WIRELESS ENGINEER

THE JOURNAL OF RADIO RESEARCH & PROGRESS

SEPTEMBER 1953

VOL. 30 No. 9 THREE SHILLINGS AND SIXPENCE

BAVR AUTOMATIC VOLTAGE STABILIZERS
(A.C. OUTPUT)

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- **INSENSITIVE TO CHANGES OF LINE FREQUENCY**
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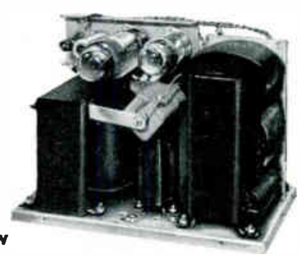
Rear View BAVR-200

The control unit is a magnetic amplifier, the inductance of which varies with the DC passed through control coils. Stabilization is achieved by monitoring the output side and regulating automatically the D.C. component so as to adjust the AC output voltage and keep it constant within precise limits, the stability being 0·15%. The functional circuit is as shewn. The Electronic Control Unit employs three tubes—one each EL37, 90C1 and A2087, and a selenium rectifier: it is foolproof.



Inside View BAVR-200

Usual Input Voltage "Swing" is 230V—12% to + 6%, and usual output voltage 230V, tolerance 0·15%, and means are provided so that the instruments may be changed by the customer, to suit them to other input voltages from 200-250V, nominal.

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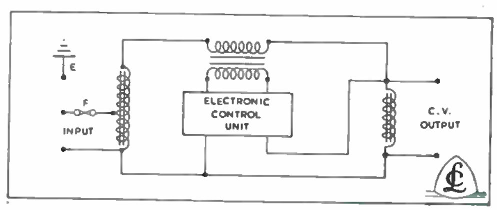

Functional Circuit BAVR

TYPE	MAXIMUM LOAD	NET PRICE
BAVR-200	200 VA	£50 0 0
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BAVR-1,000	1 kVA	£70 0 0
BMVR-1,725*	Ca. 2 kVA	£75 0 0
BMVR-7,000*	Ca. 7 kVA	Prices on application
BMVR-25,000*	Ca. 25 kVA	

* Full details now in active preparation, and will gladly be sent on written request. These three Instruments have sinusoidal output waveform (no percentage of harmonics).

Model BMVR-1725

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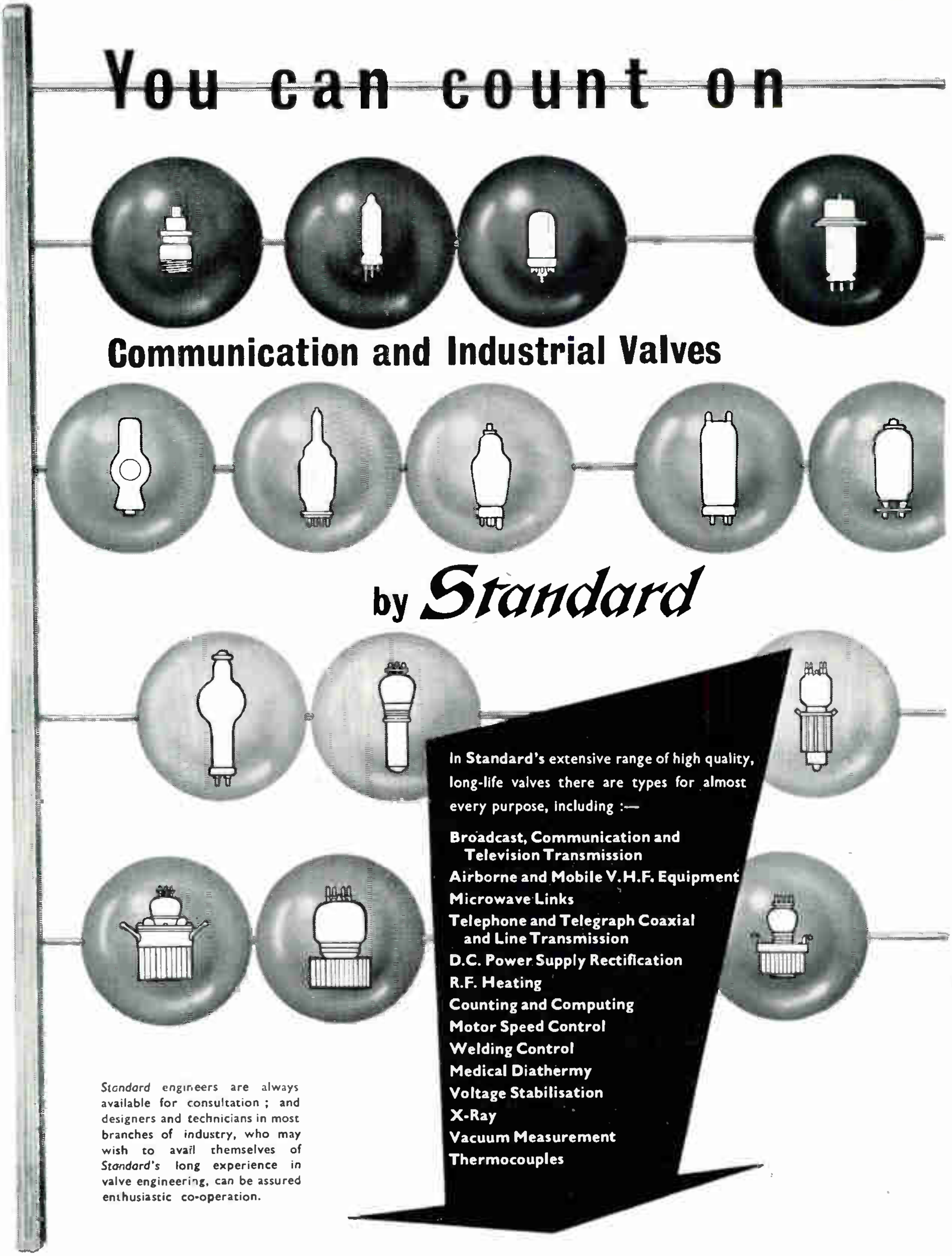

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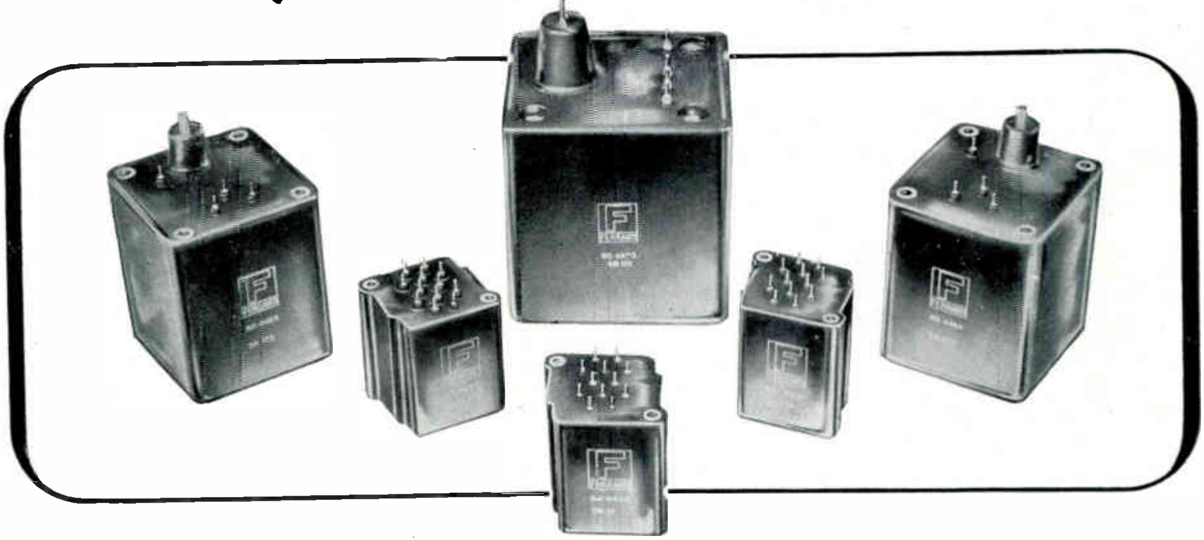

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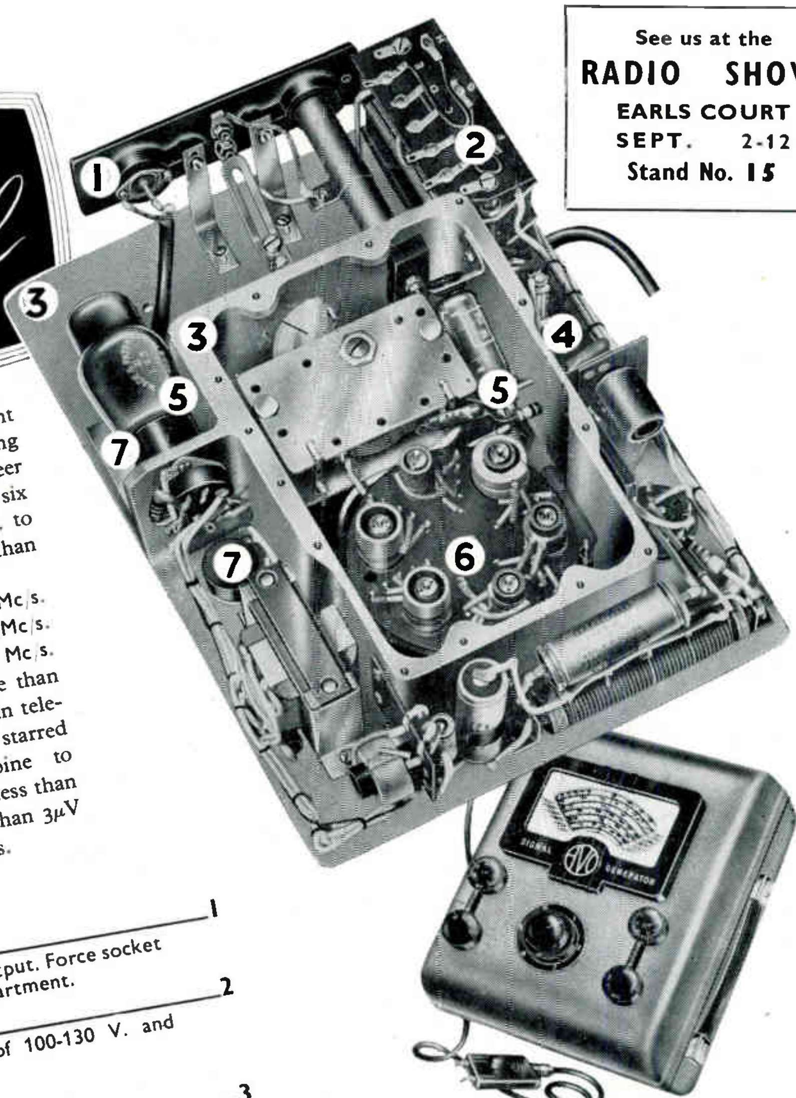

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Co-axial socket for attenuated output. Force socket located totally within H.F. compartment.

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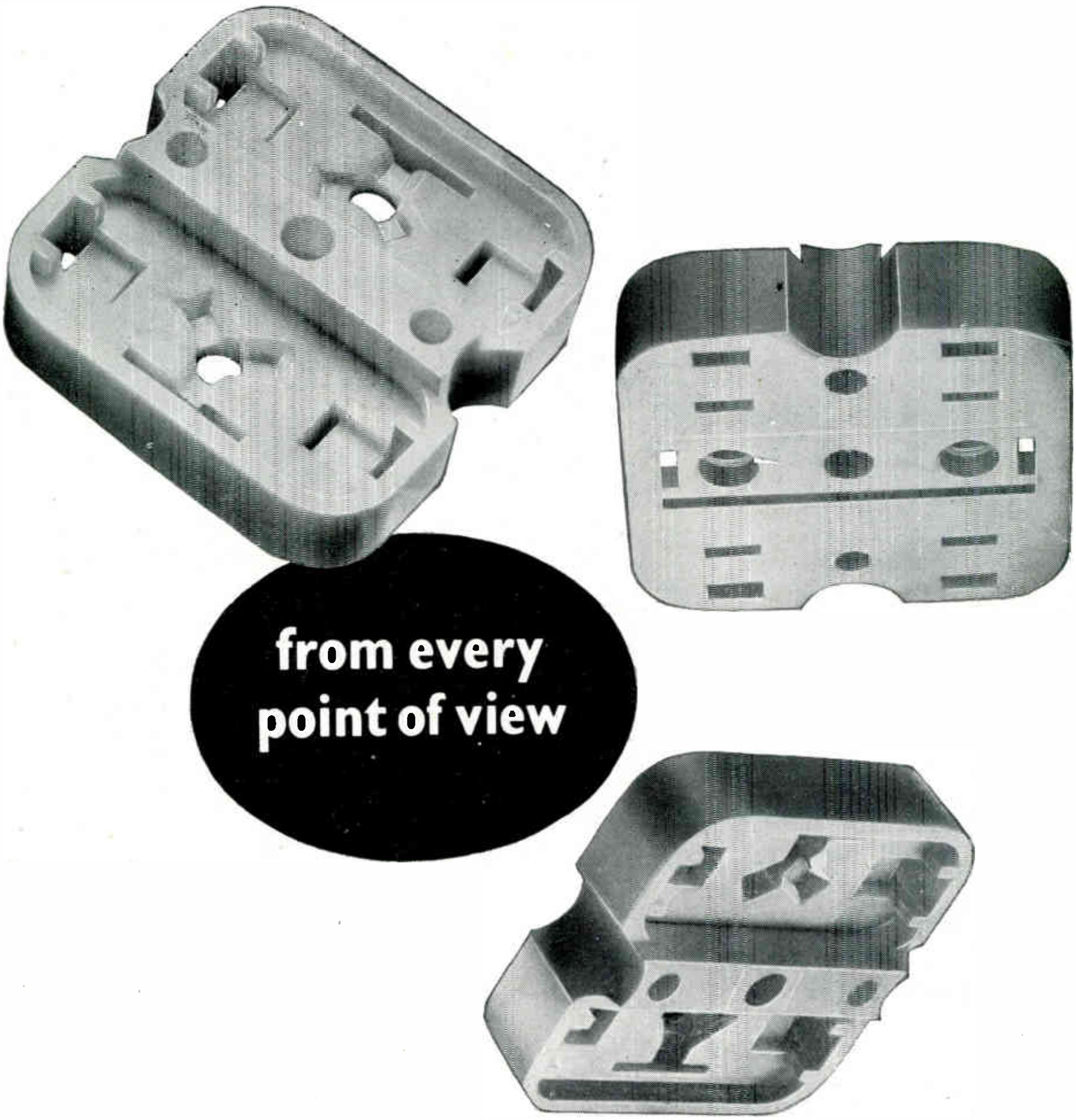
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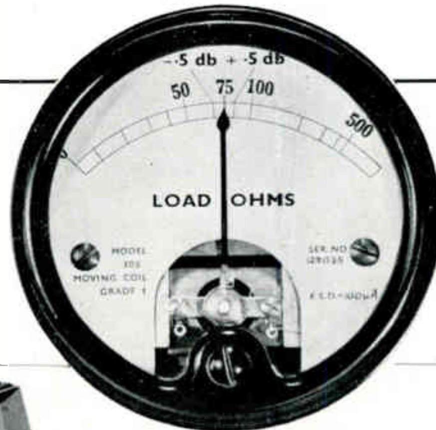

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Frequency Range:	10 Kc/s — 10 Mc/s in 6 ranges
Frequency Stability:	better than 1 in 10^3 in 1 hour
Frequency Accuracy:	1%
Output Range:	+10 db to −50 db on 1V p-p.
Output Level:	Constant to ±0.5 db at any frequency setting
Output Impedance:	75 ohms
Total Harmonic Content:	less than 1%

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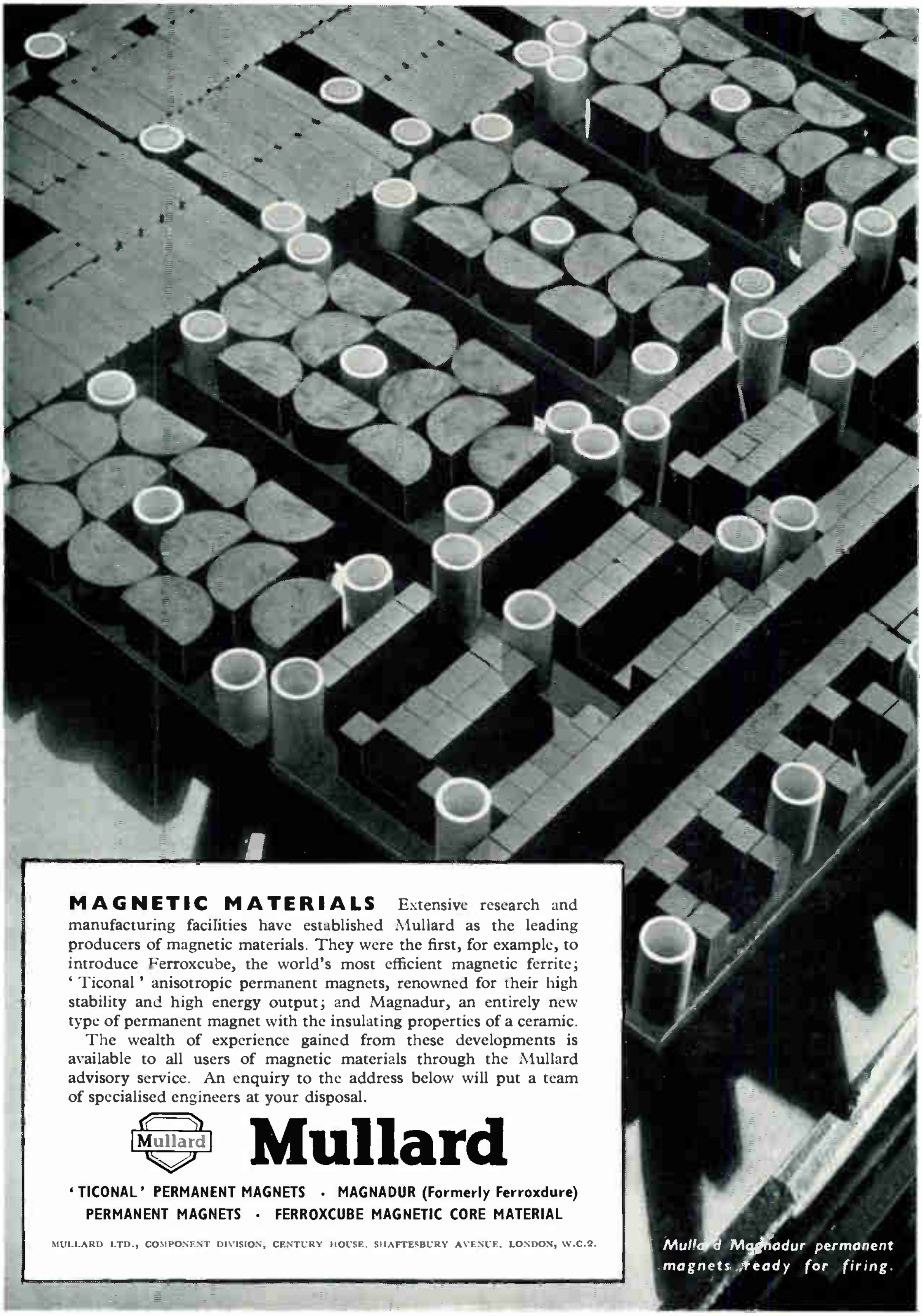

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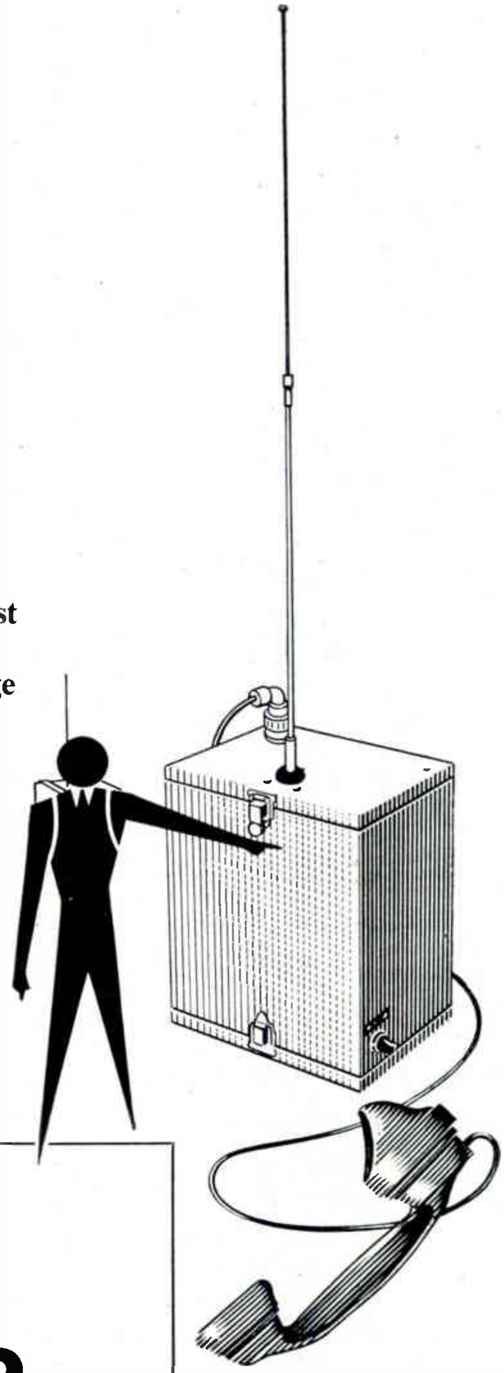

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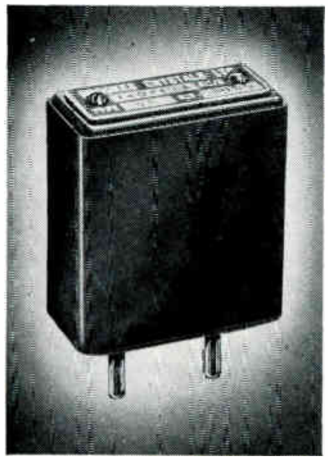

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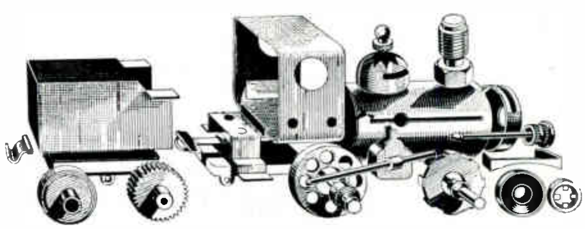

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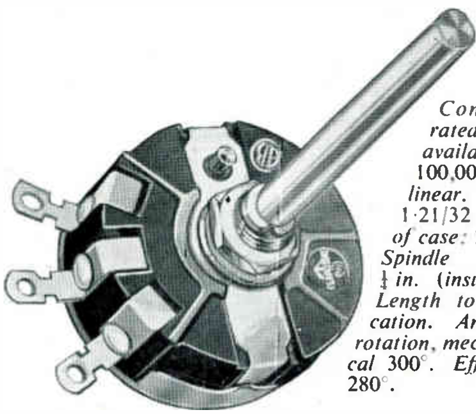
TYPE 58 (Dual)

Two controls in tandem operated by a common spindle. Each control wound to any resistance up to 100,000 ohms linear. Diam. 1·21/32 in. Total depth of case: $1\frac{9}{16}$ in.



