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THE MARCONI COMPANY AND TELEVISION RESEARCH

The public demonstration of television by radio from Chelmsford, and reception at York, which was given by the Marconi Co., from August 31st to September 7th, 1932, during the Meeting at York of the British Association for the advancement of Science, has served to advertise widely the fact, that, as the result of two years of intensive work, the Marconi Co. has now reached the stage at which its television research and development has succeeded in producing reliable television apparatus of a distinctive character, that can give a performance within the present limitations of the art not excelled by apparatus of any other make.

THE policy of the Marconi Co. in regard to television and its immediate programme of work in this new line of investigation are briefly outlined as follows :—

(1) To investigate the merits and possibilities of the various systems of television now in use, and devise new and better methods when found feasible.

(2) To discover and develop applications of television to commercial use.

(3) In the entertainment field to develop all the equipment necessary for use in the broadcast studio, in the home, in the open, and in the theatre.

(4) To conduct research on television transmission problems including the correction of the essential line networks for frequency cut-off and attenuation, and investigations for eliminating interference and distortion caused by fading and multiple image effects when these signals are propagated through the ether.

In the development of the art of communications, the research engineer cannot afford to ignore the possibilities latent in any new method of conveying intelligence, The various electrical means provided by the telegraph, the telephone, wireless telegraphy, wireless telephony, facsimile telegraphy, picture telegraphy, have each been pressed into this common service and they have each found their particular groove in which to function to the best advantage and dovetail into the scheme of the communications services.

In recent years there has been an increasing demand for the aural signal to be replaced by a visual signal in reception ; much research has also been devoted to the improvement of the transmission of photographic pictures, and now we have reached the stage where, by the aid of television, the motion of a subject at a distance can be observed, and this instrument must also be placed at the service of communications, its sphere of economic utility being determined as its technique develops.

The application of television to the transmission of messages and news will therefore, be carefully investigated and there are other commercial, marine and technical applications of television which involve the viewing at a distance of some movement of an object at the moment it occurs.

It will be the policy of the Marconi Company also to develop television apparatus suitable for entertainment purposes.

The standard radio broadcast transmitter is designed to work on a given wavelength within a limited range of adjustment, and the signal transmitted occupies a certain frequency band on either side of the carrier frequency. The television signal occupies a very wide frequency band, the actual width depending on the amount of detail given by the picture and its area. A simple form of picture may not require a wider frequency band than $\pm$ 10 kcs. A picture with a reasonable amount of detail comparable with a cinematograph film of a simple subject may require a frequency band width of $\pm$ 250 kcs.

If the radio broadcast transmitter is to be used on a television channel of wide frequency band it will require to be specially constructed. The television scanning apparatus for use in the studio ; the line amplifier which takes the output from the photo-cell amplifier in the studio and passes it on to the modulating system of the radio transmitter, must give a straight line response to all the frequencies utilised. This apparatus will involve several designs, as some broadcast authorities will contemplate installing plant suitable for a simple picture only, which will utilise a frequency band not greater than that employed for good quality broadcasting, whereas other authorities may prefer to devote a wider frequency channel to television transmissions in order to transmit a picture of greater detail.

Of two such television radio transmitters recently constructed by the Marconi Company one was capable of being modulated with frequencies up to 16 kcs. on 760 metres and the other up to 250 kcs. on 6.8 metres.

The broadcast television receiver question will receive special treatment. Although the Marconi Company does not manufacture broadcast receivers, it is interested in their development, and in the issue of licences to manufacture receivers based on the Company's patents, and this applies equally to the broadcast television receiver. The apparatus involved comprises a radio part and an optical part, which may be constructed as independent units or combined as one instrument.

Television as an adjunct to any communications system imposes many exacting requirements on the transmitting and receiving apparatus, whether line or radio, associated with it, and in consequence the characteristics of the channel which conveys the television signals, the characteristics of the line, of the amplifiers and associated apparatus, require to be investigated. But the behaviour of the Heaviside layer to these very high frequency signals provides still another field for research. It is known, for instance, that facsimile telegraphy and picture telegraphy when operated on a short wave radio channel are distorted by multiple image effects. It is to be expected that such distortion effects will be present with television. But whether they will have a sufficiently serious effect to prevent intelligible pictures being received, cannot be decided without actual test.

The Marconi Company has been carrying out tests of this nature over the greatest distances—from Chelmsford to Sydney, Australia, on 25 metres in one case—and is accumulating data from its other transmissions which will be useful in arriving at a decision.

The programme of television research and development on which the Marconi Company is at present engaged includes the following items :—

(1) The construction of radio transmitters suitable for television modulation of any frequency band width desired by our customers. As already mentioned, we have been successful in designing an ultra short wave transmitter suitable for a 250 kilocycle band modulation.

(2) The construction of high gain line amplifiers for use with these television transmitters, or as independent instruments.
An experimental model suitable for a frequency band of 10 to 150 kilocycles has been completed.

(3) A television transmitter which scans a head and shoulders or full length subject by means of a light beam and Nipkow disc, producing a 30-line picture, the transmission frequencies occupying a band width of 13 kilocycles. This has been completed.

(4) A television transmitter which scans a head and shoulders or full

length subject by means of a light beam and Nipkow disc, producing a 50-line picture, the transmission frequencies occupying a band width of 18 kilocycles. This has been complted.

(5) A television transmitter which scans a head and shoulders or full length subject by means of a light beam, a lens drum and mirror wheel combination producing a 50 line picture, the transmission frequencies occupying a band width of 18 kilocycles. This is under construction.

(6) A television transmitter which can scan a group of people by means of a light beam, a lens drum and mirror combination producing a 100-line picture, the transmission frequencies occupying a band width of 75 kilocycles. This is under construction.

(7) A television " News " transmitter designed to scan a message on a travelling tape, by means of a light beam and apertured drum, the beam travelling across the tape in 15 parallel lines and with 20 pictures per second, involving a frequency band of 18 kilocycles. This has been completed.

(8) A television " News " transmitter similar to the above, but employing a lens drum for scanning. This has been completed.

(9) Radio receiver for television on broadcast wavelengths.

(10) Radio receiver for television on short waves.

(11) Television optical receiver for 30-line picture, 7 in. by $3\frac{1}{2}$ in., using crater neon glow discharge tube and mirror wheel.

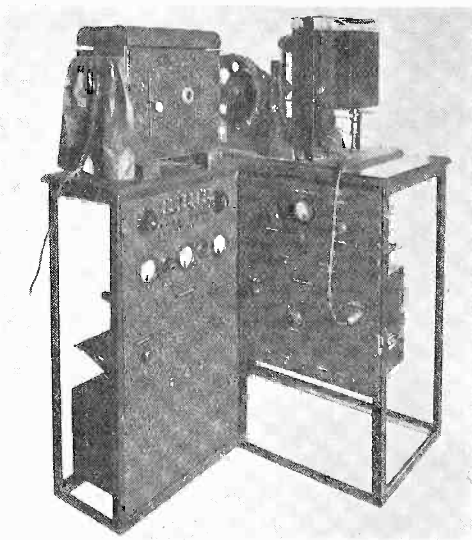
(12) Television optical receiver for 50-line picture 8 in. by 8 in., using sodium vapour tube and mirror wheel.

(13) Television optical reciever for 50-line picture for large screen projection, 4 ft. by 4 ft., using Kerr cell and mirror wheel.

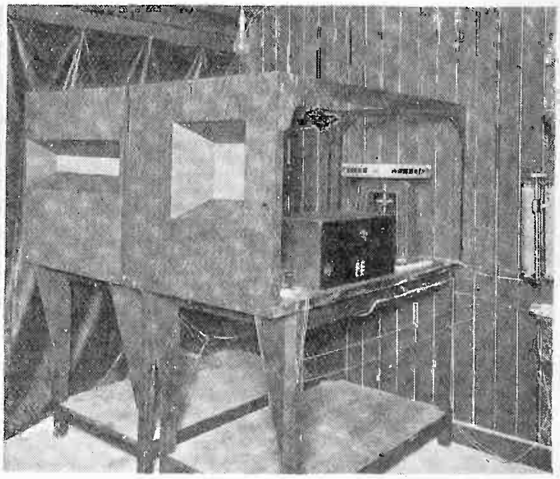
(14) Television optical receiver for 100-line picture lens drum mirror wheel, now under test.

The extent of the activities of the Marconi Company in this field of television research as described above, is an indication of our belief that this new means of conveying intelligence is likely in time to become as essential to the general scheme of commercial and entertainment communications as is telephony to-day, and every effort is, therefore, being made by the Company's research engineers to improve the performance obtainable so that this desirable end will be achieved at no very distant date.

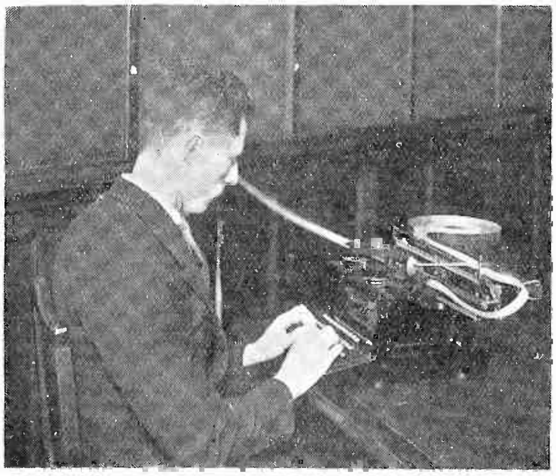
MARCONI TELEVISION EQUIPMENT.



