Hardy Parsons. *Directors :* H. R. Waddington, C. Skinner. *Secretary :* O. E. Kinsey. *Manufactures :* Broadcast Receiving Apparatus, Radio Sundries, including "Tangent" Radio Specialities, Tuning Coils, Low Frequency Transformers, "Discol" High-frequency Transformers, "Tangent" Head Phones, etc. *Radio Call Signal :* 5 FX.

GOSWELL ENGINEERING CO., LTD., 12a Pentonville Road, N.1. *T.N.:* North 3051.

Directors : A. P. Portway, R. C. Portway, W. A. Allingham, A. P. Barry. *Manufactures:* "Quality Radio Components," consisting of Coil Holder, Duplex Coils, Legless Valve Holders, etc.

GOULDEN, H. J., LTD., 39 and 40 High Street, Canterbury. *T.N. :* 139 *T.N. :* "Gouldens, Canterbury."

Directors: H. J. Goulden, H. G. R. Goulden, L. J. Goulden. *Secretary:* H. G. R. Goulden. *Manufactures:* "Itonaphone" Wireless Sets.

Members B.B.C. *Call Sign :* 6 XU.

GRAHAM, ALFRED, & CO., St. Andrew's Works, Crofton Park, S.E.4 ; also Kilmorie Works, Forest Hill, S.E.23 ; Showrooms, 25-26 Savile Row,

W.1, and 79-82 High Street, Clapham, S.W.4. *T.N.:* (Works) Sydenham 2820-1-2. *T.A.:* "Navalhada, Catgreen, London."

Sole Partner: Edward Alfred Graham. *Manufactures:* "Amplion" Loud Speaker.

GREENSLADE & BROWN, 187 Clapham Road, S.W.9. *T.N.:* Brixton 639, Brixton 3251.

Directors: A. E. Greenslade, M.J.Inst.E., R. G. J. Brown, M.J.Inst.E. *Secretary:* N. Hammond. *Manufactures:* Wireless Components. *Radio Call Signal:* 5 GM and 5 GN.

HAMBLING, CLAPP & CO., LTD., 11 Agar Street, Strand, W.C.2. *T.A.:* Gerrard 8806

Directors: A. W. Hambling, A.M.I.R.E., B. Clapp, A.M.I.R.E., C.W. Rooke. Manufacturers of Receiving Sets under Messrs. Marconi's patents. Members of the B.B.C. Experimental Stations, 2 MK Brondesbury, 2 KZ Purley, 150/200 metres. Members N.H.R.M.A.T., Wholesalers' Section.

HARROD RADIO CO., 375 Queen's Road, New Cross, S.E.14. *T.N.:* New Cross 667. *T.A.:* "Harrod, 667 N.X."

Directors: W. Harrod, P. M. Harrod. *Secretary:* W. Harrod. *Manufactures:* Wireless Instruments and Accessories.

HART ACCUMULATOR CO., LTD. *Head Office and Works:* Marshgate Lane, Stratford, London, E.15. London: 36 Victoria Street, S.W.1. Birmingham: 165 Edmund Street. Glasgow: 107 Wellington Street. Manchester: Caxton Hall, 88 Chapel Street. Bristol: 37 Victoria Street. York: 6 Bridge Street. Manchester: Caxton Hall, Chapel Street. York: 6 Bridge Street. *T.N.:* Maryland 1361, 1362. *T.A.:* "Hartmossel, Bochurch, London."

Directors: Sir John Prestige (Chairman), E. J. Clark, G. Hay, H. W. Lee, L. W. Spratt, F. J. Holmes, M.I.E.E. *Secretary:* Jno. Breeze, F.C.I.S. *Manufactures:* Electric Accumulators of all sizes and for all purposes.

HART COLLINS, LTD., 38A Bessborough Street, Westminster, S.W.1. *T.N.:* Victoria 3738. *T.A.:* "Gilboyding, Churton, London."

Directors: C. Hart Collins, H. M. Collins. *Secretary:* R. E. Wheeler. *Manufactures:* Wireless Receivers. *Radio Call Signal:* 5 NY, 5 NZ.

Receivers fitted to customers' furniture.

HARWELL, LTD., 28 John Street. Theobald's Road, London, W.C.1. *T.N.:* Museum 5422. *T.A.:* "Anvelidite, Holb., London." *Manufactures:* Semaphore Dry Batteries, Moulded Insulation Articles in Solidite, Radio Accessories.