TYPE 58

Conservatively rated at 3 watts; available up to 100,000 ohms linear. Diam. 1·21/32 in. Depth of case: 25/32 in Spindle diam. $\frac{1}{4}$ in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

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Volume 30 · Number 9

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SEPTEMBER 1953

Published on the sixth of each month

Annual Subscription: Home and overseas, 1 year £2 7s. 0d; Canada and U.S.A. $7.50
(Including Annual Index to Abstracts and References, formerly published separately)

Editorial, Advertising and Publishing Offices: Dorset House, Stamford Street, London, S.E.1
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A special feature of this valve that should prove of particular interest to designers of FM and AM/FM communication receivers is that its two sections may be operated independently. In FM circuits, it can be used as an R.F. or I.F. amplifier, or oscillator and thereby reduce the number of different valve types employed. Brief technical details of the ECH81 are given below. More comprehensive information will gladly be supplied on request.

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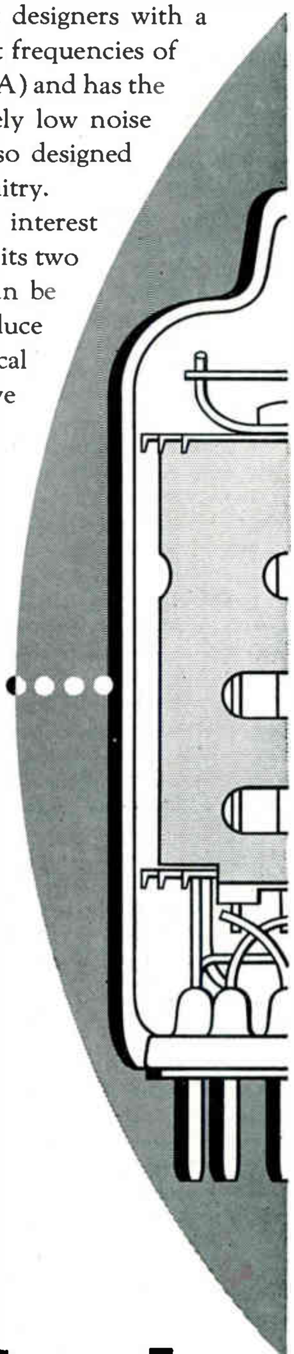
ECH81



PRINCIPAL CHARACTERISTICS

HEATER Suitable for series or parallel operation A.C. or D.C.

Vh	6.3 V
Ih	0.3 A

TYPICAL OPERATING CONDITIONS OF HEPTODE SECTION AS A MIXER

Va = Vb	250 V
Rg2 + 4	22kΩ
Rg3 + gt	47kΩ
Ig3 + gt	200 µA
Vg1	−2.0 V
Vg2 + 4	103 V
Ia	3.25mA
Ig2 + 4	6.7mA
gc	775 µA/V
ra	1.0M
Vg1 for 100 : 1 reduction in gc.	28.5 V

CHARACTERISTICS OF TRIODE SECTION

Vat	100 V
Vgt	0 V
Iat	13.5mA
gm	3.7 mA/V
µ	22

BASE B9A

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MVT135

WIRELESS ENGINEER

Vol. 30 SEPTEMBER 1953 No. 9

Dimensional Analysis, Units and Rationalization

THIS is the title of an article by R. Vermeulen in *Philips Research Reports* of December 1952, which is intended to illustrate and emphasize the fact that "undiscriminating manipulation of dimensional formulae can lead to contradictions, e.g. that 1 sec = $3 \cdot 10^{10}$ cm or that 1 oersted = 1,000 A/m." He says that "these are eliminated by defining the multiplication of physical quantities, strangely enough never done before, and by preventing the mixing up of multiplications whose physical interpretations are essentially different." He begins the article with a quotation from R. W. Pohl's book "Zur Darstellung der Elektricitätslehre" published in Göttingen in 1950, which, he says, states the problem in an admirably concise and clear way. This may be translated as follows: "Equating units of the 4-element system [such as LMTμ or LMTQ] with multiples of units of the 3-element system [LMT] is not permissible. How often one reads that the electric charge

$$e = 4{\cdot}8 \times 10^{-10} \text{ el. stat. c.g.s.} = 1{\cdot}6 \times 10^{-20} \text{ el. magn. c.g.s.} = 1{\cdot}6 \times 10^{-19} \text{ coulomb} \quad (24)$$

Substituting for the letters c.g.s. the defining equations

$$1 \text{ el. stat. c.g.s. unit of charge} = 1 \text{ cm}^{3/2} \text{g}^{1/2} \text{sec}^{-1}$$

$$1 \text{ el. magn. c.g.s. unit of charge} = 1 \text{ cm}^{1/2} \text{g}^{1/2} \quad .. \quad (25)$$

we obtain 1 sec = 3×10^{10} cm."

Pohl then says, "Is it not time to make an end of this confusion? Should we not finally agree that one must not equate either of the 3-element units with 4-element units such as the coulomb, ampere, etc.?" Vermeulen answers yes to the first question, but appears to have some doubts about the second.

Pohl's equation (24) gives beyond question the relation between the magnitudes of the three different unit charges, but the dimensional formulae (25) are a very different proposition. They are both obtained by ignoring the properties of the medium in which the defining experiment is performed; if these are taken into account the formulae become 1 $\text{cm}^{3/2}\ \text{g}^{1/2}\ \text{sec}^{-1}\ \kappa_0^{1/2}$ and 1 $\text{cm}^{1/2}\ \text{g}^{1/2}\ \mu_0^{-\frac{1}{2}}$. From which

$$1 \text{ sec} = 3 \times 10^{10} \text{ cm} \sqrt{\kappa_0\mu_0} \text{ or}$$

$$1/\sqrt{\kappa_0\mu_0} = 3 \times 10^{10} \text{ cm/sec.}$$

This is not the way that Vermeulen solves the dilemma; he says that the formulae (25) "contain products of powers of physical quantities and nobody has ever told me what these mathematical operations with physical quantities really stand for. . . . If now, as Pohl shows so clearly, the unrestrained manipulation of mathematical symbols applied to physical quantities leads to a contradiction, we should first of all examine critically the possibility that these symbols are ambiguous." With this we heartily agree. We can multiply a length or a mass or a time by a number —this merely changes the magnitude without changing the nature of the concept—but we cannot really multiply a length by another length, although we may think we do. What we really do is to multiply the number of units in one length by the number of units in the other, and apply the product to a convention, viz., that the product of two lengths is the area of a rectangle with sides equal to these lengths. We are accustomed to this concept of area, but has anyone any physical concept of the product of two times or of two masses? As Vermeulen says, there are no fundamental reasons why we should not define the product of two lengths as the area of an ellipse with these lengths as axes, but the common convention is more practical. Even with lengths it seems impossible to form any physical concept of 1 cm $^{3/2}$; it is certainly neither a length nor an area nor a volume. When we say that 3 lb × 2 ft = 6 lb-ft or 6 ft-lb the multiplication is confined to the numerals and the product is applied to a concept involving both force and distance. There is nothing in the formula to tell one whether the concept is of work done or of a torque. We can multiply a force by a number but not really by a distance.

Vermeulen states that the first formula in (25) is derived from the equation $Q_1.Q_2 = Fr^2$ and the second through $I_1 \times I_2 = \frac{1}{2}F.r/l$ from $Q_1 \times Q_2 = \frac{1}{2}F.t^2r/l$.

He uses different signs . and × for the multiplication of Q_1 and Q_2 to distinguish between the electrostatic and the electromagnetic formulae, or, in other words, $Q_1.Q_2$ means that he is ignoring κ_0 while $Q_1 \times Q_2$ means that he is ignoring μ_0, although he does not say so. Whether one writes . or × the product of 3 coulombs and 2 coulombs is presumably 6 square coulombs or coulombs squared, which seems quite meaningless, but if we take the root of the product we get $\sqrt{6}$ coulombs and are back to reality.

Vermeulen maintains that the paradox that 1 sec = 3 × 10^{10} cm can be avoided by making a clear distinction between "different symbolic products," which he does by using the different symbols . and ×, but we must confess that we can only give any meaning to this by his omission of κ_0 and μ_0 from equation (25). He then says that, "In dimensional analysis the 'units' are defined by mathematical formulae expressing all the 'derived units' in terms of three or four 'fundamental units.' Therefore, one is apt to consider these dimensional formulae, like m/sec, g.cm.^{2}sec^{-2}, A/m, etc., as the 'units.' As in the case of the symbolic product, this is taking the symbol for the real thing, and will lead to paradoxes when the symbols are not unambiguous." One gets some idea of his meaning from the page which he then devotes to a consideration of the formula for kinetic energy:

$$E = \tfrac{1}{2}m.v^2$$

to which he gives an alternative

$$A = m \times v^2$$

again distinguishing between them by . and ×. For the same values of m and v the second formula gives $A = 2E$; hence if they both give the kinetic energy, the unit in the second case must be only half that in the first case. One must not confuse the 'dimensions' with the size of the unit; in both cases the dimensions are ML^{2}T^{-2}. A velocity in miles per hour has the same dimensions as if it were in cm per sec, viz., L/T. In his recent book on Electrical Units, Bradshaw is quite clear on this point; he refers to "the four concepts or dimensions" as distinct from "the four arbitrarily defined primary units." The × instead of . in the second formula is merely a sign that the ½ has been omitted; it seems a very strange procedure. Force = mass × acceleration = ML/T^2; therefore work done = force × distance = ML^2/T^2, which are, of course, exactly the same as the dimensions of the kinetic energy just considered, but if, in each case, the mass, length and time in the defining experiment are taken of unit value, the work done in the first case is exactly double the kinetic energy in the second case. This proves that the dimensions do not fix the size of the unit, even when expressed as g.cm^2.sec-^{2}.

Turning to rationalization, Vermeulen says that a paradox results when we try to compare the Giorgi unit for the magnetic field strength H with the non-rationalized electromagnetic unit. He says "experimentally it can be established that 1 oersted = (1,000/4π)A/m, while dimensional formulae give us 1 oersted = 1,000 A/m." This is a very strange statement. The result of experiment will depend on the definition of the oersted and, as we have already seen, the dimensional formulae do not fix the magnitude of the unit. He again uses the different multiplication signs and writes:—oersted × cm = 4π oersted . cm = biot where biot designates the c.g.s. unit current of 10 amperes. He thus applies the name oersted to two different units and uses . and × to distinguish between them. He then says, "All relations and conversion factors can now be written down without any ambiguity:

oersted = Bi″/cm = 10A″/0·01m = 1,000A″/m
= (1/4π)Bi′/cm = (1/4π) . 10A′/0·01m
= (1,000/4π)A′/m."

Bi is an abbreviation of biot. On comparing this with the above formulae it is seen that when × was used, the derived formula uses ″, and when . was used, the derived formula uses ′. He thus applies the name oersted both to the classical non-rationalized unit and to the rationalized unit of field strength, and adopts these devices to indicate which is being used in any formula. It is difficult to imagine anything more irrational than applying the same name to two units, one of which is 4π times the other. This lengthy formula is the final one in the article.

This article by Vermeulen will come as a revelation to anyone who thought that any doubts or uncertainties concerning the different systems of units and the relations between them had all been satisfactorily cleared up, and were now a thing of the past. It shows that in some quarters there is still much uncertainty and confusion.

G. W. O. H.

AUTOMATIC IONOSPHERIC HEIGHT RECORDER

Frequency Range 0·65 to 25 Mc/s

By C. Clarke, A.M.I.E.E., and E. D. R. Shearman, B.Sc.(Eng.), A.C.G.I.

(Communication from the D.S.I.R. Radio Research Station, Slough)

SUMMARY.—The paper describes a commercial equipment, based on a design by Naismith and Bailey, for measuring the virtual height of reflection of ionospheric echoes as a function of transmitted frequency. A pulse transmitter consisting of a master oscillator and power amplifier is tuned through the frequency range in five bands. The receiver is separately tuned and is kept in step with the transmitter by a frequency discriminator and servo-mechanism. The receiver output is presented on two cathode-ray tubes, one for monitoring and one for photographic recording, each displaying a linear time-base sweep. Height and frequency calibrations, which are derived from a crystal source, are displayed, and a crystal-controlled time switch is incorporated for the automatic operation of the equipment.

1. Introduction

A RECENTLY published paper by Naismith and Bailey[1] described an automatic ionospheric recorder covering the frequency range 0·55 to 17 Mc/s, which produced a photographic record in the form of a graph of virtual height of reflection of ionospheric echoes against transmitted frequency. This equipment was put into service at the Radio Research Station, Slough, in 1945 but publication of its performance was delayed until 1951. In 1948 it was decided to produce copies of this equipment commercially for use in this country and abroad. The basic specifi-

MS accepted by the Editor, December 1952.

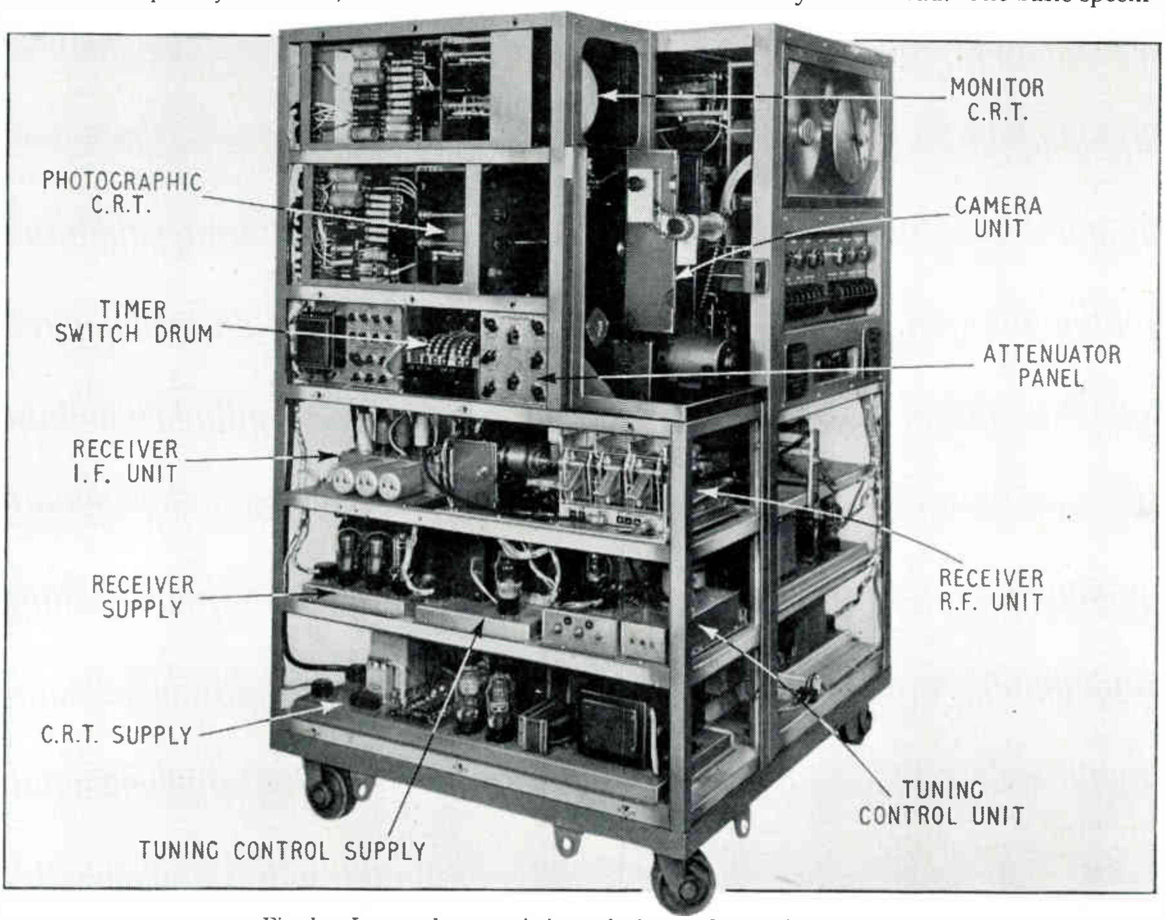
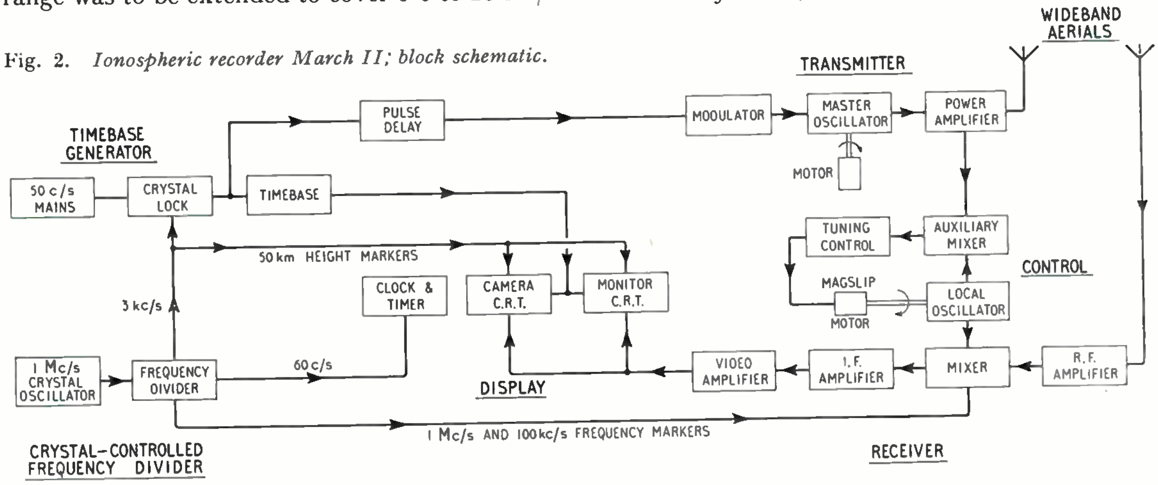


Fig. 1. *Improved automatic ionospheric recorder; receiver section.*

cation was revised to require crystal-control for the height and frequency markers and for the time switch. In addition, the operating frequency range was to be extended to cover 0·6 to 25 Mc/s.

Fig. 2. *Ionospheric recorder March II; block schematic.*



These alterations involved an extensive modification of the design of the original recorder which could no longer be regarded as a prototype for the production model. The present paper describes the recorder in the form in which it was eventually produced. Although different circuits are used to meet the new specification and to facilitate commercial production, the instrument still uses the basic principle of a separately-tuned receiver and transmitter, held in step by means of a servo-system.

2. General Description

The equipment is similar in external appearance (Fig. 1) to that described by Naismith and Bailey. The main framework is constructed of angle iron covered with alloy sheet panels and the various chassis are of a unit-construction and may be readily removed from the equipment for servicing.

Electrically the recorder may be considered under five sections as shown in the block schematic of Fig. 2.

(i) A crystal-controlled frequency-divider unit.
(ii) A linear time-base generator.
(iii) A pulse-modulated transmitter.
(iv) A receiver, the tuning of which is locked to the transmitter through a servo-system.
(v) A display unit.

The transmitter consists of a pulse-modulated master oscillator, which covers the frequency range in five bands, coupled to an aperiodic power-amplifier stage. The receiver operates on the superheterodyne principle and is tuned separately from the transmitter. As in the earlier model, it incorporates an auxiliary frequency-changer valve. This valve is associated with a frequency-sensitive tuning control unit the function of which is to keep the receiver in tune with the transmitter.

The output of the receiver is presented on two cathode-ray tubes, one for visual monitoring and one for photographic recording. The tubes display linear time-base sweeps on which are height-calibration marks derived by suitable frequency division from a 1-Mc/s crystal oscillator. The transmitter is pulse-modulated at the mains frequency in a manner such that the leading edge of each pulse is locked to a height marker. Each time-base sweep is locked to a height marker in the same way, but the sweep is started in advance of the modulation pulse to permit the presentation of frequency markers as the receiver tunes through the frequency range. The frequency-calibration markers are derived from the same crystal oscillator as the height markers.

The crystal-controlled divider unit is also used to provide a 60-c/s output, which drives a clock and a time-switch mechanism, the accuracy of which is determined by the crystal oscillator and is independent of variation in the mains frequency.

The display unit contains the monitor cathode-ray tube, on which the information is presented by plate deflection, and the photographic recording tube for which brilliance modulation is used.

3. Frequency Divider Unit

The divider unit provides the inputs to the receiver and display necessary to produce frequency and height marks on the photographic record. The unit also provides a low-frequency output for driving the clock on the front panel and the timer mechanism. These waveforms are all derived from the output of a 1-Mc/s crystal oscillator by frequency division and multiplication. Multivibrators are used for frequency division, the triggering impulses being applied to the two grids in phase for even division, and in antiphase for odd division.

3.1. *Frequency Calibration*

Frequency-calibration marks are automatically presented as the receiver tunes through all the harmonics of 100 kc/s from 700 kc/s to 25 Mc/s. They appear as pulses at the start of the time-base sweep before the ground pulse, which is suitably delayed for this purpose, and occur while the r.f. stage of the receiver is kept insensitive so that no signals are being received. They are obtained from the 1-Mc/s crystal oscillator by suitable division and distortion to obtain a waveform rich in harmonic content. The multiples of 1 Mc/s are indicated by pulses of double the duration of the 100-kc/s multiples.

The circuit of the frequency-calibrating system is shown in Fig. 3. Valve V_{1A} is a conventional 1-Mc/s crystal oscillator, the sine-wave output of which is distorted to a triangular waveform in V_{1B}. The 1-Mc/s sine-wave output is also taken through a buffer valve V_2 to synchronize the 100-kc/s multivibrator V_3, the output waveform of which is made triangular in V_4. The 1-Mc/s and 100-kc/s outputs of triangular waveform are applied respectively to gate valves V_7 and V_8. An additional 100-kc/s output to the height-mark dividers is taken from the multivibrator through a buffer stage V_{10}.

