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BULLETIN

JOURNAL OF THE RADIO SOCIETY OF GREAT BRITAIN

- ONCE UPON A TIME
- MEASUREMENTS IN RADIO EXPERIMENTAL WORK
- METHODS OF POWER AMPLIFICATION EXPLAINED

R.S.G.B. BULLETIN

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ONCE UPON A TIME

THIS short account of the annual round of contests, field days and other events, which we all took so much for granted in the days before the war, is addressed particularly to the new member; the active amateur of to-morrow.

Some were inclined to despise contests, adopting a slightly superior attitude towards those who did not share their view and maintaining that, as we were licenced as experimenters, we should not indulge in a merely sporting event. We have never supported this view because, while admitting the sporting element, we are aware that many amateurs spent much of their time, thought, and ability in bringing their stations up to peak efficiency for their own particular pet contest. That little touch of adjustment continually made to a fussy oscillator in normal hours of working, becomes a tiresome point-wasting nuisance in a contest. Many found, to their chagrin, that the long hours of continuous operation brought to light some hitherto unsuspected weak point in their apparatus, layout, and even their operating ability!

The first important competitive event of the R.S.G.B. year was the 1·7 Mc/s. contest held early in January. Always a somewhat exclusive affair—for "the top band" had its own special devotees—this event was remarkable for the consistently high standard of operating shown by participants. During 1938 and 1939 contacts were effected with the U.S.A., Canada and North Africa, all the more remarkable when it is remembered that the input power to our transmitters was limited to 10 watts. A few of the well-known "DX" men took part, but most were, by this time, thinking of the British Empire Radio Union contest, familiarly known as "Beru." This, so far as the Society was concerned, was the annual "Big Event," ranking with National Field Day in its wide appeal and importance. In essence "Beru" was divided into two sections; first, a free-for-all event which took place during 24 hours of each of the first two weekends of February, followed during the last two weekends by "Junior Beru," when power was limited to 25 watts. Participation in both sections was restricted to members of the R.S.G.B. or Affiliated Empire Societies, and only one contact per station per band counted for points. The Empire was divided into a number of zones, successful contact with each zone affording a multiplier to the number of points gained, hence contacts with two or three fresh zones towards the end could and often did, sweep the contestants' score from the mediocre to the astronomical! A six figure group was exchanged as proof of contact, the first three figures of which gave a Readability, Strength, Tone (RST) report to the station being worked while the last three were a personal serial number.

While the Empire Amateurs were busy with "Beru" their North American friends were preparing for the International DX Contest. Although not an R.S.G.B. affair, this event invariably produced keen interest among Empire, and particularly British Isles, Amateurs. Scoring was similar to the B.E.R.U. Contest with a multiplier for each American and Canadian numerical district worked per frequency band. As a test of endurance, for both operator and station, this contest (sponsored by the A.R.R.L.) easily surpassed all others, for it involved 90 hours operation, spread over a period of eight days.

By the end of March everyone sat back to take stock and to investigate the reason why that specially "hotted up" transmitter just did not seem to get out, but with the lengthening days and warmer weather the thoughts of most R.S.G.B. members turned towards the open air and National Field Day. There is no doubt that N.F.D. was the most popular single event of the year with the exception of Convention itself. N.F.D. was organised and run on a District basis, each R.S.G.B. District being allowed to place four separate stations on the air; one on each of the bands 1·7, 3·5, 7 and 14 Mc/s.

Much care and co-operative effort went into the design of suitable gear, the organisation of supplies, transport, tents, food (and drink) and above all the selection of a good site. Power, which was limited to 10 watts on 1·7 Mc/s. and 25 watts on the other three bands, had to come from some portable source. The station itself had to be housed in a tent and a time limit was set for its erection. Many of our members, who, since 1939, have performed similar manœuvres under sterner conditions, have remembered with gratitude that early training obtained during past National Field Days.

Convention and the Show! Can any one of us who had a hand in the organisation of Convention, or who helped to staff the Society's stand at Olympia, ever forget that noisy, gruelling, dusty, nerve racking, thoroughly enjoyable 10 days. From the quiet emptiness of the vast hall as Big Ben struck 11 a.m. to the frantic press of perspiring humanity soon to be clamouring for copies of the *Guide to Amateur Radio*. The hail of questions, technical, non-technical, sensible and absurd, that automatic Morse machine which nearly drove all Olympia "crackers," but which could draw a crowd quicker than a street accident. The high-pressure salesmanship of enthusiastic, hot and tired but undaunted stand attendants. The display of QSL cards, the frantic calls to the printer for

(*Continued on page* 144)

MEASUREMENTS IN RADIO EXPERIMENTAL WORK *

PART I

By R. L. SMITH-ROSE, D.Sc., Ph.D., D.I.C., A.R.C.S., M.I.E.E.
Honorary Member

Abstract

AFTER stating the desirability of conducting quantitative measurements in all radio experimental work, the manner in which the measuring technique used at radio frequencies has been built up from the fundamental electrical standards is reviewed. A brief description is given of the present position in the national laboratories of this country and America; of the absolute electrical standards of current, inductance and resistance; and of the practical working standards which are derived therefrom.

Proceeding to measurements at radio frequencies, it is explained that, as a result of the demands imposed by radio communication technique, the accuracy of measurement of frequency itself is very much higher than is attainable in any other branch of the electrical or radio fields. With the possible exception of current and voltage, all measurements at radio frequencies, such as power, impedance, reactance, resistance and field-strength, are made by reference to direct current or low frequency standards.

Some examples of the application of measurements at radio frequencies are described in Part II. The first concerns the effect of the electrical properties of the earth on electric waves travelling over the surface or reflected from it; while the second relates an experience resulting from systematic measurements in radio direction-finding.

I. The Rôle of the Amateur in Radio Development

The growth of various branches of science and their development and application to the many and varied needs of modern civilisation, takes place usually in a number of well-marked stages. In many cases it is true that the earliest observations of scientific phenomena are made by persons who are studying the subject concerned for its own intrinsic interest; these persons are frequently, if not usually, entirely disinterested in their work from the economic standpoint of the professional, and are thus usually designated by the term "amateur." In such sciences as astronomy and meteorology the amateur observer has played a very important part in building up the structure upon which our present-day knowledge is based. The early history of radio communication has provided another example of the manner in which the worker who pursues the subject from the standpoint of a hobby rather than a profession, can materially contribute to the progress of a science before and during its application to practical ends. I do not propose, however, to attempt here to enumerate the occasions on which the work of the radio amateur has been found to be in the forefront of the advance of communications technique; it is perhaps sufficient to state that in the present war the applications of radio in various forms have been so important and so widespread as to make those responsible grateful for the services of all those who had any technical knowledge or skill, which could be immediately applied to Service requirements. THE BULLETIN of your Society records in its pages the very full extent to which the services of its members are being utilised by the country at the present time.

If, however, the non-professional radio experimenter is to retain some modicum of utility in a sphere in which technical application is advancing rapidly in a very complicated manner, it is essential that he shall pursue his subject in a systematic way, rather than dabble in experiments in a haphazard manner. It has become a platitude that the knowledge of a science only becomes clear and definite when the relevant quantities concerned can be measured and the results expressed in numbers. By this, I do not mean that intricate and complicated measurements are essential before any advance can be made, but it is necessary, if only for the retention of individual interest, that programmes of experiments shall be planned in advance, that apparatus for measurement be constructed or obtained, that proper and systematic records be kept of the results, and finally that these be studied and analysed to extract from them the utmost information which it is useful to obtain. Very simple measurements sometimes lead to very useful results, and there must be many cases of amateur meteorologists and astronomers who have kept quite simple but accurate records of the natural phenomena they observe, and from them have deduced results which are a definite contribution to the sum total of our knowledge. In the field of radio, some of the work may be beyond the capabilities and resources of a single worker, but there is usually ample opportunity for team work and the sharing of duties and responsibilities.

In the following sections of this lecture, I propose to outline the basis which underlies modern radio measuring technique and then to refer to a few applications of such measurements. In view of the fact that very few radio measurements can be referred directly to an absolute standard, it has been necessary to build these up from the fundamental electrical standards, and a brief review of these is given in the next section.

II. Electrical Standards

Wireless engineering or radio physics is an application of a certain branch of electricity to communication between points not directly connected by a material conductor. This communication is effected by means of electromagnetic waves, and it is thus clear from the start that any measurements we make will be dependent upon those which form the fundamental standards of electricity and magnetism. In setting up such standards, the aim is to measure all electrical quantities in terms of the three direct fundamental standards of mass, length, and time. This can be done with the aid of certain generalisations with which we are familiar under the names of Ohm's law, Faraday's law of induction, Ampere's law of the mechanical forces between currents, and the law of the conservation of energy. An International Conference, held in London in 1908, agreed to adopt fundamental electrical units based upon the absolute system obtained from the centimetre, gramme and second as the units of length, mass, and time; and since that time the various national standardising laboratories have carried out a great deal of experimental work in order to determine the units of this system with high precision.

* Read before the Society at a meeting held on Dec. 18th, 1943, at the Institution of Electrical Engineers, London.

(*a*) Absolute Electrical Standards

The realisation of one such standard is that of inductance, since the mutual inductance between two coils, each of the single-layer solenoid type wound on a rigid cylindrical former, can be calculated with high precision from their dimensions. At the National Physical Laboratory the coils are wound on cylinders turned from statuary marble, which has an extremely small temperature coefficient of expansion of about 5×10^{-6} per °C. The wire is wound under tension in helical grooves turned on the cylindrical surface. At the United States National Bureau of Standards the solenoid is used as a standard of self-inductance, which may be regarded as a special case in which the same coil is used as both primary and secondary. The present U.S. standard consists of a solenoid of wire wound in a groove cut in the surface of a heavy-walled glass cylinder 120 cm. long and 35 cm. in diameter. The most recent investigations on such inductance standards conducted at the N.P.L. have shown that the values of inductance measured electrically are consistent with the values calculated from the linear dimensions to some five parts in a million, which is about the estimated error.

A standard of current is derived from a measure of the mechanical force between two coaxial circular coils, connected in series so that each carries the same current. One coil is suspended from an arm of a precision balance so that it hangs centrally inside the other, which is fixed to the base of the balance. Such a current balance was first established as a working standard at the N.P.L. about forty years ago, and it was reconstructed in 1935 ; with its aid the unit of current can be measured with a certainty of better than 20 parts in a million. A current balance of different form and construction set up in the National Bureau of Standards has given comparative results which agree with this accuracy.

An indirect standard of resistance can be obtained by a method which makes use of Faraday's law of the inductance of an electromotive force in an armature rotating in a magnetic field. The Lorenz machine of this type which is set up at the N.P.L. is essentially an air-cored homopolar dynamo, in which the armature is virtually a straight conductor rotating at constant speed in the uniform magnetic field provided by two coaxial coils. All the required quantities can be calculated from the linear dimensions of the system and a measurement of the time of rotation of the armature. The e.m.f. generated by this machine is proportional to the current in the magnetising coils; and the ratio of these quantities thus provides an indirect standard of resistance. By this and other methods, the unit of resistance is considered to have been established to an accuracy of $\pm$ 10 parts in a million.

An alternative method of arriving at resistance measurement is obtained by the use of sine-wave alternating current and constant inductance. If a mutual inductance M is used as an air-cored transformer, the e.m.f. in the secondary induced by a current I in the primary is given by the relation

$$E = j\,M\,\omega\,I \qquad .. \qquad .. \qquad (1)$$

where ω is $2\pi\times$ the frequency of the current.

If this e.m.f. is balanced against the voltage across a resistance R carrying the current I, then we have the relation

$$R = jM\,\omega \qquad .. \qquad .. \qquad (2)$$

The same principles may obviously be applied to self-inductors, provided we can distinguish between the inductive potential difference and the resistive one ; in such a case we can establish the relation

$$R = jL\,\omega \qquad .. \qquad .. \qquad (3)$$

which leads to our expressing resistance and reactance in terms of the same unit.

Capacitive reactance can be dealt with in the same way, and we can establish the relation

$$R = -j\,\frac{1}{C\,\omega} \qquad .. \qquad .. \qquad (4)$$

which serves to define and fix the unit of capacitance.

The measurement of frequency which is involved in each of the relations (*1*) to (*4*) is dealt with in Section III (*a*) below.

(*b*) Practical Electrical Standards

The absolute system of measurement described above requires the construction of no permanent electrical standards, but it is clear that such methods are quite unsuitable for everyday measurements or even for the comparisons of the absolute units in the different laboratories. Hence convenient practical standards of reference have been developed in the form of (i) a fixed and very stable resistance coil, and (ii) a primary cell which, on open circuit, gives an e.m.f. that can be relied upon to a high precision. Standard resistors, which are suitable for everyday industrial work as well as for fundamental standardising work, are made of manganin, a material discovered in America some forty years ago, and having the very desirable property that both its temperature coefficient of resistance and its thermo-e.m.f. against copper are exceedingly small. Such resistance coils are of convenient values in the range 1 to 100 ohms, and when protected from the atmosphere by immersion in oil, prove to be measurable and stable to an accuracy previously unknown.