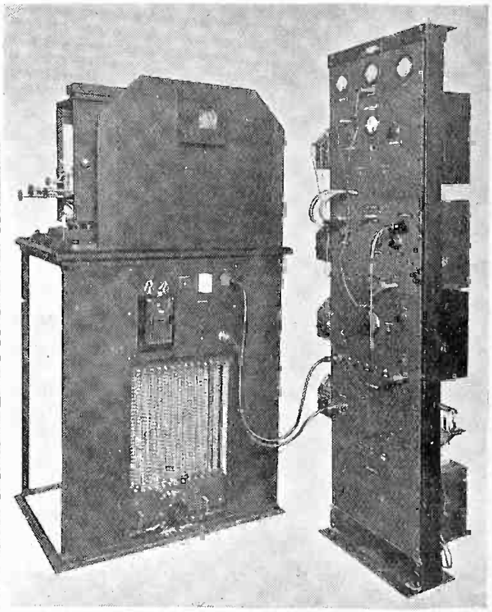
Marconi 15-line Television "News" Transmitter.



Sodium Tube projection receivers used for "News" and Broadcast television reception.



Special Typewriter employed in conjunction with "News" Transmitter.



Marconi 50-line Broadcast Television Transmitter.

MARCONI TELEVISION

DEMONSTRATION AT YORK MEETING OF THE BRITISH ASSOCIATION

THE system of television by wireless developed by the research engineers of the Marconi Company was publicly demonstrated for the first time during the meeting of the British Association—one of the oldest and most authoritative scientific societies in the world—at York, between August 31st and September 7th.

Television images were successfully transmitted by wireless from the Marconi Works, Chelmsford, to St. Peter's School, York, a distance of 180 miles.

The wireless demonstration took the form of sending verbal messages from characters printed on a moving tape which was passed through the transmitter at Chelmsford at speeds corresponding to 60 words per minute and upwards, the words being read like a moving sign on a long ground glass screen in the receiver at York. In order to show the transmitting equipment at work, local demonstrations illustrating the complete process of transmitting and receiving both verbal messages and head and shoulders pictures were also given at St. Peter's School.

The Receiving Equipment.

Two different types of television receivers were installed at York, and were inspected with great interest by many of the eminent scientists attending the British Association meeting. These were the 15-line "news" receiver and the 50-line "broadcast" receiver.

The first type, which was used—in conjunction with a simple type of radio receiver designed to have a very broad frequency response curve—for the reception of messages from Chelmsford, gives 20 pictures per second on a ground glass screen 25 in. by 3 in.

Its design incorporates a sodium tube of the dumb-bell type mounted close to an aperture, the modulated light being projected on to the screen by means of a mirror wheel driven by a synchronous motor and giving a horizontal scan, with 20 pictures per second.

The 50-line "broadcast" receiver is of a type that would be suitable for the home reception of television entertainment programmes and is designed to reproduce either full length or head and shoulders pictures transmitted from the Marconi 50-line "broadcast" transmitter. Apart from the increased detail in the scanning, necessary for this class of television, it is similar in its main features to the "news" receiver, but it gives 15 pictures per second on a ground glass screen 8 in. square.

The Transmitting Equipment.

The two types of Marconi television transmitters employed for the demonstration were the " news " 15-line transmitter and the " broadcast " 50-line transmitter.

The "news" 15-line transmitter is designed to modulate any high-class radio transmitter in such a way that images and characters printed on a semi-transparent tape can be received by a suitable receiver. Characters printed in a single line on a tape are passed through the transmitter in a continuous line at speeds which may correspond at from 60-120 five letter words per minute, the resultant image at the receiver consisting of a series of letters moving from right to left across a screen.

The frequency band occupied by transmissions of this nature can be made narrower than that needed for transmission of head and shoulder images, and in the case of the successful demonstrations between Chelmsford and York, was in fact very little wider than that necessary for good telephonic transmission.

The Marconi television " broadcast " 50-line transmitter, which was in operation at York for local demonstration, has been designed to enable head and shoulders or full length images to be transmitted at the rate of 15 per second from any high-class broadcasting transmitter.

Among its interesting features—in addition to the scanning apparatus, photo-electric cell, and amplifying system—are circuits for maintaining at constant speed a motor driven scanning disc, for generating synchronising impulses which are passed to the receiver and there synchronise the receiver motor with the transmitter motor, and for " monitoring " the transmitted picture by checking the type of image that is being transmitted.

PORTABLE UNMODULATED RADIO FREQUENCY GENERATOR AND ATTENUATOR

Present day standards of radio receiver performance have made necessary the design and development of special apparatus for the accurate measurement of the various characteristics of high frequency circuits. The Marconi Company have designed the instrument described below for this purpose.

As its name implies it consists of a Radio Frequency Generator and Radio Frequency Attenuator and in addition it is provided with a dummy aerial or alternatively any suitable form of external transfer circuit may be coupled to the instrument.

The instrument enables absolute control of known radio frequency output voltages down to a fraction of a micro-volt. It provides a ready means of measuring the sensitivity and selectivity or band width characteristics of a receiver. The methods of obtaining these data together with the means adopted to ensure complete screening calibration and etc. are described in this article.

THE measurement of the performance characteristics of radio receivers is necessary for the maintenance of high standards of production. Means are necessary for periodically checking the performance of receivers that are in constant use, also faulty circuits which may have deteriorated in performance can be quickly located. The Marconi Company employ the Radio Frequency Generator and Attenuator in their Research, Development and Testing Departments.

In setting out on the design of the instrument the main features aimed at were :—

1. Efficient screening on all frequencies.
2. Reasonable physical dimensions and weight of the complete instrument.
3. Limits of maximum and minimum output.
4. The smallest possible variation of performance with frequency.
5. Adaptability to the various types of receiver input conditions.

General.

The equipment is developed on similar lines to that adopted in the attenuator of the Marconi Portable Field Strength Measuring Apparatus, and is illustrated in Fig. 1. The Radio Frequency Generator is contained within a copper and brass screening case, the top and front of which are double screened to ensure the prevention of leakage through the covers and the control shaft bearings. The low and high tension supply batteries are contained within the screening case.

Similar precautions against leakage are taken in the attenuator unit, all covers of which are duplicated. In addition all control shafts have special spring bearing bushes at each point of intersection with screening walls to ensure that no leakage occurs at these points. The screening has been subjected to very severe tests in the following way. The instrument was set up near to and tuned to the mid-band frequency of a high gain commercial receiver. The first test was carried out on a frequency of 10,000 kc. (30 metres) and with the R.F. Generator and Attenuator completely closed and the receiver in its most sensitive condition no trace of the Generator signal could be detected. A tuned search coil was then attached to the receiver input in place of the vertical aerial and search was made to ascertain possible points of leakage on the instrument. Under these conditions a small trace of leakage from one of the covers could be detected, but the amount was so small, far below receiver noise, that it could only be detected by a change in the character of the set noise or by switching the generator on and off. The Attenuator was afterwards attached to the receiver in the normal way and an aural balance of the leakage signal made. The results proved the leakage figure to be less than ·25 micro-volt.

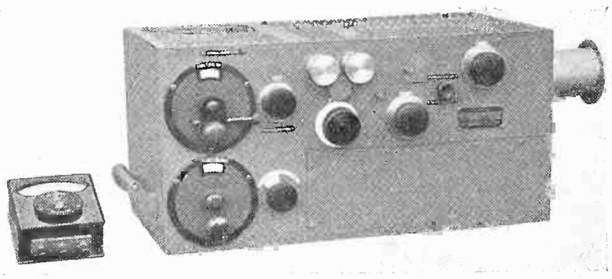


FIG. 1.

A long wave test was made as follows :—

The instrument was set up on a wavelength of 1,000 metres within a foot of the aerial of a field strength measuring set which is capable of measuring and recording on a meter at its output field strengths of 2 micro-volts per metre. No trace of leakage from the R.F. Generator and Attenuator could be detected. The frame aerial was afterwards placed within half an inch of the lid of the R.F. Generator Compartment. With this arrangement a small trace of leakage was discernible in the receiver telephones, but it was quite insufficient to cause the slightest movement on the recording meter. It is therefore estimated that the leakage on this wavelength is something considerably less than 0·5 micro-volt. For all practical purposes, however, it may be considered as entirely leakage proof on all frequencies, for no trace of leakage is detectable even on the most sensitive commercial receivers when the R.F. Generator and the receiver are set up for normal working.

For the prevention of "jump over" efficient screening of the internal parts of the apparatus is as necessary as the external screening and ample precautions have been taken in this respect by the aid of partition screens between circuits and tubular screens* carrying the resistance elements.

The method of screening the attenuator resistance network is shown in Fig. 2.

The final output of the attenuator is provided with a special type of potentiometer for intermediate control between the attenuator stages. Here again the resistances are carried in tubes, 9 in number, mounted in the form of a cylinder with suitable selecting switches, slip rings and studs. This unit passes the signal either on to a dummy aerial and thence to the output terminal or direct to the output terminal as desired.