To enable frequency-calibration markers to be presented at the start of the time-base sweep, gate pulses generated by V_5 and V_6 are applied to the suppressor grids of V_8 and V_7 respectively. A 300-μsec train of 100-kc/s pulses followed by a 300-μsec train of 1-Mc/s pulses are thus passed by the gate valves to the grid of the receiver mixer valve. As the receiver tunes through harmonics of 100 kc/s a pulse appears at the extreme left-hand side of the trace, approximately 300 μsec in duration, while at the megacycle points the pulse is effectively twice as long owing to the addition of the megacycle wave train.

To make the amplitude of the frequency marks largely independent of receiver gain, the gate pulses are used to control the i.f. gain during the presentation of the frequency marks. This is achieved by combining the gate pulses in the double diode V_9 and applying the resultant pulse to the gain control valve V_8 in the receiver, thereby increasing the i.f. gain for the duration of the pulse as described in Section 6.2.

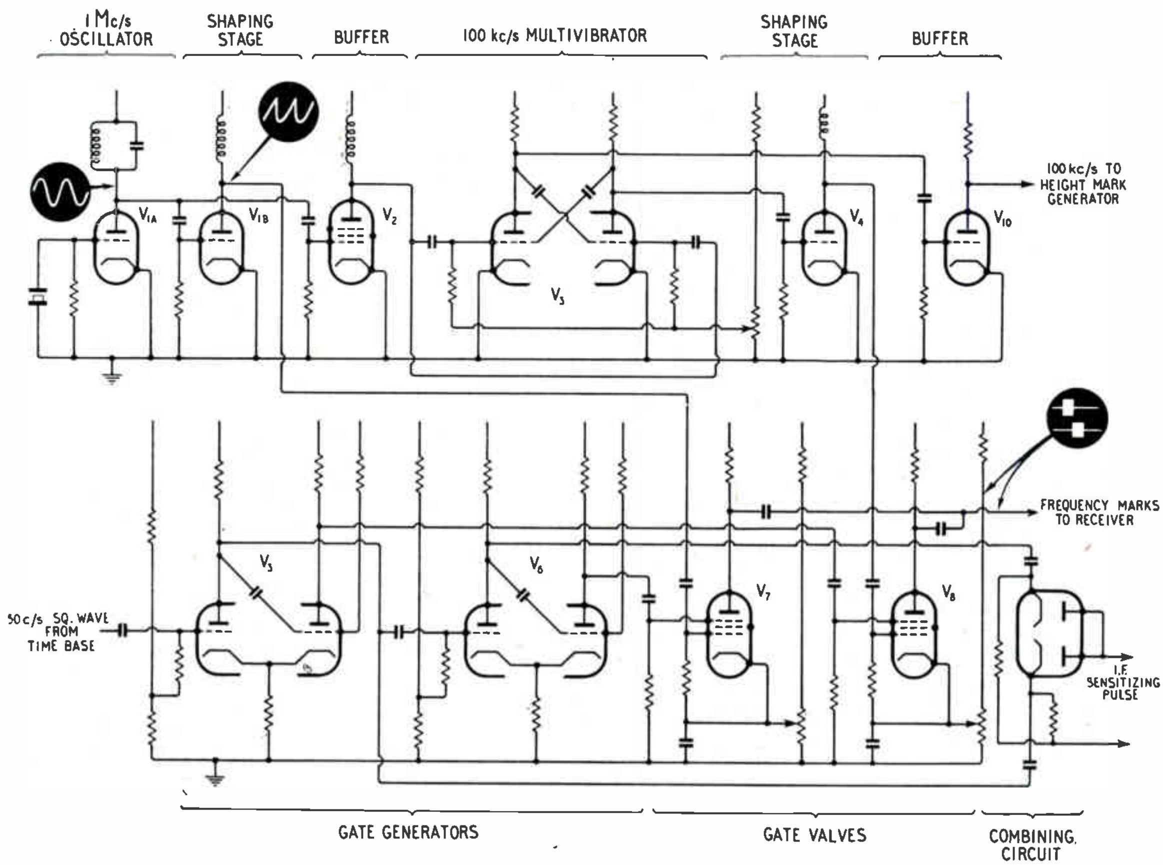


Fig. 3. *Frequency mark generator.*

3.2. *Height Calibration*

Markers are displayed on the time-base sweep at intervals equivalent to heights of 50 km, corresponding to the period of one oscillation at 3 kc/s. A 3-kc/s waveform is obtained by suitable frequency division of the output of the 100-kc/s multivibrator.

The circuit used is shown in Fig. 4. The 100-kc/s input from the buffer valve (V_{10} in Fig. 3) is used to synchronize a 25-kc/s multivibrator V_1, which in turn triggers a 5-kc/s multivibrator V_2. The 5-kc/s waveform is applied to a frequency-multiplying stage V_3, the anode circuits of which are tuned to 15 kc/s. After amplification and limiting in V_4 the 15-kc/s waveform is applied to a phase splitter V_5, and the push-pull output of this stage is used to synchronize a 3-kc/s multivibrator V_6.

The 3-kc/s output is shaped in V_7 and V_8 to produce height marks in the form of short pulses. These are applied to V_9 from which two low-impedance outputs are taken, one of positive pulses to the monitor display, and one of negative pulses to the camera display and to the time-base locking circuit.

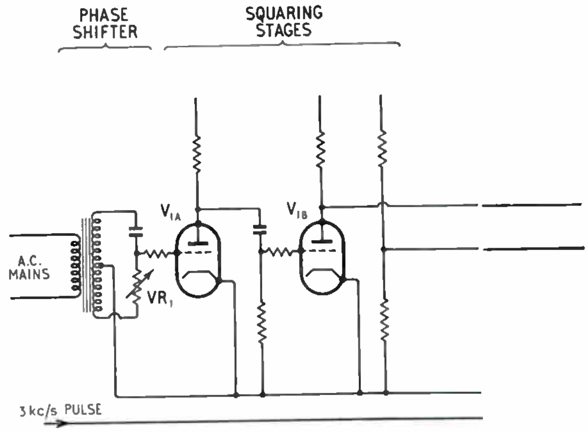
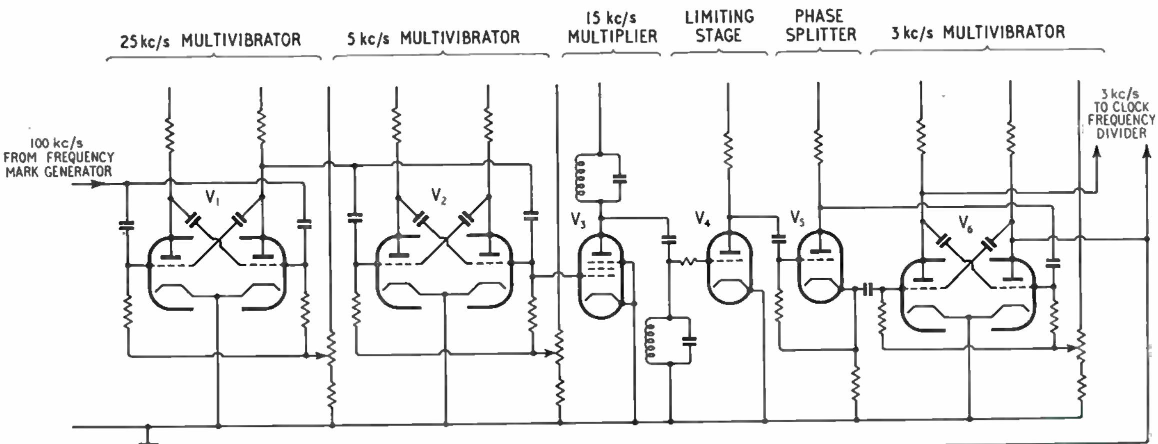


Fig. 5 (above and right). *Time-base unit.*

trated in Fig. 6. The time axes for these waveforms are directly related to show their relative durations and times of initiation.

4.1. *Square-Wave Generator*

This circuit is required in order that a stationary pattern of crystal-derived height markers may be



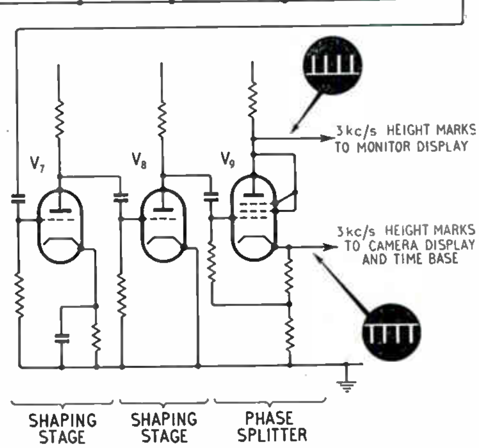


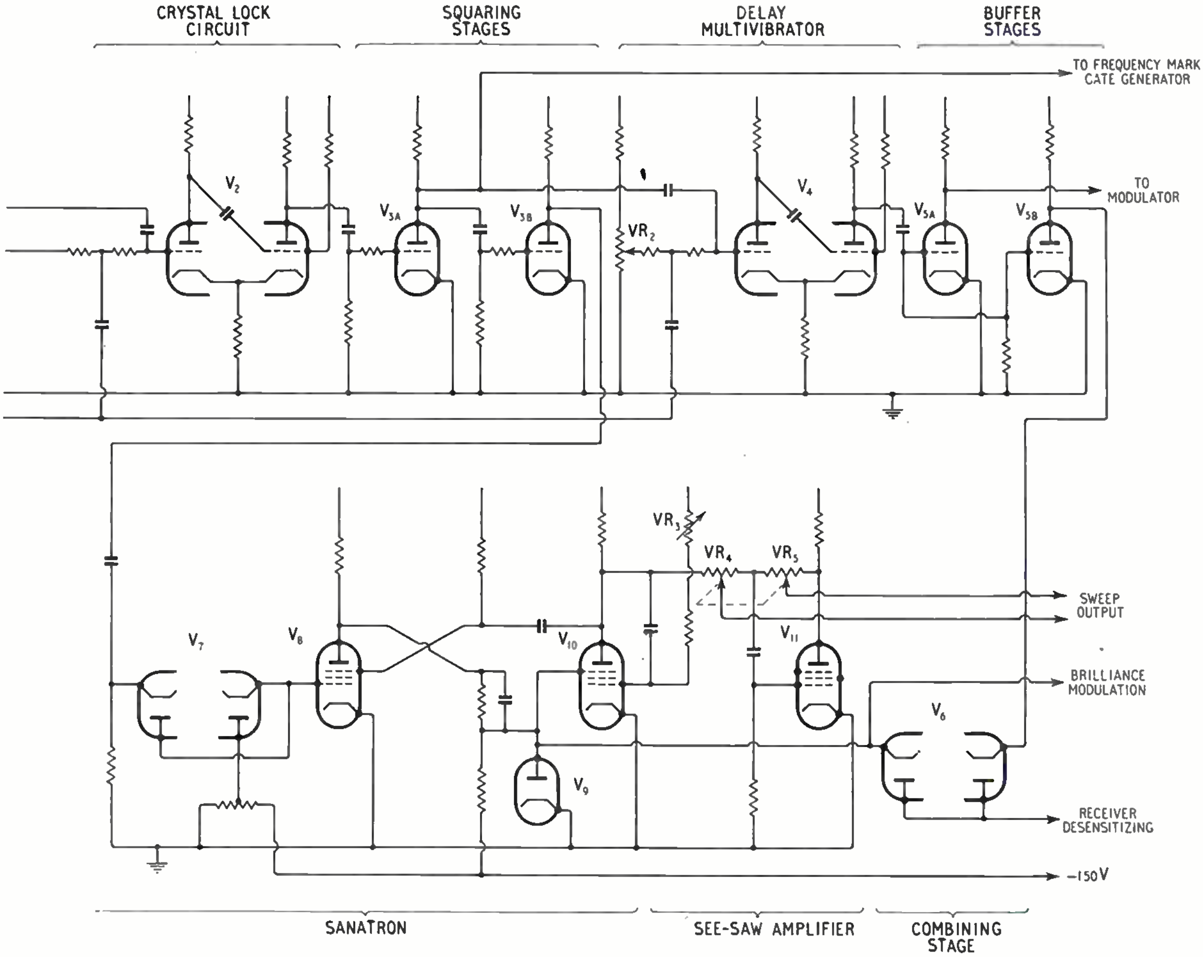
Fig. 4. *Height mark generator.*

3.3. *Low-Frequency Output*

The output from the 3-kc/s multivibrator is further divided by a chain of three multivibrators operating at 600 c/s, 120 c/s and 60 c/s. The 60-c/s waveform is applied to a tuned power amplifier which delivers a sine-wave output to the synchronous clock on the front panel of the equipment and to the time switch which controls the automatic operation of the recorder.

4. Time-Base Unit

This unit comprises the square-wave generator, the modulation-pulse delay circuit and the sweep circuit. A schematic diagram is given in Fig. 5 and the waveforms of certain of the stages illus-



displayed on the time base which is swept at the mains frequency.

Consider the circuit of Fig. 5. The transformer supplies an a.c. mains input of about 50 V r.m.s. the phase of which may be varied over nearly 180° by means of VR_1. This sine-wave input (waveform A) is amplified and limited in V_{1A} and V_{1B} (waveform B) and the resulting square wave differentiated and applied to V_2. In parallel with this input are negative-going 3-kc/s pulses (waveform C) derived from the height-mark valve on the divider chassis. V_2 forms a triggered multivibrator which is initiated by the square wave and reset by one of the 3-kc/s pulses; hence the trailing edge of the output from V_{2B} is locked to a height mark while its repetition frequency is that of the supply mains.

The waveform is amplified and limited in V_3, the output from V_{3A} going to the frequency-mark gate-pulse generator valves and the modulation-pulse delay-multivibrator V_4. The output from V_{3B} is differentiated, and the negative part of the waveform selected by the double diode V_7 and used to initiate the time-base sweep.

4.2. *Pulse-Delay Circuit*

V_4 is a triggered multivibrator similar in operation to V_2. Its function is to delay the modulation pulse relative to the start of the time-base sweep to allow an interval for the insertion of the frequency marks. It differs from the square-wave generator in that the reset time, or 'delay', is variable and controlled by VR_2. However, as the reset is always triggered by one of the 3-kc/s pulses, the delay varies in a series of discrete intervals.

The output from the delay multivibrator is applied to the phase-inverter V_{5A}, the output from which consists of a negative-going pulse, corresponding in duration to the time interval between a small integral number of height marks, usually four. This pulse is fed to the modulator where its trailing edge is used to generate the modulation pulse for the transmitter.

To enable the d.c. restoration circuits to operate in the presence of a c.w. signal the r.f. stage of the receiver is made insensitive for the total time it is not required to receive signals. The waveform applied to the r.f. stage is obtained by combining, in the double diode V_6, the fly-back pulse from the time-base with the modulator delay waveform from V_{5B}.

4.3. *Sweep Circuits*

The time-base generator uses a Sanatron circuit[2] which generates a single-stroke linear sweep. The circuit also provides a rectangular pulse, having precisely the same duration as the sweep, which is used to brilliance-modulate the cathode-ray tubes and to render the receiver insensitive during the fly-back period. The sweep time is continuously variable from 1·5 to 15 msec, controlled by VR_3.

To obtain a push-pull output, the Miller valve, V_{10} of the Sanatron, is coupled to a similar valve, V_{11}, in a see-saw phase-inverter circuit such that the voltage excursions on the two valves are complementary. Ganged potentiometers VR_4 and VR_5 control the sweep amplitude and the output is d.c. coupled to the plates of the c.r. tube.

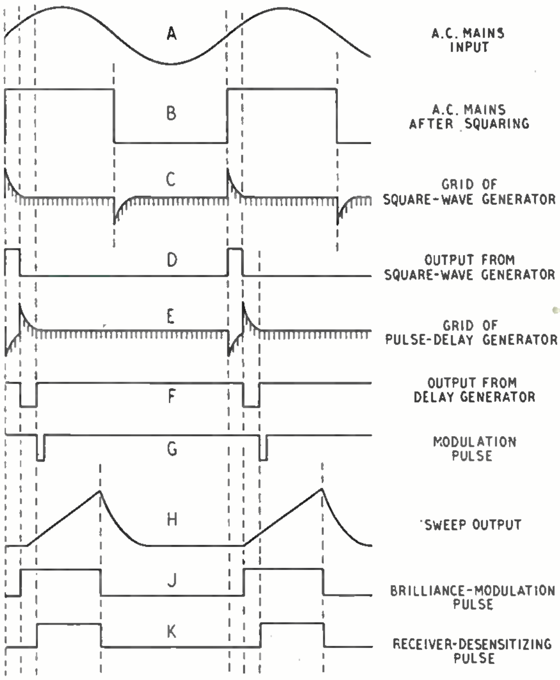


Fig. 6. *Ionospheric recorder; time-base waveforms.*

5. Transmitter

The transmitter in the recorder described by Naismith and Bailey was a pulsed oscillator coupled directly to the aerial. Bailey recommended that in future recorders this should be replaced by a master-oscillator–power-amplifier system using an aperiodic amplifier.

The present transmitter consists of a push-pull grid-modulated pulsed-oscillator driving an aperiodic class B amplifier which is coupled by a wideband auto-transformer to the aerial. The complete transmitter circuit is shown in Fig. 7.

5.1. *Operating Conditions of the Oscillator and Power-Amplifier Valves*

The oscillator and two power amplifier valves are 40-W double tetrodes (Mullard QQV 06/40) having indirectly-heated oxide-coated cathodes. In normal c.w. use these valves are operated with 750 V h.t. and give a power output of 75 W. In this transmitter the oscillator is operated with an anode supply of 1·2 kV and delivers about 80 W to the grids of the power-amplifier valves. The output stage is operated in class B with an anode

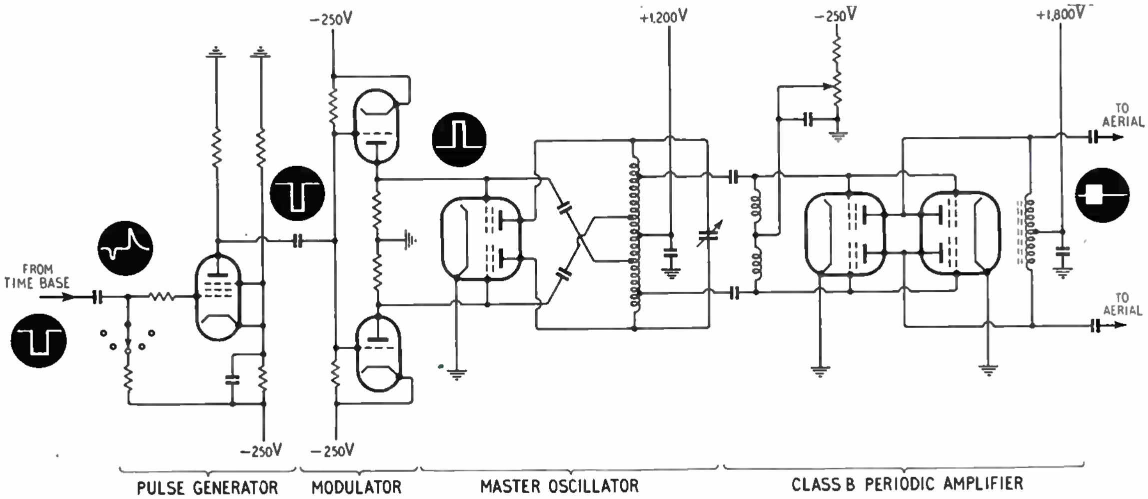


Fig. 7. *Transmitter circuit (screen-grid supply circuits omitted for simplicity).*

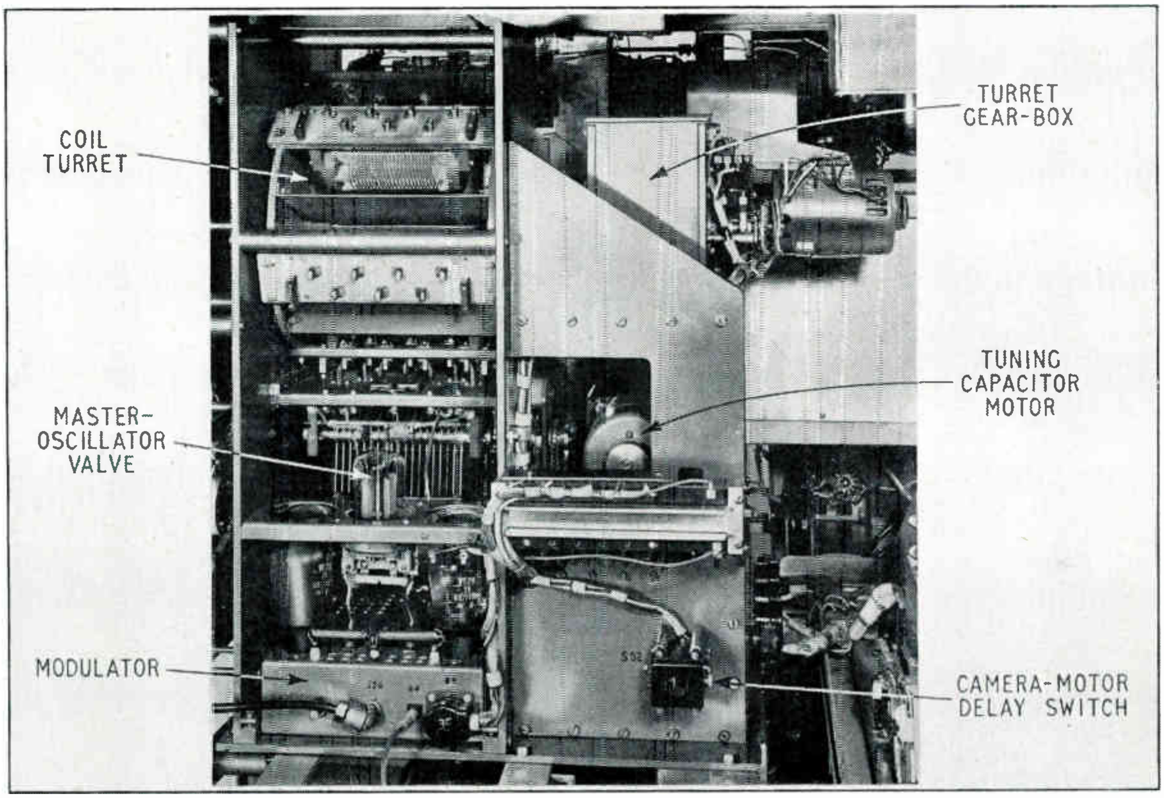


Fig. 8. *Improved automatic ionospheric recorder; transmitter.*

supply of 1·8 kV. The cathode emission at the positive limit (200 V) of the grid excursion is 3 A giving a fundamental radio-frequency component of 1·5 A peak. The grids and anodes of the output valves are cross-connected so that in each half cycle of the driving voltage two tetrode sections, one in each envelope, are conducting. The emission of 3 A is thus divided between two cathodes, and at any time current is being taken from one face only of each virtual cathode.