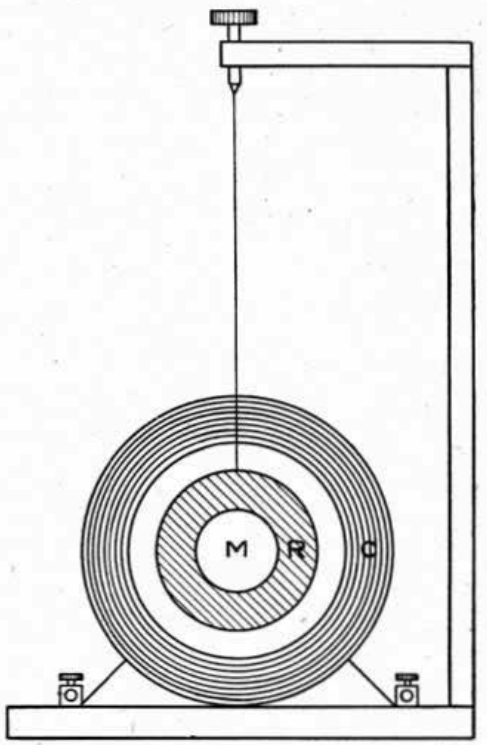

Fig. 1.
Electrodynamic Ammeter for alternating currents suggested by Fleming.

The standard cell as a practical standard of potential difference is of comparable importance to the

manganin resistance standard and the modern cell is a development of the original Weston cadmium type. In experiments at the N.P.L. cells made with specially purified materials, hermetically sealed and kept at approximately constant temperature, have remained constant to better than ten parts in a million over a period of ten to twelve years. The cells made in various laboratories are apt to differ in e.m.f., so that they must be calibrated by reference to some other standard, but once so calibrated, they satisfy all ordinary needs.

Both standard resistors and standard cells are sufficiently stable in value to warrant comparative measurements with an accuracy of one part in a million, and they are eminently satisfactory for practical experimental and industrial purposes. The two standards serve for the direct measurement of resistance and voltage. Current and power are then obtained by single derived measurements that are too well known to need description.

It is not proposed here to consider the application of the above direct-current standards to alternating current measurements at low or power frequencies, but to proceed in the succeeding section to consider the possibilities of measurement at radio frequencies. Those who desire further details of the fundamental basis of electrical standards may be referred to an excellent review of this subject by L. Hartshorn,[1] published in December, 1942.

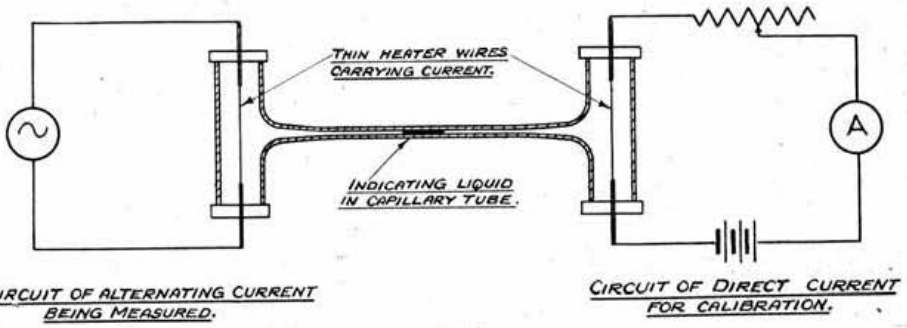

Fig. 2.

Sketch of thermal air-compensating ammeter for radio frequencies.

III. Measurements at Radio Frequencies

(a) Frequency

The frequency of an alternating current, defined as the number of cycles or alternations which take place in unit time, is one of the absolute electrical standards common to all branches of electrical engineering from the low frequencies of the power engineer to the highest used in the modern applications of radio technique. The rotating earth is the ultimate standard of frequency and time, and is unique in that it is available to all who desire to use it, although in effect this use is limited to astronomical observatories. The time signals distributed by such observatories enable successive twenty-four hour intervals to be measured to an accuracy of a few milli-seconds by modern recording technique.

The practical standard of frequency is, however, a mechanical vibrator such as a tuning fork or crystal, electrically maintained under carefully controlled conditions of temperature and pressure. The valve-maintaining tuning fork, originally invented by Eccles, was developed by Dye at the N.P.L. into a precision frequency standard having an accuracy of one part in 10^7 over long periods. While this accuracy is quite sufficient for all absolute electrical measurements, radio communication technique demands a still greater accuracy; and the piezo-electric oscillator was developed more or less simultaneously in various laboratories all over the world. The vibrating steel fork was in effect replaced by a vibrating rod, plate or ring of quartz and its lower temperature coefficient led to correspondingly greater accuracy. Most national laboratories and all the large organisations concerned with radio-communication now possess frequency standards giving an accuracy of the order of one part in 10^8. So accurate have these standards proved, that in addition to their use for electrical purposes they are now used by the observatories as standard clocks. The quartz frequency standard has indeed reached a degree of precision that is far ahead of that of any other electrical standard, and the accuracy attainable in frequency measurement is very much higher than is possible in any other branch of radio technique. Moreover, by radio transmission, standard frequencies are easily made available in every laboratory in the world, and in some countries a daily service of such transmission is provided.

In view of the fact that a lecture on "Frequency Measurement" was given before the Society by H. V. Griffiths[2] as recently as 1942, I do not propose to pursue the subject further here. Reference may also be made to a paper by J. E. Thwaites and F. J. M. Laver,[3] surveying the application of frequency measuring technique to telecommunication, particularly from the standpoint of the Post Office. In another recent publication, L. Essen[4] has described the improvements made in the technique of frequency measurement at the National Physical Laboratory. It is shown that frequencies below 30 Mc/s. are compared directly with a signal obtained from oscillators controlled by the standard, and the accuracy of the measurement is limited only by that of the standard, which is $\pm$ 2 parts in 10^8 if the primary quartz clock of the Laboratory is used. Frequencies above 30 Mc/s. and up to at least 2,000 Mc/s. are compared with harmonics of an uncontrolled oscillator, of which the frequency is less than 30 Mc/s. and is measured by the direct method. In this case the accuracy is governed by the stability of this oscillator during the measurement and is of the order of 1 part in 10^6.

As the author has already pointed out elsewhere,[16] the accuracy with which wavelength can be measured is much less than that of the frequency determination referred to in this section, since our knowledge of the precise velocity of electric waves under various conditions is uncertain to at least 100 parts in a million.

(b) Current

Although most of the methods used for the measurement of current or power at radio frequencies depend upon the heating effect resulting from the passage of

the current through a piece of resistance wire, various attempts have been made from time to time to establish an absolute standard of current. Thus J. A. Fleming[5] used an electrodynamic type of alternating current galvanometer (Fig. 1), comprising a copper or silver disc R suspended so that it hangs within a coil C with the plane of the disc at 45° to the plane of the coil. If the coil is traversed by an alternating current, a current is induced in the disc which tends to set itself in a position with its plane more nearly parallel with the magnetic field of the latter. The theory of this suspended disc dynamometer has been given by G. W. Pierce, who has shown that the torque to which the suspended disc is subject is proportional to the square of the current and to the square of the frequency. In a more modern form of the instrument described by H. M. Turner and P. C. Michel,[6] it is shown that if the suspended disc, or small coil, as it was in this case, is free to oscillate under the torque due to the electro-magnetic field, the frequency of this mechanical oscillation is proportional to the current flowing in the primary coil; and, within a frequency range of the order of 1 to 100 Mc/s. per second for the instrument described by the above authors, the frequency of the mechanical oscillation was independent of the frequency of the current being measured. The instrument was stated to be suitable for currents of between one and five amperes.

Another dynamometer type of ammeter has been devised by E. B. Moullin[7] for dealing with currents up to several hundred amperes at radio frequencies. In this instrument a measure is obtained of the repulsive force between two parallel cylinders arranged in series and carrying the current in opposite directions; one of the cylinders is fixed while the other is free to move, the displacement of the latter being proportional to the square of the current and inversely proportional to the distance between the centres of the cylinders. Two models of the instrument have been described capable of measuring 2 and 25 amperes respectively. Correction factors have been evaluated for the frequency error which arises because the alternating current does not distribute itself uniformly over the cross-sections and because the capacity between the two cylinders will cause the current to alter along the length of the parallel system.

Turning now to methods utilising the heating effect of a current traversing a conductor, two have survived the test of time and long experience; one of these utilises an air thermometer principle and is suitable for laboratory standardisation work, while the other is more suitable for practical everyday measurements. The use of a type of air thermometer for measuring the heating effect of a wire carrying an electric current seems to have originated as long ago as 1827, and the principle has been utilised in various forms since that date. A differential form of the instrument, in which the alternating current can be compared directly with direct current was described by J. A. Fleming in 1910; and this forms the basis of the modern type of instrument such as has been described by M. J. O. Strutt and K. S. Knoll[8] for measuring currents at frequencies up to 1,500 Mc/s. (wavelength 20 cm.). In this instrument (Fig. 2) two air chambers, each carrying a fine wire through which current may be passed, are connected together with a piece of capillary containing a drop of liquid as indicator. When a radio-frequency current is passed through one wire, the heat generated causes the air to expand and the water drop moves along the tube. If a direct current is passed through the other wire, and adjusted until the drop returns to its initial position, then it is known that the heating effects of the alternating and direct currents are equal, and that therefore the root-mean-square value of the radio-frequency current is equal to the direct current. If the wire carrying the alternating current is so fine that skin effect is negligible for the frequency in use, then we have a means of referring the radio-frequency current directly to our direct-current standard. In this way, Strutt and Knoll have measured currents of a few milliamperes to an accuracy of a few per cent. at frequencies up to 1,500 Mc/s. (wavelength 20 cm.).

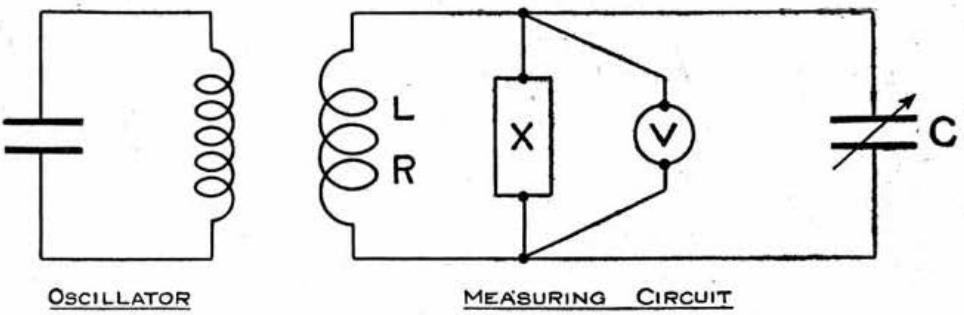

Fig. 3.
Circuit arrangement of reactance-variation method of measuring impedances.

Such a method as that just described is very suitable for standardising purposes, and may be used for calibrating the more practical type of instrument which makes use of a thermo-electric conversion of the radio-frequency current to a direct-current e.m.f. The thermo-ammeter and the more versatile vacuum thermojunction unit are too well known to need more than a brief reference here, since they have passed through all the stages of development leading to commercial production. In its modern form the thermo-couple is separated electrically from the heater wire by a suitable bead of insulating material, while for very high-frequency working, it is desirable that the heater leads shall be short and straight to avoid undesirable reactance effects, and it is usual to mount the whole assembly in a very small evacuated envelope similar to that forming the acorn valve. Certain precautions are necessary when calibrating such thermo-electric instruments, chiefly from the standpoint of ensuring that the same current is passing through the standard instrument and that under test.

Further details on the various methods available for measuring current at radio frequencies will be found in a review of progress by T. I. Jones,[9] published in 1938.

(c) Voltage and Power Measurement

Measurements of current and voltage at radio frequencies are very much interlinked, since if a current is passed through a non-inductive resistance

or a reactance of known value, the resulting voltage across the component can be deduced, and *vice versa*. The properties of the resistance or reactance at the frequency in use must be measured by some independent method such as that to be described in the next section. While certain electrostatic types of instruments for measuring alternating voltages may be referred directly to a d.c. calibration, the more usual types of valve voltmeters, whether of laboratory or commercial pattern, rely upon a calibration by means of current or upon a known behaviour between high and low frequency conditions.

If the resistance used in the current-measuring device is known at the frequency in use, then the power being dissipated therein can be measured, and this arrangement constitutes one of the methods of estimating such power. In many cases it is more useful to measure the power either radiated from a transmitter under normal operation or injected into a receiver when adjusted to give a normal signal output. Here the requisite quantity can be evaluated from a field-strength measuring technique, which has been developed to a considerable degree at the National Physical Laboratory of recent years, and an application of which will be described in section IV.

(*d*) Impedance, Resistance and Reactance

The measurement of generalised impedances and of their components, resistance and reactance, at radio frequencies, calls for a technique which can become increasingly complicated as the frequency is raised. In addition to direct methods, involving the measurement of current and voltage relationships, there are two general methods of measuring impedances which may be classed as bridge and resonance methods.

The principles of the Wheatstone bridge network may be adapted to alternating currents at high frequencies, by using arrangements in which the arm containing the unknown impedance is balanced by the adjustment of a variable and known reactance, positive or negative, in series or in parallel, with a variable non-inductive resistance. Special care is necessary in the choice of the ratio-arms, which are usually accurately matched impedances, and also in the screening of the individual components so that their characteristic values are known at the working frequencies. Apart from such screening, it is necessary to eliminate errors due to the effect of capacitances to earth, and certain special earth-connection devices have been devised to attain this objective. Although considerable progress has attended the development of bridge methods, the accompanying difficulties tend to become very great at the higher radio frequencies, and it is consequently not surprising to find that methods based on different principles are in use to a considerable extent.