* "Short Wave Signal Measuring Apparatus," by T. L. Eckersley, "The Marconi Review," No. 12, September, 1930.

In designing the apparatus efforts have been made to preserve as great a measure of accessibility as possible to the various parts of the circuits. This has to a great extent been achieved in spite of the limitations of size and weight imposed by the need for portability, and the necessity for effective screening between the different circuits.

The complete instrument can be carried by one person. The physical dimensions are tabulated below :—

Weight (ready for use),	80 lbs.
Length,	21 in.
Width (back to front),	$10\frac{3}{4}$ in.
Depth,	10 in.

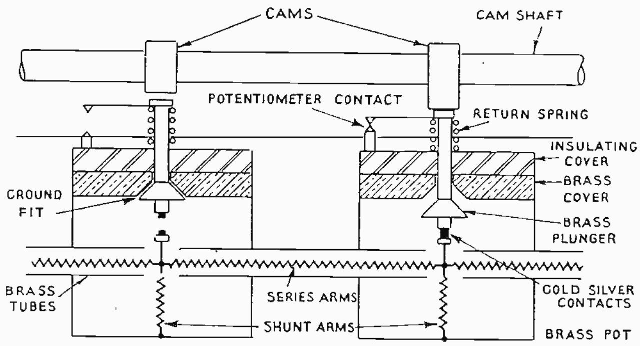


FIG. 2.

Equipment.

1 P.215 Valve.
1 Type D.Y.4 Exide 2 volt accumulator.
1 120 volt H.T. Battery of any make, capable of 10 m/a drain and not exceeding the following dimensions :—Length, $12\frac{1}{2}$ in., width, $10\frac{1}{4}$ in., depth, $3\frac{5}{8}$ in.
1 25 m/a Elliot Thermo-couple.
1 50 m/a ,, ,,
1 Type " I " Cambridge unipivot galvanometer.
7 Range Blocks (for full frequency range).

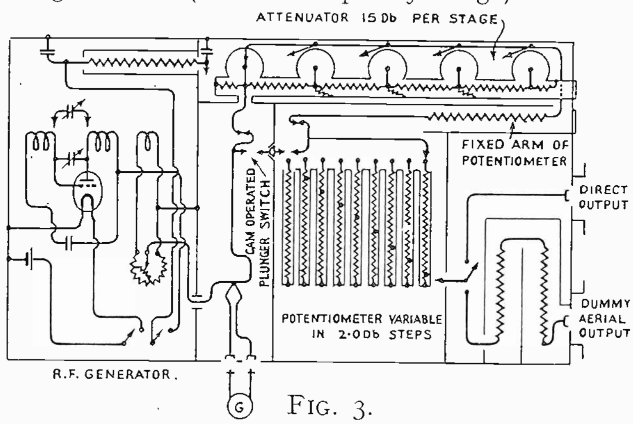


FIG. 3.

Schematic diagrams of the equipment are given in Figs. 3 and 4.

Technical Description. The Radio Frequency Generator.

The generator circuit is illustrated in Fig. 2.

The complete wave range is covered by 7 interchangeable range blocks and two tuning capacities of ·00025 mfd. to ·0014 mfd. respectively. The smaller capacity only is in circuit up to 300 metres and both are in circuit above 300 metres. The tuning condenser switching is accomplished automatically with the change of range blocks. The smaller condenser scale is provided with a very high ratio

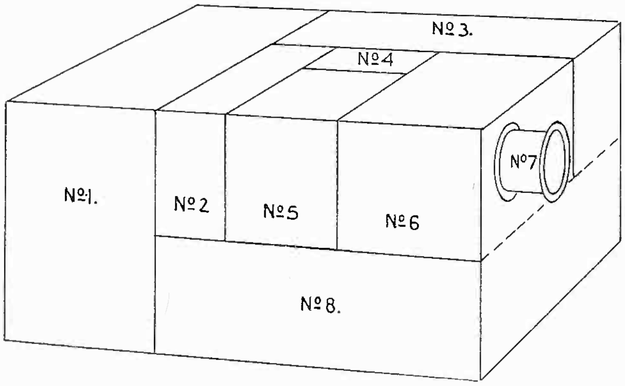


FIG. 4.

No. 1 Radio Frequency Generator.
No. 2 Thermo Couple and control switch.
No. 3 Radio Frequency Attenuator.
No. 4 Radio Frequency input end output potentiometers.
No. 5 Radio Frequency output end output potentiometers.
No. 6 Dummy aerial and Direct output lead.
No. 7 Screening tube for output lead.
No. 8 R.F. Generator H.T. Battery.

reduction gear to give the necessary vernier adjustments on the short wave band and also to enable small definite frequency changes to be made when performing selectivity tests.

The R.F. Generator output is obtained from a fixed coupling coil contained in each inductance block and controlled by a potentiometer, the latter being provided with a vernier adjustment. The current entering the attenuator is measured by means of a thermo-couple and plug-in galvanometer.

The R.F. Generator L.T. battery is housed in the Generator compartment and the separately screened H.T. battery is fed into the Generator compartment through a resistance capacity filter circuit, when employing high output levels an external H.T. battery can be used.

The Attenuator.

Fig. 5 gives the construction of the attenuator and potentiometer, all the resistance elements of which are of No. 47 Eureka resistance wire. The resistance valves are adjusted to within $\pm$ 2 per cent. of the theoretical values.

The Attenuator as is seen from the diagram, is of the π network form. All the resistances are of straight wire centrally disposed inside brass tubes. This method of mounting the resistance eliminates the possibility of high frequency "jump over." To facilitate mounting, adjustment and withdrawal the resistances are mounted on brass chassis which in turn slide into the main screening tube. When the soldered connections in each pot are released the complete attenuator can be withdrawn through the end of the screening tube. Although the attenuator is controlled by a slightly different method from that used in the Marconi Field Strength Measuring Equipment, from theoretical considerations it is essentially the same. See "Short Wave Signal Measuring Apparatus," by T. L. Eckersley in The Marconi Review of 1929, in which the essential features are explained.

The instrument is calibrated in decibels, the total attenuation in the attenuator proper being 60 decibels, controlled in 4 stages of 15 db. Mechanically the variations are controlled by a cam shaft selector switch and a special type of contact plunger. (See Fig. 2). Any plunger being depressed by the cam automatically becomes insulated from the "earth" casing and makes contact through two pairs of gold-silver contact faces one pair with the attenuator line and the other pair with a conductor which carries the signal to the output potentiometer. All plungers in the "off" position are held, by the action of the return springs, in position against the lids of the "Pots," thus completely closing and forming part of the screen.

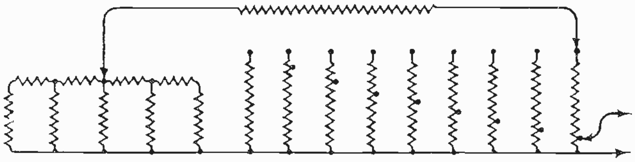


Fig. 5.

The surge-impedance of the network looked at from the input end is approximately 4 ohms. Obviously it would not be correct to tap off at any point along the attenuator with an impedance that is comparable with its surge impedance. Actually it is possible to tap off through an impedance of 20 ohms without seriously misterminating the system. In this instrument, however, the tap impedance is of about 40 ohms. This total includes the variable output potentiometer impedance and its value effects a mistermination of about 4·5 per cent. for which due allowance is made in the calibration.

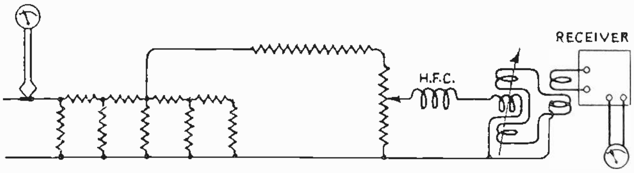


Fig. 6.

The Output Potentiometer.

The total impedance of the potentiometer as just mentioned is about 40 ohms. The maximum tap off this is 7·98 ohms and the minimum tap 1·413 ohms, with intermediate variations in 7 steps of 2 db. per step and 1 step of 1 db., making a total of 15 db. This arrangement provides variations between the 15 db. stages of the attenuator and also a direct cross check against the performance of any stage of the attenuator.

Actually when a change is made from one potentiometer tap to another, the whole 7·98 ohm portion of the potentiometer is changed, hence, as mentioned earlier, there are 9 potentiometer resistances. This construction provides precision intermediate attenuation steps and eliminates errors commonly associated with tapped potentiometers.

For the higher level outputs the main attenuator is switched out of circuit and the R.F. Generator output is fed directly through the 7·98 ohm portion of the potentiometer, the operation being accomplished by a cam and plunger switch. Output levels are detailed later.

The Dummy Aerial (applicable to wave of 14 to 100 metres).

The final output of the equipment can be either direct from the potentiometer to an output terminal or via a dummy aerial of approximately 160 ohms resistance. The dummy aerial consists of two graphite resistance rods connected in series.

The value of 160 ohms is chosen as a mean value of $\frac{1}{2}$ wave aerial resistance from values determined experimentally by T. L. Eckersley* and also by B.B.C. Engineers.†

The dummy aerial is, of course, only useful for matching the aerial conditions of receivers operating on half-wave aerials, in general wavelengths below 100 metres. For alternative aerial matching conditions see later paragraphs on transfer circuits.