5.2. *The Modulator*

The output from the pulse-delay circuit in the time base is differentiated, and the positive part of the waveform limited and inverted in the pulse generator valve V_1, and the resulting negative-going pulse is applied to the grids of the modulator valves V_2 and V_3. The anode loads of these valves are the grid leaks of the two sections of the oscillator valve V_4 which is normally biased beyond cut off. When the negative-going pulse from V_1 is applied to V_2 and V_3 they are momentarily cut off, and the bias is removed from the oscillator, which is thus allowed to oscillate for the duration of the modulator pulse. The pulse width is variable from 80 μsec to 330 μsec.

5.3. *Oscillator and Power Amplifier*

A conventional Hartley circuit is used for the oscillator, the only unusual feature being the use of a fixed capacitor in series with the tuning capacitor on the highest frequency range (15-25 Mc/s). This is done to reduce the rate of frequency sweep on this range in order to obtain sufficient detail in the photographic record. The power amplifier is operated with fixed bias, the grids being connected to the bias supply through r.f. chokes to prevent self bias being developed by grid current.

The optimum anode impedance required by the output valves is approximately 600 ohms and they are thus matched to rhombic or delta aerials whose mean impedance is about this value. However, the operation of the amplifier in class B makes it necessary to use a transformer to balance out the even harmonics present in the anode-current waveform. If this is not done, large in-phase voltages at the frequencies of the even harmonics are applied to the aerial, giving undesired radiation and reduced efficiency. The close coupling needed in the transformer required the use of a high-permeability core having a loss sufficiently low to prevent excessive heating. In the design adopted the two halves of the winding are interwound over the whole perimeter of a Permalloy-dust ring having a permeability of 110. Two transformers of this type are used to cover the frequency range, one being used from 0·6 to 7 Mc/s and the other from 7-25 Mc/s. It is of interest to mention that with the two halves of the winding interwound, a coupling coefficient of 0·98 is obtained, whereas with the two halves wound on opposite 180° segments the coupling coefficient drops to about 0·8.

The output transformers have been used to match the transmitter to a coaxial cable by adding an 80-ohm secondary winding.

The power packs supplying screen and anode voltages to the power-amplifier valves have large capacitance in the output sections of their ripple filters. This is necessary to ensure that the charge drawn from the capacitors during the pulse does not cause the voltage to drop appreciably.

5.4. *Mechanical Construction*

The transmitter and modulator form a separate unit which may be removed from the recorder if necessary. The construction is shown in Fig. 8. The modulator chassis is removable and fits directly beneath the oscillator valve panel. The oscillator tuning capacitor has a straight-line frequency law, and is driven by a synchronous motor through a cam which is cut to give a quick return motion. The coil turret is driven by a similar motor through a five-position Geneva movement. Extra contacts are provided on the turret to switch the two aerial transformers.

6. Receiver Section

6.1. *Receiving Aerial*

The receiver is normally used with delta or vertical rhombic-type aerials. Suitable designs are discussed in a paper by Bailey.[3] A balance-to-unbalance transformer of the type described by Maurice and Minns[4] is used at the base of the aerial to feed a coaxial cable connected to the receiver input. Unbalanced pick-up on the aerial is thus eliminated and the effect of local interference near the recorder is reduced.

6.2. *Receiver*

Fig. 9 shows the circuit diagram of the receiver which, in general principles, follows closely that described by Naismith and Bailey. The low-impedance input feeds a tuned radio-frequency stage V_1 followed by a triode-hexode frequency changer V_2. The intermediate frequency of 500 kc/s passes through two i.f. stages, V_4, V_5, to a diode detector stage V_6, the output of which is amplified in a video stage V_7 connected to the display unit. The receiver is tuned by a three-gang linear-law capacitor driven by a magslip induction motor through a gear-box and magnetic clutch.

To maintain the tuning of the receiver in step with that of the transmitter, an a.f.c. system similar to that of the earlier model is used. The principle is shown in the block schematic of Fig. 2. An auxiliary frequency changer V_3, the oscillator section of which is effectively in parallel with that of the main frequency changer, produces a beat frequency between the receiver local-oscillator and the transmitter master-oscillator frequencies. The beat frequency is fed to a frequency-sensitive servo-amplifier, in which a discriminator circuit tuned to 500 kc/s is used.

The rectified output from the discriminator is thus zero when the input signal is at the intermediate frequency (that is, when the receiver and transmitter are in tune) but increases rapidly on either side of this frequency with a change of polarity on passing through the tuning point.

The waveform of the discriminator output is the envelope of the transmitted radio frequency and is thus in the form of short positive or negative pulses having the same repetition rate as the a.c. mains. The 50-c/s sine-wave component of the pulse waveform is selected in the tuned

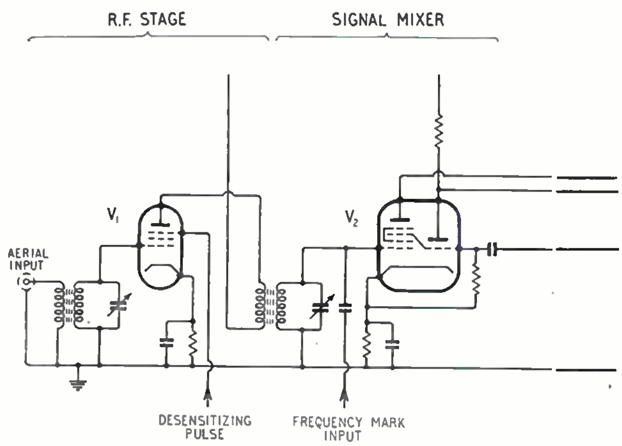


Fig. 9 (above and right). *Receiver and tuning-control circuit (anode decoupling and screen-supply circuits have been omitted for clarity).*

transformer T_1 and is there added as a correction to a steady 50-c/s 'drive' voltage. The resultant voltage is then applied to one field of the two-phase magslip motor which drives the receiver tuning capacitor through the magnetic clutch, and controls its speed in a manner such that the receiver is kept in tune with the transmitter.

To prevent hunting of the tuning capacitor about the correct position, a 50-c/s voltage proportional to velocity is derived from a generator geared to the magslip and is added to the magslip drive voltage. This system is discussed in detail in the earlier paper.[1]

The gain of the receiver is controlled by varying the bias on the variable-mu i.f. valves, the cathodes of which are connected to a potentiometer system between h.t. and earth. The fixed element of this network consists of the triode valve, V_8, which is operated at a low bias and which, in its normal conducting condition, may be considered as a resistance between cathode line and h.t. The variable element consists of two groups of attenuator controls. The first consists of three basic attenuators, one of which is permanently in circuit, while the other two may be automatically switched, as required, by means of the time unit; this group operates equally on all bands. The second group consists of individual attenuators, one for each band of the receiver.

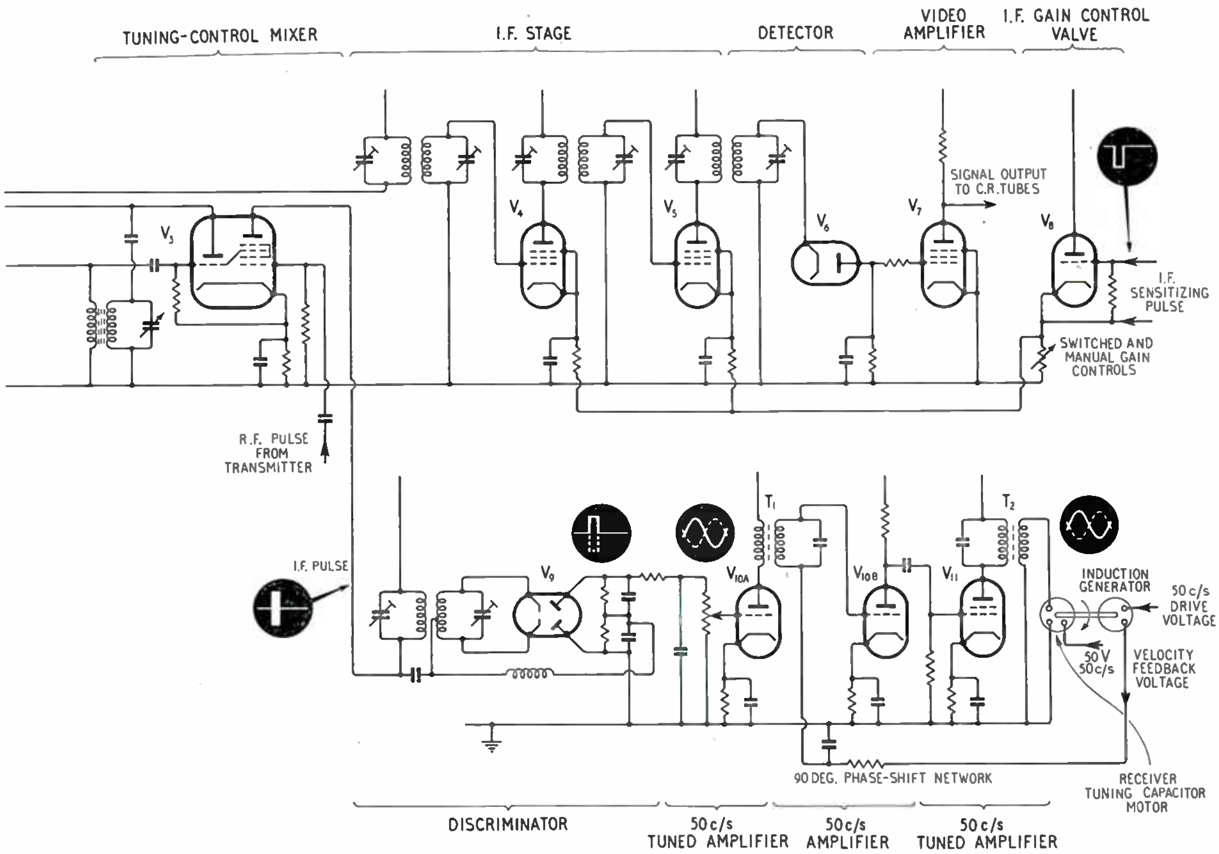
The use of the gain-control valve V_8 as the fixed element in the potentiometer network enables the gain of the receiver to be controlled electronically by pulses applied to the valve grid. Thus, during the presentation of the frequency markers the valve is cut off by the combined gate pulses from the megacycle and 100-kc/s output valves, so that the potential of the cathode line is reduced and the receiver sensitized to a more-or-less fixed level. Thus the output required from the frequency-marker circuit may remain constant, independent of the gain of the receiver, which greatly facilitates the presentation of the markers.

To ensure that no external signals are received during the presentation of the frequency markers, and to assist the operation of the cathode-ray tube d.c. restoration circuits, a desensitizing pulse is applied to the suppressor grid of the r.f. valve for the whole of the fly-back time, and from the start of the sweep to the beginning of the transmitter pulse (see Section 4.2).

7. Display Units

The display arrangement consists of two 6-in. diameter cathode-ray tubes as shown in the photograph of Fig. 1. The upper tube is for visual monitoring and the lower is a photographic tube in front of which is mounted the camera.

The camera is a self-contained unit with its own drive motor and is designed to use unperforated paper 70-mm wide driven continuously past the lens by means of a friction drive. The lens is an f/3·5 anastigmat of 3-in. focal length; no shutter is provided. Besides photographing the screen of



the cathode-ray tube the camera also automatically records the date and time, to the nearest minute, at the commencement of each recording, by photographing the data presented in a suitable form by the timer unit.

The monitor and camera cathode-ray tubes are identical apart from the colours of their screens, green being used for the monitor and blue for the camera tube; they are therefore operated from a common e.h.t. supply. The Y-shift controls are independent for each tube but the X-plate shifts are common to monitor and camera tubes so that positioning of the trace in the horizontal direction may be checked for both tubes by reference to the monitor.

The static operating conditions for the cathode-ray tubes are such that in the absence of any sweep voltage they are blacked out. During the time-base sweep a brilliance-modulation pulse is applied to the grid circuits, thus rendering the traces visible for the duration of the sweep. In addition, the brilliance-modulation pulse to the camera tube is interrupted by means of a relay to provide a black-out between bands.

The method of presenting information is different for the two cathode-ray tubes. In the case of the monitor the signals and frequency markers from the receiver output are applied as an amplitude deflection to one of the Y plates to give an upwards deflection while the height markers are applied to the other Y plate and deflect downwards. In the camera tube, however, all information is presented as a brilliance modulation of the trace, the output from the receiver being applied to the cathode and the height markers to the grid. Hence, both signals and markers appear as breaks in the trace so that as the recording paper in the camera is drawn steadily past the lens, a series of lines are drawn on the record corresponding to the breaks in the trace which do not affect the sensitized paper.

The frequency markers, which occur at the commencement of the time-base sweep before the ground pulse, cause momentary breaks in the trace as the receiver tunes through harmonics of 100 kc/s, and thus appear as discrete pulses beneath the continuous ground pulse as shown in Fig. 11.

8. Operation

The operation of the recorder is almost identical with that of the earlier model and will not be described in detail. A complete frequency sweep occupies approximately five minutes made up of 50 seconds per band and 10 seconds for band changing, and such records may be made completely automatically at any combination of 15-minute intervals. In addition, any combination of bands 1, 4 and 5 may be omitted for a given hour, the sequence repeating after 24 hours, while at the same time any one of three degrees of attenuation may be introduced.

Operating in this manner, making one recording of five bands per hour, the equipment may be left unattended for three days, after which the camera requires reloading. The time of switching on is controlled by the crystal-controlled timer unit and is independent of the frequency stability of the supply mains.

For special investigations the equipment may be operated continuously over the full frequency range, or over any selected band, or on any selected frequency. In addition, the sweep speed may be adjusted so that the full width of the time-base displays any range of heights from 100 to 2000 km, although for operational use a normal figure is about 1200 km.

9. Performance

9.1. *Transmitter*

The power output from the transmitter is limited at the lower frequencies mainly by the peak emission available from the cathodes of the power-amplifier stage, while at the higher frequencies an additional factor is the inherent stray distributed capacitance associated with the wide-band transformer required to balance out the harmonics present from the class B operation of the stage. Table 1 gives power output figures for a typical equipment, deduced from the current generated in a dummy load of 600 ohms using a modulation pulse of 250 μsec.

TABLE 1

Band	Frequency (Mc/s)	Power output (kW)
1	0·67 1·10 1·35	1·17 1·68 1·36
2	1·45 2·40 3·20	1·04 1·20 1·12
3	3·25 5·30 6·80	1·34 1·19 0·95
4	7·2 11·3 15·3	0·74 0·66 0·62
5	15·4 20·0 23·8	0·45 0·68 0·79

9.2. *Receiver*

The desirable characteristics of a receiver for this type of recorder are:

(i) The sensitivity should be inversely proportional to the power output from the transmitter.

Such a characteristic should also include the transmitting and receiving aerials and is not a practical specification. However, a compromise is to make the sensitivity characteristic of each band of the receiver approximately flat so that the gain of individual bands may be adjusted to compensate for the decrease of the transmitter power with increasing frequency.

(ii) There should be no paralysis of the receiver due to strong signals such as the ground pulse from the transmitter.

(iii) Pulse broadening and delay should be reduced to a minimum consistent with the comparatively-narrow bandwidth necessary to reject interfering stations.

Table 2 shows the absolute sensitivity of the receiver, measured without adjusting the levels between bands. It is expressed in terms of the input carrier (modulated to a depth of 60%) required at the aerial terminals to produce a 2-cm deflection on the cathode-ray tube.

As may be seen from the records of Fig. 10 there is no appreciable paralysis of the receiver due to strong signals even though the r.f. stage remains at full sensitivity during the emission of the ground pulse from the transmitter. This has been achieved by a suitable choice of time constants throughout all the stages.

The receiver bandwidth is shown in Table 3.

TABLE 2

Band	Frequency (Mc/s)	Input (μV)
1	0·68 1·10 1·35	1·2 1·3 1·0
2	1·4 2·4 3·2	1·5 0·8 1·0
3	3·3 5·3 6·8	1·7 1·0 0·8
4	7·2 11·3 15·3	1·5 2·1 1·5
5	15·4 20·0 23·8	2·5 1·2 1·0

TABLE 3

Loss in db	kc/s from Resonance	
6 20 40	−15 −22 −35	+13 +20 +32

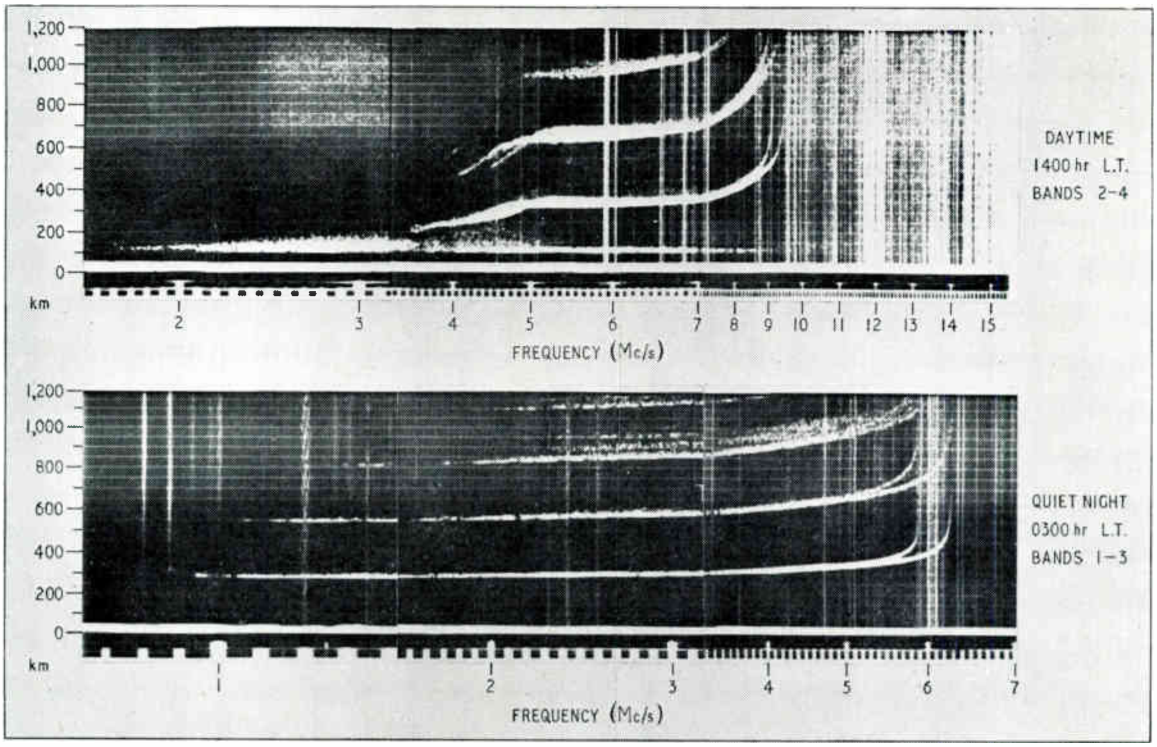


Fig. 10. *Examples of photographic records.*

This selectivity is determined largely by the three i.f. transformers which are adjusted for critical coupling and are all tuned to the intermediate frequency of 500 kc/s. The pulse broadening under these conditions is such that an 80-μsec ground pulse is broadened to approximately 150 μsec and greater pulse widths are broadened by proportionately smaller amounts. There is thus no possibility of the trailing edge of the ground pulse merging with the leading edge of the lowest echo likely to be received from the E region. For echoes where overloading does not occur in the early stages of the receiver, no appreciable pulse broadening is observed.

variations of the order of 1 km in the heights of the layers may be detected.

No temperature control is applied to the crystal oscillator but under normal room-temperature variations the timer unit is accurate to 2 or 3 seconds per day.

10. Conclusions

The equipment described in this paper has been in small-scale production by a commercial firm and a number of the recorders operated on a routine basis for some months. The results obtained are very satisfactory and experience indicates that the mechanical complexity inherent in an instrument

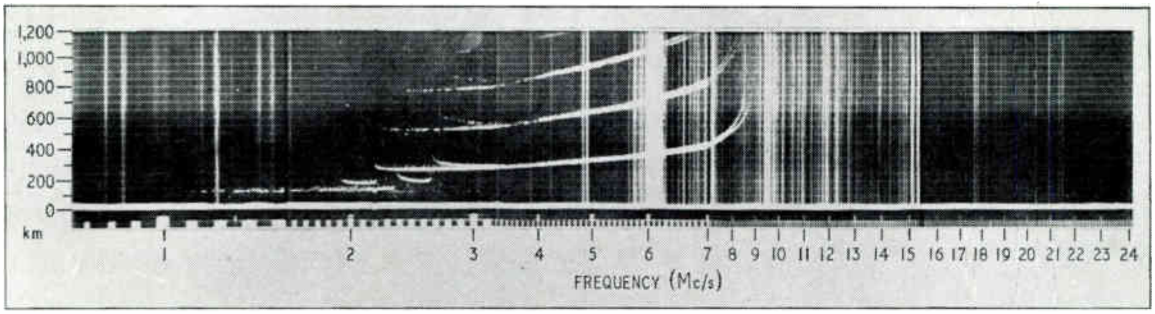


Fig. 11. *Example of photographic record showing full frequency coverage of recorder.*

9.3. *General Performance*

The overall performance which may be expected from this type of equipment is illustrated by the sample records shown in Figs. 10 and 11, taken at Ibadan, Nigeria. A more complete selection of records was given in the earlier paper[1] but the records reproduced here show the improved presentation of frequency marks and the linear height scale.

The accuracy of the frequency calibration is determined by the interpolation accuracy on the final record and is lowest on bands 4 and 5 where a range of 8 or 9 Mc/s is presented in a space of 7 cm. Even on these bands, however, an accuracy of 0·1 Mc/s is readily obtainable.

The height on routine recordings is measured to the nearest 5 km and the absolute height may be considered accurate to this limit if a correction is made for the pulse delay in the receiver. This delay is equivalent to an error not greater than 2 km in range. On the expanded time scale, which covers the frequency range in a number of bands, has not introduced any unreliability.

Acknowledgments

The work described above was carried out as part of the programme of the Radio Research Board. This paper is published by permission of the Director of the National Physical Laboratory, and the Director of Radio Research of the Department of Scientific and Industrial Research.

The authors desire to acknowledge the work of Mr. G. W. Holland who collaborated in the development, and the Union Radio Co., Ltd., for the mechanical design of the transmitter.