The alternative methods of measuring impedance utilise the effect produced on a resonant circuit by connecting to it, directly or indirectly, the component or circuit under test. The alteration resulting from this connection can be measured in terms of the change in current or voltage resonance in the circuit, the change in its resonant frequency, or the change in either the inductance or capacitance of the circuit required to restore it to its previous resonant condition. While all these varieties of technique have been utilised in practical measuring equipment, one of the simplest and at the same time most accurate for all radio frequencies up to at least 100 Mc/s. (wavelength 3 m.), is the reactance-variation method with a thermionic voltmeter as the detector of voltage resonance. Equipments devised at the National Physical Laboratory, on this principle and used for a wide variety of applications[10] possess advantages in that variable air condensers are the only calibrated standards required and that the operating frequency remains constant during the measurement.

The basic circuit arrangement is shown in Fig 3, in which C is a variable and accurately calibrated air condenser with micrometer adjustment; LR is the inductance coil, which is tuned to resonance by C; X is the impedance being measured; and V is the voltmeter used to indicate the resonant conditions of the circuit. By adjusting the variable condenser, a resonance curve for the circuit can be determined in terms of the deflections of the voltmeter, these deflections being usually and conveniently proportional to the square of the voltage. It can be shown that if C_a and C_b are the values of the capacitance C at which the voltmeter deflection is half that obtained at resonance then the effective conductance G of the circuit in parallel with the condenser is given by the relation

$$G = \pi f (C_a - C_b) \quad .. \quad .. \quad (5)$$

where f is the operating frequency.

Thus if the width of the resonance curve at the "half-deflection" position is determined, first with the impedance X disconnected and then with it connected as shown, the effective conductance of X can be determined by difference. The reactance component of X is obtained directly from the change in the value of the capacitance of the condenser for the two cases; the advantage of using the voltage resonance method is thus seen in the fact that the reactance required to produce the resonant condition is independent of the conductance of the circuit. It is clear that the impedance to be measured may have either a positive or negative reactance, and that all the measurements are made at a single frequency and if, as is often the case, it is required to know the power factor of the impedance, then the frequency is not involved in the measurement of this quantity.

The equipment developed and used on the above principles is described in detail elsewhere,[10] and it has found widespread application for the determination of the properties of dielectric materials, made up as standard samples for use in a special condenser, and for measuring the characteristics of radio frequency cables at frequencies up to 100 M/cs.

For further details on both the principles and apparatus involved in the measurement of impedances of all types the reader may be referred to a recently published book by L. Hartshorn.[11]

(e) Field strength

An important factor in radio communications technique is that of field-strength and the measurement of this quantity is required in connection with the assessment of the radiated power of transmitters, and the sensitivity of receivers, as well as in the study of the effective gain of aerial systems and the attenuation of waves propagated along the earth's surface or through the atmosphere. The essential principle of a field-strength measuring equipment is that an aerial of effective height "h" is exposed to the field "E" to be measured, and the resulting electromotive force e ($=E \times h$) is measured by a suitable receiver used as a voltmeter. It is usual to calibrate such an equipment by injecting a similar known voltage from a local generator, either by a measured current through a resistance included in the aerial circuit, or by the aid of a mutual inductance. In either case it is seen that the measurement of field-strength essentially depends upon the determination of a quantity, current, voltage or power, which may be referred to its own standard on the lines already described. The effective height of the receiving aerial is sometimes a somewhat obscure quantity to determine, but there are certain

(*Continued on page* 144)

METHODS OF POWER AMPLIFICATION EXPLAINED

By R. G. KITCHENN, Grad.I.E.E., Assoc.Brit.I.R.E. (G3SK)

THIS article is presented with the object of giving a clear description of the principles and applications of the various classes of power amplification in current use. The three main types of amplification are described as *Class A*, *Class B*, and *Class C*. Modes of operation intermediate between Class A and Class B are also used.

Class A

A *Class A* amplifier is, by definition, one in which anode current flows for 360° of the input cycle (Fig. 1). That is to say, the input voltage cycle A-B-C-D-E causes a similar current cycle F-G-H-J-K in the anode circuit. To obtain this condition, a point P is chosen as the fixed grid bias, so that equal grid voltage excursions above and below this point produce equal anode current variations above and below the no-signal current *Q*. The part of the I_a–E_g characteristic in use under these conditions is X-Y-Z, which portion should be as straight as possible in order to avoid second and third harmonic distortion.

It will be noticed that when no signal is applied to the grid, a steady current of value *Q* flows in the anode circuit. This current obviously contributes nothing to the signal output, and represents a continuous waste of power. The power efficiency (ratio of D.C. input power to the anode, to A.C. power output from the anode load) of a Class A stage is consequently very low. The maximum theoretical efficiency of such a stage is 50 per cent., but this value is never attained in practice.

A Class A amplifier, therefore, is only used where power outputs are small, and low efficiency is of minor importance. It is the " standard " type used in broadcast receivers employing audio triodes or pentodes where the power output does not exceed 2–3 watts. Larger power outputs may be obtained by using two similar valves in Class A push-pull, although the efficiency still remains low. The Class A type of amplifier is not used for R.F. power amplification because of its low efficiency.

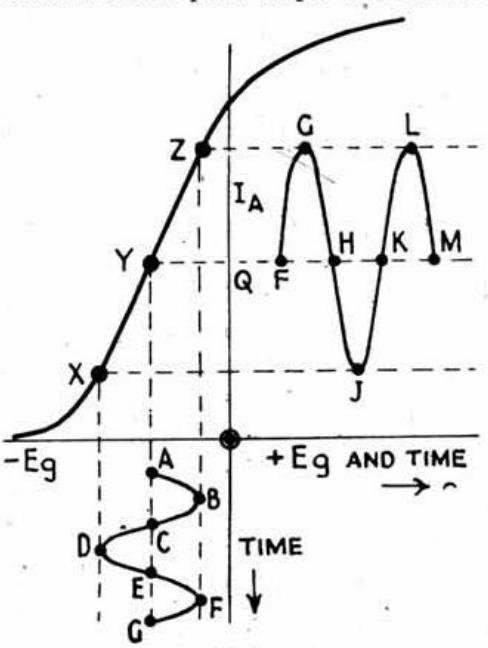

Fig. 1.
Illustrates triode " Class A " operation.

Class B

The definition states that a *Class B* amplifier is one in which anode current flows for only slightly more than 180° of the input cycle of voltage. In explanation of this, it is helpful to consider Fig. 2.

Again, I_a represents anode current, E_g grid volts,

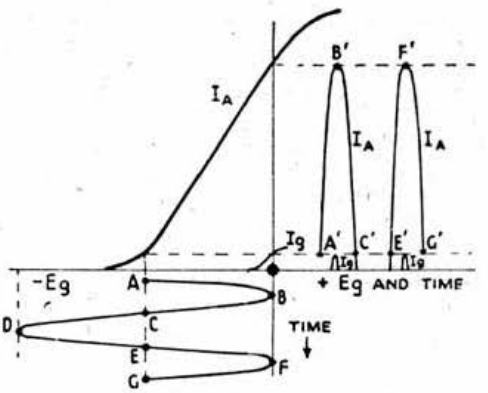

Fig. 2.
Illustrates triode " Class B " operation.

and the small curve the E_g–I_g characteristic. (I_g represents grid current.) It will be noticed that (*a*) the input voltage has to be considerably greater than in the case of Class A ; (*b*) the static value of grid bias is more negative, and (*c*) the no-signal anode current is almost zero. The input signal, although " biased-back," is still sufficiently large to cause the grid to run positive with respect to the cathode during positive half-cycles, and consequently, short pulses of grid current flow during such periods.

The anode current will be seen to consist mainly of a large pulse every positive half-cycle of grid voltage, while during the negative half-cycle, the already small anode current is reduced to zero.

Now assume that the input is at radio frequency and it is desired to use the stage as a Class B power amplifier. The circuit shown in Fig. 3 is identical to that which would be used for Class A amplifier, the only difference being in its operating conditions.

Consider the passage of a R.F. signal through the stage. The signal is applied across A-B and to the grid *via* a blocking condenser C1. Bias, sufficient almost to cut off the anode current when there is no applied signal, is applied to the grid by means of the leak R. As it is only necessary to amplify a single frequency (and, perhaps, a relatively small band of frequencies above and below it) a resonant circuit may be used as the anode load. Now, if a pulse of energy is introduced into a parallel resonant circuit, such as LC in Fig. 3, an oscillation of gradually decreasing amplitude will take place in that circuit, having a frequency of $\left(\frac{1}{2\pi\sqrt{LC}}\right)$ approximately.

The oscillations will die away at a rate determined by the R.F. resistance and the L/C ratio of the tuned circuit. Returning to Fig. 2, when the grid voltage passes through the positive half-cycle A-B-C, a large pulse of current A′-B′-C′ flows in the anode circuit, thus exciting the resonant circuit LC, and causing it to oscillate at a frequency of approximately

$$\left(\frac{1}{2\pi\sqrt{LC}}\right)$$

The negative input half-cycle has little effect on the anode current, but the next positive half-cycle E-F-G will produce another pulse E′-F′-G′ in the LC circuit. If the frequency of the input signal is the same as that to which the LC circuit is tuned, the second pulse will arrive at the right instant to assist the maintenance of the damped oscillation already existing in LC (caused by the first pulse). Subsequent pulses of anode current maintain a R.F. current in LC, if the latter is tuned to the input frequency. LC behaves as a resistive load of L/CR ohms, and power may be drawn from it to feed any desired load by suitable proportioning of L1.

Now, if a tuned circuit were used as the anode load of a triode in the usual way (*i.e.* between anode and HT+) the grid-anode capacity of the valve would feed back energy from the anode to the grid in such phase as to cause the stage to oscillate. This being undesirable, steps must be taken to prevent oscillation.

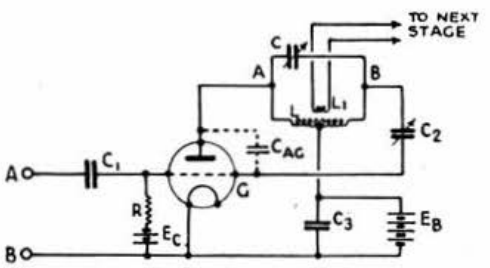

Fig. 3.
Basic circuit of a neutralised " Class B " or " Class C " R.F. power amplifier.

The circuit of Fig. 3 is frequently used. The operation of such a circuit is as follows. At any instant, the R.F. voltage at A is equal and opposite to that at B, with respect to cathode, as the centre tap of L is connected to earth (as far as R.F. is concerned) by the condenser C3. Hence, if the small variable condenser C2 is adjusted to have a value equal to that of the valve capacity C_{a-g}, two equal and opposite voltages will be applied to the grid, one *via* C_{a-g}, and the other *via* C2. Hence the feedback voltage *via* C_{a-g} is cancelled by that *via* C2, and oscillation cannot take place.

The setting of C2 should, theoretically, not require changing with a change of operating frequency, but in practice, owing to the imperfect centre tap available on the coil, and stray reactances in the wiring, it has to be reset for each frequency.

Neutralising may be avoided by the use of Beam Power valves in which C_{a-g} is reduced to a negligible quantity by the addition of a specially aligned " earthed " grid between grid and anode. In the past, beam power valves were limited to comparatively low powers, but are now available to handle powers up to 20 kW, and are replacing neutralised triodes for all applications, with consequent greater simplicity of operation and efficiency.

The fact that the pulses of grid current flow during peaks of grid voltage (see Fig. 2) indicates that the previous stage has to supply *power* to a Class B stage, whereas voltage only is required to drive a Class A stage.

It will also be seen from an examination of Fig. 3 that the only return path open to the grid current is to the cathode *via* R and the grid bias battery. The voltage drop I_gR across R adds to the battery voltage and causes the grid to become even more negative with respect to the cathode.

The values of the battery bias, grid leak, and R.F. " drive " have to be chosen with this point in mind. The voltage drop I_gR may be avoided by substituting an R.F. choke for the grid leak R.

Fig. 4 shows conditions in a Class B stage when a modulated R.F. signal is applied at the grid. The output contains the modulation envelope in the same manner as half-wave rectification, except that the half-wave pulses in the anode circuit are not by-passed as in rectification, but are used to excite the " tank " circuit LC. Provided that the L/C ratio of the tuned circuit is correctly chosen, the amplitude of the R.F. voltage and current in that circuit will " follow " the modulation faithfully.

The maximum power efficiency theoretically obtainable in a Class B system is 78·54 per cent., a considerable improvement over Class A. This improvement, of course, is due to the fact that anode current flows only in short pulses in Class B operation, hence its average value is lower than if it flowed continuously, as in Class A.

It will be remembered that the R.F. Class B amplifier is only required to operate at a fixed frequency; hence a single valve with resonant anode load could be employed, making use of the " flywheel " characteristic of the tank circuit LC.

In audio amplification, however, not one frequency, but a band of from approximately 100 c.p.s. to 10,000 c.p.s. has to be amplified, and every frequency in that band must receive the same degree of amplification. Hence a resonant circuit cannot be employed to " make up " for the loss of the negative half-cycle in the stage. A separate valve is used to amplify the negative half-cycle in the same manner as the positive. Thus an audio Class B stage must have two valves per stage, connected in push-pull, as shown in Fig. 5.

The grid bias voltage E_g and the H.T. voltage E_a are adjusted to give Class B conditions in each valve, *i.e.* almost zero anode current.

Assume an audio frequency to be applied to the primary of T1 at A-B and that the secondary (C-D-E) is centre tapped at D. The latter point is fixed at cathode potential with respect to audio frequency.