HAZELTINE NEUTRODYNE RADIO SETS, LTD., 147 Queen Victoria Street, E.C.4. *T.N.:* Central 7121. *T.A.:* "Neutrodyne, London."

Directors: G. A. Mower, U.S.A., G. R. Thursfield, A. H. Curtis, J. C. Elms, U.S.A., A. H. Corwin, U.S.A., J. C. Elms, Junior, U.S.A. *Secretary:* W. H. Ward. *Manufactures:* Receiving Sets.

HEATON WALLACE, LTD. (RADIO), 17/27 Change Alley, Sheffield; 119 New Bond Street, London; Imperial Buildings, Rotherham. *T.N.:* Cent 255. *T.A.:* "Zodella, Sheffield"; "Zodellaria Wesdo, London."

Directors: Wallace E. Heaton, London, G. W. McIntosh, Sheffield. *Secretary:* M. McIntosh. *Manufactures:* Wireless Instruments and Accessories, Scientific and Photographic Apparatus.

Proprietors of Zodel and Zodelphone (Trade Mark) Wireless Specialities.

HENDERSON, W. J., & CO., 351 Fulham Road, S.W.10. *T.N.:* Kensington 8983.

Partners: W. J. Henderson, A. F. Phelp, R. M. Dilion. *Manufactures:* Broadcasting Receiving Apparatus, Components of all descriptions.

HENLEY'S, W. T., TELEGRAPH WORKS CO., LTD., Holborn Viaduct, London, E.C.1. *Works:* North Woolwich, E.16; and Gravesend, Kent. *T.N.:* City 2271 (10 lines). *T.A.:* "Henletel, Cent., London."

Managing Director : Sir George Sutton, Bart. (Chairman). *Directors :* Sir Montague Hughman, W. J. Potter, R. J. Hatton, M.I.Mech.E., M.I.E.E., Martin Roberts, M.Inst.C.E., A. A. Campbell Swinton, F.R.S., M.Inst.C.E., M.I.E.E. *Secretary :* A. E. Salmon. *Manufactures :* All kinds of Electric Cables and Wires and Distribution Accessories.

HENTON, EDMUND B., Hollywood, near King's Heath, Birmingham. *Manufactures :* "Entuna" Variable Condensers. *Radio Call Signal :* 6 WG.

Actual manufacturer and supplier to the trade.

HESTAVOX, LTD., 32 Palmerston Road, Acton, London, W.3. *T.N. :* Chiswick 586.

Directors : A. H. Rice, H. A. Rice. *Manufactures :* Loud Speakers.

HILL & BOLL, Kingston and Park Road, Yeovil. *T.N. :* 98. *T.A. :* "Boll, Yeovil."

Proprietor : F. W. Boll. *Manager :* L. W. C. Martin. Manufacturers of the "Martinphone Receivers," and Wireless Sets and Components.

HINDERLICH, A., 1 Lechmere Road, London, N.W.2. *T.N. :* Willesden 2668.

Manufactures : Crystals in Bulk or Packed ; Crystal Detectors ; "Ghane" Crystal Combination. (Wholesale and Retail.) *Call Sign :* 2 QY.

HOPLEY, JOSEPH, & SON, Whitchurch, Salop. *T.N.* 51. *T.A. :* "Hopley Whitchurch."

Directors : Arthur S. Hopley, Alan H. Entwistle. *Manufactures :* Wireless Apparatus, Receivers, etc., known as Entley Radio Products.

Component part sets for amateur constructors known as Entley-Ponents.

HOUGH, J. E., LTD., Edison Bell Works, Glengall Road, London, S.E.15. *T.N. :* Hop 64 and 65. *T.A. :* "Phonokino, Kent, London."

Technical Manager : Thomas Hough. *Commercial Manager :* W. F. Robbins. *Manufactures :* Wireless Sets, Component Parts, Insulators, etc.

Pioneers of the British Gramophone Industry.

HUDSON IRVING RADIO CO., THE, 5 Pitt Street, Glasgow. *T.N. :* Central 8033.

Managing Director : H. G. Russell. *Manufactures :* Radio Instruments, Component Parts, and Wireless Factors. *Radio Call Signal :* 5 SS.

IGRANIC ELECTRIC CO., LTD., 147 Queen Victoria Street, London. Also at Glasgow, Manchester, and Leeds. *Works :* Bedford. *T.N. :* Central 7123, Bedford 232. *T.A. :* "Igranic," London, Glasgow, Manchester, Leeds, Bedford.