REFERENCES

[1] R. Naismith and R. Bailey. "An Automatic Ionospheric Recorder for the Frequency Range 0·55 to 17 Mc/s", *Proc. Instn elect. Engrs*, 1951, Pt. III, Vol. 98, p. 11.
[2] F. C. Williams and N. F. Moody. "Ranging Circuits, Linear Time Base Generators and Associated Circuits", *J. Instn elect. Engrs*, 1947, Pt. IIIA, Vol. 93, p. 1188.
[3] R. Bailey. "Aperiodic Aerials", *Wireless Engr*, 1951, Vol. 28, p. 208.
[4] D. Maurice and R. H. Minns. "Very Wide-Band Radio-Frequency Transformers", *Wireless Engr*, 1947, Vol. 24, p. 168.

NON- ESONANT SLOPING-V AERIAL

By J. S. Hall, M.Eng., B.Sc. (Eng.) RAND.

(*Formerly, Canadian Aviation Electronics, Ltd.*)

MARY.—Explicit formulae are derived for the distant electric-field components, at any n and azimuth, for the apex-driven, non-resonant, sloping-V aerial. Typical calculated partial ns are in agreement with experiment.

luction

E non-resonant sloping-V aerial, although well known and used on some important links, seems to have received little attention radio literature.[1] Nevertheless for military use, or in isolated places where ease of installation is important, it appears attractive. Mechanically simple, it has wide frequency range and fair directivity.

As considered in this paper, it consists of two straight wires in the form of a V, supported at the apex on a tall pole. The other ends, on short poles, are earthed, usually through resistances of a few hundred ohms. Operation is intended to be essentially non-resonant. The transmission line, connected at the apex, forms a continuation of the two aerial wires.

A basic analysis of this aerial was published in 1943 by Harrison.[1] He achieved considerable simplification by restricting his analysis to the planes $y = 0$ and $z = h$, obtaining polar-pattern formulae for two important cases, the vertical field in the horizontal plane, and the horizontal field in the vertical bisector plane. While these patterns are undoubtedly of great interest, such restrictions are avoided in the present paper.

Here, explicit formulae are found for the distant-field components at any azimuth and elevation, and illustrated by calculated patterns for a typical aerial. Experimental results, unfortunately not available to the author for publication at this time, are in substantial agreement with these computed values.

$$e_\phi = K \cos\gamma \times \left[\begin{array}{l} + \sin(\eta-\phi)\, j_0\{\pi l\,[1 - \text{cs.}\cos(\eta-\phi) - \text{sc}]\}\, e^{-j2\pi h\cos\theta} \\ + \sin(\eta+\phi)\, j_0\{\pi l\,[1 - \text{cs.}\cos(\eta+\phi) - \text{sc}]\}\, e^{-j2\pi(h\cos\theta + w\sin\theta\sin\phi)} \\ - \sin(\eta-\phi)\, j_0\{\pi l\,[1 - \text{cs.}\cos(\eta-\phi) + \text{sc}]\}\, e^{-j0} \\ - \sin(\eta+\phi)\, j_0\{\pi l\,[1 - \text{cs.}\cos(\eta+\phi) + \text{sc}]\}\, e^{-j2\pi w\sin\theta\sin\phi} \end{array}\right] \quad .. \quad .. \quad (1)$$

2. Dimensions and Co-ordinates

Any particular sloping-V aerial has three basic dimensions, usually stated as the apex height above ground, the leg length, and half the angle between the legs in their plane, denoted by H, L, and τ respectively (see Fig. 1). However, it is convenient to write the height and length in wavelengths, $h = H/\lambda$ and $l = L/\lambda$, and to introduce: $w = W/\lambda$, half the distance in wavelengths between the open ends; ρ, the angle between the V plane and ground plane; γ, the angle between leg and ground plane; and η, the angle between the projection of each leg on the ground plane and the vertical bisector plane of the V.

The apex of the V image is chosen as the origin of the spherical co-ordinate system, with the Z-axis vertical. The point of observation P is situated at d, θ, ϕ.

3. Formulae

As shown in the appendix, the electric-field components at the distant point P are

MS accepted by the Editor, December 1952.

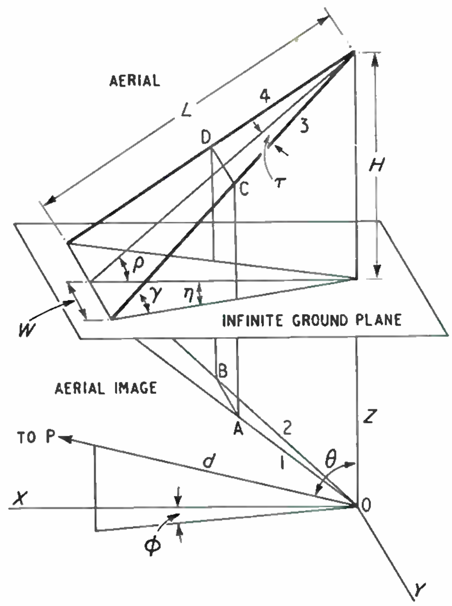


Fig. 1. *Sloping-V aerial and co-ordinate system.*

$$e_\theta = K \times$$

$$\left[\begin{array}{l} -\,[\text{ss} - \text{cc.}\cos(\eta - \phi)]\,\mathrm{j}_0\{\pi l\,[1 - \text{cs.}\cos(\eta - \phi) - \text{sc}]\}\,e^{-j2\pi\,h\cos\theta} \\ +\,[\text{ss} - \text{cc.}\cos(\eta + \phi)]\,\mathrm{j}_0\{\pi l\,[1 - \text{cs.}\cos(\eta + \phi) - \text{sc}]\}\,e^{-j2\pi(h\cos\theta + w\sin\theta\sin} \\ -\,[\text{ss} + \text{cc.}\cos(\eta - \phi)]\,\mathrm{j}_0\{\pi l\,[1 - \text{cs.}\cos(\eta - \phi) + \text{sc}]\}\,e^{-j0} \\ +\,[\text{ss} + \text{cc.}\cos(\eta + \phi)]\,\mathrm{j}_0\{\pi l\,[1 - \text{cs.}\cos(\eta + \phi) + \text{sc}]\}\,e^{-j2\pi w\sin\theta\sin\phi} \end{array}\right]$$

with the abbreviations

$K = [60\pi\, lI \cos(2\pi ft - \alpha)]/d$

$\text{ss} = \sin\gamma \sin\theta$

$\text{sc} = \sin\gamma \cos\theta$

$\text{cs} = \cos\gamma \sin\theta$

$\text{cc} = \cos\gamma \cos\theta$

$\mathrm{j}_0\{x\} = (\sin x)/x$ = spherical Bessel function of zero order.

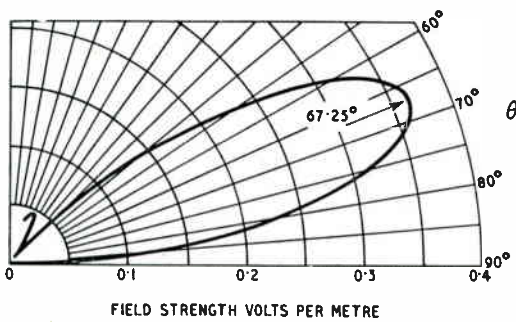


Fig. 2. *Vertical directivity pattern in line-of-shoot ($\phi = 0$) for one ampere in a typical sloping-V aerial, at a distance of 1,000 metres and frequency of 7,478 kc/s.*

In the special case where $\phi = 0$ (i.e., in the vertical plane bisecting the V) the theta-field component is zero, so that the total field is given by

$$e_\phi = K_1 \begin{bmatrix} \mathrm{j}_0\{\pi l\,[1 - \cos\tau \sin(\theta + \rho)]\}\,e^{-j2\pi\,h\cos\theta} \\ -\mathrm{j}_0\{\pi l\,[1 - \cos\tau\sin(\theta - \rho)]\} \end{bmatrix} \qquad (3)$$

where $K_1 = [120\,\pi l\, I\cos\gamma\cos\eta\cos(2\pi ft - \alpha)]/d$

This formula gives the pattern at various angles of elevation in the direction of maximum horizontally-polarized radiation or line-of-shoot.

Similarly, in the special case where $\theta = 90°$, the phi-field component is zero and the total field is

$$e_\theta = K_2 \begin{bmatrix} \mathrm{j}_0\{\pi l\,[1 - \cos\gamma\cos(\phi + \eta)]\}\,e^{-j2\pi w\sin\phi} \\ -\mathrm{j}_0\{\pi l\,[1 - \cos\gamma\cos(\phi - \eta)]\} \end{bmatrix} \qquad (4)$$

where $K_2 = [120\,\pi l\, I\sin\gamma\cos(2\pi ft - \alpha)]/d$

These equations giving special values of e_ϕ and e_θ are equivalent to equations (12) and (16) of Harrison's paper,[1] but have been written in a form which emphasizes their similarity.

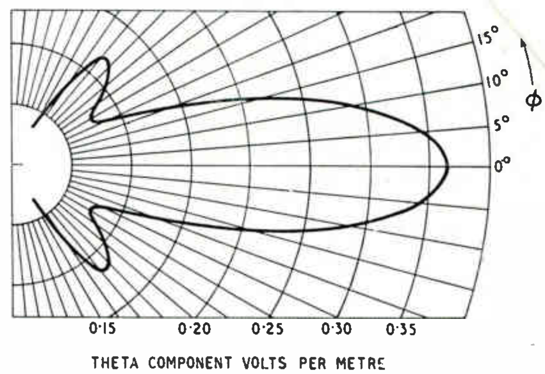


Fig. 3. *Horizontal-polarization azimuth pattern at elevation of vertical-pattern maximum ($\theta = 67{\cdot}25°$) under same conditions as Fig. 2.*

4. Patterns

Some typical patterns are given (Figs. 2, 3 and 4) in volts per metre at a distance of 1,000 metres for a current of 1 ampere in an aerial having $L = 450$ ft, $H = 81$ ft, and $\tau = 16{\cdot}25°$. Partial patterns are presented, because measurements suggest that in practice the minor lobes are sensitive to secondary effects ignored in the present analysis. In calculating l, at $f = 7{,}478$ kc/s, the velocity along the aerial was arbitrarily taken to be 95% of the free-space velocity. This assumption is not rigorous, but has little effect on the shape of the main lobe.

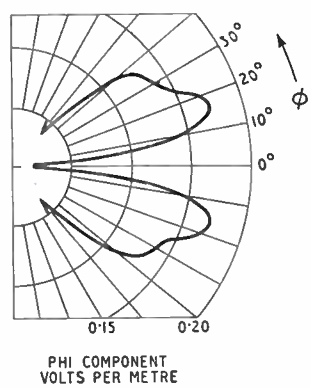


Fig. 4 (right). *Same as Fig. 3, but for phi component.*

The length and half-angle of this aerial appear to be fairly well chosen for the given height. As the frequency rises, the elevation of maximum horizontally-polarized radiation decreases, changing from $\theta = 67° 15'$ at 7,478 kc/s (half-power azimuthal beam width of 12°) to approximately $\theta = 81°$ at 20,000 kc/s. A proportionate increase in height and length, leaving angles γ and τ unchanged, will lower the elevation of main-lobe maximum in the line-of-shoot at a given frequency and decrease the relative main-lobe width. In other words, such an increase will give similar patterns at a lower operating frequency.

While the patterns are for the distant field of a transmitting aerial, the properties of the same aerial when receiving may be cautiously inferred.

In particular, the sensitivity to vertically-polarized radiation at low angles of arrival off the line-of-shoot may make the non-resonant sloping-V aerial unsuitable for reception in noisy surroundings.

Conclusions

Explicit formulae have been derived for the distant electric-field components at any azimuth and elevation for the non-resonant sloping-V aerial, apex driven, under assumptions of uniform current distribution and infinite ground conductivity. Calculated patterns, in agreement with experiment for a typical aerial, show the expected desirable characteristics. There is, however, considerable vertically-polarized radiation off the line-of-shoot.

Acknowledgments

This work formed part of a study initiated by the Royal Canadian Air Force whose permission to publish is gratefully acknowledged; however, such permission is not to be construed as endorsement of the contractor, his products and services, or of the contents of the article as published.

The author wishes to acknowledge the helpful advice of C. E. Soucy, Chief Engineer of Canadian Aviation Electronics, Ltd., in 1949, when the work on which this paper is based was done. He extends his thanks to that company for permission to publish, to J. E. Kadish, formerly of that company, for valuable criticism, and to Professor F. S. Howes, of McGill University, Montreal, for much encouragement.

APPENDIX

Distant Field of Linear Radiator

The field strength at a point P a large distance d' from a doublet of length δl carrying uniform current I' is

$$\delta e = [(30 I' \delta l \sin \psi')/d'] \cos \omega(t - d'/c) \quad .. \quad (5)$$

where ψ' is the angle between the doublet and a line joining it to P. For a linear radiator, so driven by distributed sources that it carries a uniform travelling current I_1 throughout its length l, the field at P is

$$e_1 = \int_0^l \delta e_1$$

$$e_1 = (60 I_1/d)(\cot \psi_1/2)[\sin \pi l(1 - \cos \psi_1)] \cos(\omega t - \alpha_1) \quad .. \quad .. \quad (6)$$

where α_1 is the phase difference between the field at P and the current at the centre of the radiator. This result holds for each of the four radiators; i.e., for the two V legs and their images.

In what follows, the field of radiator (1) is considered first. Then, the four partial fields are resolved into components in two directions at right angles. Summing them gives the total field of the V, under the assumed conditions.

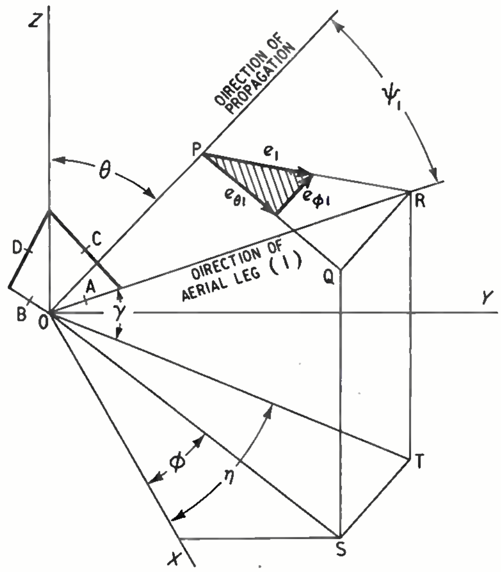


Fig. 5. *Resolution of distant field into components.*

Resolution into Components

The electric vector e_1, due to radiator (1), is in the same plane OPR (see Fig. 5) as the direction OP of propagation through P and the direction OR of the radiator OA. Being perpendicular to the direction of propagation, e_1 is also contained in the plane QPR, where $O\hat{P}Q$, $O\hat{P}R$ and $P\hat{Q}R$ are right-angles. Its components are $e_{\phi 1}$ and $e_{\theta 1}$, proportional to QR and PQ respectively. The horizontal, or phi, component $e_{\phi 1}$ is parallel to the ground plane XOY and to QR. However, the so-called vertical, or theta, component, while in a vertical plane through the point of observation, in fact makes an angle of $90° - \theta$ with the vertical. If OR is taken as unit length,

$$\mathrm{OT} = \cos \gamma \qquad \mathrm{SQ} = \mathrm{TR} = \sin \gamma$$

$$\mathrm{QR} = \mathrm{ST} = \mathrm{OT} \sin(\eta - \phi) = \cos \gamma \sin(\eta - \phi)$$

$$\mathrm{OS} = \mathrm{OT} \cos(\eta - \phi) = \cos \gamma \cos(\eta - \phi)$$

$$\mathrm{PQ} = \mathrm{OS} \cos \theta - \mathrm{SQ} \sin \theta$$

$$= \cos \gamma \cos(\eta - \phi) \cos \theta - \sin \gamma \sin \theta$$

$$\mathrm{PR} = \sin \psi_1$$

$$e_{\phi 1} = e_1(\mathrm{QR}/\mathrm{PR}) = e_1 \cos \gamma \sin(\eta - \phi)/\sin \psi_1 \quad .. \quad (7)$$

$$e_{\theta 1} = e_1(\mathrm{PQ}/\mathrm{PR})$$

$$= e_1[\cos \gamma \cos(\eta - \phi) \cos \theta - \sin \gamma \sin \theta]/\sin \psi_1 \quad (8)$$

Determination of $\cos \psi_1$

The vertical plane OPQS of Fig. 5 is shown in Fig. 6.

$$\mathrm{OP} = \mathrm{OS} \sin \theta + \mathrm{SQ} \cos \theta$$

$$= \cos \gamma \cos(\eta - \phi) \sin \theta + \sin \gamma \cos \theta$$

$$\cos \psi_1 = \mathrm{OP}/\mathrm{OR}$$

$$= \cos \gamma \cos(\eta - \phi) \sin \theta + \sin \gamma \cos \theta \quad .. \quad (9)$$

Radiation Components for One Radiator

Combination of equations (6), (7), (8) and (9), with $\cot \psi/2 = \sin \psi/(1 - \cos \psi)$, leads to explicit expressions for the field components:

$$e_{\phi_1} = (60I_1/d)[\cos(\omega t - \alpha_1)][\cos \gamma \sin (\eta - \phi)] \times \frac{\sin \pi l[1 - \cos \gamma \cos (\eta - \phi) \sin \theta - \sin \gamma \cos \theta]}{1 - \cos \gamma \cos (\eta - \phi) \sin \theta - \sin \gamma \cos \theta} \quad (10)$$

$$e_{\theta_1} = (60I_1/d)[\cos(\omega t - \alpha_1)][\cos \gamma \cos (\eta - \phi) \cos \theta - \sin \gamma \sin \theta] \times \frac{\sin \pi l[1 - \cos \gamma \cos (\eta - \phi) \sin \theta - \sin \gamma \cos \theta]}{1 - \cos \gamma \cos (\eta - \phi) \sin \theta - \sin \gamma \cos \theta} \quad .. \quad (11)$$

The above equations hold for radiator (1), the direction of which is fixed by γ and η. Similar expressions can be found for the other radiators by replacing these angles, respectively, by:

γ and $-\eta$ for radiator (2)
$-\gamma$ and η for radiator (3)
$-\gamma$ and $-\eta$ for radiator (4) .. .. .. (12)

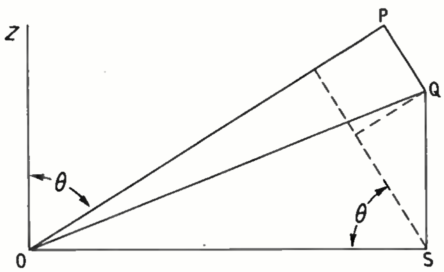


Fig. 6. *Projections used to find* ψ_1.

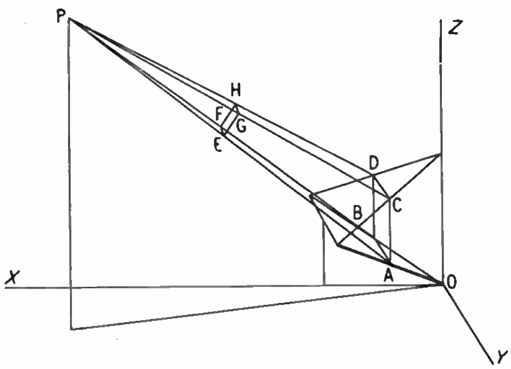


Fig. 7. *Path lengths from radiators to point of observation.*

Determination of the Phase Differences

When the contributions of the four radiators are added to give the total field, the relative phases must be taken into account. They depend upon the relative phases of the currents at the centres of the radiators and their relative distances from the point of observation.

The aerial is symmetrically-driven at the apex by a balanced source. At an instant when the current at D (I_4) is flowing away from the drive point, the current at C (I_3) will be flowing towards it. (The directions of wave travel and of current flow are independent.) For a flat, lossless ground plane, the image current flows towards the image apex when its corresponding aerial current flows away from the apex, since the tangential electric-field component undergoes a phase reversal on reflection. Thus, when equations (10) and (11), originally written for radiator (1), are applied to the other radiators,

I_1 is to be replaced by $-I_2$, $-I_3$, and I_4 .. (13)

Let h be the height of the V apex above ground in wavelengths and let w be half the distance in wavelengths between the open ends of the V. Thus

$$h = H/\lambda \; ; \qquad w = W/\lambda.$$

Then the centres of the radiators, (1), (2), (4) and (3), are situated at the corners of a rectangle ABDC of height h and width w (see Figs. 7 and 8). As P recedes, the rays PA, PB, PC, and PD become perpendicular to the plane EGHF with PE = PG = PH = PF.

The radiation from C arrives at P first, that from D travels the extra distance JH = KF = p, that from A the extra distance NE = MK = u, and that from B the extra distance MF = $p + u$ where JK = HF = GE and JG = KE = MN = BA. Draw EKV parallel to the ground plane with V vertically below F. Then, with the notation of Fig. 8,

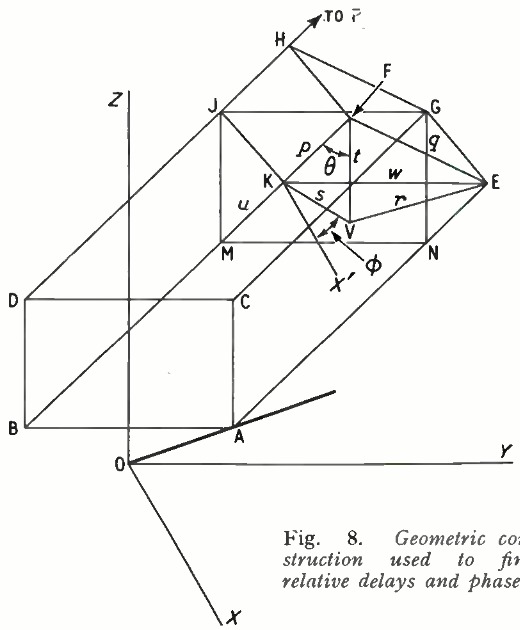


Fig. 8. *Geometric construction used to find relative delays and phases.*

$$r^2 = q^2 - t^2 = (w^2 - p^2) - (p^2 - s^2)$$
$$w^2 - 2p^2 = r^2 - s^2 = w^2 - 2sw \sin \phi$$
$$p = w \sin \theta \sin \phi; \qquad u = h \cos \theta$$
$$\alpha_1 - \alpha_3 = 2\pi h \cos \theta \quad .. \quad (14)$$
$$\alpha_4 - \alpha_3 = 2\pi w \sin \theta \sin \phi \quad .. \quad (15)$$
$$\alpha_2 - \alpha_3 = 2\pi h \cos \theta + 2\pi w \sin \theta \sin \phi \quad .. \quad (16)$$

Expressions for the Total Field Components

Let I be the apex current, and α its phase relative to the field at P due to radiator (3), and introduce exponentials for the phase-shift terms. Then, combination of equations (10) to (16) with suitable abbreviations leads to the expressions (1) and (2) for the total field components.