The secondary winding will experience voltage changes across C and E, due to the input at A-B, and

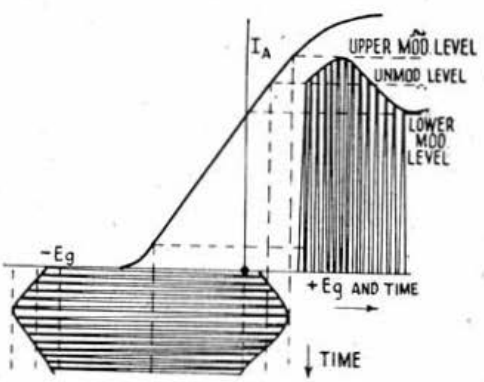

Fig. 4.
Illustrates " Class B " amplification of modulated radio frequency.

when C is positive with respect to D, E will be an equal amount negative with respect to D. Similarly, on the next half-cycle, C will be negative, and E positive, with respect to D. In other words, C-D-E may be regarded as a "voltage see-saw," with D as the "pivot."

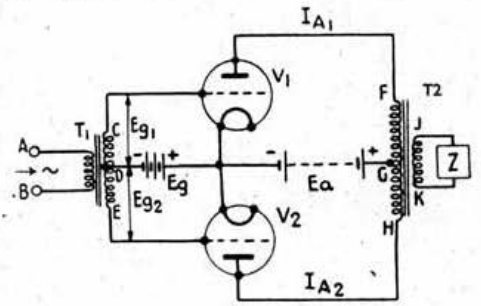

Fig. 5.
Basic circuit of "Class B" audio amplifier.

Consider the conditions at the instant when C is positive, and E negative, with respect to D. The grid bias on V1 will be reduced by the voltage E_g1, and the anode current I_a1 will rise in proportion to E_g1, and will flow from F to G through the primary of the output transformer, to the H.T. battery. The impulse is communicated to the secondary of T2, and a current flows into the load in the direction K-J.

While E_g1 is positive, E_g2 is equally negative, and is added to the already large negative grid bias on V2. The small residual anode current is therefore reduced to zero but this has negligible effect in the secondary T2.

When E_g2 becomes positive during the next half-cycle of input signal, the bias on V2 will be reduced, and the current I_a2 will rise, flowing through the primary of T2 in the direction J-K. Thus, alternate half-cycles at the input cause similar alternate half-cycles in the secondary of T2 as depicted in Fig. 6.

As previously mentioned, the stage before the Class B unit has to supply power to the grids of V1 and V2; consequently the input transformer must be designed to introduce no distortion at the peaks of half-cycles during the momentary flow of grid current.

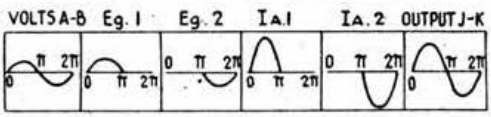

Fig. 6.
Current and voltage relationship in "Class B" stage of Fig. 5.

Class A-B

As its title suggests, the mode of operation of a *Class A-B* stage lies between that of Class A and Class B. By definition, it is a stage in which anode current flows for more than 180°, but less than 360° of the input cycle. It has the advantage of greater power efficiency than Class A, but design considerations of the input transformer may not be so stringent as for Class B, if no grid current flows during the input cycle.

In Class A-B, the grids may or may not be driven positive with respect to the cathodes of the valves. (Again, two valves must be used, for the same reason as in audio Class B.) The design of the input transformer depends on this factor. Also, as each side of the primary of the output transformer carries a different current in Class A-B, it must be carefully designed, both electrically and mechanically.

It will be realised that in both Class B and Class A-B the mean anode currents vary in proportion to the input signal. Hence the normal form of cathode bias, as used in Class A, cannot be used, as the varying anode current would cause varying grid bias. Either a battery or a separate grid bias power pack is required.

Class C

A *Class C* amplifier has its anode current flowing for less than 180° of the input cycle, at the time when its instantaneous anode voltage is low. Its main characteristics are high power output and high efficiency. (The latter can be made as high as 90 per cent.) However, owing to the severe distortion of the waveform in the amplifying process, it is only suitable for use with unmodulated R.F.

The static value of grid bias used is considerably in excess of cut-off, and may be between 1·5 and 3 times the latter figure. (As shown in Fig. 7.)

It will be seen from the sketch that the input signal must have a large voltage swing, and that the anode current reaches saturation point, with consequent severe distortion of waveform, and introduction of many harmonic components of the original signal. Further, only a small portion of the input positive half-cycle causes anode current to flow, the remaining

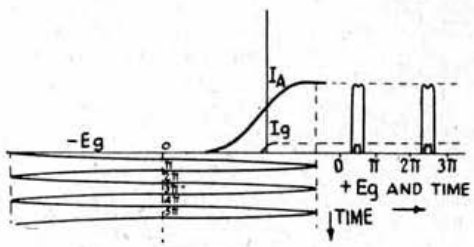

Fig. 7.
Illustrates grid voltage, grid current, and anode voltage relationships in a "Class C" amplifier.

portion being below the cut-off value of E_g. Hence the anode current will flow for less than 180° of the input cycle.

It will be appreciated that if the grid bias is made more negative, and the drive increased to give the same anode current peak value as before, the duration of that peak will be less than in the original case, thus decreasing the average value of the feed current, and increasing the efficiency.

Grid current will flow in pulses of short duration during the positive peaks of input signal, but the peaks will be comparatively large. Thus the previous stage has to supply appreciable power (more than in the case of Class B) to a Class C stage.

The fact that harmonics are produced in a Class C amplifier enables such a stage to be used as a frequency doubler, and, with less efficiency, as a trebler or quadrupler. The basic circuit remains the same as in Fig. 3, with the exception that the resonant circuit LC is tuned to the required output harmonic. Thus, if the input frequency is f kc/s., and the stage is required to operate as a frequency doubler, the anode tank circuit must be tuned to $2f$ kc/s. The first pulse of anode current causes the LC circuit to oscillate freely at its natural frequency, $2f$, and the pulses, which contain a considerable component at a frequency of $2f$ kc/s., "keep it going."

The Class C amplifier is used in stages before and including the modulator in radiotelephone transmitters, and in all stages in C.W. transmitters. Power amplifiers after the modulator in a radiotelephone transmitter must be of the Class B type, as the waveform of the modulation envelope must be preserved. A Class C amplifier would introduce distortion, as previously explained.

New Books

RADIO UPKEEP AND REPAIRS. By A. T. Witts. 237 pp., 166 diagrams. Pitman; 7s. 6d.

The sixth edition of this popular text-book—known previously under the title "Radio Upkeep and Repairs *for Amateurs*"—provides the service-engineer, the radio mechanic and the amateur experimenter with a clear and up-to-date account of fault clearing technique. The book is full of valuable hints and tips, not only on how to locate faults but how to clear them. Under present conditions, with service-engineers working at high pressure and with depleted staffs, it behoves those who understand something about radio circuits to effect their own repairs whenever possible. This book will help many to achieve that end, for it furnishes clues to the unusual as well as to the more usual types of faults.

Chapter X, "Gramophone Pick-ups—How to Fit, Use and Service," is entirely new, the older chapter on pick-ups having been deleted. Considerable additions and alterations have been made to Chapter V which deals with the servicing of mains-supply equipment.

"Radio Upkeep and Repairs" is essentially a practical book and as such it deserves a place in the library of every practical radio amateur.

RADIO QUESTIONS AND ANSWERS. Vol. 1: Basic Radio. By E. M. Squire. 86 pp., 82 illustrations. Pitman; 5s.

Self questioning, as the author states in his preface, is a great aid to learning and it is in that style that this new book is written. The questions are especially suitable for those U/T as Wireless Mechanics or Wireless operators.

The following list of chapters indicates the ground covered: I, The Direct Current Circuit; II, Magnets and Electromagnets; III, Cells and Batteries; IV, The Alternating Current; V, Inductance, Transformers, Condensers; VI, Meters; VII, Thermionic Valves.

Two examples, selected at random, will serve to illustrate the lucid style adopted by the author.

Q. Is not a pulsating current also an alternating current?

A. Whether a pulsating current can be called alternating or not depends upon the direction of the pulses. If the pulses are alternating in opposite directions, the pulsating current could be called an alternating current. But if the pulses are all in the same direction, the current is called unidirectional current.

Q. Why does the suppressor grid have a very open mesh?

A. Because the secondary electrons emitted from the anode have only a low velocity and consequently a small repelling field is sufficient to turn them back to the anode.

This is a book many have been waiting for. We express one fear—it may be out-of-print before this notice appears!

MANUAL OF DIRECT DISC RECORDING. By Donald W. Aldous, M.Inst.E., F.R.S.A., A.S.M.P.E., Mem. R.S.G.B. Bernards (Publishers), Ltd.; price 2s.

This new publication, the first dealing with direct disc recording to appear in Great Britain, stands to the credit of Mr. Donald Aldous, well-known in R.S.G.B. circles for his work in connection with the British Sound Recording Association.

The subject of disc-recording is as fascinating as it is instructive, involving a knowledge of acoustics, electrical engineering and musical reproduction. The author has attempted in the limited compass of 48 pages to cover a wide range of subjects, including Recording Amplifiers, Cutting-head couplings, Equalisers, Microphone and Monitor Circuits. He also gives a suggested, design, and constructional details, of a wooden studio-recording console and describes and illustrates microphone positions for a single speaker or a dance band.

Details of Record Blanks are given in tabulated form, followed by a Defects Table arranged in order of descriptive term. Dry-cut, Grey-cut, Kinky thread, Orange-peel effect, Piano-whine, Swirl-lines, Wows, and Whiskers are among the more novel additions to our vocabulary. Of particular value to the student is a comprehensive list of over 200 Selected References, the preparation of which reflects much credit upon the Author. A list of 16 Disc Recording and Reproduction Standards approved by the National Association of Broadcasters in America is followed by an extensive Glossary.

The "make-up" of the booklet could have been improved. For example, Page 1 contains two circuit diagrams and three brief captions. The diagram associated with the third caption turns up at the top of Page 2! Certain diagrams have been reduced so greatly as to make examination far from easy. These criticisms apart, the student interested in Direct Disc-Recording will thank Mr. Aldous for presenting him with a veritable mine of useful information.

Due to the speed of production and distribution, a few printers errors and omissions, as well as several circuit diagram slips have occurred in this printing, but it is understood that an Errata and Addenda Sheet will be sent to all who send a stamped addressed envelope to the author, c/o B.S.R.A., "Strathdee," Studley Road, Torquay.

RADIO DATA CHARTS. By R. T. Beatty, M.A., etc. Third edition revised by J. McG. Sowerby, B.A., Grad.I.E.E. Iliffe; 7s. 6d.

This well-known series of Abacs, which provide most of the essential data required in Receiver Design, has been extensively revised since the second edition appeared some years ago. Eleven of the original charts have been redrawn and ten new ones added. Most of the text is also new.

The new Charts cover:—

Nos. 5 and 6. Inductance, Capacity and Frequency (I.F. and Audio Ranges).
No. 16. Change of Inductance of Coil due to a Coaxial Cylindrical Screening Can.
No. 17. Increase of R.F. Resistance of a Coil due to a Coaxial Cylindrical Screening Can.
No. 22. Characteristic impedance of transmission lines.
No. 23. Attenuation of Transmission Lines.
No. 24. "Q" of a Quarter-wave Resonant Line.
No. 25. Resonant length of a Capacity-loaded Transmission Line.
No. 30. Output transformer ratios.
No. 36. Loudspeaker Dividing Networks.

Due to paper restrictions the present edition appears on thinner paper than was used for earlier editions, whilst the cover is also less stout. These minor war-time inconveniences, however, detract in no way from the value of this most popular collection of data charts.

FOUNDATIONS OF WIRELESS. By M. G. Scroggie, B.Sc., A.M.I.E.E. Fourth edition. Completely revised. 358 pp., 221 diagrams. Iliffe; 7s. 6d.

Probably no more popular radio book has ever been published in Great Britain than "Foundations of Wireless." The three earlier editions set the standard by presenting in clear and lucid style, the basic principles of radio. The author has now prepared a completely revised edition covering more recent developments. His preface on Mathematical Formulæ is a masterpiece of lucidity and will help to clear the ground for the reader who sees mystery in x or y!

Space limitations do not permit a detailed account being given of the contents, but of especial interest are the chapters dealing with the Superheterodyne and its Frequency-Changer, Radiation and Aerials, and Transmission Lines.

The experimenter who aspires to operate an amateur transmitting station after the war and is not too sure of his theory will find that "Foundations of Wireless" provide both bread and meat for his appetite. In common with all "best sellers" this new edition will probably be out of print at an early date. Our advice is "snap up a copy as soon as you see one".

PLASTICS IN THE RADIO INDUSTRY. By E. G. Couzens, B.Sc., A.R.C.S., and W. A. Wearmouth, Ph.D. Published by Hulton Press; 2s. 6d., 58 pp. and 21 diagrams.

This new *Electronic Engineering* Monograph appears at a time when the attention of most radio engineers is being directed to the value of plastics in the industry. The authors pay a tribute to the foresight of those firms, who recognising future applications, devoted time and money to plastics research. The Monograph is divided into five well-defined chapters dealing with: I, Nature and Types of Plastics; II, Manufacture; III, Manufactured Plastic Products; IV, Manipulation of Plastics; V, Electrical Properties. Appendices list Cements and Solvents for Plastics, Identification Tests for Plastic Raw Materials, Books on Plastics, Articles on Plastics.

A useful and comprehensive table, which occupies the centre pages, gives the basic composition of any proprietary plastic material and the forms in which the material is available. A coloured frontispiece depicts examples of various plastic products.

A most useful book, well produced and offered at a reasonable price. J.C.