Directors : G. A. Mower, F. R. Bacon, F. L. Pierce. *Secretary :* G. R. Thursfield. *Manufactures :* Honeycomb Inductance Coils, Slab Inductance Coils, Basket Inductance Coils, Intervalve Transformers, Coil Holders, Filament Rheostats, Variometers, Variable Condensers, Fixed Grid Leaks, Valve Holders, Potentiometers, etc., etc.

Sole licensees under De Forest British Patents.

IMPERIAL MOTOR INDUSTRIES, LTD., Denmark Street, Charing Cross Road, W.C.2. *T.N. :* Gerrard 3347/3348. *T.A. :* "Giftedness, London."

Directors : H. Cowen, H. Weinberg. *Secretary :* C. L. Hullard. *Manufactures :* I.M.I. Crystal Sets.

Factors of all Wireless Sundries.

ISTED, T. H., Radio Works, Terling, Witham, Essex. *T.N. :* Hatfield Peverel 19. *T.A. :* "Wireless, Terling."

Proprietor : T. H. Isted. *Manufactures :* All classes of Wireless Receivers. *Radio Call Signal :* 2 ZM.

JACKSON, T., SONS, & CO., LTD., Sandford Works, Sandford Road, Bexley Heath. *T.N. :* Bexley Heath 21. *T.A. :* "Jacksons, Bexley Heath."

Managing Director : T. Jackson. *Secretary :* P. G. Jackson. *Manufactures :* Wireless Sets and Parts to customers' own designs.

Motor Engineers and Sheet Metal Workers.

JEARY ELECTRICAL CO,. LTD., THE, 8 Lambeth Hill, E.C.4. *T.N. :* Bank 5075 and 6. *T.A. :* "Jearylec Cent., London."

Directors : F. O. Franks, A. J. Franks. *Manufactures :* All Wireless and Electrical Accessories.

JOHNSON & MURRELL ELECTRIC CO., LTD. Successors to Croggon & Co., Ltd. (Electrical Department). 230 Upper Thames Street, London, E.C.4. *T.N. :* City 4470. *T.A. :* "Johnson, City 4470, London."

Manufactures : Wireless Apparatus.

JONES & CO., Radio Engineers, 237 Westbourne Grove, London, W.11.

Manager : R. Jones. *Manufactures :* Radio Receiving Apparatus. Sole Agents for "Malone" Loud Speaker Attachments, "Maloneite" crystal, "Malonium" platinum and Silver Cat's Whiskers. Dealers in all Parts and Accessories.

JONES, SYDNEY, 31A Spray Street, Woolwich, S.E.18.

Proprietor : Sydney Jones. *Manufactures :* Ebonite Sheet Rod Tubing. All Accessories and Parts for Wireless Instruments. London Agent for Ebonite for St. Helen's Cable Co., Warrington, Lancs.

Ebonite Parts include Panels, Valve-holders, Scales of various types, Slider Knobs, Condenser Tops. 1½ Condenser Knobs, Condensers, Tuners, Coilholders, Headphones, Rheostats, Transformers. Brass Terminals, Nuts, and Metal-work.

JONES, WALTER, & CO., Charlton Works, Newlands Park, Sydenham, S.E.26. *T.N. :* Sydenham 1465.

Manufactures : Wireless Apparatus and Components, Telegraph and Telephone Apparatus.

Contractors to Admiralty, Post Office, and principal Cable Companies.

KEEN WIRELESS CO., 1 Dane Road, Ealing, London, W.13 (Office and Works and Temporary Showrooms).

Partners : W. F. Clark, F. Hall, L. G. Wimbledon (Members B.B. Co., Ltd.).

Manufactures : Component Parts, Filament Rheostats, 3-coil Holders, Intervalve Transformers, Variometers, Crystal Sets, Valve Sets, etc.

KENBAR ENGINEERING CO., 17/19 Lonsdale Road, Kilburn, N.W.6. *T.N. :* Willesden 3021.

Partners : H. A. Kentish, L. C. Kentish, A. F. Kentish, E. H. Barker. *Manufactures :* Wireless Transformers and Electrical Control Gear.

KENT BROS. ELECTRIC WIRE CO. & E. H. PHILLIPS, LTD., 15 Berners Street, Oxford Street, W.1. *Stores :* 43 Berners Mews, W.1. *Works :* 2 Newman Yard, W.1. *T.N. :* Museum 8200/1. *T.A. :* "Encosil Wesdo, London."

Directors : Arthur Kent (Chairman), Albert Kent, and E. H. Phillips (Joint Managing Directors), H. Hargreaves. *Manufactures :* Instrument Wires. Sole Agents for British Empire of "Sweetstrand" Enamelled Copper Wires.