REFERENCES

[1] C. H. Harrison, "Radiation from Vee Antennas." *Proc. Inst. Radio Engrs,* July 1943, Vol. 31, pp. 362-364. A similar aerial, consisting of two sagging wires, is described in U.S.A. patent number 2,081,162 (1937). Except where noted, symbols have the same significance here as in Harrison's paper.

TERMINATION VARIATION IN THE CONSTANT-K FILTER

By Sidney C. Dunn, M.Sc., A.M.I.E.E.

It is shown here that the response obtained from the conventional constant-k filter terminated in its design resistance is also forthcoming under more general conditions. It is well known that the response of a constant-k filter depends only on the number of sections it contains, provided that the independent variable is a suitably chosen dimensionless function.[3,4,5,6,7,8,9] This fact enables us to talk in quite general terms about, for example, all full-section filters whether they are low- or high-pass or band-filters. The appropriate dimensionless function is identical with that expressing the variation in reactance with frequency of the series arm of the section. In Fig. 1 we may refer to the series arm as $j\lambda R$ and to the shunt arm as $R/j\lambda$, where

$$R = \sqrt{L/C}$$
$$\omega_0 = 1/\sqrt{LC}$$
$$\lambda = \omega/\omega_0$$

and the insertion-loss ratio can be written as

$$\text{i.r.} = \frac{1}{\sqrt{1+\lambda^6}} \quad \cdots \quad (1)$$

and the insertion phase-shift as

$$\tan^{-1}\left(\frac{\lambda^2 - 2}{1 - 2\lambda^2}\right) \quad \cdots \quad (2)$$

Equations (1) and (2) will still be true if any other constant-k structures are substituted for the above, provided the definition of λ is changed accordingly. In this way the analysis of circuits can be considerably simplified since the number of significant response functions is reduced. Diversity of curve shape is exchanged for complication in interpreting the scales used for plotting the curves. This is, of course, a distinctive feature of any normalizing procedure.

Conventional filter theory regards filters essentially as power transfer devices but for a large field of application the output voltage from a filter does not need to be associated with power since it may be used to control the grid of a valve. In such filters the terminating resistances may be considered merely as damping agents used to flatten characteristics which would otherwise contain undesirable poles. The problem attempted here is to find the modification required to a conventional filter when the terminations are resistive but otherwise quite general. A particular case, that of open-circuit filters, has already received treatment by Cauer,[2] Norton,[1] and Belevitch.[10]

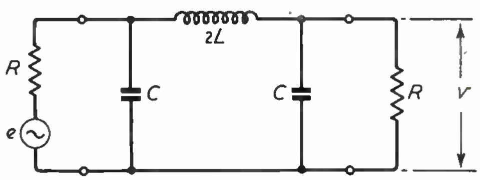


Fig. 1. *Single-section low-pass filter.*

MS accepted by the Editor, December 1952.

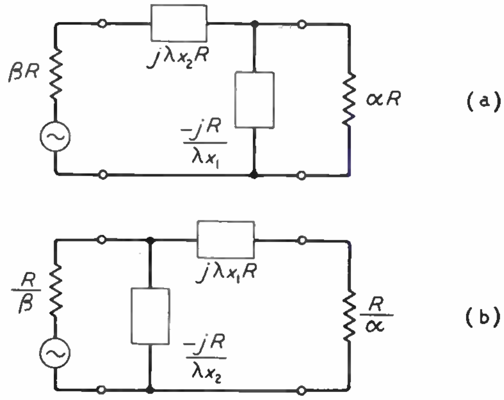


Fig. 2. *Two forms of half-section filters.*

Half-Sections

Fig. 2 shows two possible half-sections with the elements given their normalized values as explained above and, in addition, modified by factors x_1 and x_2 to correspond with the change in termination from equal values R to those modified by factors β and α. For these two circuits the insertion transfer ratio is

$$\text{i.t.r.} = \frac{1}{\left(1 - \lambda^2 \dfrac{\alpha x_1 x_2}{\alpha+\beta}\right) + j\lambda\left(\dfrac{\alpha\beta x_1 + x_2}{\alpha+\beta}\right)} \quad (3)$$

while for the original circuit with x_1, x_2, α and β all equal to 1,

$$\text{i.t.r.} = \frac{1}{(1 - \frac{1}{2}\lambda^2) + j\lambda} \quad \cdots \quad (4)$$

If, following Starr[11] we equate corresponding coefficients of powers of $j\lambda$, we obtain a pair of simultaneous equations which, if solved for x_1 and x_2 in terms of α and β, yield the condition that the original and modified circuits have the same variation of insertion transfer ratio with frequency. Thus,

$$\frac{\alpha x_1 x_2}{\alpha + \beta} = \frac{1}{2} \quad \ldots \quad (5)$$

$$\frac{x_2 + \alpha\beta x_1}{\alpha + \beta} = 1 \quad \ldots \quad (6)$$

$$\text{yielding } \frac{1}{x_2} = \frac{1}{\beta} \mp \frac{1}{\beta}\sqrt{\frac{\alpha - \beta}{\alpha + \beta}} \quad \ldots \quad (7)$$

$$\frac{1}{x_1} = \alpha \pm \alpha\sqrt{\frac{\alpha - \beta}{\alpha + \beta}} \quad \ldots \quad (8)$$

from which it will be seen that a necessary condition is that $\alpha > \beta$. If we solve the above equations for a different choice of variables it is possible to display the variations of the four parameters by means of only one curve. Two implicit solutions are found as

$$\frac{\alpha}{\beta} = \frac{2(\alpha x_1)^2 - 2(\alpha x_1) + 1}{2\alpha x_1 - 1}$$

$$= \frac{2\left(\frac{\alpha + \beta}{2x_2}\right)^2 - 2\left(\frac{\alpha + \beta}{2x_2}\right) + 1}{2\left(\frac{\alpha + \beta}{2x_2}\right) - 1} \quad \ldots \quad (9)$$

and plotted in Fig. 3. This diagram may be used to solve the common problem of inserting between a generator and load of different impedances a

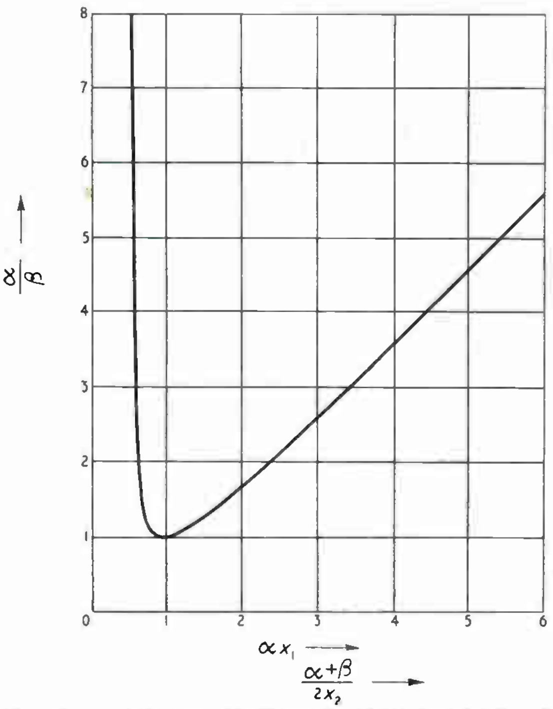


Fig. 3. *Design curve to determine circuit elements for impedance matching.*

filter of a certain cut-off frequency. The cut-off frequency gives one relation in the form of the product of L and C. The ratio of L and C is then given an arbitrary value. This determines α and β and from the curve the values of x_1 and x_2 may be found.

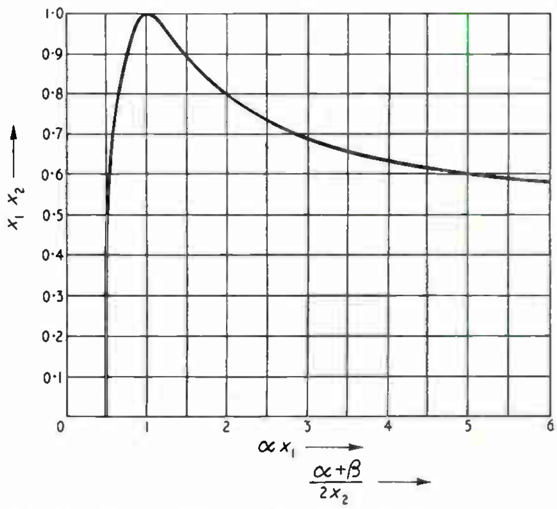


Fig. 4. *Design curve to determine impedance for given circuit elements.*

Example 1

An L-section low-pass filter of cut-off frequency $\omega_c = 10^4$ is required between a generator of resistance 7 kΩ and a load of resistance 25 kΩ, Fig. 2(a).

$LC = 10^{-8}$, take $L/C = 10^8$, then $L = 1$ H, $C = 0{\cdot}01\ \mu$F, $\alpha = 2{\cdot}5$, $\beta = 0{\cdot}7$.

Then $\alpha/\beta = 3{\cdot}57$; $\alpha + \beta = 3{\cdot}2$, and from Fig. 3 we have

$\alpha x_1 = 4$ or $0{\cdot}6$; i.e., $x_1 = 1{\cdot}6$ or $0{\cdot}24$,

$(\alpha + \beta)/2x_2 = 4$ or $0{\cdot}6$; i.e., $x_2 = 0{\cdot}4$ or $2{\cdot}66$.

There are thus two possible solutions, 0·4 H and 0·016 μF or 2·66 H and 0·0024 μF. It is also interesting to note that if the load has an impedance less than that of the generator the shunt element must be put on the input side and the circuit of Fig. 2(b) used.

The reverse problem may also be solved, viz. the change in termination required when the elements are modified. Fig. 4 may be used for this purpose and is constructed as follows,

$$x_1 x_2 = \tfrac{1}{2}(1 + \beta/\alpha), \quad \beta/\alpha < 1 \quad \ldots \quad (10)$$

Various values of αx_1 are taken as abscissae from Fig. 3, the corresponding α/β read off and substituted above. In this case if the cut-off frequency is to remain the same, then $x_1 x_2$ must be less than unity. If the shape of the response is to be preserved, then x_1x_2 can only be made greater if the cut-off frequency is allowed to change.

Example 2

If in the previous case the prototype filter is modified so that $L' = 0{\cdot}9$ H and $C' = 0{\cdot}008\ \mu$F then $x_1 = 0{\cdot}9$ and $x_2 = 0{\cdot}8$ and thus $x_1x_2 = 0{\cdot}72$ and from Fig. 4 we find $\alpha = 0{\cdot}79$ and $\beta = 0{\cdot}345$, or $\alpha = 3{\cdot}38$ and $\beta = 1{\cdot}48$.

If, however, we make $L' = 1{\cdot}2$ H and $C' = 0{\cdot}015\ \mu$F then $x_1x_2 = 1{\cdot}2$. No value of α or β is possible from Fig. 4 but if we accept a new cut-off frequency of $\omega_0 = 7{,}450$ the terminations can have the new 'design' value

$$\sqrt{(1{\cdot}2/1{\cdot}5)} \times 10^4 = 8{,}950\ \Omega.$$

Cut-off frequency here means the frequency corresponding to $\lambda = 1$.

Full-Sections

The two symmetrical combinations of half-sections are shown in Fig. 5. If each is labelled in the manner shown, they are represented by a common formula for insertion transfer ratio

$$\text{i.t.r.} = \frac{1}{1 - \lambda^2\left(\dfrac{\alpha x_1x_2 + \beta x_2x_3}{\alpha + \beta}\right) + j\lambda\left(\dfrac{\alpha\beta x_1 + x_2 + \alpha\beta x_3}{\alpha + \beta} - \dfrac{\lambda^2\alpha\beta x_1x_2x_3}{\alpha + \beta}\right)} \quad (11)$$

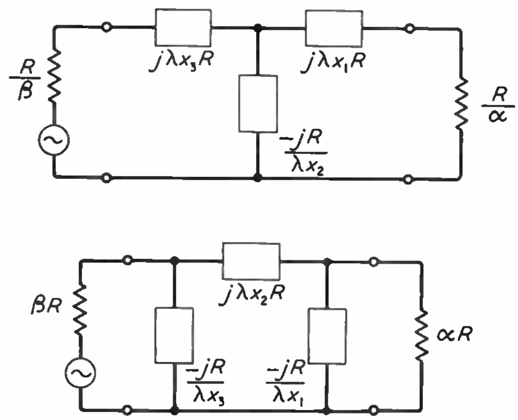


Fig. 5. *Two forms of full-section filter.*

The corresponding formula for the original circuit is

$$\text{i.t.r.} = \frac{1}{1 - 2\lambda^2 + j\lambda(2 - \lambda^2)} \quad (12)$$

and, equating coefficients as before, we get three equations

$$\begin{aligned} \alpha x_1x_2 + \beta x_2x_3 &= 2(\alpha + \beta) \\ \alpha\beta x_1x_2x_3 &= \alpha + \beta \\ \alpha\beta x_1 + x_2 + \alpha\beta x_3 &= 2(\alpha + \beta) \end{aligned} \quad (13)$$

Solving these equations for x_1 and x_3 as implicit functions of α and β,

$$\frac{\alpha}{\beta} = \frac{3(x_3\beta)^2 - 3x_3\beta + 1}{(2x_3\beta - 1)(x_3{}^2\beta^2 - x_3\beta + 1)} \quad (14)$$

$$\frac{\beta}{\alpha} = \frac{3(x_1\alpha)^2 - 3x_1\alpha + 1}{(2x_1\alpha - 1)(x_1{}^2\alpha^2 - x_1\alpha + 1)} \quad (15)$$

The relation between x_2 and α/β is best plotted from the above curves using relation,

$$\frac{x_2}{\alpha + \beta} = \frac{1}{x_1x_3\alpha\beta} \quad (16)$$

and the whole family is drawn in Fig. 6. Certain restrictions may also be noted in this case,

$$\frac{x_2}{\alpha + \beta} < 1; \quad x_3\beta > \tfrac{1}{2}; \quad x_1\alpha > \tfrac{1}{2} \quad (17)$$

A full-section filter can always be fitted between arbitrary resistive terminations and provide a response identical with the standard case, but three arbitrary elements, though they are of the correct reactive sign, will only be accommodated by resistive terminations if particular relations exist between them. It is even more obvious in the case of multi-section filters that changing two resistances cannot compensate for any number of variations within the

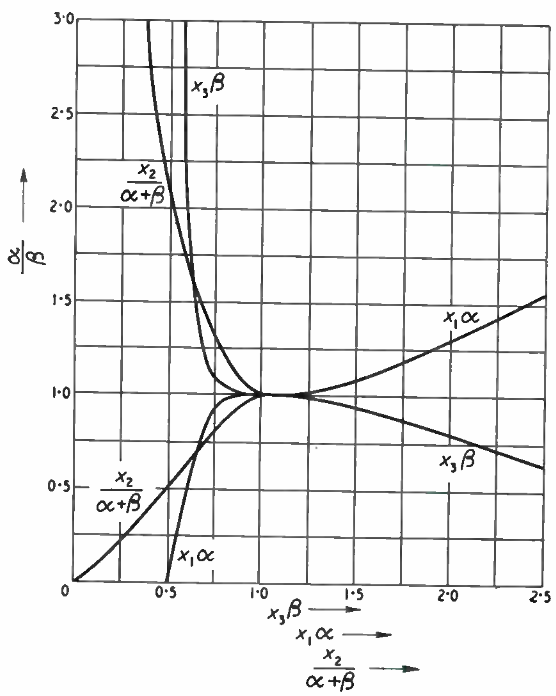


Fig. 6. *Curves corresponding to those of Fig. 3, but for a full-section filter.*

body of the network. Given the terminations, however, it has not yet been shown that a multi-section filter can be specified to work between them in the standard manner.

Extreme Termination

There are four interesting cases corresponding to special generator and load arrangements. The source of signal may be one of constant current (infinite impedance) or of constant voltage (zero impedance). The damping resistance may be located at either end. For $\alpha = \infty$ we have from Equs (5) and (6)

$$x_1 = 1/\beta, \quad x_2 = \beta/2 \qquad \ldots \quad \ldots \quad \ldots \quad (18)$$

and for $\alpha = \infty$ from Equ. (13)

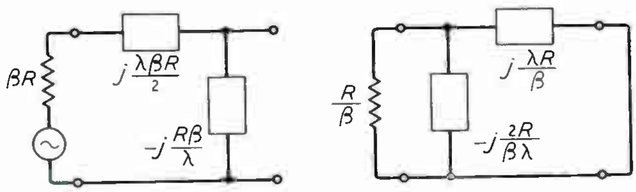
$$x_1 = 3/2\beta, \quad x_2 = 4\beta/3, \quad x_3 = 1/2\beta \qquad \ldots \quad (19)$$

Similarly for $\beta = 0$ we have for the half-section

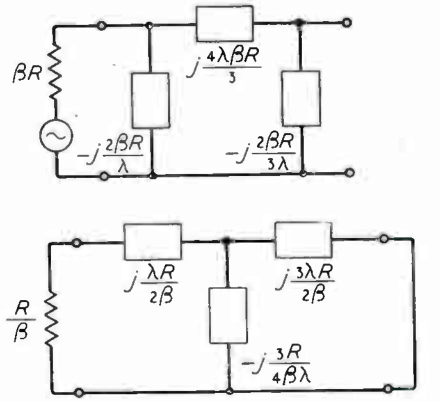
$$x_1 = 1/2\alpha, \quad x_2 = \alpha \qquad \ldots \quad \ldots \quad \ldots \quad (20)$$

and for the full-section, $\beta = \infty$

$$x_1 = 1/2\alpha, \quad x_2 = 4\alpha/3, \quad x_3 = 3/2\alpha \qquad \ldots \quad (21)$$

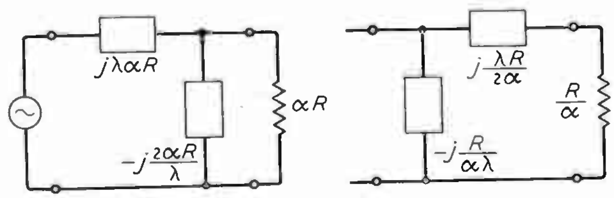


(a) (b)

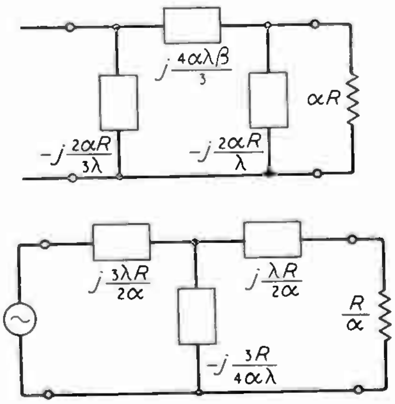


(c) (d)

Fig. 7. *Various forms of filter; (a) and (c) are voltage and (b) and (d) are current filters, the others being power types.*



(e) (f)



(g) (h)

These cases are shown in Fig. 7 of which (a) and (c) are voltage filters, (b) and (d) are current filters. The remainder are power filters, but all offer interesting possibilities when operated in valve circuits.

The general expressions for x_r in the case of an n-branch ladder network have been worked out by Norton[1] for the particular instance of a voltage- or current-fed filter when the modulus of the transfer response is prescribed by

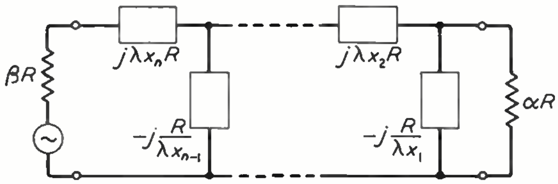
$$J = \frac{1}{M\sqrt{1 + y^{2n}}} \qquad \ldots \quad \ldots \quad \ldots \quad (22)$$

where M is a constant and y is an imaginary, odd rational function of frequency.

Belevitch[10] has given a method of designing, by rational operations only, an open-circuit filter having the same insertion loss as any prescribed symmetrically-terminated filter.

Multi-Section Filters

Fig. 8 shows the circuit diagrams used to represent a multi-section filter. This method is chosen because it facilitates the progressive elaboration of the network. Since it is only the denominator of the insertion transfer ratio which is of interest it is most convenient to work out the input voltage required to produce unit current in the load. By this means the results obtained for one particular number of branches can be used to initate the calculation on the next highest number. Whether α, β or their reciprocals are used to represent the terminations depends only on the position of the branch nearest the load. The per-unit input voltage is a polynomial in $j\lambda$ whose constant term is either $(\alpha + \beta)$ or $(1/\alpha +$



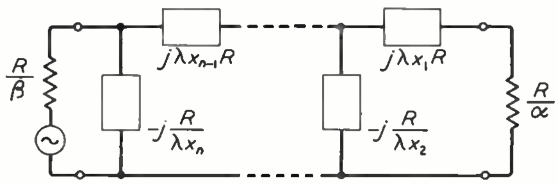


Fig. 8. *Representation of multi-section filter.*

$1/\beta)$. The coefficients of the various powers of $j\lambda$ are all sums of products of the filter branch factors taken a definite number at a time and according to a certain scheme. Moreover these sums are considered as two groups and are weighted accordingly. For a network of n branches the degree of the polynomial is n. The coefficient of the rth term is the sum of the branch factors taken r at a time. When r is even, each partial product must consist of an equal number of odd and even subscript factors. It is required that when these subscripts are written in sequence, alternately odd and even, the subscripts shall be in ascending order. When the leading subscript is odd the partial product is further multiplied by α; when the leader is even the multiplier is β. When r is odd there are two groups of partial products, those in which the majority of subscripts are odd and those where they are even. This majority is always a margin of 1. The even-predominant products are left unweighted while the odd-predominant products are multiplied by $\alpha\beta$.

As an example, let us predict the coefficient of the fourth-degree term in the polynomial for a seven-branch network. The only group of suffixes which can occur are:

$1pq4$, $1pq6$, $3pq6$, $2qp5$, $2qp7$, $4qp7$,

where p is an even and q an odd integer. The required term is therefore

$$\alpha(x_1x_2x_3x_4 + x_1x_4x_5x_6 + x_3x_4x_5x_6 + x_1x_2x_3x_6 + x_1x_2x_5x_6)$$
$$+ \beta(x_2x_3x_4x_5 + x_2x_3x_4x_7 + x_4x_5x_6x_7 + x_2x_3x_6x_7 + x_2x_5x_6x_7)$$

The denominator of the insertion transfer ratio is the above polynomial divided throughout by the constant term.