The direct output is provided with the object of permitting the attenuator to be coupled to alternative artificial aerials. Types of such suitable circuits are given in another part of this article. Under these conditions it is necessary that the ratio of the impedance of the load circuit across which the attenuator output potentiometer is tapped must be high compared with the potentiometer resistance, otherwise errors will be introduced.

Ranges.

The maximum output obtainable from the instrument is 320 milli volts with 40 m/a input. Under conditions of maximum output the network as mentioned earlier is switched out of operation and the Generator output is tapped direct across the 7·98 ohm portion of the attenuator output potentiometer. The total attenuation now available will be approximately 45 db.—15 db. on the potentiometer and a further 30 db. by current variation, i.e., by a reduction of input current from 40 m/a to 1·26 m/a. With the attenuator in circuit the maximum available output (with 40 m/a input) is 31 milli volts, and the maximum instrumental attenuation available is 75 db. A further 30 db. is available by input current reduction, making 105 db. total attenuation, this corresponds to a minimum output of ·19 mcirovolts.

The frequency range of the generator is 21,400 kc. to 60 kc. (14 metres to 5,000 metres).

Performance and Calibration Checks.

As mentioned earlier, a rapid check on performance can be made by matching any particular stage on the attenuator against the full variation on the output potentiometer. For a given output; attenuation can be put in or taken out on the attenuator and compensated for on the potentiometer. The two values of variation should be equal and opposite if the instrument is performing properly. Below 100 metres the attenuator and potentiometer do not quite cross check, owing to slightly different variations with frequency. Corrections are applied for these frequency variations as will be seen later.

* T. L. Eckersley, "Radiation from a Short Wave Aerial," "The Marconi Review," No. 23, August, 1930.

† P. P. Eckersley, T. L. Eckersley and H. L. Kirke, "The Design of Transmitting Aerial and etc." Proc. I.E.E. (Wireless Section), Vol. 4, No. 2.

The method adopted for checking the instrument is as follows :—The output is coupled via a mutual coupling to a receiver, the latter being equipped with a suitable recording meter at its output. A signal is then injected into the receiver from the attenuator, the attenuator input current and the deflection of the receiver output meter being noted. A + or — 15 db. variation of the attenuator is then made and the input current increased or decreased until the receiver output meter gives the same deflection as previously. The ratio of the two input currents should then check with the alteration of attenuation. It should be noted that in adjusting the input current to the attenuator the frequency shifts slightly and the generator must therefore be retuned after any current alteration. Another method of checking is against a calibrated mutual.* This check is somewhat similar to the current check except in this case the alteration of attenuation is compensated for by mutual variation from the calibration of which the ratios can be checked. Fig. 6 shows the circuit arrangement used for both methods.

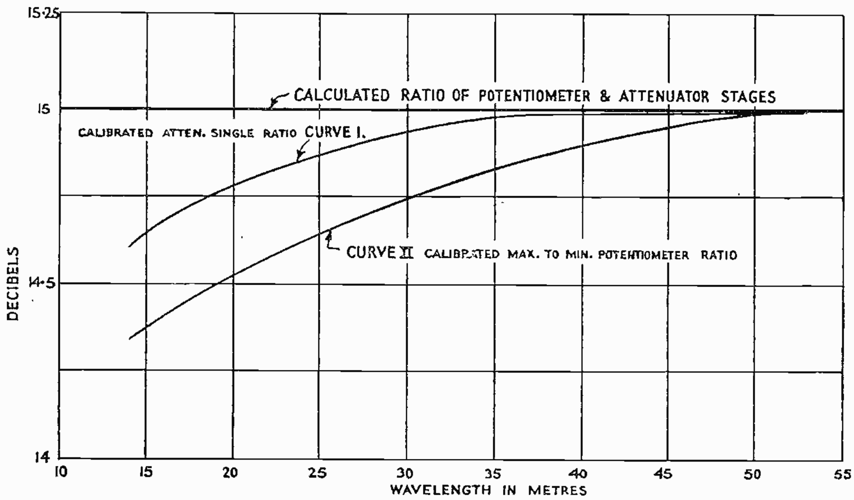


FIG. 7.

On wavelength above 50 metres the ratios check in agreement with the calculated and direct current values, and the scale markings on the instrument are a true indication of the amount of attenuation.

Below 50 metres the ratios have a frequency variation. Curves 1 and 2 give (Fig. 7 the results obtained, the values given being the average of a number of checks on each frequency, the average being struck to eliminate as far as possible experimental errors. The values given for the potentiometer apply to the ratio of maximum to minimum taps. The frequency correction of intermediate taps would be proportionately less, but as the errors would involve a correction for each tap a mean of the maximum error on each frequency is taken for the overall correction curve. The maximum error of output thus introduced is only of the order of 0·3 db. for the

* See " Short Wave Signal Measuring Apparatus, II." by T. L. Eckersley, " The Marconi Review," No. 12, September, 1929.

worst case. An overall correction curve to allow for these variations, together with two other frequency corrections of which mention will be made later, is supplied with the instrument.

It will be observed that the foregoing checks only deal with ratios and not with numerical values of output. For numerical output values the instrument is practically self checking. Consider the instrument as set up for the high level outputs. Under these conditions the R.F. Generator output current is fed directly

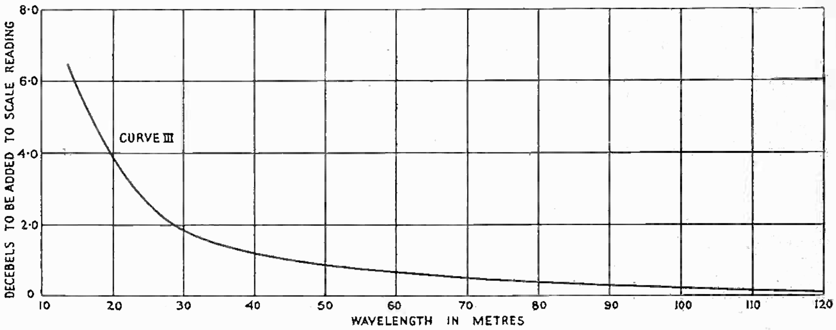


FIG. 8.

through the 7·98 ohm potentiometer resistance and the output voltage to the dummy aerial or load circuit is proportional to the R.I. drop across the potentiometer tap. See Curve 4 (Fig. 9) for Z potentiometer below 100 metres. If the output voltage is adjusted so that its value is within the overlap of the minimum obtainable on the high level output adjustment and the maximum output obtainable with the full attenuator in circuit, i.e., 2 millivolts and 20 millivolts respectively (see Ranges), a direct check of the attenuator output is obtainable. For wavelengths below 100 metres allowance must be made on the full attenuator side for the inductive drop due to connecting

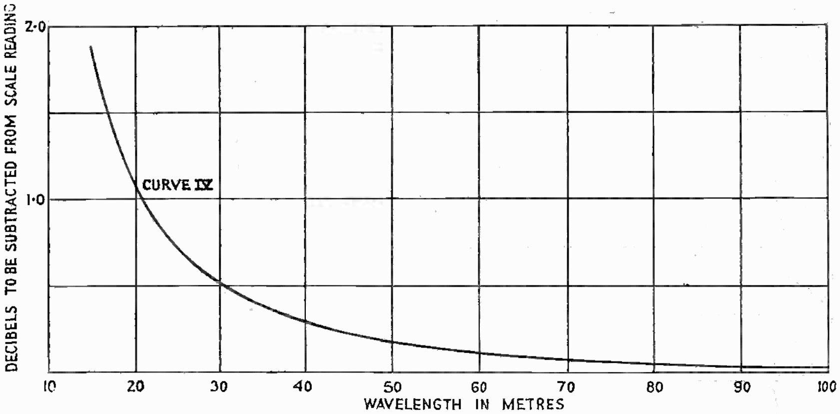


FIG. 9.

leads as well as the resistance drop across the full potentiometers. The leads have an inductance of the order of 0·55 micro-henries and this accounts for a loss of 6 db. on 15 metres and about 2 db. on 30 metres. A correction for this, which, by the way, is in the opposite direction from the current ratio corrections and tends to cancel these, is included in the overall correction curves. See Curve 3, Fig. 8. An additional of check of numerical output values was made against another R.F. Attenuator of the type used for the Field Strength Measuring Apparatus. The two instruments agreed within 0·5 db. on the worst wavelength.

There is a correction for the impedance Z of the potentiometer. For wavelengths down to 60 metres the impedance may be taken as equal to its resistance but below this wavelength the inductive drop down the resistance wire approaches the resistive drop as the frequency increases. This point is fully explained by T. L. Eckersley in THE MARCONI REVIEW, No. 12, previously referred to.

This correction is plotted in Curve 4 (Fig. 9), but its value is included in the overall correction curves supplied with the instrument.