Synthescope Side Slips

December, 1943, *issue*, *Page* 83.
Fig. 1. + and − Time-base connections reversed.
December, 1943, *issue*, *Page* 85.
Second sentence of caption under Fig. 3a should read: "Note rejection trough at about $-0{\cdot}1$ kc/s."
February, 1944, *issue*, *Page* 121.
Second sentence of caption under Fig. 3 should read: "The *right*-hand peak is the fundamental, those from *right* to left are 2nd to nth harmonics in ascending order."

Forces Stamp Club

Capt. J. S. Timpson, Hon. Administrator, Forces Stamp Distributing Centre, 51 Herga Court, Harrow-on-the-Hill, wishes to thank all members who responded to his appeal published in the January issue. If you have any duplicates please send them to Capt. Timpson who has been delegated by the Command Welfare Officer (A.A. Command) to organise the free distribution of stamps to H.M. Forces.

OUR FRONT COVER

THIS month's illustration shows another of the Mullard range of cathode-ray tubes—the ECR. 35.

It has a screen diameter of approximately 3½"; gives a brilliant trace with a small spot size and has a high deflection sensitivity. Useful points are that the deflector plates are brought out separately, and that the tube is suitable for asymmetrical deflection.

Letters to The Editor

A Foreign Languages Vocabulary for Radio Amateurs

DEAR SIR,—With reference to my letter on the above subject in the January issue of THE BULLETIN, I have to record that the interest shown to date is somewhat disappointing. This, I think, is primarily due to the lack of any definite lead to members as to what is actually required.

There have been a number of offers to supply translations in foreign languages of lists of phrases, but no member has yet produced a list of English phrases likely to be of use to the radio experimenter.

It is a fairly simple matter to compile a glossary of technical terms, everyday words, numerals, etc., which are commonly used by the transmitting amateur, but as the object of radio contacts is primarily to confirm the results of experiments carried out, I consider the vocabulary should also include a list of simple phrases (questions and answers) which would be used by the amateur in the course of his work.

The field of experimentation could be conveniently divided into six groups :—

1. Aerial system.
2. Transmitter.
3. Keying system.
4. Modulation system.
5. Receiver.
6. Checking and measuring equipment.

It is accordingly suggested that members interested in this scheme should forward to me a minimum list of simple phrases—covering one or more of these groups—which they consider would deal in a fairly adequate way with the majority of tests likely to be carried out. In addition, if others would prepare a list of technical terms, etc., time would ultimately be saved in compiling the vocabulary and the possibility of anything being overlooked would be much reduced.

Once we have comprehensive lists on these lines it will be time enough to approach foreign amateurs for their co-operation.

All lists should be sent to the undersigned, c/o R.S.G.B. Headquarters.

Yours faithfully,
E. H. PAULTON (G4IT).

What Constitutes a Communications Type Receiver ?

DEAR SIR,—On receiving THE BULLETIN for January, the first thing which caught my eye was a description of " A Four Valve Communications Receiver." Expecting something really deadly I turned to page 98 and, lo and behold, a straight four valves !

To get to the point. It is universally understood that the term " communications " is applied to a receiver which can " hold " a signal in the most unfavourable and adverse conditions of reception. This implies a big reserve of amplification, selectivity which is controlled and can be made extreme, if necessary, and as great a signal-to-noise-ratio as is possible. How does 2BJY reconcile such requirements with an H.F. detector 2 L.F. receiver, good as his design may be ?

I myself am a " straight " enthusiast, but I find it hard to believe that Mr. Johnson's effort approaches the selectivity of even a simple superhet. The circuit in question has been used by amateurs for years. Why is it that no one has discovered its remarkable selectivity until now ?

If one is given the responsibility of submitting a design for the guidance of others, one's enthusiasm for praising its qualities should always be tempered by a little modesty and discretion.

It is not many months ago since another receiver appeared in THE BULLETIN with a rather misleading title. The circuit in that case bore no likeness to its alleged prototype, namely the " W.W. Single-Span Superhet."

A journal of such high standing as our BULLETIN should preserve with jealous care its reputation for accurate and up-to-date information and not descend to the level of certain pre-war wireless weeklies with their sensational and exaggerated claims for each and every design they produced.

Yours faithfully,
IAN B. JAMIESON (BRS6752).

DEAR SIR,—I feel sure that BRS6752 has misunderstood the motive and purpose of my article. It is undeniably a fact that a well designed superhet will score over a straight receiver. But, and I am confident that BRS6752 will agree with me on this point, unfortunately suitable components to build a specialised short-wave communications superhet are not at present available in open market. The very nature of a well thought out superhet design is surely the exact adherence to specified components. That was my motive in submitting a description of a straight receiver. My purpose was to provide a practical design which could be built with components to be found in any amateur's store. The term " communications receiver " as far as I know, can be applied to any receiver used for communications purposes, and surely a straight receiver can give a good performance in the three qualifications he mentions. I have no doubt that BRS6752 and I would fail to agree about our definitions of the *average* superhet communications receiver, but at least my design is free from second channel interference, a high noise level and unwanted reaction effects.

Yours faithfully,
W. G. JOHNSON (2BJY).

Electrical Guitars

Mr. H. G. White, **BRS5027,** 6 Beaumont Road, Acton Green, Chiswick, London, W.4, seeks information concerning magnetic and electrostatic pick-ups for electrical guitars. Members in a position to assist are asked to communicate direct with Mr. White.

An article dealing with electrical guitars would receive favourable editorial consideration. Any offers ?

The Microtimer

The Microtimer, as its name suggests, is an instrument intended for the convenient and accurate measurement of short time intervals ranging from one millisecond to one second. It will probably find its greatest use in the development and testing of relays, contact breakers, fuses, stroboscopes, camera shutter releases, and all kinds of automatic machinery. Less obvious applications are in measuring viscosity, high accelerations and velocities, speed of chemical (especially explosive) reactions and in the calibration of radiolocation apparatus. The instrument is suitable for operation by unskilled personnel.

The principle is that a large capacitance condenser which has previously been charged by a high voltage D.C. supply, is discharged, during the time interval which it is proposed to measure, through a constant current circuit into a selected high-stability precision condenser. The voltage developed across this second condenser is a function of the time during which the constant current flowed, and is indicated by a D.C. valve voltmeter of exceptionally high input resistance, stabilised by the introduction of heavy negative feedback. Two diodes are included, one to by-pass the current, which charges or leaks through the large condenser, which later becomes the source of power for the discharging current, and the second to prevent the charge introduced into the precision timing condenser from leaking out after the interval to be measured has passed.

The standard model is controlled by the making or breaking of two pairs of external electrical contacts ; any of the four combinations of makes and breaks can be used. It can also be operated directly without contacts by a photo-cell and valve amplifier. Six ranges with maxima of 10, 20, 100, 200, 500 and 1,000 milliseconds are provided, and in all cases accuracy is within $\pm$ 1 per cent. of full scale. Time intervals are read directly on the four inch long meter scale which is calibrated in milliseconds. Special circuits ensure an almost complete absence of zero drift ; the stabilising system renders accuracy totally unaffected by any normal change of valve parameters or in mains supply voltage. The instrument is entirely self-contained, normally includes no batteries, and may be connected to any A.C. mains supply ; a battery-driven model is available. The meter scale can be supplied with other calibrations (e.g. feet per second, relative viscosity) in cases where the instrument is used under defined conditions for one special purpose. The Microtimer is a product of R. K. Dundas, Ltd., The Airport, Portsmouth.

Radio Equipment of the late G8IX for Sale

Mr. W. E. Russell, G5WP, " Milestones," Mayford, Woking, Surrey (District 7 Representative) acting on instructions received from the parents of the late F./Sgt. R. J. Rider, G8IX, offers the following equipment for sale :—

30 watt Audio Amplifier (6C5–6N7–6C5–6L6's and VM1 output)—£5. Tobe Ham-Band Tuner with 2–465 kc/s. I.F.'s and B.F.O. coils.—£3 15s. the lot. Avo Minor—£2. Pifco A.C./D.C. Meter—10s. 60 watt Auto-transformer—15s. 2-10" Philco Eliptical Energised Speakers (new) 27/6 each. B.T.H. Generator/Motor—Gen. 1200v 100mA. or 12v input—1,000v 30mA. output 30/-. S.A.E. with inquiries please.

Applications for Membership

Members who sponsor applications for Corporate Membership are requested to insert their call sign or B.R.S. number after their signature in the space provided on the application form.

Silent Key

Mrs. L. E. HUTCHINGS, VK3HM

Australian Amateur Radio has suffered a severe loss in the death of Mrs. L. E. Hutchings, VK3HM, of Callawadda, Victoria, Australia. An active amateur since 1931 (during which year she became the first overseas lady member of the R.S.G.B.), Mrs. Hutchings had the proud distinction of being the mother of two other equally-famous amateurs—Marjory, VK3HQ, and Alan, VK3HL.

VK3HM was known to many British Empire amateurs, for she devoted much of her free time to correspondence with her " friends of the air ". She was a regular contestant in Empire and local contests, whilst her knowledge of International Amateur Radio was extensive.

Mrs. Hutchings passed away after a sudden heart attack on December 1 last, while staying at Stawell, 18 miles from her home.

To Alan and Marjory Hutchings we offer, on behalf of their numerous R.S.G.B. friends, sincere sympathies and condolences. J. C.

BRITISH ISLES NOTES AND NEWS

DISTRICT 1 (North Western)

D.R.: H. W. Stacey (G6CX), "Sandleas," Eddisbury Road, West Kirby, Cheshire. Hoylake 337.

The D.R. has received no reports for publication this month, but membership continues to grow. It is hoped that all new members will endeavour to attend a P.D.M. which it is planned to arrange in May or June. Details will be announced as soon as the venue has been settled.

As there is now promise of sufficient support for a series of monthly meetings in the Liverpool area the D.R. has reserved accommodation for a preliminary get-together on March 25, details of which will be found in "Forthcoming Events." Please do your best to attend so that the meeting will be fully representative. G6CX.

DISTRICT 2 (North Eastern)

D.R.: C. A. Sharp (G6KU), 316 Poplar Grove, Gt. Horton, Bradford. Bfd. 10772. Scribe: H. Beadle (G8UO), 13 Chandos Street, Keighley.

A P.D.M. will be held in Leeds on Sunday May 14th. Full details will be announced next month. Book the date.

The D.R. extends a cordial invitation to BRS members living, or serving, in the Bradford area, to attend a meeting at his home on either a Monday or Wednesday evening. Those who can accept should please phone or write. Other members are also welcome, but most seem too busy.

Morley.—The Morley and District Radio and Television Society held another successful meeting on February 6 when the President (Mr. N. Hunter, M.I.E.E.) conducted members around the electricity works and afterwards entertained them with a cinema show. A collection taken for the P.O.W. Fund resulted in the sum of £1 being sent to Headquarters. Those present included 5YV, 5BX, 6NP, 6PL, 6QO, 8UO, 8WP, 2CGR, 2HHV, BRS1151, 4224, 5893, 6709, 6730 and Messrs. Woad, Pearce, Brocholme, Gill, Green and Somerscales. 5YV is highly satisfied with his home-built 10-valve receiver, 5893 is collecting gear to make a similar receiver.

Sowerby Bridge and Halifax.—A meeting was held on February 10 when a talk on early experiments and the activities of the R.S.G.B. was given by G6BX. Those present included 2WB, 8CB, 2AWK, 2DUX, BRS6806, 6807, 6441, 7607 and 7685. It is hoped that this will be the first of a series of meetings. Geoff. Davies, G2PC, now a Ft./Sgt. reports fit and well. News has also been received of A.Q.M.S. R. Greenwood, 5386.

General.—G4LD (P.O. Tel., R.N.), who has been on leave recently inquired about Bradford meetings! 3KF (Cpl., R.A.F.) recently visited 2SU. He wishes to be remembered to 6KU, 4CL is attempting to remove the snags in his amplifier. 4412 hopes to attend meetings in London. W. F. Badcock, 2BAP, 53 Porth-y-Felin, Holyhead, would like to hear from 8BA. 2BBJ, 6352 and 7120 (Mexbro') meet regularly at their homes; they would welcome any other members who may be passing that way. 2BBJ is Signals and Radio Instructor to 2013 (Dearne) Squadron A.T.C. G6PJ (India) wishes to be remembered to all old friends, especially 2MI, 2XK, 5YV, 5KT, 5OA, 5UA and 6LZ. Congrats are offered to P.O. Radio Mech. J. H. Brazzill, G3WP, on obtaining a first-class pass in City and Guilds Exams. The Scribe sincerely thanks members who have written to him. Please write again. G8UO.

DISTRICT 3 (West Midlands)

D.R.: V. M. Desmond (G5VM), "The Chestnuts," Hanley Castle, Worcester. Scribe: E. J. Wilson (2FDR), 48 Westbourne Road, Olton, Birmingham.

The D.R. announces that a P.D.M. will be held in Birmingham on Saturday, April 15. See special announcement. All who intend to be present are asked to write to G5VM by not later than April 8.

Congrats to Ted Rowley, G6TC (Wolverhampton), on his recent marriage. It is learned that he and his colleagues are doing a good job in H.G. Signals. 2FDR.

DISTRICT 4 (East Midlands)

Deputy D.R.: A. E. Clipstone (G8DZ), 14 Epperstone Road, West Bridgford, Notts.

Leicester.—Four members only attended the special meeting held at G2IX, but the discussion on "Break-in" and "Tuning-Fork Control" showed that quite varied opinions are held.

G2RI, now in India, complains of varying climate and lack of contacts. 5674 in N. Africa, also reports no contacts. (*via* 5605.)