For any given number of branches the response of the conventional form of the filter may be written down, since the x terms are known. For any degree of unbalance between the terminations the required modifying factors for each branch could be worked out by a method similar to that used for the full- and half-sections. The system of equations consists, for an n-branch network, of n equations, each being of different degree from 1 to n. The actual solution of these equations is, however, very tedious.

REFERENCES

[1] E. L. Norton. "Filter Operation into Open Circuit", U.S. Patent 1,788,538, Jan. 13 1931.
[2] W. Cauer. "Filters on Open Circuit at the Output Side", *Elekt. Nachr. Tech.*, June 1939, Vol. 16, pp. 161–163.
[3] O. S. Meixell. "An Analysis of Constant-*k* Low- and High-Pass Filters", *R.C.A. Review*, Jan. 1941, Vol. 5, pp. 337–346.
[4] C. W. Miller. "Single-Section *m*-Derived Filters", *Wireless Engr*, Jan. 1944, Vol. 21, p. 4.
[5] D. G. Tucker. "Insertion Loss of Filters", *Wireless Engr*, Feb. 1945, Vol. 22, pp. 62–71.
[6] J. B. Rudd. "The Transfer Impedance of Recurrent π and T Networks", *A.W.A. Tech. Rev.*, 1946, Vol. 7, p. 79.
[7] J. B. Rudd. "Insertion Characteristics of Filters", *A.W.A. Tech. Rev.*, 1946, Vol. 7, pp. 145–176.
[8] J. B. Rudd. "Insertion Characteristics of Filters—II", *A.W.A. Tech. Rev.*, 1948, Vol. 8, pp. 77–95.
[9] L. J. Giacoletto. "Optimum Resistive Terminations for Single-Section Constant-*k* Ladder-Type Filters", *R.C.A. Review*, Sept. 1947, Vol. 8, pp. 460–479.
[10] V. Belevitch. "Tchebyshev Filters and Amplifier Networks", *Wireless Engr*, April 1952, Vol. 24, pp. 106–110.
[11] A. T. Starr. "Electric Circuits and Wave Filters", Sir Isaac Pitman & Sons, Ltd., 1946, p. 263.

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CORRESPONDENCE

Letters to the Editor on technical subjects are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

Harmonic Distortion and Negative Feedback

SIR,—With reference to Mr. Rowlands' article in the June issue (p. 133), I feel that it should be pointed out that an amplifier, the curve of which "does not deviate appreciably from linearity over the working range", will not generate harmonics. The use of feedback to reduce harmonics then seems superfluous.

More seriously, I would contend that the usual formula for distortion with negative feedback is perfectly valid. It must be remembered that a non-linear amplifier has not a constant gain. If the curve of the amplifier is drawn in terms of the output voltage plotted against the input voltage, and the gain defined as the ratio of these quantities, it is immediately apparent that the gain A is a function of the input voltage.

If V_0 is the instantaneous output for an instantaneous input V_i,

$$A = \frac{V_0}{V_i} \text{ or } V_0 = AV_i$$

We may refer the amplifier curve to the input voltage V_i, choosing an arbitrary zero (in practice, the input level under no-signal conditions), and we then find that $V_0 = f(V_i) \times V_i$. (In the linear case $V_0 = f(0) \times V_i$, and $A = f(0) =$ a constant.)

Whence $A = f(V_i)$. Now output voltage with feedback

$$V_0' = \frac{V_0}{1 + A\beta} \cdot = \frac{V_0}{1 + \beta f(V_i)} = \frac{V_i f(V_i)}{1 + \beta f(V_i)}$$

The corresponding linear amplifier would have, with feedback, an output voltage

$$V_0'' = \frac{V_i f(0)}{1 + \beta f(0)}$$

Now, if we define distortion D (no feedback) as $\left[1 \sim \frac{\text{distorted}}{\text{undistorted}}\right]$ output voltages without feedback,

we have $D = 1 \sim \dfrac{f(V_i)}{f(0)}$

(note: the sign $\sim$ signifies "difference")

Similarly, with feedback

$$D' = 1 \sim \frac{V_0'}{V_0''} = 1 \sim \frac{\dfrac{V_i f(V_i)}{1 + \beta f(V_i)}}{\dfrac{V_i f(0)}{1 + \beta f(0)}} = 1 \sim \frac{f(V_i)}{f(V_0)} \, \frac{1 + \beta f(0)}{1 + \beta f(V_i)}$$

Feedback reduces distortion by D'/D, where

$$\frac{D'}{D} = \frac{\dfrac{f(0)[1 + \beta f(V_i)] \sim f(V_i)[1 + \beta f(0)]}{f(0)[1 + \beta f(V_i)]}}{\dfrac{f(0) \sim f(V_i)}{f(0)}}$$

$$= \frac{f(0) \sim f(V_i) \dfrac{1 + \beta f(0)}{1 + \beta f(V_i)}}{f(0) \sim f(V_i)}$$

It will be obvious that $f(0)$ represents the slope of the curve at the point where it passes through the zero.

Since $V_0 = AV_i = V_i f(V_i)$, the original amplifier curve is represented by this expression. Suppose the amplifier curve to have been

$$V_0 = pV_i^3 + qV_i^2 + rV_i$$

Then $f(V_i) = \dfrac{V_0}{V_i} = pV_i^2 + qV_i + r$

When $V_i = 0$, $f(V_i) = r$. This is also the slope of the curve at $V_i = 0$, since

$$\frac{dV_0}{dV_i} = 3pV_i^2 + 2qV_i + r, \text{ and when } V_i = 0$$

$$\frac{dV_0}{dV_i} = r. \left(= \frac{V_0}{V_i} \text{ at } V_i = 0\right)$$

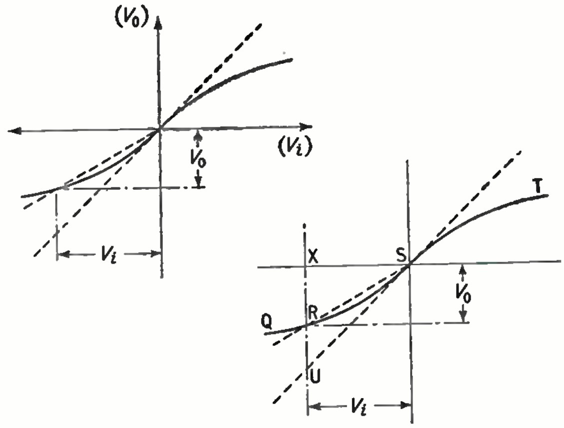
These results are quite general, for curves containing any powers of V_i.

The objection that the equation for the curve may not be known, although the curve itself is available, is quite valid. For this reason, a graphical solution (basically the same as the mathematical) giving the overall distortion for a given peak input, follows below.

However, when $V_i \neq 0$, the amplification (referred to the same zero) is not the slope of the curve for V_0, but that of the line passing through the zero and the point on the curve corresponding to the value of V_i considered. This is V_0/V_i, as stated above.

So, in the expressions obtained for amplification and distortion,

$$f(V_i) = \frac{\text{(Equation for curve of amplifier)}}{V_i}$$



In the diagram, S is the zero. The line QRST represents the curve, and the line US has the same slope as QRST when the latter passes through zero. The input level V_i intercepts US at U and QRST at R. (V_i is the *peak* input level if maximum distortion is required).

The undistorted output would be UX; the actual output is RX.

Slope of US = undistorted gain = UX/SX

Slope of RS = actual gain = RX/SX

If feedback is applied, both slopes are reduced in the same way,

Undistorted gain with feedback

$$= \frac{\text{Slope of US}}{1 + \beta \times \text{slope of US}} = \frac{V_0''}{V_i}$$

Actual gain with feedback

$$= \frac{\text{Slope of RS}}{1 + \beta \times \text{slope of RS}} = \frac{V_0'}{V_i}$$

$D =$ Distortion without feedback $= 1 \sim$ RX/UX

D' = Distortion with feedback

$$= 1 \sim \frac{\dfrac{\text{slope of RS}}{1 + \beta \times \text{slope of RS}}}{\dfrac{\text{Slope of US}}{1 + \beta \times \text{Slope of US}}} = 1 \sim \frac{V_0'}{V_0''}$$

$$= 1 \sim \frac{\text{Slope of RS } [1 + \beta \times \text{slope of US}]}{\text{Slope of US } [1 + \beta \times \text{slope of RS}]}$$

$$= 1 \sim \frac{\dfrac{\text{RX}}{\text{SX}}\left[1 + \beta \times \dfrac{\text{UX}}{\text{SX}}\right]}{\dfrac{\text{UX}}{\text{SX}}\left[1 + \beta \times \dfrac{\text{RX}}{\text{SX}}\right]}$$

$$= 1 \sim \frac{\text{RX}\left[1 + \beta \dfrac{\text{UX}}{\text{SX}}\right]}{\text{UX}\left[1 + \beta \dfrac{\text{RX}}{\text{SX}}\right]} = 1 \sim \frac{\text{RX (SX} + \beta \text{ UX)}}{\text{UX (SX} + \beta \text{ RX)}}$$

The value thus found is for excursions in one direction only; for asymmetrical curves the result will have to be adjusted for equivalent excursions of input voltage in the other direction. It is entirely in terms of peak voltages; but for, say, audio amplifiers (where the peak and r.m.s. inputs do not bear any fixed relationship), what other criteria are valid? Distortion figures should always be quoted in terms of peak voltage input (or the equivalent peak power output) for fairly obvious reasons.

It seems to me that this approach is better than that of Mr. Rowlands, if only because (in the mathematical part) the standard formula for reduction of distortion by feedback is retained. This is always valid, provided that its true meaning is remembered.

It should be noted that the graphical solution given will give only the overall distortion, regardless of harmonic content. However, the mathematical method can readily be extended to give these. Finally, all distortion figures are referred to unity, and must be multiplied by 100 to obtain percentages.

FRANK G. KERR.

Richmond, Surrey.
15th June 1953.

SIR,—I have read with great interest the article, "Harmonic Distortion and Negative Feedback," by R. O. Rowlands, which was published in *Wireless Engineer*, June 1953, p. 133, and I found the following part not sufficiently proved.

"Let S be a point on the curve corresponding to the same value V_0 as K in Fig. 2.
Then UV = ST" (That is clear enough).
(But why) "UV = ST = KJ = d_0".

I could not find any proof in the whole article for the statement quoted above.

The transformation of the Equ. 2 proved only that:
$f(V_0)$ = PQ = HJ = d_i.

S. UMINSKI.

London, N.21.
9th July 1953.

SIR,—In reply to the query raised by Mr. Uminski, I would point out that S in Fig. 3 is specially chosen in order that ST = KJ.

To make it more explicit, the last two lines above Fig. 2, could be re-written, "the point P (or Q, or T or V) and H (or J) correspond to the same value of V_0. Then since S corresponds to K, ST = KJ.

R. O. ROWLANDS.

Evesham,
Worcestershire.
13th July 1953.

Nomenclature for E.M. Wave Modes

SIR,—It will, I think, be generally accepted that the standardization of nomenclature at an early stage in the development of a new subject is desirable in order to avoid the growth of a variety of practices which later become difficult to eradicate. With the growing application of microwaves there is a need to establish an agreed terminology for the description of the various wave modes associated with waveguides, resonant cavities, etc., and a glance at current literature is sufficient to show the widely-differing approach to this matter now existing.

At the same time, I understand that the British Standards Institution prefer to use their influence in promoting standardization of nomenclature only when there is definite evidence of general adoption and use. May I therefore, towards that end, put forward some proposals which have arisen in discussing the matter with my colleagues Dr. Cullen and Mr. Karbowiak.

The proposals are as follows:—

(*a*) That a wave having a component of the electric field in the direction of propagation be described as an 'E' mode (not a 'TM' mode).

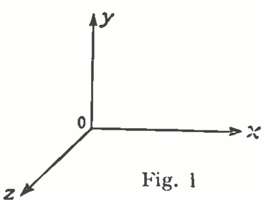
(*b*) That a wave having a component of the magnetic field in the direction of propagation be described as an 'H' mode (not a 'TE' mode).

(*c*) That mixed wave modes (such as occur particularly in dielectric guides) be described as 'EH' modes.

(*d*) That in order to define precisely the particular form of wave mode, three subscripts to the letter 'E' or 'H' should be used corresponding to the co-ordinate system employed. These subscripts should represent, where appropriate, the standing-wave pattern along the different co-ordinates, using numbers according to accepted practice or, in the case of a travelling wave, by the use of a dot for the direction of propagation and in the case of an evanescent field by the use, in a similar way, of a cross. Thus the principal wave in a hollow metal guide of rectangular cross-section would be described by $H_{01\cdot}$ when propagating or $H_{01\times}$ when evanescent.

(*e*) That the subscripts used to describe a particular wave mode be related to one of the four co-ordinate systems commonly used in practice, namely (1) rectangular (2) cylindrical (3) spherical and (4) elliptical. For this purpose the initial letter of the relevant co-ordinate system should be employed as a prefix to the letter 'E' or 'H' defining the form of wave. Thus, for the hollow metal guide of rectangular cross-section, propagating the principal mode we should have:—${}_rH_{01\cdot}$.

(*f*) That the sequence of the three symbols in the subscript should follow the accepted sequence of co-ordinates in the corresponding right-hand co-ordinate system. Thus if we take the x axis as the direction of propagation for the H_{01} mode in a hollow metal guide of rectangular cross-section then we should have the arrangement of Fig. 1.



Wave mode described as ${}_rH_{01\cdot}$ with subscript sequence of yzx

Fig. 1

For the so-called H_{01} mode is in metal guide of circular cross-section and propagating in the x direction we should have the arrangement of Fig. 2. For spherical co-ordinates the accepted sequence is $r\theta\phi$ and this should be the sequence of the corresponding subscripts in that case.

(*g*) In order to avoid any ambiguity the above definitions should be interpreted in relation to a *loss-free* guide.

(*h*) It will be observed that pure resonant systems such as cavities will have three numerals following the letter 'E' or 'H' describing the type of wave, as is the usual practice now.

The Goubau surface wave supported by a dielectric coated loss-free conductor is described by:—

$${}_cE_{\cdot 0}$$

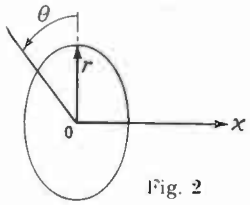


Fig. 2

Wave mode described as ${}_cH_{10}$.

with subscript sequence of $r\theta x$

I hope that these suggestions will be of interest to your readers and that discussion of them may bring about a measure of agreement as a preliminary to standardization.

H. M. BARLOW.

University College London,
Gower St., London, W.C.1.
23rd July 1953.

While we support Professor Barlow's plea for standardization, we do not much like his proposed standard and we have a strong objection to part of it.

We consider the use of the cross and dot subscripts to be undesirable on editorial and printing grounds. The cross would be hard to distinguish from an 'x' in manuscript (many people write an 'x' as a cross; most people would type a cross as an 'x'); unless a manuscript were exceptionally well prepared, therefore, considerable confusion would arise. It is difficult enough already to distinguish between x, χ and $\times$ without adding crosses; the editor now has frequently to write 'chi' or 'multiplication sign' alongside.

The objection to the dot is rather different. It is that, as a subscript, it will often be so small that there would be a danger of its being overlooked or taken for an accidental mark on the paper.

We suggest that it would be preferable to use E and P as subscripts for the evanescent and propagating modes, and these have the additional advantage of suggesting their meanings.

Professor Barlow seems to take it for granted that the subscript order in the rectangular system of co-ordinates should by yzx. We feel that xyz is to be preferred, z being the direction of propagation, since it is more easily remembered. In a two-co-ordinate system it is usual to use x and y, generally for the horizontal and vertical axes respectively (e.g., a c.r. display) and it is natural to retain these letters for the main axes of a three-co-ordinate system, adding z for the third axis. In a waveguide, the mode is distinguished primarily by the field maxima along the two dimensions of a cross-section through it and it seems to us to be the natural thing to make these the x and y dimensions and z the direction of propagation.—Editor.

PREFERRED VALVES

A second edition of the S.I.M.A. List of Preferred Valves is now available in the form of a 28-page booklet. It is obtainable from the Secretary, Scientific Instrument Manufacturers' Association, 20 Queen Anne St., London, W.1; at the price of 3s. 6d. including postage.

BRIT.I.R.E. MEETING

30th September. "The Impact of Communication Theory on Television", by D. A. Bell, M.A., B.Sc., Ph.D., at 6.30 p.m. at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

CHANGE OF ADDRESS

The British Standards Institution has moved to new premises at 2 Park Street, London, W.1; telephone Mayfair 9000. In the new building, previously scattered departments have been brought together and better accommodation for committee meetings has been provided.

NEW JOURNAL

Journal of the Audio Engineering Society. Published quarterly by the Audio Engineering Society, P.O. Box 12, Old Chelsea Station, New York 11, N.Y., U.S.A. Subscriptions for non-members, $8 per annum.

STANDARD-FREQUENCY TRANSMISSIONS

(Communication from the National Physical Laboratory)

Values for July 1953

Date 1953 July	Frequency deviation from nominal: parts in 10^8		Lead of MSF impulses on GBR 1000 G.M.T. time signal in milliseconds
	MSF 60 kc/s 1429-1530 G.M.T.	Droitwich 200 kc/s 1030 G.M.T.	
1	—1·3	+3	—28·6
2	—1·4	+2	—30·9
3	—1·4	+2	N.M.
4	N.M.	+3	N.M.
5	N.M.	N.M.	N.M.
6	—1·2	+2	—37·8
7	—1·2	+2	—39·9
8	—1·2	+4	N.M.
9	—1·1	+3	—43·6
10	—1·2	+3	—45·6
11	—1·2	+3	N.M.
12	—1·2	+3	N.M.
13	—1·4	+4	N.M.
14	—1·3	+4	—51·5
15	—1·2	+3	—52·7
16	—1·2	+4	—54·3
17	—1·2	+4	—54·7
18	—1·2	+1	N.M.
19	—1·1	+2	N.M.
20	—1·1	+3	—57·2
21	—1·1	+4	N.M.
22	—1·1	+4	—58·4
23	—1·1	+4	—58·9
24	—1·0	+4	—58·8
25	—1·0	+4	N.M.
26	N.M.	N.M.	N.M.
27	—1·0	+4	—58·7
28	—1·0	+4	—59·1
29	—0·9	+6	—59·1
30	N.M.	—2	N.M.
31	—1·0	—1	—59·8

The values are based on astronomical data available on 1st August 1953.
The transmitter employed for the 60-kc/s signal is sometimes required for another service.
N.M. = Not Measured.

ABSTRACTS and REFERENCES

Compiled by the Radio Research Organization of the Department of Scientific and Industrial Research and published by arrangement with that Department.

The abstracts are classified in accordance with the Universal Decimal Classification. They are arranged within broad subject sections in the order of the U.D.C. numbers, except that notices of book reviews are placed at the ends of the sections. U.D.C. numbers marked with a dagger (†) must be regarded as provisional. The abbreviations of journal titles conform generally with the style of the World List of Scientific Periodicals. An Author and Subject Index to the abstracts is published annually; it includes a list of journals abstracted, the abbreviations of their titles and their publishers' addresses.

ACOUSTICS AND AUDIO FREQUENCIES

534 : 061.4 **2531**

Audio Developments.—(*Wireless World*, July 1953, Vol. 59, No. 7, pp. 301–305.) New products shown at the exhibitions organized by the Association of Public-Address Engineers and by the British Sound-Recording Association in London, May 1953, are described.

534.2 : 534.011 **2532**

An Acoustic Gyrator.—W. E. Kock. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, p. 575.) See 1874 of July.

534.21 : 551.596 **2533**

A Review of the Influence of Meteorological Conditions on Sound Propagation.—U. Ingård. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 405–411.) Discussion of the effects of the physical constitution of the atmosphere, temperature gradients, wind gradients, gustiness of wind, and ground absorption, on the propagation of sound waves. 36 references.

534.21-14 **2534**

Experimental Determination of the Damping of Pulsating Air Bubbles in Water.—M. L. Exner & W. Hampe. (*Acustica*, 1953, Vol. 3, No. 2, pp. 67–72. In English.)

534.21-14 : 538.566 **2535**

Longitudinal Magneto-hydrodynamic Waves.—Anderson. (See 2635.)

534.21-14 : 534.61 **2536**

On the Forces due to Acoustic Wave Motion in a Viscous Medium and their Use in the Measurement of Acoustic Intensity.—F. E. Borgnis. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 546–548.) The sum of the forces due to acoustic radiation and to the hydrodynamic flow associated with acoustic waves in viscous fluids is shown, under certain conditions, to be independent of the absorption in the fluid and also, within a considerable range, of the distance from the acoustic source. The source intensity of an acoustic beam can thus be measured without the use of thin screening films to eliminate the flow.

534.213.4 **2537**

The Attenuation of the Higher Modes of Acoustic Waves in a Rectangular Tube.—E. A. G. Shaw. (*Acustica*, 1953, Vol. 3, No. 2, pp. 87–95.) Kirchhoff's theoretical treatment is applied to propagation between a pair of infinite parallel planes. The attenuation of (1,0) waves in the range 2·4–3·0 kc/s has been measured accurately using a new probe-microphone technique. Under suitable conditions, attenuation is due almost entirely to thermal-conductivity, and viscosity effects in the gas near the tube walls.

534.213.4-14 **2538**

The Dispersion of a Pulse Propagated through a Cylindrical Tube.—D. V. Anderson & C. Barnes. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 525–528.) The dispersion of an ultrasonic pulse transmitted through a thin-walled tube filled with water and immersed in a tank of water was investigated. The dispersion is in sufficiently close agreement with theory for the envelope of the dispersed pulse to be used for determining approximately the frequency spectrum of the initial pulse.

534.232 : 534.321.9 **2539**

The Ionophone applied in Ultrasonics.—R. Miquel. (*Toute la Radio*, March/April 1953, Vol. 20, No. 174, pp. 114–117.) Report of an interview with S. Klein on the development of the ionophone (896 of 1952), particularly as an ultrasonic generator. Power output is comparable with that of a siren; frequencies of 3 Mc/s have been reached in air. Distortion and response curves in the a.f. range are shown.

534.24/.25 + 538.566.2 **2540**

Total Reflection of Waves from a Point Source.—E. Gerjuoy. (*Commun. pure appl. Math.*, Feb. 1953, Vol. 6, No. 1, pp. 73–91.) An analysis is made of the reflection of a pulse of sound at a plane boundary between nonabsorbing media, the velocity of propagation being greater in the second than in the first medium. It is shown without approximation that a pulse is received in the first medium after a delay consistent with propagation along the boundary with the velocity appropriate to the second medium. The theory affords an explanation of the head wave observed in acoustic experiments. The method is applicable to the analysis of the reflection of e.m. waves radiated from a vertical dipole.