KINE-RADIO CO., THE, 146 Sunbridge Road, Bradford, Yorks. *T.N. :* Bradford 5966.

Directors : F. Harwood, J. Robinson, A. Sykes, F. Needham. *Secretary :* F. Harwood. *Manufactures :* Scientific and Wireless Instruments ; K-R. Variable Condensers, Variometers, and Vario-couplers. Members of the B.B.Co.

LANG SQUIRE WIRELESS MANUFACTURING CO., LTD., THE, Wales Farm Road, Acton, London, W.3. *T.N. :* Chiswick 493. *T.A. :* "Lang Squire Wireless, Acton."

Directors : P. Garfield Blake (Chairman), G. R. H. Squire, Renold Marx, C. H. Durrad Lang. *Secretary :* C. H. Durrad Lang, A.M.I.E.E. *Manufactures :* Wireless Apparatus.

LILLEY, S., & SON, 80 Alcester Street, Birmingham. *T.N. :* Mid. 2385. *T.A. :* "Lilley, Alcester Street, Birmingham."

Principal : A. E. Lilley. *Secretary and Manager :* P. E. Lilley. *Manufactures :* Manufacturers to the Wholesale Trade ; Wireless Sundries from the Bar, also all kinds of Stampings ; Makers of the Royal Imperial Crystal Set. *Radio Call Signal :* P. E. Lilley 2 WV. Experimental Aerial.

THE LINCOLN WIRELESS CO., LTD., 30 Newlands, Lincoln. Members of B.B.C.

LINZELL, DICKINSON & CO., 7 Cazenove Road, Stoke Newington, N.16.

LOCKHEAD, T. H., (LOCKHEAD-SAYER RADIO CO.), 126 Middleton Hall Road, King's Norton, Birmingham. *T.N. :* K.N. 114.

Director : G. Sayer. *Manufactures :* Wireless Apparatus, "Elcophone" Receivers, etc. *Radio Call Signal :* 2 UO.

LONDON ELECTRICAL CO., THE, 1 Sherborne Lane, King William Street, London, E.C.4. *T.N. :* (Private Branch Exchange) Central 6208/9, 6249. *T.A. :* "Electa-phone, London."

Principal : Mr. A. E. Webster. *Manufactures :* Actual Manufacturers of the "L.E.C.-O.-Phone" and "Tropadyne" Receiving Sets. Make a speciality of manufacturing Experimental Sets to Amateurs' own Specifications. Established 1905.

LONGTON, H., A.M.I.Mech.E., 43 Johnson Street, Westminster, S.W.1. *T.N. :* Vict. 1222. *T.A. :* "Indsupply, Sowest, London."

Proprietor : H. Longton. *Manufactures :* Steel Radio Masts, Stay Tighteners (Prov. Pat. 27891/22), Galvanized Ironwork, Fusible Alloy (Salunite Brand).

MANCHESTER DISTRICT WIRELESS CO., THE, 21 Agur Street, Bury. *T.N. :* 692. *Proprietor :* E. L. Bate.

MANCHESTER RADIO CO., LTD., THE, 155 Oxford Road, Manchester. *T.N. :* Central 4935.

Managing Director : F. H. McCrea. *Directors :* W. R. Burne, F. G. Lawrence. *Secretary :* F. G. Lawrence. *Manufactures :* Wireless Instruments and Transformers. *Radio Call Signals :* 5 LL and 5 LM.

MANN, EGERTON & CO., LTD., 5 Prince of Wales Road, Norwich ; 156 New Bond Street, London, W.1 ; Messrs. Botwoods, Ltd., Major's Corner, Ipswich ; Fornham Road, Bury St. Edmunds ; London Road, South, Lowestoft. *T.N. :* Norwich 482, Gerrard 9060, Bury St. Edmunds 32. *T.A. :* "Installation, Norwich" ; "Installating, Wesdo, London."

Chairman and Managing Director : G. N. C. Mann. *General Manager and Director :* G. L. Wilford. *Secretary :* K. A. J. Varney. *Manufactures :* Electrical Goods, Wireless Sets, "Mecophone" One-valve Set.

MARCONI SCIENTIFIC INSTRUMENT CO., LTD., THE. *Registered Office and Works :* 70 Dudden Hill Lane, Willesden. *T.N. :* Willesden 2617/8. *T.A. :* "Themasinco, Will Road."