Mansfield and Sutton.—G8OT, one of the "Robin Hood Gang," serving in the R.A.F., says that his present activities are confined to reading THE BULL. and dreaming of the super rig he is going to build when things are normal again. (*via* 7171.)

Nottingham.—Despite bad weather there was an excellent attendance at the Beeston Lad's Club last month. The rooms were kindly lent by the Brigade Captain, Mr. Chas. P. Williams, who also provided an excellent tea at his own expense. For these favours we record to him our thanks.

Amplifiers and test gear were demonstrated and the members concerned gave brief descriptions.

A member has forwarded 10s. to the P.O.W. Fund representing a bonus awarded him for a suggestion made at his place of employment to reduce wastage of solder. A further sum of 8s. was raised for the fund by 7416 who runs a daily paper loan system. (Many thanks O.M's. G6CL.)

2FRI, who is at present in the area, recently visited G8DZ.

The next meeting, to be held at 2AOO, will feature Radio Quiz 6 and a sale of disused gear. G8DZ.

DISTRICT 5 (Western)

D.R.: R. A. Bartlett (G6RB), 31 King's Drive, Bishopston, Bristol. Bristol 46960.

Bristol.—At the February meeting which was fairly well attended, we were pleased to welcome 3RQ home on leave, BRS7257 of Birmingham, who is stationed in the locality, GI5HV and ex-2XU. A collection for the P.O.W. Fund realised £1 10s. 0d.

4CM is back in this country after a long spell abroad. Another airgraph is to hand from 5UH, but as the censor "went mad" and deleted all call signs it conveys practically nothing! 'UH is now entering his last year of overseas service and is looking forward to coming home. He sends 73 to all.

Swindon.—Another welcome report is to hand from 3JO, who is still stationed near Gainsboro. The Signals Officer at his station is 5FP of Cheddar. 3HS has been posted to Chigwell, Essex, 3NC is still near Dover. No news of 2CGN and 2BUJ. He raises the query echoed by the D.R., what has happened to the Cheltenham gang? Let's hear from you. G6RB.

WEST MIDLANDS PROVINCIAL DISTRICT MEETING

to be held on

SATURDAY, APRIL 15th, 1944

at the

Imperial Hotel, Temple St., Birmingham

PROGRAMME

ASSEMBLE	1 p.m.
LUNCH	1.30 p.m.
BUSINESS MEETING	3 p.m.
TEA	4.30 p.m.
OPEN DISCUSSION	5.30 p.m.

INCLUSIVE CHARGE 8/6

Reservations to Mr. V. M. DESMOND, G5VM, 90 Worcester Street, Birmingham, by not later than April 8th, 1944

ALL MEMBERS CORDIALLY INVITED TO ATTEND

DISTRICT 6 (South Western)

D.R.: W. B. Sydenham, B.Sc. (G5SY), Sherrington, Cleveland Road, Torquay. Torquay 2097.

Torquay.—A meeting was held on Sunday, February 27, at the home of the T.R., G2GK. Though the attendance was rather small, the event proved very interesting. G2GK, 5SY, 2ARA, BRS6779 and 7002 were present. 2GK and 2ARA got their heads well down to it when they discovered that both came from Walton-on-Thames. 5SY was pleased to see G3JD during his recent leave. Letters have been received from new members E. C. Halliday, BRS6398, 33 Hill Top Crest, Higher Street, St. Budeaux, Plymouth, and P. D. Collings-Wells, BRS6885, Horslake, Cheriton Bishop, near Exeter, both of whom wish to contact local members. BRS6389 would like to see meetings started in the Plymouth area. G5SY.

DISTRICT 7 (Southern)

D.R.: W. E. Russell (G5WP), Milestones, Mayford, Woking, Surrey. Woking 1589.

Bournemouth.—Local members were glad to see the T.R. when he was home on leave recently. 4MY is building a 10 watt amplifier and 2NS an O-V-1 regen. G2NS, 2RZ, 3BM and 4MY met recently for a "rag-chew." (*via* G2NS.)

Coulsdon.—The T.R. wishes to thank new members 6946 and 7351 for their letters. The former has just returned after two years' service abroad with the R.A. (Sigs.), the latter is serving in the R.N.V.R. (*via* 3003.)

Croydon.—Old timers 2KU, 5XH and 5XW attended the February meeting in addition to 2DP, 2HP, 3ST, 3VN, 4NI, 5BT, 2HHD, 1545, 3003, 4324, 4584, 6064 and 6915. A talk on the

construction of Multivibrators was given by 2DP and well received. VE3ASJ (Smith Falls, Ontario) and 2HNO (T.R., Bournemouth), were welcomed as visitors. 2HGN writes to say that he looks for District Notes every month and is glad to see we are very much alive in Croydon. See Forthcoming Events for date of next meeting. (*via* G2DP.)

Reading.—The February meeting was well attended with G2YI, 5TP, 2BTY, 2DIO, 2BYZ, 4805, 5225, 6957, and many friends and representatives of the radio trade present. 2BYZ brought along a very neat and compact Valve Voltmeter probe.

Details of the next meeting will be found under "Forthcoming Events." The talk which is to be given by Dr. Moss (Cossors') on "The Cathode Ray Oscilloscope" will be illustrated by slides and should be well worth hearing.

4716, in a letter from C.M.F. says he is pleased to see Reading in the news once more. (*via* 4573.)

Southampton.—S./Sgt. F. G. Rylands, G2VF, 9, Atherley Road, Southampton, deploring the lack of news from his town, would like to hear from 5OB and 8OV. G5WP.

Forthcoming Events

Mar. 19	District 1 (Ashton-under-Lyne R.S.), 3 p.m. at BRS5043, 30 Ruth Avenue, New Moston, Manchester, 19.
Mar. 19	District 4 (Nottingham section), 6 p.m. at 2AOO, 78 Henry Road, West Bridgford.
Mar. 19	District 15 (High Wycombe section) 2.30 p.m. at BRS4781, 37 Melbourne Road, High Wycombe. (Bus 326 from Castle Street to terminus. A p.c. if attending.)
Mar. 25	London Meeting, 2.30 p.m. at the I.E.E. "Some less-common metals and their radio applications." By E. H. Laister, BRS3386.
Mar. 25	District 1, 3 p.m. at The Stork Hotel, Queens Square, Liverpool.
Mar. 25	District 7 (Reading section), 6.30 p.m., The Comrades' Club (first floor), 42 Oxford Street.
Mar. 26	District 5, 3 p.m. at 17 Colston, Avenue, Centre, Bristol.
Mar. 26	Scotland "A" District, 3 p.m. in the Royal Technical College, George Street, Glasgow. Enter by Montrose Street.
Mar. 26	District 12, 3 p.m. at G2RX, 14B Belsize Lane, Hampstead, N.W.4.
Mar. 26	District 4 (Leicester section), 2.30, p.m. at BRS5605, 292 Gwendolen Road, Leicester.
Mar. 29	District 19, 7 p.m. at Bourgoynes Wine Rooms, Newgate Street, Newcastle-on-Tyne (opposite St. Andrews Church).
April 1	District 15, 3 p.m. at The Excelsior Hotel, 1 Ladbroke Gardens, Ladbroke Grove, Notting Hill, W.11.
April 2	District 7 (Croydon Area) and District 13 (South Central and Eastern Areas), 3 p.m. at Croydon Y.M.C.A., North End, West Croydon.
April 15	West Midlands Provincial District Meeting, 1 p.m. at the Imperial Hotel, Temple Street, Birmingham.

DISTRICT 8 (Home Counties)

Deputy D.R.: L. W. Jones (*G5JO*), 16, *Leys Road, Cambridge. Telephone: Cambridge* 3406.

Members availed themselves of the opportunity to hear Mr. P. G. A. Voight speak on "Sound Reproduction" at the Engineering Laboratories, Cambridge, on February 22. Another event during the past month was the formation of the Cambridge Wireless Group (I.E.E.) when several amateurs attended the inaugural meeting together with a large number of other well known radio men. Mr. T. E. Goldup (Chairman I.E.E. Wireless Section) paid a high tribute to the amateurs and spoke of the valuable work they had done in the past. The new Group will undoubtedly be a great success.

There are still insufficient local amateurs available to give time to a meeting of their own, and very few have been in contact with the writer during the past month. New members to the district should write in if they would like to attend a social function but this cannot be arranged unless there are sufficient numbers to warrant the hiring of premises.

If this issue reaches local members serving abroad the D.D.R. will be pleased to hear from them and every effort will be made to reply as quickly as possible. Similarly those from the district who are stationed in the British Isles are also requested to report. With best wishes to all. G5JO.

DISTRICT 10 (South Wales & Monmouthshire)

Deputy D.R.: H. H. Phillips (*GW4KQ*), 82 *Cottrell Road, Roath Park, Cardiff. Cardiff* 2697 *during business hours.*

Cardiff.—Post-war development of Amateur Radio and its bearing upon Society activities was discussed at the February meeting attended by GW2UH, 4KQ, 8AM and 8HU. The next meeting will take place at the home of GW8UH, 29 Ladysmith Road, off Penylan Hill, Roath Park, at 2.30 p.m. on Sunday, March 26, 1944. A cordial invitation is extended to all Service members and others in the District.

Swansea.—GW4CC (Mr. W. Bowen, Thistle Dhu, Killay) would like to hear from those willing to support a local meeting. He extends a welcome to any member of the Services who may be stationed in the area.

Carmarthenshire.—Interest is increasing and suggestions are invited regarding future meetings at a central point. G8MQ and 3767 would like to meet others in this area.

5673 (late T.R. Newport), now in District 2, has made contact with several members including 2COR. 7674 would like to meet members in District 11. The writer will be pleased to hear from members on active service. GW4KQ.

DISTRICT 11 (North Wales)

Deputy D.R.: C. Spillane (*BRS1060*), "*Woodside,*" *Meliden Road, Prestatyn.*

L./Bdr. Shersby, G2GZ, at present stationed near Rhyl, has kindly offered to act as a local contact to members of H.M.F. or others in that area. His address can be obtained from BRS1060.

Airgraphs are to hand from VE4YG (India) and BRS4023 (M.E.F.). They send 73 to all who know them. 4444 reports construction of a grid current valve voltmeter using a 42E, which is giving excellent results. 7516, 7520, 7529 report from a local Radio College, where they are on a course. 5520 (Radio Officer, M.N.) has returned to sea, after a spell of leave.

News is sought of G2KI, 3TS, 8JM, 3044, 4410 and other one-time visitors to District 11, to whom the writer would like to drop a line. BRS1060.

DISTRICT 12 (London North and Herts)

D.R.: S. Buckingham (*G5QF*), 41 *Brunswick Park Road, New Southgate, N.*11. *Enterprise* 3112.

The February meeting held at The Cock, Cockfosters, was attended by G2RX, 3YY and YL, 5QF, 6QM and YL, 2HNT, BRS6759, 6811 and 6940. With the lengthening evenings it is hoped to be able to find suitable accommodation for a Sunday afternoon and evening gathering.

The D.R. was pleased to receive a visit from 7373 and letters from 7141, 7420, 7622 and 7793.

The next meeting will be held on Sunday, March 26, at the home of Mr. Read, G2RX, 14B Belsize Lane, Hampstead, N.W.4 (fourth turning on left up Havistock Hill, nearest underground station Belsize Park). G5QF.

DISTRICT 14 (Eastern)

Scribe: L. J. Fuller (*G6LB*), 167 *Galleywood Road, Chelmsford, Essex. Chelmsford* 3929.

Chelmsford.—The Scribe has received several letters from members, and other amateurs who have visited, or been stationed in, the District. He is always pleased to receive letters, but craves the indulgence of the writers if they do not always get answered. Pressure of business has reduced to a minimum the time available for private correspondence.

Chingford.—G8DG having returned to Acton, G2HR is now looking after affairs in this area.

He hopes to continue meetings when possible, and appeals for a venue, his own QRA being at the moment unsuitable. Offers to 25 Clivedon Road, Highams Park, E.4, please. G6LB.

DISTRICT 15 (London West, Middlesex and Buckinghamshire)

D.R.: H. V. Wilkins (*G6WN*), 539 *Oldfield Lane, Sudbury Hill, Greenford, Middlesex. Byron* 3369.

Headline for this month—"Our Illusionist Returns Home"! Mr. Deveen (G4HF), who has been entertaining the troops abroad for the past three years is now back in England. He has had the

★ LONDON MEETING ★

Mr. E. H. LAISTER (BRS3386)

WILL DELIVER A LECTURE ENTITLED

"SOME LESS-COMMON METALS AND THEIR RADIO APPLICATIONS"

at

A Meeting of the Society to be held at

The Institution of Electrical Engineers

Savoy Place, Victoria Embankment, W.C.2

On SATURDAY, MARCH 25th, 1944

The meeting will commence at 2.30 p.m.

followed by TEA at 4 p.m.

honour of teaching King Feisal of Iraq the art of magic and has been right through the Middle East and on into Sicily and Italy. We welcome him back.

Airgraphs are to hand from 8IH and 8FA. The former says he had a very dry Christmas, while 8FA reports that he has been visiting amateurs during his tours. He met a New Zealander who had spent weeks trying to raise G6VP! Both send 73 to old friends.

A welcome to BRS7412, who is in the Navy. 7235 writes of his interest in F.M. Both are members of District 12, but feel they would like to associate with us as well.

High Wycombe.—6IF, 4781, 4782 and 5666 are busy with U.H.F. receivers and other small gear; it is rumoured that 6IF is also building a model railway.

A welcome to all new members of the District and we hope they will try to get along to local meetings.