A further final test of the instrument was carried out as follows :—

A small transmitter emitting a steady signal was set up about 1½ miles distant from a commercial superheterodyne receiver equipped with various half-wave vertical aerials. The receiver was carefully tuned and its calibrated intermediate frequency attenuator adjusted to bring the detector output down to reference level of 1 micro-volt per metre, the attenuator settings being noted. The received signal was then measured on a field strength measuring set located in the same building as the commercial receiver. An equivalent voltage to that indicated by the field strength measuring equipment was then applied via the R.F. Generator and Attenuator and dummy aerial to the receiver input terminal, care being taken to terminate the receiver correctly, the I.F. attenuation for reference level was again noted. Table No. 1 gives the results obtained which are highly satisfactory.

This series of comparisons between an 160 ohm dummy aerial and various half-wave vertical aerials suitably matched to the receiver input impedance clearly shows that for short wave receiver testing the dummy aerial is sufficiently precise and can be relied upon when testing this class of receiver. The effective height of half-wave aerials is taken as $\frac{\lambda}{\pi}$ in all cases considered.

TABLE No. 1.

Wavelength in metres.		Field strength measurement in micro v/m.	Micro-volts ejected into Receiver = x micro v/m.	Receiver I.F. Attenuation for Reference level. A = Signal on half-wave aerial. B = R.F. Gen. and Atten.
Baldock Receiver.	15	12·95	61·7	A 29·5 db. B 29·8 db.
	25	53·5	426	A 74·5 db. B 74·0 db.
	55	45·25	792	A 87·0 db. B 83·0 db.
Egyptian Receiver.	16	58·5	298	A 53 db. B 54 db.
	16	61·0	310	A 54 db. B 54 db.
	20	60·0	382	A 43 db. B 44 db.

Calculation of Voltage Output. High Level Output Adjustment.

The voltage available across the output terminals of the instrument when set up for high level outputs is :—

With the output potentiometer in the 0 db. position

$E = IR$

where E = milli-volts output.
I = input current (milliamperes).
R = 7·98 ohms.

For other settings of the potentiometer

E becomes 7·98 I—X decibels.

Lower Level Output Adjustment.

The output voltage available across the output terminals of the instrument when set up with the full attenuator in circuit is :—

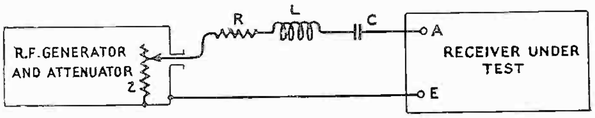


FIG. 10.

$$E = \frac{I\,Z}{K_1\,K_2\,C_1\,C_2}$$

where E = voltage in milli-volts.
I = input current (milliamperes).
Z = surge impedance of attenuator = 4·04 ohms.
C_1 = correction factor for mistermination loss = 1·044.
C_2 = constant for fixed potentiometer loss = 5·02.
K_1 = attenuator reduction factor.
K_2 = potentiometer (variable portion) reduction factor.

$$\therefore\ E = \frac{I\ 4{\cdot}04}{K_1\,K_2 \times 1{\cdot}044 \times 5{\cdot}02} = \frac{0{\cdot}77\ I}{K_1\,K_2}$$

The values K_1 K_2 expressed in decibels are clearly marked on the control scales. The total attenuation will be the sum of the scale settings.

E becomes 0·77 I—X decibels.

Practical Applications.

The fundamental principle underlying the accurate operation of the R.F. Generator and Attenuator with dummy half-wave aerial is that matched impedance conditions should prevail.

As already mentioned, the dummy aerial incorporated with the instrument may be used for matching the input conditions of receivers operating on half-wave aerials, these are usually confined to wavelengths below 100 metres.

The receiver input voltage is then derived directly from the attenuator constants, i.e.,

V = IC—X decibels.

where I = attenuator input current.
C = constant depending on which output arrangement is being used, i.e., high or low level.

By a suitable arrangement of transfer resistance values the attenuator output can be adapted to practically any type of feeder system, but the process is simplified if matched impedances are employed.

Varying types of receiver input conditions call for alternative types of transfer circuits. A few such circuits are, therefore, here suggested, but other forms will, of course, occur to the reader and may be used, provided, as mentioned before, the impedance across which the attenuator output potentiometer is tapped is high compared with 7·98 ohms or, if a lower maximum value of potentiometer is selected, by means of the potentiometer adjusting switch, a proportionately lower circuit impedance may be used. The values of the potentiometer taps are supplied with the instrument.

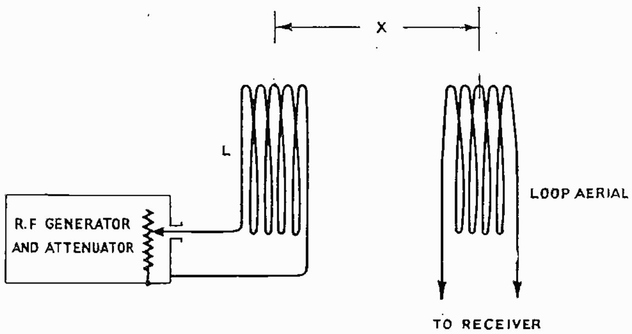


FIG. 11.

Artificial Aerial for open aerial broadcast band receiver, see Fig. 10 where :—

Z = attenuator output potentiometer.
L = 20 micro henries.
C = 0·0002 micro farad.
R + Resistance component of L = 25 ohms.

NOTE.—The Z adjustment for this circuit should be on one of the lower taps—15, 14 or 12 db. positions.

The voltage induced by this method is directly arrived at from the R.F. attenuator constants.

Receiver with Frame Aerial, see Fig. 11.

This method of transfer consists of inducing a known voltage into the frame aerial.

The voltage induced is :—

$$E = E_1 Q$$

where E = the voltage induced in the frame aerial in micro-volts.
E_1 = the field intensity in micro-volts/m at the frame aerial.
Q = the effective height of the frame aerial.

The values E_1 and Q may be calculated as follows :—

$$E_1 = \frac{18850 \quad N_1 \quad A^2 \quad I}{(A^2+X^2)^{3/2}} \text{ Cos B},$$

where N_1 = the number of turns in the coupling coil L.
A = the radius of the coupling coil in centimetres.
X = the distance in centimetres between the centres of the coupling coil and loop aerial.
B = angle, if any, between the axis of the loop aerial and the line between the coil centres,

and $I = \frac{V}{Z}$

where V = voltage in micro-volts across the output terminals of the attenuator,

and Z = the impedance of the coupling coil L,

and $Q = 2 \ N_2 \ h \text{ Sin } \frac{\pi \ fs}{300{,}000}$

where N_2 = number of turns in frame aerial
h = effective height of frame aerial in metres
S = length of frame aerial in metres
f = frequency in kilocycles.

The distance X must be large compared with the frame aerial dimensions. The frame aerial and coupling coil L must be coaxial.

Another method of testing a receiver with a frame aerial is to use the frame aerial in place of the artificial aerial in Fig. 10 and to connect the attenuator output between the low potential end of the frame aerial and the earth terminal of the receiver. The voltage induced is then directly arrived at as before, from the radio frequency attenuator constants.

NOTE ON THE FIELD INTENSITY OF THE MARCONI BROADCASTING STATION ERECTED AT WARSAW

The comprehensive field intensity survey of the signal from the 120 kw. Broadcasting Station at Warsaw, published in the last issue of THE MARCONI REVIEW, *affords material for testing the theories of transmission of the longer broadcast band of waves. The following article discusses the agreement between observed and theoretical results.*

THE conditions governing transmission from the Marconi Broadcasting Station at Warsaw appear almost ideal. The region to the North East, towards Minsk, is practically dead flat, and from the internal evidence of the signal contours is uniform in earth resistance characteristics.

The usually accepted theory of broadcast daylight transmission is that due to Sommerfeld, who has investigated, theoretically, the propagation of waves over a semi-conducting plane surface. The effect of the ground resistivity is to waste the energy of the waves, and so give rise to an attenuation which increases rapidly as the wavelength decreases. The theory gives quite a satisfactory account of the characteristics of the shorter waves, 200 to 500 m. over fairly short ranges, say, up to 300 km. But at the longer ranges fed by high power long wave stations such as Warsaw, the ideal case of a flat plane no longer represents the facts with sufficient accuracy, and the effect of the earth's curvature has to be taken into account.

The effect of this curvature is the more marked on the longer wavelengths, 1,000 m. upwards, since in this range the ground attenuation alone is small, and diffraction becomes the dominant factor.