Directors : C. T. Bazell, Lt.-Col. Adrian, F. H. S. Simpson, C.M.G., Henry Morgan. *Secretary :* V. M. Luke, A.C.I.S. *Manufactures :* Instruments for Wireless Telegraphy and Telephony, Telegraph Instruments, Scientific Instruments. *Radio Call Signal :* 2 MF.

MARCONI'S WIRELESS TELEGRAPH CO., LTD., Marconi House, Strand, London. W.C.2. *T.N. :* City 8710. *T.A. :* "Expanse Estrand, London."

Managing Director : The Rt. Hon. F. G. Kellaway, P.C. *Chairman :* Senatore G. Marconi, G.C.V.O., LL.D., D.Sc. *Secretary :* A. Ogle, M.C., A.C.I.S. *Manufactures :* Wireless Apparatus of all descriptions. World-range High-powered Stations. Beam Wireless Stations, etc.

World Pioneers in Commercial Wireless.

MASTER RADIO MANUFACTURING CO., Carver Street, Old Trafford, Manchester. *T.N. :* Trafford 1111. *T.A. :* "Mastavox, Manchester."

Principal : William H. Lowth. *Manufactures :* "Master-Junior" and "Mastavox" Radio Sets and Component Parts.

McMICHAEL, L., LTD., Hastings House, Norfolk Street, Strand, W.C.2. *T.N.:* Central 8272/8273. *T.A.:* "Radiether, Estrand, London."

Directors: Leslie McMichael, F.Inst.R.E.; René H. Klein, M.Inst.R.E. *Manufactures:* Wireless Apparatus and Accessories of every description. *Radio Call Signals:* 2 FC and 2 HT.

Mr. L. McMichael and Mr. R. H. Klein are both Vice-Presidents of the Radio Society of Great Britain. *Trade Mark:* M.H.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester. 14 Long Millgate, Manchester. *Head Office and Works:* Trafford Park, Manchester. *T. & C.A.:* "Metrovick, Manchester." *T.:* 190/199 Trafford Park. *Codes used:* Westinghouse, Lieber, Bentley's, and A.B.C. (6th Ed.). *Registered Offices:* London: 4 Central Buildings, Westminster, S.W.1, and Offices of Metropolitan-Vickers Electrical Export Co., Ltd. *T.A.:* "Multiphase, Vic., London." *C.A.:* "Multiphase, London." *T.:* 8693/8 Victoria.

Manufactures: Wireless Receiving Sets, Crystal Sets, Valve Sets, Amplifiers, Loud Speakers, etc., etc. *Radio Call Signal:* 2 ZY.

METROVICK SUPPLIES, LTD. (Proprietors: Metropolitan-Vickers Electrical Co., Ltd.) *Registered Offices:* London, 4 Central Buildings, Westminster. *T.A.:* "Multiphase, Parl, London." *C.A.:* "Multiphase, London." *T.:* 9628–38 Victoria. *Codes used:* Westinghouse, Lieber, Bentley's, and A.B.C (6th Ed.). *Works:* Trafford Park, Manchester; Brimsdown, Middlesex; and at Birmingham. *Manufactures:* Wireless Receiving Sets, Crystal Sets, Valve Sets, Amplifiers, Loud Speakers, Valves, etc. *Radio Call Signal:* 2AC.

MICANITE & INSULATOR CO., LTD., THE, Empire Works, Blackhorse Lane, Walthamstow, E.17. *T.N.:* Walthamstow 738/739. *T.A.:* "Mytilite Phone, London."

Manufactures: Insulating Materials, Micanite, Paxolin, Empire Cloth Mica, etc.

Electrical Insulation Engineers.

MIKRO, LTD., 32 Craven Street, Charing Cross, London. W.C.2. *T.N.:* Ger. 2689.

Directors: J. Skinderviken, C.V. Whitgreave. *Secretary:* K. G. Wilson. *Manufactures:* Microphones, Electrical Gramophone Reproducers, Electrical Stethoscopes, Watch Testers, Motor Horns, Loud Speaking Telephones, Specialists in Electrical Sound Transmission Devices.

MILLIGAN'S WIRELESS CO., LTD. *Head Office:* 50 Sauchiehall Street. *Showrooms:* 56 Bath Street, 19 Maxwell Road, Glasgow. *T.N.:* Douglas 3844, Douglas 2403. *T.A.:* "Radamax, Glasgow."

Managing Director: F. M. Milligan. *Directors:* F. R. Forbes, L. G. Murray. *Secretary:* F. N. West. *Manufactures:* Factors. *Radio Call Signal:* 5 MG.