For information the addresses of our acting T.Rs. for High Wycombe and Aylesbury are:—Mr. Freer (BRS4781), 37 Melbourne Road, High Wycombe, Mr. Hamer (G8BW), 165 Park Street, Aylesbury. G6WN.

DISTRICT 17 (Mid East)

D.R.: A. C. Simons (G5BD), Admiralty Road, Mablethorpe. Phone 69.

The only news to hand is from 2BUV, who bemoans shortage of contacts. He sends news of 2HBN, now in Iraq.

Sorry chaps, that's all. G5BD.

DISTRICT 19 (Northern)

D.R.: R. J. Bradley (G2FO), 36 Raby Road, Stockton-on-Tees.

Newcastle.—The T.R. reports that the Northern Radio Club has been granted affiliation to R.S.G.B. Meetings are held on the first Wednesday of every month at 7 p.m. in Bourgoyne's Wine Rooms, Newgate Street, Newcastle.

BRS3849 of Durham is enjoying himself in the signals section of the local Home Guard, 6843 is building a valve voltmeter. 6904 is at present in the Shetlands with the R.A.F. 5474 and 2HMM are at the same station. 6943 is in the Royal Tank Corps and stationed in the district. He reports that the military authorities have promised to try and arrange meetings for any R.S.G.B. members in the camp. G2FO.

Scotland

Scottish Records Officer: J. Hunter (GM6ZV), 51 Camphill Avenue, Glasgow, S.1. Langside 237.

"A" District.—There was a better attendance at the February meeting and it is hoped that the improvement will be maintained. A small committee was appointed to assist the D.O. in running meetings, etc. During the meeting short talks were given on regenerative H.F. stages, the transitron oscillator and novel test instruments.

"H" District.—The D.O. extends a hearty welcome to all recent new members to the district. Old-timers in "H" will be glad to hear that Tommy Paton, 2DVV (R.A.F.) has recently been "Mentioned in Dispatches." We take this opportunity of offering him hearty congratulations. Well done Tommy! Our nomadic R.A.F. Sergeant, BRS5320, having arrived in Canada, believes that this time he may stay "put." GM3LG in the M.E. sends 73 to all his friends in "H." GM8MQ, who reports regularly, recently escaped disaster when a wheel came off the truck he was driving. The rumour that "Tubby" Thomson, BRS2929 was missing is completely unfounded and members will be glad to hear that he is safe and well. GM6ZV.

BRITISH ISLES DISTRICTS

For the information of new members we give below a list of D.R.'s or Deputy D.R.'s and the areas forming each of the 21 British Isles Districts. Members resident in Scotland should communicate with the Scottish Records Officer for the address of their local District Officer.

District 1 (*North Western*). Cheshire, Cumberland, Lancashire, Westmorland.
D.R.: Mr. H. W. Stacey (G6CX), "Sandleas," Eddisbury Road, West Kirby, Wirral, Cheshire.
District 2 (*North Eastern*). Yorkshire (West Riding and part of North Riding).
D.R.: Mr. C. A. Sharp (G6KU), 316 Poplar Grove, Gt. Horton, Bradford. *Scribe:* Mr. H. Beadle (G8UO), 13 Chandos Street, Keighley.
District 3 (*West Midlands*). Part of Shropshire, Staffordshire, Warwick, Worcester.
D.R.: Mr. V. M. Desmond (G5VM), "The Chestnuts," Hanley Castle, Worcestershire. *Scribe:* Mr. E. J. Wilson (2FDR), 48 Westbourne Road, Olton, Birmingham.
District 4 (*East Midlands*).* Derby, Leicester, Northants, Notts.
Deputy D.R.: Mr. A. E. Clipstone (G8DZ), 14 Epperstone Road, West Bridgford, Nottingham.
District 5 (*Western*). Gloucester, Hereford, Wiltshire.
D.R.: Mr. R. A. Bartlett (G6RB), 31 Kings Road, Bishopston, Bristol.
District 6 (*South-Western*). Cornwall, Devon, Dorset, Somerset.
D.R.: Mr. W. B. Sydenham, B.Sc. (G5SY), "Sherrington," Cleveland Road, Torquay.
District 7 (*Southern*). Berkshire, Hampshire, Oxfordshire, Surrey.
D.R.: Mr. W. E. Russell (G5WP), "Milestones," Westfield Road, Mayford, Woking, Surrey.
District 8 (*Home Counties*). Beds, Cambs, Hunts, and the towns of Peterborough and Newmarket.
Deputy D.R.: Mr. L. W. Jones (G5JO), "Mella Loona," Leys Road, Cambridge.
District 9 (*East Anglia*). Norfolk and Suffolk.
D.R.: Mr. H. W. Sadler (G2XS), The Warren Farm, South Wootton, Kings Lynn, Norfolk.
District 10 (*South Wales and Monmouth*).*
Deputy D.R.: Mr. H. H. Phillips (GW4KQ), 82 Cottrell Road, Roath, Cardiff.
District 11 (*North Wales*). Anglesey, Caernarvon, Denbighshire, Flintshire, Merioneth, Montgomery, Radnorshire and parts of Shropshire not in District 3.
Deputy D.R.: Mr. C. E. Spillane (BRS1060), "Woodside," Meliden Road, Prestatyn, Flints.
District 12 (*London North and Herts*). North London Postal Districts, Herts, and North Middlesex.
D.R.: Mr. S. Buckingham (G5QF), 41 Brunswick Park Road, New Southgate, N.11.
District 13 (*London South*). South Eastern and Central Areas.
A.R.: Mr. S. E. Langley (G3ST), 62 Dumbarton Hill, S.W.2. South Western Area.
A.R.: Mr. E. H. Simmonds (G8QH), 17 Roedean Crescent, Roehampton, S.W.15.
District 14 (*Eastern*). East London and Essex.
Scribe: Mr. L. J. Fuller (G6LB), 167 Galleywood Road, Chelmsford, Essex.
District 15 (*London West*). West London Postal Districts, Bucks and that part of Middlesex not included in District 12.
D.R.: Mr. H. V. Wilkins (G6WN), 539 Oldfield Lane, Sudbury Hill, Greenford, Middlesex.
District 16 (*South Eastern*).* Kent and Sussex.
Deputy D.R.: Mr. W. A. Scarr, M.A. (G2WS), 8 Beckenham Grove, Shortlands, Kent.
District 17 (*Mid-East*). Lincolnshire and Rutland.
D.R.: Mr. A. C. Simons (G5BD), Admiralty Road, Mablethorpe, Lincs.
District 18 (*East Yorkshire*). Yorkshire (East Riding and part of North Riding).
Scribe: Mr. S. Davidson (G6SO),10 Sidney Street, Scarborough.
District 19 (*Northern*). Northumberland, Durham and North Yorkshire.
D.R.: Mr. R. J. Bradley (G2FO), 36 Raby Road, Stockton-on-Tees.
Scotland.
Records Officer: Mr. James Hunter (GM6ZV), 51 Camphill Avenue, Langside, Glasgow.
Northern Ireland.
D.R.: Mr. J. N. Smith (GI5QX), 19 Hawthornden Drive, Belfast.

Messrs. Langley and Simmonds are Area Representatives.

* *Indicates that the D.R. is on active service.*

KHAKI AND BLUE

● Capt. Ken Ellis, **SU5KW,** once more back in Egypt sends greetings to all old friends and expresses his regrets that he was unable to visit the District 7 (Thornton Heath) meeting just prior to leaving England last November. With the assistance of a "Sunderland" he managed to arrive in time to attend the Christmas Conventionette held in Cairo. Major McHale, BRS3261, Lt. Lord, G5NU, and Sgt. McDermott, G3NZ, are with him. Ken relieved Capt. Cecil Runeckles, now back in England. Incidentally who remembers "Runny of SU8RS"?

● L.A.C. N. D. Glass, **2FFM,** writing from H.Q. 219 Group, R.A.F., reports that 2DTQ, 2FPY and 6PQ have left for an unknown destination, 3TQ is in Italy, and 3TA is in the land of the "Pasha and Donkey." S./Ldr. Geoff Mason, G5BR, is still his C.S.O. 2FFM is willing to collect news from members serving in his area with a view to sending in monthly reports to H.Q. His Service number is 917634.

● E. W. Hunt, **G5IK—VU2FD,** W/T Superintendent of Police, Sitapur, U.P., India, would like to contact members in the United Provinces. He frequently visits Lucknow, Cawnpore, Meerut, Agra, Allahabad in connection with police wireless.

● After serving abroad for the past two years, W./O. H. D. Bramwell, **G2RF,** late T.R. for Liverpool, is now back in England. During his travels he met G3BB, W2FNT and the late Arthur Tomlinson, ZD2A, who lost his life whilst returning to the U.K. G2RF, whose home address is 53 Druids Cross Gardens, Liverpool, 18, sends 73 to all old friends.

● Sgt. H. Davies, **3896,** one-time member of C.W.R. sends greetings from R.A.F., India, to Messrs Boyce, Davies, Morris and others who were with him at Cranwell. He also offers his congrats to P./O. A. A. Lamb, 4206, on his "elevation" to commissioned rank.

● Just before closing for press, news reached H.Q.s that A.C.1 Arthur Goode, 2DTQ, C.Q.M.S. Harry Hornsby, G5QY and R. H. Newland, G3VW, have returned to England after a long spell of duty overseas. 2DTQ is living at 128 New Victoria Street, Mansfield, Notts.

● From GM6ZV we learn that Bill Robertson, GM6RI, R. Sigs., has recently collected his third pip.

HEADQUARTERS CALLING

COUNCIL 1944

President:
ERNEST LETT GARDINER, B.Sc., G6GR.

Executive Vice-President: S. K. Lewer, B.Sc., G6LJ.
Honorary Secretary: H. A. M. Clark, B.Sc., G6OT.
Honorary Treasurer: A. J. H. Watson, A.S.A.A., G2YD.
Honorary Editor: Arthur O. Milne, G2MI.
Immediate Past President: A. D. Gay, G6NF.

* *

Members: F. Charman, G6CJ, D. N. Corfield, D.L.C.(Hons.), G5CD, Wing-Com. G. R. Scott Farnie, GW5FI, F. Hoare, G2DP, Wing-Com. J. Hunter, G2ZQ, W. E. Russell, G5WP, H. W. Stacey, G6CX.

General Secretary: John Clarricoats, G6CL.

January Council Meeting

*Resume of the Minutes of a Meeting of the Council of the Society, held at New Ruskin House, Little Russell Street, London, W.C.*1, *at* 6 *p.m., January* 17, 1944.

Present.—Messrs. E. L. Gardiner (President), S. K. Lewer, H. A. M. Clark, A. J. H. Watson, A. D. Gay, F. Charman, D. N. Corfield, F. G. Hoare, W. E. Russell, H. W. Stacey and John Clarricoats (General Secretary).

Apologies were received from Messrs. A. O. Milne and A. E. Watts.

1. It was unanimously resolved to elect 201 new members including 7 Associates (161 applications had been sponsored by Corporate Members and 33 were supported by references).

2. A copy of the new emergency membership certificate was tabled.

3. A Lecture programme for 1944 was prepared and agreed.

4. It was agreed to authorise the holding of Provincial District Meetings in Birmingham, Leeds, Leicester and Liverpool and in such other towns as the responsible "D.R."s may consider suitable.

5. It was announced that 841 B.R.S. Members, 495 Members with Full Calls, 196 Members with Artificial Aerial Calls and 9 B.E.R.S. Members voted in the recent Council Elections. Forty-five forms were rejected out of a total of 1,541 received.

6. Further consideration was given to the Trust Deed submitted by Mr. Adams.

7. Matters relating to post-war planning were discussed.

The meeting closed at 8.40 p.m.

London Meetings

Mr. E. H. Laister, BRS3386, will lecture on "Some less-common Metals and their Radio Applications," at a meeting of the Society to be held at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, S.W.1, on Saturday, March 25, 1944, at 2.30 p.m. Tea will be served free of charge at 4 p.m.

At the February meeting Mr. E. A. Dedman, G2NH, lectured on "The Manufacture of Quartz Crystals and their applications to Amateur Radio purposes." Numerous exhibits, loaned by the Quartz Crystal Co., New Malden, were displayed and examined with great interest by one of the largest gatherings of members recorded at a Society meeting for some months. The chair was taken by Mr. E. L. Gardiner, G6GR (President), who was supported by Mr. A. D. Gay (Past President) and other members of Council.

S./Ldr. J. N. Walker, G5JU, moved and Mr. S. K. Lewer, G6LJ, seconded a hearty vote of thanks to Mr. Dedman, which was carried with acclamation. Before concluding the meeting, the President, on behalf of Council, extended greetings to the many overseas Service amateurs who were present.

I.E.E. Wireless Section

The following meetings have been arranged to take place at the I.E.E., Savoy Place, Victoria Embankment, London, S.W.1 :—

March 21.—Discussion on "Treatment and Tests for Extreme Climatic Conditions." (Opened by E. M. Lee, B.Sc.)

April 5.—Lecture "Energy Conversion in Electron Valves." (By D. Gabor, Dr. Ing.) Meetings commence at 5.30 p.m. Tea at 5 p.m. By courtesy of the President and Council of the Institution, Society members are invited to attend these meetings.

Publicity Leaflet

A revised leaflet outlining the aims and objects of the Society and privileges of membership is now available for the information of prospective members. An application form is also included. Copies are available on request to Headquarters.