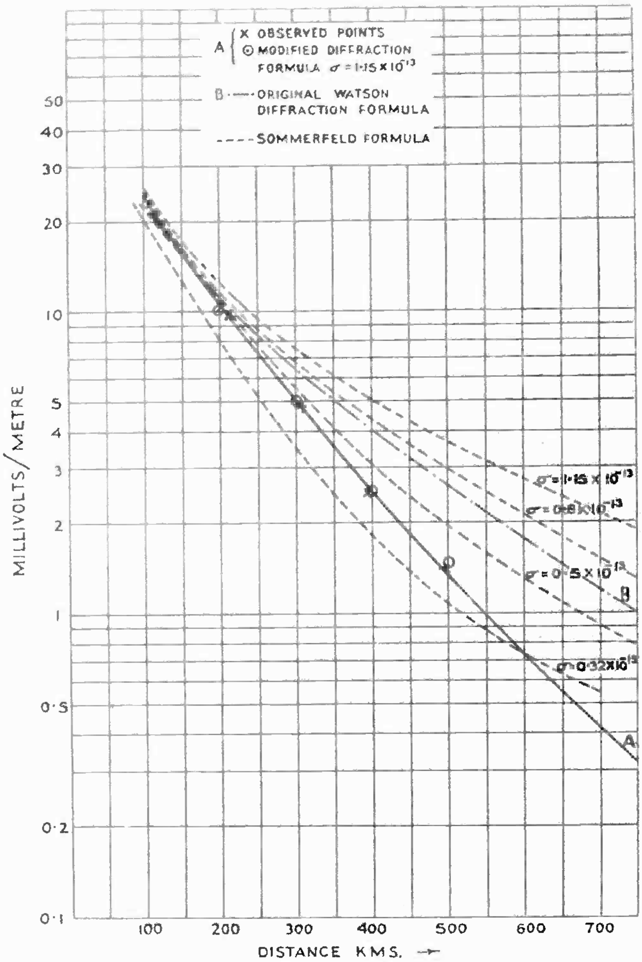
The diffraction of waves round a conducting sphere has been investigated theoretically by many mathematicians, Macdonald, Poincaré, Nicholson, Lowe, and, notably, G. N. Watson, who in 1919 gave a theory of this diffraction which later was put in an explicit form by Van der Pol.

$$E = \frac{0{\cdot}5365}{(\sin\theta)^{1/2}} \frac{hI}{\lambda^{7/6}} \operatorname{Exp}\left(\frac{-2390}{\lambda^{1/3}}\right)$$

In deriving this result, Watson considered wavelengths rather longer than that of Warsaw. It followed consequently that the effective earth attenuation was so low in his case that the diffracted intensity was practically independent of the resistivity so long as this conductivity was $=$ or $> 10^{-13}$ C.G.S. units.

Watson's results cannot be applied without modification to the waves in the longer broadcast band, where the diffracted field intensity is no longer only a function of the power radiated and wavelength, but depends also on the earth's conductivity.

That such is the case in practice can be seen from the actual signal contours reproduced in the case of Warsaw, which would be circles centred on the transmitter were it not for the effect of the non-uniformity of the ground contours and characteristics.



WARSAW λ 1400 M 100 K.W RADIATED

The modifications to Watson's formula occasioned by the effect of ground resistivity was investigated by the writer,* who derived an exponential attenuation factor which is a function of the earth conductivity as well as of the wavelength, and which reduces to Watson's form when the wavelength or conductivity is sufficiently great.

In figure 1, the field intensity derived from the contours is plotted as a function

* Proc. Roy. Soc. A Vol. 136, 1932, p. 499, particularly pp. 518 et seq.

of the distance along a line N.E. from Warsaw towards Minsk. The crosses represent the observed points.

For comparison, the theoretical diffraction curve for $\sigma = 1.1410^{-13}$, λ 1400 is plotted, and the points are represented by the circles. The agreement is remarkably close, and affords a good check on the diffraction formula. A family of the Sommerfeld curves with different values of σ is also plotted. It will be seen that it is impossible to choose a value of σ to make the observed and theoretical Sommerfeld values fit. The curves are the wrong shape. Thus, if σ is chosen so that the two curves fit at 100 km. distance, the calculated value is considerably too high at 600 km.; on the other hand, if σ is chosen so as to give the observed value at 600 km., the calculated value is too low at 100 km. This discrepancy becomes more and more apparent the greater the distance. Measurements of the field intensity of the Warsaw station (in the daytime) have been made at Broomfield, near Chelmsford, England. The field intensity is not quite steady even in the daytime, so that there must be a small component of reflected energy, but by averaging over a large number of observations, this component should be eliminated —at least to the first approximation—and we get a value for the surface ray which may perhaps be a slight over-estimate. This value is 40μ v/m., and the distance is 1,400 km. If we extend the theoretical curve A to this distance the calculated diffraction value with $\sigma = 1.14 \times 10^{-13}$ should be 15μ v/m., which is rather too small. The path from Warsaw to Chelmsford includes 200 km. of sea, so that the observed value should lie above the calculated, also the observed value may be over-estimated on account of incomplete elimination of the reflected ray. The observed point in any case lies much nearer the diffraction value than the Sommerfeld value, which for $\sigma = 10^{-13}$, is of the order 500 v/m.

The curve B represents the unmodified Watson diffraction formula, which represents the case of perfect conductivity.

This gives values considerably too high at great distances, and to obtain a satisfactory account of the actual results we have to take account of the resistance correction to the diffraction formula.

The measurements made by Kirke of the B.B.C. on 5XX afford a further check on this modified diffraction formula. These results are published in the paper already referred to, and, although the observed points are more scattered, probably on account of the irregularity of the terrain over which the measurements were made, there can be no doubt that the modified diffraction formula with $\sigma = 10^{-13}$ fits the facts much better than the Sommerfeld formula, or even the unmodified diffraction formula.

The results discussed here support the view that diffraction is the controlling factor in long distance long wave (100 to 2,000 m.) daylight broadcasting.

T. L. Eckersley.

POINT TO POINT RADIO TELEGRAPHY

PRESENT POSITION AND POSSIBLE FUTURE DEVELOPMENT

The following article is part of Paper No. 11—Section IX, submitted to the Congress International d'electricite de 1932—Paris, by N. Wells, M.Sc., of Marconi's Wireless Telegraph Co., Ltd. The whole paper is divided under six headings, these being :—

(1) *History and early development.*
(2) *Valves, wavelengths and modern developments.*
(3) *Short Waves.*
(4) *Traffic and allied subjects.*
(5) *Time Signals and allied services.*
(6) *Present position and possible future development, Beam Aerials. Diversity Reception and Transmission, Facsimile, etc.*

Only the last section is given below, the first five detailing the historical growth of the art of wireless telegraphy, the revolutionary changes inspired by the advent of short wave radio communication, and the utilisation of wireless communication for the international standardization of time.

Anti-Fading Methods.

IN a previous section dealing with short waves it has been mentioned that the radio energy may take various paths, according to the degree of ionisation in the upper layers of terrestrial space, further the path is seldom through uniform conditions of light or darkness ; it follows that at the target, in other words the receiving aerial, there will be varying deflection and fringe effects—moreover, in addition to the energy arriving through the main stream, there will be side paths terminating at the target and giving rise to auxiliary signals that lag or lead on the main signals.

These effects constitute a serious form of fading and distortion, but with regard to the former the most common form of fading is found to occur at intervals separated by only a few wavelengths, and full advantage has been taken of this fact—notably in the conspicuously successful work of H. H. Beverage—by erecting receiving aerials spaced some ten wavelengths apart and combining the results to obtain a good average level of received signal strength. The methods employed are simple and have largely contributed to the degree of reliability that is possible with modern high speed equipments.

The problem may also be approached from the transmitting end, by Tone Modulating the continuous waves at the transmitter in such a way that the emission is split into, preferably, three channels separated by frequencies of two or three hundred cycles ; thus if one or two channels suffer fading the others, or the other, arrives at normal energy level. Though perhaps not as efficient as Diversity Reception, this method is of considerable value when correctly applied. In practice a combination of Diversity Reception and Tone Moodulated Transmission gives the most satisfactory results.

Anti-Distortion and Anti-Atmospheric Methods.

It has been found that high short-wave receiving aerials, by narrowing the width of the total effective angle of incidence in the vertical field, form one of the surest safeguards against that insiduous form of distortion due to secondary signal paths arriving at high angles. Also it must be obvious that Beams and other forms of directive antennæ, by narrowing the angle of reception in the horizontal field, greatly reduce the effect of atmospherics and extraneous noises.

Beam Aerials.

By converging the transmitted or received energy into comparatively narrow streams of emission or incidence a great degree of concentration is obtained, resulting in such signal strengths that the short wave services became in many cases equal or superior to cable services. There is another feature of interest connected with a Beam Aerial of appreciable height and width, namely that it acts as a tank or integrator during certain classes of fading, a feature which has added in some measure to its success.

Echo.

Space scarcely permits discussion of secondary and echo effects, that is, of signals which travel past the receiving station, round the earth and impinge as a secondary, or even a terciary, etc., at intervals of about one seventh of a second. Again there are signals which arrive from the opposite direction, and finally signals which travel away into space, to reach the receiver at various periods of time lag, amounting occasionally to several seconds. The practical outcome is that it is useful to employ an efficient back screen or reflector to the receiver aerial system, preferably higher than the active elements of the receiving surface. In regard to transmitter aerials, the same circumstances do not all apply, but it is desirable to employ concentrated directive transmission and efficient back screening.

Aerial Systems.

To sum up, it may be said that for first class circuits it is sound policy to employ high and wide Beam aerials, preferably duplicated at the receiving end for diversity reception, or again to employ some cheaper form of Directive Aerial, preferably in triplicate at the receiving end. It is difficult to generalise, but one might visualise a series of aerial combinations headed by high and wide Beams and ending with simple half-wave broadcast aerials, according to the nature of the services and the likely returns for capital outlay.

Receivers.

The tendency is to increase selectivity and, by scrupulous attention to principles, to increase the efficiency of signal amplification while reducing the level of extraneous and valve noises. There is also a tendency to incorporate limiting devices and timed circuits in order to suppress the effects of secondary signals or other sources of distortion.