MILLINGTON, E. H., & CO., LTD., 5 Vaughton Street South, Birmingham. *T.N.:* Mid. 312.

Managing Director: E. H. Millington. *Manufactures:* Wireless Sets and Accessories, and Gas and Electric Lighting Fittings.

MITCHELL'S ELECTRICAL & WIRELESS, LTD. *Registered Office and Retail Department:* 188 Rye Lane, Peckham, London, S.E.15. *Works and Wholesale Department:* McDermott Road, Peckham, London, S.E.15. *T.N.:* Wholesale Department, New Cross 1541, Retail Department, New Cross 1540. *T.A.:* "London, New Cross, 1540."

Directors: F. L. Mitchell, R. Lee Knight, T. Bacon. *Manufactures:* All classes of Wireless Receivers and Components; the "Lokap" Coil Winding Machine, and "Lokap" Filament Regulator.

M.O. VALVE CO., LTD., THE, Osram Works, Brook Green, Hammersmith, W.6; and Marconi House, Strand, W.C. *T.N.:* Riverside 3431. *T.A.:* "Thermionic, Phone, London."

Directors: C. Wilson, J. Y. Fletcher, I. Shoenberg, A. Simpson. *Secretary* H. W. Corby. *Manufactures:* Wireless Valves.

MULLARD RADIO VALVE CO., LTD., THE, 45 Nightingale Lane, Balham, S.W.12. *T.N. :* Battersea 1068. *T.A. :* "Radiovalve Wandscom, London."

Managing Director : S. R. Mullard, M.B.E., A.M.I.E.E. *Directors :* S. G. L. Eustace (Chairman), B. Binyon, O.B.E., A.M.I.E.E., C. F. Elwell, Fel.I.Rad.E. *Secretary :* H. J. Owens, E.S., Fleetwood, A.C.A. *Manufactures :* Radio Valves and Instruments.

Contractors to H.M. Government. Sole Licensees under Admiralty Patents for Silica High Power Transmitting Valves.

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Also make apparatus for Optical Projection.

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Principal : J. Nokes.

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Managing Proprietor : Norman Hall, A.I.Rad.Engrs. *Manufactures :* Super-grade Radio Apparatus ; "Cymosite" Detector Crystal. *Radio Call Signals :* 2 RT, 2 RU.

NOTTINGHAM RADIO SUPPLIES, THE, 33 Mansfield Road, Nottingham. *T.N. :* 5944. *T.A. :* "Chantecler, Nottingham."

Director : Gordon A. Litchfield. *Secretary :* L. W. J. Pinnock. *Manufactures :* Complete Wireless Sets, Components, and Installations. *Radio Call Signal :* 5 RK.

Everything for Wireless in stock. Manufacturers of "Chantecler" Radio Sets.

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Directors : H. F. Smith. *Manufactures :* Wireless Apparatus and Components.

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PETO SCOTT CO., LTD., THE, 77 City Road, London, E.C.1, and Branches. *T.N.:* Clerkenwell 9406/7.

Managing Director : W. Scott Worthington. *Manufactures :* Complete Radio Receiving Sets Units. Pioneers of the Sets of Parts System. Broadcasting Sets. Accessories. Super-Heterodyne Sets.

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Directors : T. Pettigrew, A.M.I.E.E., E. Merriman, A.M.I.E.E. *Secretary :* S. H. Goodger. *Manufactures :* All Wireless Apparatus ; Valve and Crystal Receivers, etc.

European Representatives for Federal Telephone & Telegraph Co., Cook Electric Co., Brunet & Co. Sole distributors for Newey Snap Terminals and Condensers. Distributors for Ashley Wireless Co., Mullard Radio Valve Co., Ltd., Igranic Electric, Ltd., and S. G. Brown, Ltd.

PORTABLE UTILITIES CO., LTD., THE, Eureka House, 8 Fisher Street, Southampton Row, London, W.C.1. *T.N.:* Holborn 240 or 711. *T.A.:* "Nattiness, London."

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Directors: E. J. Power, S. C. B. Bevan. *Manufactures:* Power Locking Coil Holders.

PYE, W. G., & CO., "Granta" Works, Montague Road, Cambridge. *T.N.:* 314. *T.A.:* "Pye, Cambridge."

Partners: W. G. Pye, T. A. W. Robinson. *Manufactures:* Broadcasting Receiving Apparatus.

RADIAX, LTD., 4 Percy Street, Tottenham Court Road, W.1. *T.N.:* Museum 490. *T.A.:* "Museum 490, London."