R.S.G.B. Prisoners of War Fund

DONATIONS.—The General Secretary acknowledges with thanks on behalf of Council, receipt of donations from :—M. Holden, BERS410, £1 7s. 6d.; G. Proctor, GM8SQ, 10s.; R. H. Drew, G3MD, 5s.; Masteradio No. 1 Factory per S. L. Robinson, £3 13s.; Anon, 3s.; J. A. Plowman, 4760, 5s.; E. James, 7377, 10s.; H. W. Fisher, 2CKP, 5s.; Capt. F. S. Saxon, 4156, 15s.; L. Allen, 4497, 10s.; Morley and District R. and T.S. per G5YV, £1; H. Arnfield, G3LX, 12s. 6d.; R. Bradley, 4209, 10s.; Hon. J. Forbes, EI8N/G4JL, £5 2s.; Miss Slight, 6039, 5s.; R. G. Silson, 5974, 2s. 6d.; H. Draper, 6866, 2s. 6d.; B. Wallich, 6BW, £1 7s.; R. H. Chapman, 4586, 4s. 6d.; Staff P.W.T.O., Devonport, per ON4FT, 15s.; H. Higham, 3172, 5s.; Mrs. K. Ellis (wife of SU5KW), £1 7s. 6d.; District 7 per G2DP, £1 10s.; L. Parnell, G8PP, 5s. **Total received to date, £1080 1s. 9d. Total Expenditure to date, £492 19s. 4d. Balance in hand at 28th February 1944, £587 2s. 5d.**

DESPATCHES.—As invoices have not yet been received from the Army and Navy Stores for despatches made during November, December, January and February, the Balance in Hand figure is inflated by approximately £130.

Changes of Address

Members who change their permanent address are asked to note that at least one month must elapse before the change can become effective for BULLETIN despatch purposes.

The Society cannot, under existing conditions, send the BULLETIN direct to a Service address. Members on Active Service should arrange for re-direction from their home address. Provided re-direction is effected promptly, no additional postage is required.

Technical Publications

The attention of members is directed to the fact that no facilities exist at Headquarters for obtaining technical publications other than the A.R.R.L. and Radio Handbooks listed below. Considerable inconvenience is caused by members who send cheques and postal orders for other publishers' books when forwarding either their subscription or an order for American handbooks.

American Publications

The Society is in a position to accept orders for the following publications which are ordered individually from America :

"QST" (Official monthly publication of The American Radio Relay League). By subscription, per annum	17s. 6d.
"The Radio Amateur's Handbook" (A.R.R.L.) ..	10s. 6d.
"The Radio Amateur's Handbook"—Special Defence Edition (A.R.R.L.)	8s. 6d.
"The Antenna Handbook" (A.R.R.L.)	4s. 0d.
"A Course in Radio Fundamentals" (A.R.R.L.) ..	3s. 6d.
"Radio" (Published by Radio Magazines Inc. New York). By subscription, per annum	21s. 0d.
"The Radio Handbook" (Editors and Engineers Los Angeles)	12s. 0d.

Orders must be accompanied by a remittance made payable to the Society and rates and prices are subject to alteration without previous notice. Delivery can be expected in about 12 weeks from date of order. Service Addresses must not be used. Single copies of text books only may be ordered.

The Amateur Radio Handbook

The tenth printing (22,500 copies) of the Society's Handbook is now on sale price 4s. post free. Cloth bound copies are also available, price 6s. 6d. Headquarters will be pleased to allow trade terms on orders for 12 or more copies.

Cash Sales Department

The following items are now in stock at Headquarters :—

Members' Notepaper (new style), 100 sheets ..	3s. 6d.
Car Plaque of Emblem	3s. 6d.
Rubber Stamp of Emblem	3s. 0d.
Kilocycles to Meters Conversion Booklet	1s. 6d.

All the above items will be sent post free to any address in Great Britain on receipt of remittance. Orders for Eire are despatched *via* the Censorship authorities.

Headquarters Address

Last month more than 500 letters, dealing with Society business, were delivered to the General Secretary's private address. This, in spite of frequent requests for all official R.S.G.B. correspondence to be sent to New Ruskin House, 28/30 Little Russell Street, London, W.C.1.

Those who act as sponsors to applicants for membership are kindly requested to record the above address on the application form, if the latter bears the temporary war-time address of the Society, *viz.* 16 Ashridge Gardens, Palmers Green, London, N.13.

When communicating with Headquarters the Society's name must *always* preface the address. Embarrassment and delays are often caused because letters intended for the Society are opened by one of the other firms operating from New Ruskin House.

EDITORIAL—(*continued from page 129*)

more, more, more *Guides*—no paper rationing then!

How weary we were, but how we loved it! And so to Convention itself, with the Conversazione, the conducted tours, the business meeting, with the perennial debate on 7 Mc/s. 'phone and the desirability of retaining or scrapping District Notes.

Finally the Dinner and the Draw. The station visits next day and so back to the shack with new ideas for the coming months.

There then is a rough guide to the "high-lights" of the British Amateur's year as he knew it up to 1939. We have not mentioned the many foreign-sponsored contests—all of which drew their quota of British participants—and the many local field days, contests and competitions. We *have*, however, tried to show that we managed to combine our more serious work with that modicum of sportsmanship, fun and adventure which makes life worth living. We hope too that we have been able to show that this lighter side of our activities made its not inconsiderable contribution towards that ingenuity, resource and initiative which characterises the radio amateur and which has served the country so well in its time of need.

All this and much more is summed up in that phrase for which no alternative has yet been invented, "The Ham Spirit." Long may it live and spread amongst us—Old Timers and New Members alike. A.O.M.

MEASUREMENTS IN RADIO EXPERIMENTAL WORK

—(*continued from page 134*)

special cases in which the problem may be simplified to one of straightforward dimensional measurement. For example, the effective height of an earthed vertical aerial, very short compared with the wavelength, may be taken as one-half of its actual height or length; for a half-wavelength dipole, the value is $1/\pi$ times the wavelength; in each case it is assumed that the aerial is parallel to the electric force in the field being measured. In many cases it is convenient to use a tuned loop aerial, for which the effective height is equal to 2π times $\frac{\text{area} \times \text{turns}}{\text{wavelength}}$.

The technique of field strength measurement at wavelengths below 10 metres (frequencies above 30 Mc/s.) has been developed to a considerable extent at the National Physical Laboratory during the past five years or so, and reference may be made to a group of papers on this subject published elsewhere.[12] The application of some of this work is dealt with in the following section.

In concluding the present section, it may be stated that the accuracy with which field strengths may be measured at high frequencies, as judged by the limited amount of quantitative data available, is estimated to be of the order of 10 per cent. This is to be contrasted with the accuracy of one part in ten million for frequency measurement described at the beginning of the present section. (*To be continued.*)

1938 Hallicrafter Sky Buddy, £10. A.C. mains, Radiomart Oscilloscope, Hivac tube, £9 10s. Ferranti 3½ in. M.C. meter 0–5mA, £2 10s. Aluminium screening cabinet 9 in. × 9 in. × 9 in., £1.—Box 307, PARRS, 121 Kingsway, London, W.C.2.

1 DOZ. 16 mfd 500v wkg Electrolytics, exchange for gram cabinet or 10 in. 1,000 ohm speaker. Write.—12 Clares Lane, Oakengates, Wellington, Shropshire.

100 KC/s crystal, Triumph model 420 valve tester, two-inch Dumont Oscilloscope, as new. Offers. Wanted: First-class recording head and tracking gear, also ribbon microphone.—STACEY, "Noreth" St. Michael's Avenue, Yeovil, Somerset.

EXCHANGE & MART—ADVERTISEMENT RATES

MEMBERS' private advertisements 2d. per word, minimum 3s. TRADE advertisements 4d. per word, minimum 6s. Box Numbers: 6 words, plus 1s. TERMS: Cash with order. All copy and payments to be sent direct to Advertisement Managers, Parrs Advertising Ltd., 121 Kingsway, London, W.C.2, by the 30th of the month for following month's issue.

Advertisers and buyers are reminded that under Defence Regulations 1939, *Statutory Rules and Orders* 1940, *Number* 1689, *a permit (T 99 G) must be obtained before sale or purchase of certain electrical and wireless apparatus, particularly such valves and apparatus as are applicable to wireless transmission.*

ALL KINDS OF PRINT.—Send your enquiries to G6MN, Castlemount, Worksop.

ALL following new—perfect.—Mallory VP551, 6v Vibrapack, £5. Special HRO Vibrapack (6v), £10. Rotary converter (12v), 500v 100 m/a output, £12. McElroy loudspeaker practice oscillator (minus one tube), £5. Weston 301 flush meters 0–20, 0–200 m/a, £3 10s. each. 0–16, 0–500 D.C. moving-coil voltmeters flush, £4 each. McElroy heavy "Bug" Key (unused), 75s., perfect. Numerous real quality items: Valves, chokes, transformers, condensers, relays, coils, resistors, headphones, chassis, cabinets, rack panels; much unused beautiful stuff, positively no junk. State wants. Stamps please.—Box 314, PARRS, 121 Kingsway, London, W.C.2.

BULLETINS for sale.—October, 1935, to January, 1944, 94 numbers.—Offers to G5VG, 13 Alder Road, Glasgow, S.3.

FOR SALE.—Meters, two only 0–1 m/a.—L. W. MANT, A.M.Inst.B.E., 28 Welbourne Road, Broadgreen, Liverpool, 16.

HARDWOOD photo frames, double glass. Postcard size 5s. 6d. Others made to your own requirements. Prices moderate. Inquiries invited.—CORBETT FORD, 2DWW, John Street, Dunoon, Argyll.

MONOMARK service.—Permanent London address. Letters redirected. Confidential. 5s. p.a. Royal patronage. Key tag 9d.—Write BM/MONO7A, W.C.1.

SALE.—A.C., S.W. Converter, 12–80 metres, also motor generator, input 100v D.C., output 230v A.C.—Offers, Stockburn, 40 Netherburn Road, Sunderland.

SALE.—Excellent 2-valve short-wave receiver, with valves and coils, 65s.—Box 302, PARRS, 121 Kingsway, London, W.C.2.

SALE.—Harley pick-up, requires rubbers, 15s. Double spring gramophone motor, 10s. Single spring, 5s. Three ancient Cosmos 6 volt triodes, never used, 10s. three—Box 304, PARRS, 121 Kingsway, London, W.C.2.

SALE.—KTW63, N65, KTW63, DH63, KT63, U50, £3, unused. Prefer arrange swap 0–1 to 0–5mA, 2–2½ in. movement.—CLARK, 27 Pemberton Road, E. Molesey, Surrey.

SALE.—Taylormeter 425, 0–1 5mA (4½ in. square), unused, makers carton. Rothermel brush crystal pick-up.—Offers, REED, 15 Leyland Road, Southport, Lancs.

SALE.—2v SW Superhet, QST February, 1941, plus diode NL, OP Pentode, AC/DC mains, one set coils, requires 6K8 and rect., good parts in cabinet with 4 in. PM speaker. Baby Universal Avo, no scale. Offers. Wireless World quality amplifier, requires one PX4 and rect. and rewiring, best offer over £6. Wanted: Slide rules P.I.C. Faber, etc., all sizes, will buy or exchange for parts—S.M. dials, etc. State wants.—S.A.E. to F. J. FORBES, 78 West Hill, East Grinstead, Sussex.

SPECIAL Colonial model Eddystone 4-valve Battery Receiver, cast aluminium 3-section case, 12½–2,000 metres, cost £28 pre-war, £20. Majestic model 160, 9-valve Radiogram chassis, complete all valves, 12 in. auditorium speaker, £20. Special 3-valve T.R.F. receiver (by N. E. Read, G6US) Hivac S/W valves, in super portable cabinet, 1·7 to 28 Mc/s, £15. Majestic "Colotura" 12 in. auditorium speaker, £7 10s. E.D.C. rotary converter, input 220/250 D.C., output 230v 50cy, 3 KVA, barely used, £35.—Box 303, PARRS, 121 Kingsway, London, W.C.2.

SPRING clean.—One each K8, Q7, 6U7, AC/TP, AC/HLDD, all new, 9s. 6d. each. Two R.C.A. 955, one each 954, 956, 30s. each. Three ·000015 variable ceramic insulation, 3s. each. Two 8 + 8 electrolytics 450v working, 8s. each.—Box 319, PARRS, 121 Kingsway, London, W.C.2.

URGENTLY required.—AC/DC radio receiver (for 240v D.C.) output 2½ watts or over.—Offers to 11a Welwyn Close, Intake, Sheffield.

WANTED.—Avodaptor valve tester for 4, 5, and 7 pins.—BIRD, 79 High Street, Hadley, Wellington, Salop.

WANTED.—Coils for National short-wave 3-valve receiver, but not band spread amateur coils. Particularly required, coils Nos. 18, 19, 20.—LAVIN, Old House, Sonning, Reading.

WANTED.—Eddystone coils 6BB, 6B, 6Y, 6R, Dial cat 1097 or 1099, knobs cat 1089 or 1086, coil holder cat 969.—WHITEHOUSE, 12 Abbey View Road, St. Albans.

WANTED.—Eddystone type 1034 cabinet, also type 1070 dual-speed dial, or similar.—THOMSON, 37 Lansdale Road, Peterhead, Aberdeen.

WANTED.—Either Hallicrafters SX.32, SX.28 or National H.R.O. with matched speaker, in good condition. State price.—Box 311, PARRS, 121 Kingsway, London, W.C.2.

WANTED.—Transformers 500–0–500 250 m/a, 400–0–400 200 m/a. 6·3v 3–6 amp. 1,000–0–1000 300 m/a. 2·5v 10 amp. 5v 10 amp. Thordarson driver T84, D59, also Shure crystal mike.—WILLIAMS, 101 Bush Street, Pembroke Dock, Wales.

(*Continued at bottom of previous column.*)

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