Screen Grid Valves have had a considerable influence upon the design of the earlier stages of modern receivers, rendering them more stable. Again, in some cases automatic level controls are being applied to telegraph receivers where a good minimum level of received signal strength is assured.

Transmitters.

Considerable improvements are being effected in stabilising the frequency of the transmitted wave. At present, either by means of a compensated valve drive or by employing a thermally controlled constant temperature crystal or, again, by vibration forks, a stability of 1/25,000 cycles is practicable and can be guaranteed on commercial services. It is probable that greater stability will be achieved in the near future, and one interesting aspect is the attention given to vibrating steel cylindrical rods, the structure of which can be controlled and made virtually homogenous.

Improvements in the efficiency of power valves and power rectifier valves have been fairly continuous and, with the growing knowledge of valve characteristics, the modern transmitter is a series of scientifically built units, whose output increases from stage to stage.

Ultra Short Waves.

Waves of the order of 5 metres down to 0.5 metre are being successfully employed for communicating over ranges extending to perhaps 300 kilometres, the important point being to erect the apparatus on cliffs or mountains in such a manner that an uninterrupted straight line joins the two termini. This ensures that the services are free from fading and similar effects.

It is worthy of note that in some cases buildings are partially transparent to continuous waves of about 5 metres, and good reception can be effected within such buildings.

Facsimile.

The transmission of print, hand writing and diagrams or illustrations has always appealed to the radio engineer, and the advent of short waves gave a wider scope for the development of this subject. In the earlier experimental stages, however, difficulties were encountered because of the distortion effects already briefly described ; indeed it is largely due to the painstaking labour bestowed upon Facsimile that we owe much of our more accurate knowledge of the behaviour of radio propagation in space. The difficulties originally encountered have now been largely overcome and, as the subject is likely to have an important bearing on Radio Telegraphy, an outline of the general principles may be of interest.

In Facsimile the print or picture is placed upon a cylinder and scanned by a tiny pencil of light, which is reflected through a suitable optical system and caused to impinge on a Photo-Electric Cell. The reflected pencil will suffer variations in intensity, according to the graduations from black to white on the surface of the subject, and these are transformed into variations of amplitude in the current through the cell ; from this point the variations are magnified until they become strong enough to operate a Power Transmitter which radiates electro-magnetic disturbances corresponding to the gradations of the subject as it is scanned. In turn the radio signals are received across space and transformed back into a pencil of light, whose motion is synchronised with that scanning the original, and directed upon a sensitive negative. At this end the requisite changes in intensity of the recording light may be produced either through the medium of a Kerr Cell in conjunction with a Nicol Prism, or directly through the medium of a suitable Neon tube.

In order to reproduce the gradations from black through greys to white at both transmitter and receiver, it is necessary to break up the illumination into a series of spots of light, thus conveying a series of impressions whose intensities may be reproduced by the operation of transient effects ; in other words the pencil of light is chopped in order to form a carrier for the transmission of facsimile modulation. The frequency of chopping generally found suitable for the process of reproduction is around 5,000 spots per second. In regard to radio transmission these spots might be reproduced as so many microscopical squares but one is immediately confronted with the difficulty that square form spots at such frequencies occupy a very wide band in the wave spectrum, therefore some compromise is desirable ; if the spot mark is formed by pure sinusoidal modulation the spread of frequencies will be considerably reduced but the spot will not be so well defined and in practice a speed of about 1,000 spots per second is the limit of faithful reproduction.

In reference to distortion the most interesting problem centres round the elimination of "multiple" and "echo" effects, a form of signal distortion wherein marks are prolonged by increments of signal due to side streams and other characteristics of radio transmission through space. Fortunately these effects are fairly constant in magnitude and if the spot frequency is slowed down sufficiently their presence can be ignored in comparison with the main signal, hence the speed is reduced to a rate varying between 250 and 500 spots per second, according to conditions.

Another interesting problem is that of maintaining an absolute constancy in the amplitude of the received high frequency radio carrier wave, for unless this constancy is assured the super-imposed amplitudes, which mark varying degrees of light and shade, cannot be faithfully reproduced. Some engineers strive to gain this constancy at the receiver with the object of reproducing half tone effects ; other engineers limit the amplitude of the spots or dots to a value that is constant and well within the range of received signals. With this latter class of apparatus it is possible to combine varying lengths of spot marks to obtain half tone effects ; another device misphases these marks at each revolution of the picture cylinder, thus producing an effect of uniform gradation that greatly enhances the quality of reproduction. There is a third method that appears to come half-way between varying amplitude and synthetic half tone, it is to employ a multiple channel transmitter with a corresponding multiple channel receiver, and by giving to each channel a different value of light intensity the picture can be broken up into, say, six component effects.

Enough has been said to indicate that valuable work has been accomplished and that Facsimile is a factor to be reckoned within the near future.

Future Tendencies.

Beyond the indications given in preceding paragraphs, very little can be added within the scope of this paper. It is safe to prophesy, however, that automatic printing apparatus, eliminating human error and labour, will be generally adopted in keeping with the increasing reliability or radio plant and apparatus. Again it is probable that frequencies will be tightened up, and that separate messages will be transmitted on short wave frequency channels differing from each other by only a few hundred cycles.

Long wave transmitters will still be employed, though short waves will largely predominate. This state of affairs will certainly last for some years to come ; after that, who knows ?

MARCONI NEWS AND NOTES

GERMANY HONOURS MARCHESE MARCONI

A FURTHER international honour was recently accorded to H. E. Marchese Marconi on account of his unique contributions to science and communications, when President von Hindenburg awarded to him the Goethe Medal for Science and Art, which was instituted by the German President in commemoration of the Goethe Centenary this year.

The Medal, and a special Diploma, were forwarded with a personal letter signed by the President to Marchese Marconi in Rome through the medium of the German Ambassador to Italy.

H. E. Marchese Marconi: a recent portrait.

In this connection it is interesting to recall that Marchese Marconi, whose work has been recognised by governments, universities, and learned societies in all parts of the world was also presented earlier this year on May 3rd, with the Kelvin Medal of the Institution of Civil Engineers, London. Among many other scientific awards granted to him may be mentioned the Nobel Prize for Physics in 1909, the Albert Medal of the Royal Society of Arts, the Franklin Medal, and the John Fritz Medal awarded to him in the United States of America "for the invention of wireless telegraphy." Marchese Marconi is also President of the Italian National Council of Research, President of the Italian Academy of Science, and a member of the Pontifical College of Sciences.

Manchester Aerodrome Wireless Station.

THE Marconi Company is to erect on behalf of the Air Ministry a wireless station at the Manchester Corporation Aerodrome at Barton Moss. This will be the first fully equipped wireless station to be erected at a municipal air port in Great Britain for the use of civil aviation services, and is an indication of the progressive policy of officially fostering provincial air services in the United Kingdom.

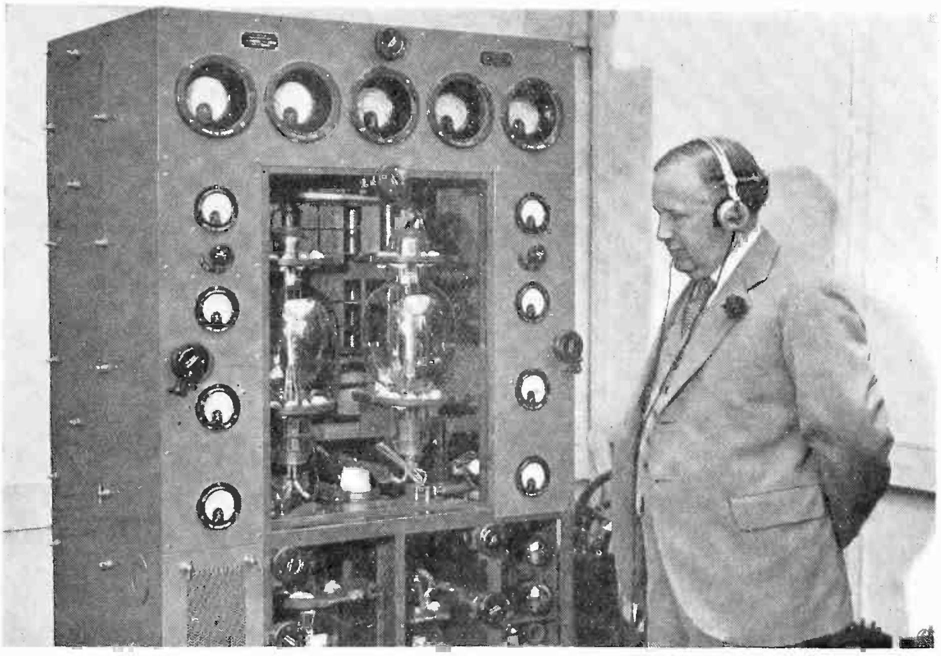
The wireless station will have sufficient power and range to communicate with aircraft making the Irish Sea crossing to Belfast or Dublin, as well as over a wide area of north-west England and Wales, and the midlands. It will provide various classes of wireless service that have proved to be of value to aviation, including ground-to-air communication by telephone or telegraph, meteorological broadcasts, wireless direction finding, and inter-aerodrome services.