Managing Director: Albert E. Oakley. *Manufactures:* "Radiax" Receiving Sets, Intervalve Couplings, Low Loss H. E. Coils, Frame Aerials, Super-heterodyne Components.

RADIO COMMUNICATION CO., LTD., 34/35 Norfolk Street, Strand, W.C.2. *T.N.:* Central 8480 (Private Branch Exchange). *T.A.:* "Radiocomco, Estrand."

Managing Director: Major B. Binyon, O.B.E., M.I.E.E. *Secretary:* W. H. C. Rowe, Esq., C.B.E. *Manufactures:* Marine Wireless Apparatus, Broadcasting Receiving and Transmitting Apparatus. *Radio Call Signals:* 2 AA (Slough Experimental Station); 2 AJ (Barnes).

RADIO ELECTRIC CO., 17 Victoria Street, and 21 St. John Street, Wolverhampton. *T.N.:* 1347, also Cannock 142. Radio Manufacturers and Retailers.

RADIO EXPERIMENTAL CO., 117 Carver Street, Sheffield.

Manufactures: Wireless Instruments and Accessories.

RADIO MANUFACTURING CO., THE, 100 Dale End, Birmingham.

Directors: E. W. Scammell, S. H. V. Abbott. *Manufactures:* Receiving Sets, Component Parts.

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Principal: Major G. K. Field, F.R.S.A., A.M.I.E.E. *Secretary:* K. Bowell. *Manufactures:* Wireless and Electrical Instruments and Accessories.

REGENT RADIOPHONE CO., THE, 120 Derby Road, Nottingham.

Partners: G. S. Crawley. G. R. Hodgkison. *Manufactures:* Complete Wireless Installations and Component Parts, and Brass Square Low Variable Condensers.

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ROBINS ELECTRICAL AND WIRELESS DEPOT AND INSTITUTE, LTD. *Works and Warehouse:* Fanny Street, Cathays, Cardiff. *Showroom:* 18A Oxford Street, Swansea. *T.N.:* Cardiff 5176.

Directors: R. W. Robins, L. R. Robins, H. L. Tredree.

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ROGERS, FOSTER & HOWELL, LTD., Edward Road, Balsall Heath, Birmingham. *T.N. :* South 265. *T.A. :* "Autowire."
Directors : W. I. Rogers, J. T. Foster, M. Howell. *Secretary :* M. Howell. *Manufactures :* Radio Sets of all types. Component Parts for the same. Have been established in the Radio Industry for several years.
ROWCELL & CO., 28 Rendezvous Street, Folkestone. *T.N. :* Folkestone 490.
Directors : G. Flessati, F. Williams. *Manufactures :* Rowcell Wireless High-tension Battery Cabinets.

SANKEY, JOSEPH & SONS, LTD., Bilston, Staffs. *T.N. :* 264. *T.A. :* "Sankey."
Managing Director : George H. Sankey. *Secretary :* Edgar J. Budd. *Manufactures :* Stampings for Radio Work and for the Electrical Trade generally.
SAVILLE, H., Delamere Works, Stretford, near Manchester. *T.N. :* Trafford Park 512.
Proprietor : H. Saville. *Manufactures :* Electrical and Mechanical Engineers and Ironfounders. *Radio Call Signal :* 6 HS. Member of B.B. Co., Ltd.
SCOTTISH WIRELESS TELEPHONE SUPPLIES, LTD., THE, 36/38 Chapel Street, Aberdeen. *T.N. :* 3553.
Directors : Joseph Johnston, William R. Clark, Mary Hutcheon.
Manufactures : Wireless Apparatus and Accessories.
SCRUTTON, H. D., trading as **BOWDEN PATENTS CO.,** 149 Coldharbour Lane, Camberwell, London, S.E.5. *T.N. :* Brixton 2281.
Manufactures : Wire Workers, etc.
SHARPIN, W. S., Wellington Works, Wellington Road, Bow, E.3.
Members of the B.B.C.
SHEFFIELD ELECTRICAL INSTALLATIONS CO., THE, 75 Ecclesall Road, Sheffield. *T.N. :* West 37.
Director : J. K. Bell. *Manufactures :* "Seico" Wireless Receiving Sets, also of Component Parts and Cabinets. Members of the B.B. Co., Ltd.
SIEMENS BROTHERS & CO., LTD. *Head Office :* Caxton House, Westminster, S.W.1. *General Offices and Works :* Woolwich, London, S.E.18. *T.N. :* Caxton House—Victoria 9390; Woolwich 1161. *T.A. :* "Siemens, Parc, London"; "Siemens, Woolwich."
Managing Director : F. Hird, B.A., M.I.E.E. *Directors :* G. Mure Ritchie (Chairman); Right Hon. Sir William Bull, Bart., M.P.; G. Chauvin; General Sir Hubert de la Poer Gough, G.C.M.G., K.C.B., K.C.V.O.; Sir Walter Roper Lawrence, Bart., G.C.V.O., G.C.I.E., C.B.; Lord Queenborough; W. O. Smith. *Secretary :* W. Wheeler. *Manufactures :* Electrical Cables and Wires; Telephone, Telegraph, Signalling, and Measuring Apparatus; Batteries, Wireless Equipments, etc. *Radio Call Signal :* 2 AD.
SIMMONS BROS. *Manufactures :* Receiving Sets and Components. Manufacturers of "Berclif" Specialities. Full Stock of Materials for Amateurs.
SKETT & CO., Frederick Street, St. Paul's, Birmingham. *T.N. :* Central 879. *Manufactures :* Wireless Accessories, Sketophone Headphones, Loud Speakers, etc.
SOLIDITE MANUFACTURING CO., LTD., Albion Works, North Street, Clapham, S.W.4. *T.N. :* Mitcham 2401.
Manufactures : Moulded Insulation Articles in Solidite (e.g. Valve-holders, Coil Mountings, Knobs, etc.).
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SOUTHERN RADIO SUPPLIES, LTD., 26 Junction Road, Eastbourne. *T.N. :* 882.

Managing Director : Owen H. Relly. *Secretary :* L. Morton. *Manufactures :* "Southion" Radio Receivers and other Wireless Apparatus. *Radio Call Signal :* 2 AO.

Members of the B.B. Co., Ltd.

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STERLING TELEPHONE & ELECTRIC CO., LTD., 210/212 Tottenham Court Road, London, W. *Sterling Works :* Dagenham, Essex. *T.N. :* Museum 4144 (7 lines). *T.A. :* "Cucumis Wesdo, London."

Managing Director : Guy Burney. *Chairman :* Rt. Hon. F. G. Kellaway. *Secretary :* Chas. E. Sherwood. *Manufactures :* Telephones, Wireless and Signalling Apparatus.

STIRLINGS, LTD., 17 Clarence Street, Kingston-on-Thames. *T.N. :* Kingston 712.

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Managing Director : H. W. Woods. *Directors :* F. M. Sexton. A.R.C.S. (I), F. P. Sexton, A.R.C.S., A.M.I.E.E. *Manufactures :* Wireless apparatus.

THAMES ELECTRIC WIRELESS CO., LTD., THE, 40 Old Town, Clapham, London, S.W.4. *T.N. :* Battersea 1156. *T.A. :* "Battersea 1156."

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All valve apparatus is manufactured at our own factory, and duly licensed by the Marconi Company.

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Secretary : A. Hitner. *Manufactures :* Dealers in Wireless Apparatus and Electrical Sundries.

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WAINWRIGHT MANUFACTURING CO., LTD., THE, 531 Forest Road, Walthamstow, London, E.17. *T.N.:* Walthamstow 987. *T.A.:* "Nominatus, Waltstreet, London."

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WATT & WRIGHT, Aboyne, N.B.

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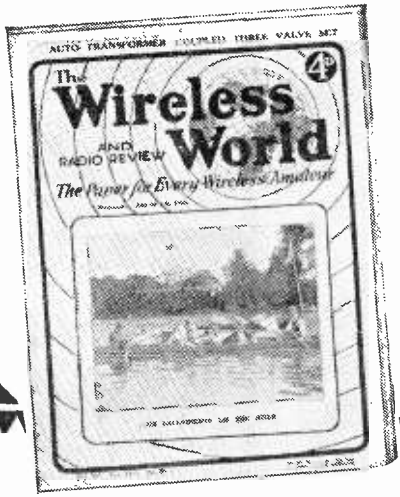

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Type R	Type B3	Type B5
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Anode volts 45–100 volts	Anode volts 20–80 volts	Anode volts 20–80 volts
Filament current 0·7 amp.	Filament current 0·35 amp.	Filament current 0·06 amp

POWER AMPLIFYING

Type B4	Type B6	Type B7
Filament volts 6 volts	Filament volts 2·8 volts	Filament volts 6 volts
Anode volts 40–120 volts	Anode volts 40–120 volts	Anode volts 40–120 volts
Filament current 0·25 amp.	Filament current 0·12 amp.	Filament current 0·06 amp.

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