The station will be controlled by the Air Ministry, which is also establishing at Manchester Air Port a complete Meteorological Office for the issue of weather reports.

The wireless equipment to be installed, all of which is of the most modern design, comprises a Marconi ground station transmitter of approximately three kilowatts power input, and a direction finding receiver.

It is expected that the work of installation and testing will be completed by the spring of next year.

The transmitting station will be erected at a distance of about a mile from the aerodrome at Barton Moss and remotely operated from the control room there, in order to obviate any possible danger to aircraft using the aerodrome on account of the two 100-feet masts and the aerials of the transmitting station.



Sir Kingsley Wood, the British Postmaster-General, inspecting a Marconi short-wave telephone transmitter—of the type installed on passenger liners for ship-to-shore telephone services—at the recent National Radio Exhibition at Olympia, London.

New Broadcasting Station for Cape Town.

A NEW transmitting station for the African Broadcasting Company is to be erected by the Marconi Company near Cape Town, and is expected to be in operation by the summer of next year.

The equipment for the new station will embody the most modern developments in broadcasting technique in addition to considerably higher power than the present installation at Cape Town, and will provide a service of greatly enhanced range and first-class quality for South African listeners. It is expected to broadcast on the wavelength of 370 metres, which is practically the same as that of the present Cape Town broadcasting station.

The transmitting equipment, masts and aerials of the new station will be at Milnerton, about 15 miles north of Cape Town, but the studios will be situated in the centre of the town as at present.

The existing Cape Town station, which was also erected by the Marconi Company and inaugurated in September, 1924, will probably be removed from its present site and re-erected in a suitable position to give a more efficient broadcasting service to the Eastern Province of the Union.

Wireless Watch on Oil Supplies.

A CHAIN of Marconi stations is to be built through Iraq, Syria and Palestine, to maintain communication along the projected British oil pipelines which are to connect the wells of the Iraq Petroleum Company at Kirkuk with the Mediterranean ports of Tripoli (Syria) and Haifa (Palestine).

At present these wells are shut in for lack of means of transport. The pipelines, covering in all a distance of more than 1,200 miles, will when completed, enable the oil to be pumped into tank-ships at these ports.

The building of the pipelines is an enterprise of outstanding importance for the future of the world's oil supplies, and careful plans, in which wireless communication is to play an essential part, have been made to ensure that there will be no interruption of the regular flow of oil from the wells to the distant Mediterranean ports in spite of the difficult conditions to be encountered on the route.

A double pipeline will stretch from Kirkuk to Haditha, on the Euphrates, where a bifurcation will be made, one line running to the north through Syria to Tripoli, and the other to the south through Iraq, Palestine and Transjordan to Haifa.

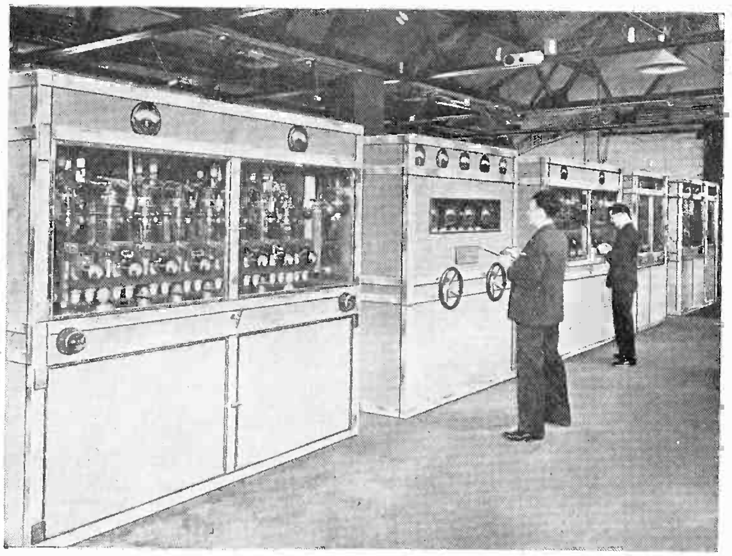
Utility of Wireless.

The erection of wireless stations along the pipeline routes will serve a double purpose during the actual laying of the pipes and after they are completed. By their means, messages can be flashed from point to point along the pipelines, giving information to all the engineers of any breakdowns in the line or accidents to personnel.

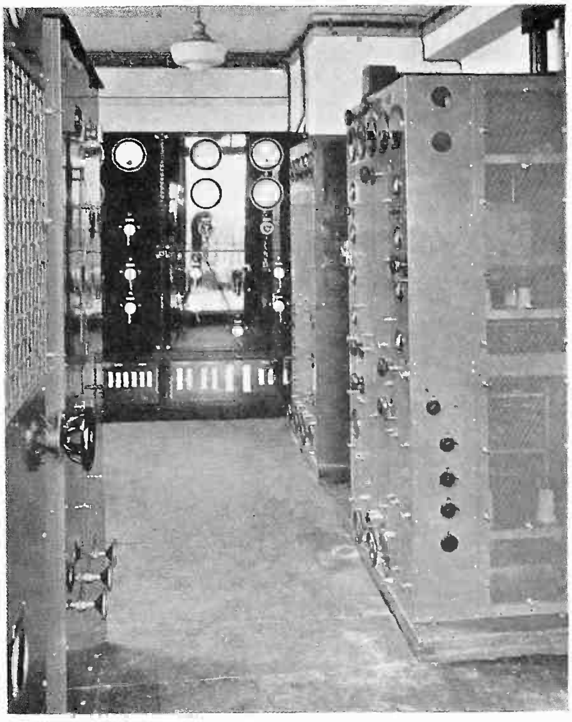
In addition the use of wireless communication will greatly facilitate and expedite the gigantic engineering task of building and maintaining hundreds of miles of pipeline over undeveloped territory, providing a means of rapidly interchanging reports of progress and minimising any delays that may arise through temporary breakdowns or difficulties with supplies.

The wireless stations will be suitable for both telegraph and telephone services, so that while normally they may operate on the Morse system it will be possible in the case of urgent messages for the engineers at the salient points on the pipelines to speak personally and directly with their distant colleagues. The wireless services afforded in this way will constitute the most rapid and complete system of cross-desert communications in the world.

Two of the stations are to be erected on the Eastern Section, at Kirkuk, near the site of the wells, and at Haditha, the site of the pipeline bifurcation. The 400-mile northern pipeline from Haditha through Syria will be served by two stations at Homs and Tripoli, and the 500-mile southern pipeline from Haditha by three stations, at Rutbah, 120 miles south-west of the junction, at Mafrak, 250 miles further over the mountains, and at Haifa.



The Marconi high-power broadcasting transmitter for the Irish Free State, now installed at Moydrum, near Athlone, is here shown undergoing its final tests at the Marconi Works, Chelmsford. The station gave special transmissions of the proceedings of the Eucharistic Congress in June, and is expected to come into regular operation shortly.



Marconi 6-8 metre transmitter installed at Broadcasting House, London, for ultra-short-wave broadcasting tests in collaboration with the British Broadcasting Corporation.

Wireless Training for Aviators.

BRITAIN'S "Air University," the flying school of Air Service Training Limited opened at Hamble, near Southampton, in June, 1931, by H.R.H. the Duke of Gloucester, has been equipped with Marconi apparatus for the benefit of its students undertaking the wireless course.

The equipment includes telegraph and telephone apparatus for use in the air, a ground station, and various parts and accessories for instructional purposes.

The aircraft equipment is the Marconi Company's latest model "all-purpose" aircraft set, type A.D.6M. This instrument comprises a combined transmitter and receiver, suitable for both telegraph and telephone communication, the transmitter having a power of 150 watts. For the ground station at Hamble, another Marconi model of the same series has been suitably adapted for ground-to-air operation.

The practical nature of the wireless instruction afforded to students by Air Service Training Limited is assured by the fact that Marconi equipment of various types has been fitted in civil, military, and naval aircraft of more than 30 countries and is in regular use practically throughout the world.

The instructor in wireless at Hamble is an ex-Royal Air Force instructor recently employed on the staff of the electrical and wireless school at the R.A.F. training centre at Cranwell, and students will qualify for the Air Ministry's wireless telegraph air operator's licence at the termination of their training.

Ship-to-Shore Telephony.

THE work of equipping British coastal wireless stations with Marconi telephone installations has now been completed, and eleven of these stations are in operation.

A complete chain of low-power wireless telephone stations has thus been established by means of which all ships within two or three hundred miles of the coasts of Great Britain and Ireland can, with suitable equipment, communicate by telephone with the shore at any time. The service area of each station has been arranged to overlap that of each of its neighbouring stations in order to form a complete service area around the British Isles.

A steadily increasing number of ships, now totalling approximately 150, has been fitted with the low-power ship installations designed by the Marconi Company for use with the coastal telephone stations, whose services are in consequence in considerable demand.

The advantage of a telephone service of this nature is that it enables ships which do not normally carry wireless installations, and are under no obligation to do so under international regulations, to enjoy the benefits of wireless communication with land by means of the most simple and economical apparatus, operated by a member of the ship's ordinary personnel without the addition of a skilled wireless operator.

Such a service is of great value to coasting and fishing vessels, and in many instances also to ocean-going ships when approaching or leaving port.