534.24(26) **2541**

The Scattering of Sound from the Sea Surface.—C. Eckart. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 566–570.) A theoretical analysis of the problem.

534.321.9-14 : 534.614 **2542**

An Acoustic Interferometer for High Fluid Pressure.—H. D. Parbrook. (*Acustica*, 1953, Vol. 3, No. 2, pp. 49–54. In English.) Apparatus used for investigating ultrasonic propagation in fluids at critical pressure [3310 of 1952 (Parbrook & Richardson)] is described. The quartz-crystal transducer operates at pressures up to 270 atm and in the temperature range 0–80°C. The effectiveness of different types of crystal holder is discussed.

534.321.9-14 : 534.612 **2543**

The Dependence of Sound Intensity at the Source on the Coefficient of Absorption in Liquids.—S. Parthasarathy, S. S. Chari & D. Srinivasan. (*Z. Phys.*, 25th March 1953, Vol. 134, No. 4, pp. 408–412.) From measurements of radiation pressure, the intensity at the surface of a quartz-crystal radiator immersed in various organic liquids was determined for frequencies of 5 and 15 Mc/s. The intensity was not found to be inversely proportional to the acoustic impedance, as expected on theoretical grounds. At 5 Mc/s the intensity was proportional to the coefficient of absorption in 15 out of 19 liquids tested. At 15 Mc/s no relation between absorption coefficient and intensity could be established.

534.612.4 **2544**

The Reciprocity Calibration of Capacitor Microphones.—W. Holle & G. Latzel. (*Funk u. Ton*, March 1953, Vol. 7, No. 3, pp. 109–123.) Discussion of the application of the reciprocity principle to free-field calibration, corresponding to the conditions in which the microphone will later be used. By introducing a frequency-dependent voltage divider between the transmitting microphone and its amplifier, measurement of the capacitance of the reversible transducer and the frequency is not required. The frequency-response curve of the microphone is directly given by addition or subtraction of two curves obtained with a frequency-sweep recorder.

534.64 **2545**

Measurement of Acoustic Impedance by a Resonance Method.—M. Ferrero & G. G. Sacerdote. (*Alta Frequenza*, Feb. 1953, Vol. 22, No. 1, pp. 3–16.) The theory of the method described by Harris (3310 of 1948) is discussed and some experimental results obtained by this method are reported.

534.76 **2546**

Stereoaudition.—H. Kietz. (*Acustica*, 1953, Vol. 3, No. 2, pp. 73–86. In German.) Discussion, based on experimental results, of binaural hearing processes by which the direction and distance of a sound source may be estimated. 80 references.

534.845 : 551.575 **2547**

The Absorption of Sound in Suspensions and Emulsions: Part 1 — Water Fog in Air.—P. S. Epstein & R. R. Carhart. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 553–565.) The analysis presented is concerned with the effect of fluid spheres in a fluid medium. Viscosity and thermal conduction are both taken into account in the solution of the diffraction problem. The reduction of the general results to explicit formulae for attenuation is restricted to the case of liquid drops suspended in gases. Numerical calculations for fog in air are in satisfactory agreement with measurements made by Knudsen et al. (614 of 1949).

534.845.1/.2 **2548**

The Coefficient of Sound Absorption as a Function of the Angle of Incidence of the Sound.—F. K. Schröder. (*Acustica*, 1953, Vol. 3, No. 2, pp. 54–66. In German.) The absorption of porous material and of different forms of resonant absorber were investigated, using a pulse technique in a chamber specially designed to simulate two-dimensional space. With porous materials, results are in good agreement with theory; for resonant systems agreement is only qualitative. The absorption factor for partitioned cells is unexpectedly high in the frequency region above resonance and increases greatly with increasing angle of incidence, especially when the damping factor of the cavities is low. Energy losses depend largely on the manner of mounting in the case of facings and vibrating foils. Wedge arrangements show increased reflection towards grazing incidence.

534.851 : 621.317.35 : 621.3.018.78 **2549**

Distortion in Phonograph Reproduction.—Roys. (See 2736.)

621.395.625.2 **2550**

Binaural Disc Recording.—E. Cook. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 1–3.) A description is given of the two-band method of binaural recording, which is completely compatible with ordinary disk recording; the two styli are spaced $1\frac{11}{16}$ in. apart on a 12-in. disk. Radial play-back error is discussed, and testing and alignment methods are indicated.

621.395.625.3 **2551**

Magnetic Sound-Recording Equipment.—D. A. Snel. (*Philips tech. Rev.*, Jan. 1953, Vol. 14, No. 7, pp. 181–190.) The general principles of sound recording on magnetic tape are outlined, the required magnetic and mechanical properties of the tape are discussed, and a general description is given of a recorder suitable for use in broadcasting studios and also of a portable recorder, with details of the unit containing the erasing, recording and reproducing heads.

621.395.625.3 **2552**

Methods of Measuring Surface Induction of Magnetic Tape.—J. D. Bick. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 4–9; *J. Soc. Mot. Pict. Telev. Engrs*, April 1953, Vol. 60, No. 4, pp. 516–525.) Two methods of measuring the recorded signal are described, in both of which the output from the recorded tape is measured with a calibrated reproducer. One method makes use of a narrow-gap head and the other of a head with a gap wide compared with the sound wavelength [2121 of 1950 (Axon)]. Frequency characteristics obtained by the two methods are compared.

621.395.625.3 **2553**

A New Professiona Magnetic Recording Tape.—E. Schmidt. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 10–16.) Production methods are described and performance figures given for tapes with bases of (*a*) standard 0·0015-in. cellulose acetate and (*b*) 0·001-in. mylar A.

621.395.625.3 **2554**

The Reproduction of Signals recorded on Magnetic Tape.—E. D. Daniel & P. E. Axon. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 157–167.)The conventional analysis of the action of the ring type of reproducing head is re-examined, and experiments are described which demonstrate divergences between theoretical and practical results. The action of a single loop as a reproducer is analysed. Experiments check the theory. Common faults of reproducing heads are discussed and the practical aspects of standardization are considered.

621.395.625.3 **2555**

The Influence of Some Head and Tape Constants on the Signal recorded on a Magnetic Tape.—E. D. Daniel. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 168–175.) With recording heads of conventional design, the distribution of magnetization through the thickness of the magnetic material may be markedly nonuniform, the amount of the nonuniformity depending on the high-frequency bias setting. Analysis of this effect affords an explanation of certain aspects of recording performance, including the anomalous loss of high-frequency response when using large values of high-frequency bias. The effect of self-demagnetization on the recording characteristic of tape is also discussed.

AERIALS AND TRANSMISSION LINES

621.315.21 : 621.392.21 **2556**

Determination of the Primary Parameters of Uniform [cable] **Circuits.**—P. M. Prache. (*Câbles & Transm.*, April 1953, Vol. 7, No. 2, pp. 89–96.) Rigorous formulae are given for the required parameters, and also approximate formulae which are applicable when the loss angle of the circuit is small or when the circuit is short.

621.315.212 : 621.317.336 **2557**

Reflections in a Coaxial Cable due to Impedance Irregularities.—G. Fuchs. (*Câbles & Transm.*, April 1953, Vol. 7, No. 2, pp. 122–141.) Translation. See 3495 of 1952.

621.315.212 : 621.317.343 **2558**

Determination of the Local and Mean Characteristic Impedance of Coaxial Cables by means of the Unit-Step Signal.—Comte & Ponthus. (See 2732.)

621.315.212 : 621.392.2 **2559**

Transmission Parameters of a [cable] **Amplification Section.**—R. Roch & J. A. Ville. (*Câbles & Transm.*, April 1953, Vol. 7, No. 2, pp. 159–168.) The quadripole formed by a length of cable can be characterized by five parameters, the three usual parameters of attenuation and input and output image impedances, and two new parameters: the image impedances of short sections at the two ends. Making use of these five parameters, methods of analysis previously described [3374 of 1952 (Ville)] are applied to a quadripole chain representing a length of cable between two amplifiers. From the various parameters of the constituent sections, those of the whole length are deduced. The formula for the attenuation takes account of all the physical factors concerned, such as the reflections at the junctions of the various sections, and also double reflections.

621.392 **2560**

Heaviside's Condition for Distortionless Transmission.—E. Astuni. (*Alta Frequenza*, Feb. 1953, Vol. 22, No. 1, pp. 37–39.) The relations required between the parameters of a transmission line to provide distortionless transmission are derived by a simple method starting from consideration of an ideal line with zero inductance and capacitance.

621.392 **2561**

Heaviside, Vaschy, Pupin and Some Others.—P. Lombardi. (*Alta Frequenza*, Feb. 1953, Vol. 22, No. 1, pp. 39–43.) Comment on 2560 above.

621.392 + 621.315.212].018.44 **2562**

Transmission Properties of Laminated Clogston-Type Conductors.—E. F. Vaage. (*Bell Syst. tech. J.*, May 1953, Vol. 32, No. 3, pp. 695–713.) The laminated transmission lines described by Clogston (2908 of 1951) are discussed and compared with ordinary coaxial cable. Approximate formulae are derived for the equivalent inductance, capacitance and resistance, and expressions are obtained for the attenuation, phase constant and propagation velocity, using conventional transmission-line theory. The results are compared with those obtained using the rigorous formulae developed by Morgan (25 of January and 618 of March).

621.392.26 **2563**

Calculation of the Excitation of Waveguides.—L. S. Benenson. (*Zh. tekh. Fiz.*, April 1952, Vol. 22, No. 4, pp. 559–578.) The excitation of a waveguide loaded at the ends is discussed and the amplitudes of voltages at slots are calculated. The case of a slot cut along the middle line of the wider wall of a rectangular waveguide is considered separately, and it is shown that it can be excited by a reactive vibrator, i.e., a vibrator short-circuited by the waveguide wall. The coupling of two rectangular waveguides by means of a longitudinal and a transverse slot cut in the shape of a cross is examined. The discussion is illustrated by experimental data.

621.392.26 **2564**

Excitation of a Circular Waveguide.—G. T. Markov. (*Zh. tekh. Fiz.*, April 1952, Vol. 22, No. 4, pp. 747–758.) A solution is obtained of a vectorial inhomogeneous wave equation by conversion to an analytical form referred to a cylindrical system of coordinates; the electric and magnetic fields due to external electric currents distributed in a uniform space are determined. The solution is used for considering the external and internal excitation of a perfectly conducting, infinitely long cylindrical waveguide. A number of particular problems, such as the diffraction of waves near the waveguide, operation of metal aerials on and near its surface, and the effect of slots in the surface, are discussed.

621.392.26 **2565**

The Susceptance of a Circular Obstacle to an Incident Dominant Circular-Electric Wave.—L. S. Sheingold. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 414–422.) A variational method is applied to determine the susceptance of a thin obstacle in a uniform round waveguide with an incident TE_{01} wave. The formulae obtained give results in good agreement with experimental values. Curves of normalized susceptance as a function of aperture, guide wavelength and free-space wavelength are included.

621.392.26 **2566**

The Slotted Diaphragm in Waveguides with Rectangular Cross-Section.—R. Müller. (*Z. angew. Phys.*, April 1953, Vol. 5, No. 4, pp. 142–148.) Continuation of work noted in 1583 of June. The reflecting power of a symmetrically placed slit for an H_{10} wave is calculated as a function of wave number and slit width. For the case of a wide slit, the previously derived Fredholm integral equation is used; for the case of a narrow slit, a further integral equation is developed. By suitably transforming these equations they can be solved by a recurrence method, details of which are given.

621.392.26 : 621.316.727.018.424 **2567**

A Wide-Band Waveguide Phase-Shifter.—G. J. Halford. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 117–124.) Phase-shifters consisting of long slabs of dielectric, some with stepped ends, are discussed. For 3 × 1·5 in. waveguide, a cross section of 1 × 0·5 in.

was adopted for the distrene used, which is supported on rods parallel to the wider side of the waveguide, motion along the rods giving phase shifts up to a maximum of 180°. Design theory is given for slabs with linear-taper, quadratic-taper and stepped ends. Performance figures are given for four S-band models of the latter type with bandwidths of 10–25%.

621.396.67 **2568**

Distribution of Current and Voltage in Cylindrical, Ellipsoidal and Conical Aerials.—O. Zinke. (*Onde élect.*, Feb. 1953, Vol. 33, No. 311, pp. 107–117.) See 2437 of 1952.

621.396.67.011.21 **2569**

Mutual Impedance of Two Thin Straight Aerials, Parallel or with Directions Intersecting, carrying Harmonic Currents.—F. Babin. (*Ann. Télécommun.*, April 1953, Vol. 8, No. 4, pp. 145–148.) Harmonic currents are defined as of the form $Ce^{jKz} + C'e^{-jKz}$, where $K = 2\pi/\lambda$, C and C' are complex coefficients, z is measured along the aerial, and λ is the wavelength in air and on the aerial. A general method is given for calculating the field and also the mutual impedance of wire aerials (*a*) parallel, (*b*) concurrent.

621.396.677 **2570**

The Field Radiated by a Ring Quasi-array of an Infinite Number of Tangential or Radial Dipoles.—H. L. Knudsen. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 781–789.) The term 'quasi-array' is used rather than 'array' because with a tangential or radial arrangement of the elements they are not identically oriented. An analysis is made of the field due to such a system of an infinite number of dipoles carrying currents of the same amplitude but with phase varying uniformly round the ring. The gain of the system increases with the total change of phase round the ring, tending in the limit to the condition of 'supergain'. An approximate expression is derived for the minimum practical value of the ring radius for a given phase change.

621.396.677 **2571**

The Optimum Linear Array for a Single Main Beam.—D. R. Rhodes. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 793–794.) A method is indicated for determining current distribution and element spacing for an aerial array so as to obtain a single-beam endfire radiation pattern with minimum beam width for a given side-lobe level.

621.396.677 **2572**

A Note on the Circular Dielectric-Disk Antenna.—E. M. T. Jones & R. A. Folsom, Jr. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, p. 798.) Brief discussion of an aerial similar to that noted in 2442 of 1952 (Jones).

621.396.677.1 : 523.72 : 621.396.822 **2573**

A High-Resolution Aerial for Radio Astronomy.—W. N. Christiansen. (*Nature, Lond.*, 9th May 1953, Vol. 171, No. 4358, pp. 831–833.) An aerial constructed near Sydney, for scanning the sun, is described; it operates on a wavelength of 21 cm. The system consists of 32 paraboloids, each 6 ft in diameter, mounted on individual axes and arranged at equal distances along a 700-ft roughly east-west line. A family of beams with angular separation of 1·7° is produced; the earth's rotation causes these beams to sweep across the solar disk in succession. The aerials are connected by a branch 2-wire-line system to a receiver with a continuously recording milliammeter connected to its output. Peaks on the records indicate areas of enhanced brightness on the solar disk; these are found to lie above sunspot groups or close to places previously occupied by sunspots. Use of the records to study the angular distribution of emission and time variations of emission from these areas is discussed.

CIRCUITS AND CIRCUIT ELEMENTS

534.13 **2574**

Diffraction Patterns for Solid Delay Lines.—R. A. Mapleton. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 516–524.) Solutions of the vector equation of equilibrium for an isotropic solid are presented for the special case of loss-free sine waves. Examples are considered in which the distribution of a single stress component is selected to simulate the stress produced by a high-frequency quartz crystal.

621.3.011.6 **2575**

Extension of the Concept of the Time Constant.—F. Nechleba. (*Elektrotech. Z.*, *Edn A*, 11th Feb. 1953, Vol. 74, No. 4, pp. 98–101.) Examples of the application of a general expression for the time constant

$$T = [1/(x_\infty - x_0)]\int_0^\infty (x_\infty - x)\, dt$$

are illustrated in cases where the function is not exponential.

621.3.012.11 **2576**

Geometrical Transformation of Impedance Diagrams.—H. Briner & W. Graffunder. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 102–110.) The limited impedance range of the normal circle-diagram representation of impedances is noted. A second type of circle diagram can be constructed in which all possible impedance values satisfying the required conditions lie within the unit circle; its construction by means of Riemann's number sphere is required.

621.314.2.029.4 **2577**

Consideration of Some Factors concerning the Use of Audio Transformers.—W. E. Lehnert. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 105–110.) The effect on the frequency response of using source or load impedances different from the rated values is discussed. Methods of reducing distortion due to nonlinear core characteristics and of eliminating noise due to various causes are indicated. Methods of matching several impedances to a single one simultaneously are shown.

621.314.235.012.12 **2578**

The Input Impedance and Transimpedance of I.F. Transformers.—H. H. van Abbe. (*Electronic Applic. Bull.*, Nov./Dec. 1952, Vol. 13, Nos. 11/12, pp. 178–200.) Formulae are derived for the conventional i.f. transformer consisting of two coupled circuits tuned to the same frequency. The relation between transimpedance and input-impedance variations and the form of the frequency response curve are investigated. The method of constructing polar diagrams is explained, and diagrams are shown for the two impedances for various values of the parameters, their usefulness in the study of feedback phenomena, particularly feedback from valve anode to grid, is indicated.

621.314.3† + 621.318.435.3 **2579**

Dynamic Characteristics of Transductors, or Magnetic Amplifiers.—W. Schmidt. (*Arch. elekt. Übertragung*, May 1953, Vol. 7, No. 5, pp. 249–255.) Review of the physical characteristics of transductors with low-resistance control circuits and of the self-excitation type.

621.314.3† **2580**

The Figure of Merit of Magnetic Amplifiers.—J. T. Carleton & W. F. Horton. (*Elect. Engng, N.Y.*, March 1953, Vol. 72, No. 3, p. 229.) Digest only.

621.314.3† 2581
Magnetic Amplifier with Reset Control.—G. M. Attura. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 161–163.)

621.314.7 : 621.392.5 2582
Transistor Negative-Impedance Converters.—J. G. Linvill. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 725–729.) Improved converters of the general type described by Merrill (1323 of 1951) are obtained by using transistor circuits in place of the original valve circuits. The characteristics obtained are highly stable. Various practical circuits are illustrated and discussed, and applications in telephone repeaters are described.

621.314.7 : [621.396.645 + 621.318.57 2583
Symmetrical Properties of Transistors and their Applications.—G. C. Sziklai. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 717–724.) Symmetry of one kind is found in the complementary characteristics of the *n-p-n* and *p-n-p* types of junction transistor; by using these two types in combination, reduction of the number of components and other circuit simplifications can be achieved, particularly in single-ended push-pull amplifiers. Symmetry of a second kind can be found in single transistors and is evidenced by interchangeability as regards operation of emitter and collector; use is made of this property in switching circuits, e.g., for clamping and modulation, and for a high-efficiency television deflection circuit.

621.318.43.042.4 2584
On the Magnetization of Toroids with One and Two Air-Gaps.—F. F. Panesenkov. (*Zh. tekh. Fiz.*, June 1952, Vol. 22, No. 6, pp. 989–999.) A method is proposed for calculating the leakage coefficient in the case of a toroid with one large air-gap, and an experimental formula is derived for determining the average leakage coefficient for the cases of toroids with one air-gap and with two diametrically opposite air-gaps.

621.392 2585
The Second Fundamental Theorem of Electrical Networks.—C. Saltzer. (*Quart. appl. Math.*, April 1953, Vol. 11, No. 1, pp. 119–123.) An independent proof is given of a theorem which states, for the Norton (nodal) representation, the relations previously proved by Ingram & Cramlet (435 of 1945) for the Thévenin (mesh) representation. The nodal equations of Kron, as given by Le Corbeiller (1892 of 1950), are deduced by a method similar to that of Synge (347 of 1952). The relation between the nodal and mesh theorems is discussed.

621.392 2586
Network Transformations.—L. Norde. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 137–139.) A method of finding an equivalent for a given network is outlined, a table of equivalent networks is presented, and examples of the use of the method are given.

621.392.4/.5 2587
The Solution of Passive Electrical Networks by means of Mathematical Trees.—W. S. Percival. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 143–150.) A new method of solution for network problems is based on the properties of certain basic types of network termed 'trees' and '2-trees'. Linkage functions, defined in terms of sets of trees and 2-trees, obey laws analogous to those of Kirchhoff, so that relations involving voltages and currents can be expressed in terms of linkages. Results of the method are given in terms of admittances. See also 347 of 1952 (Synge).

621.392.43 : 621.396.67 2588
Design Procedures for Pi-Network Antenna Couplers.—L. Storch. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 790–793.) Discussion on paper noted in 571 of 1950.

621.392.5 2589
Reciprocal Ladder Networks.—J. B. Rudd. (*A.W.A. tech. Rev.*, Jan. 1953, Vol. 9, No. 3, pp. 159–170.) The transfer impedance of a system comprising generator and load with ladder network interposed is unchanged if instead of the original network a 'reciprocal' network is connected in reverse. The reciprocal network is derived from the original one by replacing series impedances by shunt impedances and vice versa, the product of the original and new impedances being in each case equal to the product of the generator and load impedances.

621.392.5 2590
Reactive T or Π Sections resolvable into Two Matched Half-Sections.—R. Leroy. (*Cables & Transm.*, April 1953, Vol. 7, No. 2, pp. 156–158.) Means are indicated for determining whether the resolution into half-sections with matched terminal impedances is possible.

621.392.5 2591
Study of an Electronic Antiresonant Circuit.—P. Riéty. (*Ann. Télécommun.*, April 1953, Vol. 8, No. 4, pp. 113–122.) Theory is given of a circuit which can either be used as a low-pass filter or as an antiresonant circuit. The operation of the circuit in the steady state in response to an applied sinusoidal voltage, and in the transient regime in response to a unit-step voltage, is analysed. As an antiresonant circuit it is more selective than a double-T *RC* circuit. Its characteristics can be varied within wide limits and the values of the components can easily be calculated from the characteristics specified. Its high selectivity, independent of the cut-off frequency, makes it particularly suitable for use at very low frequencies.

621.392.5 : 621.396.611.35 2592
Resistive Bidirectional Coupler.—L. Rosenthal. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 799–800.) A resistive T network is discussed which, when inserted between a source and a load, acts as a bi-directional coupler, providing voltages proportional respectively to the incident and reflected waves. The arrangement is applicable to measurement purposes, and is used, e.g., in the wattmeter described by Ryder & McVay (2394 of August).

621.392.5 : 621.396.645 2593
Resistance-Capacitance Networks in Amplifier Design.—E. D. Sisson. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 116–124.) Two types of *RC* network are distinguished, the first of which includes all networks with a simple series or shunt capacitor. This type only is considered. Frequency and phase characteristics are derived and reduced to simple graphical form. Impedance matching and loading effects are discussed. Typical equalizer and tone-control circuits are examined.

621.392.5 : 621.396.667 2594
Attenuation Equalizers.—F. R. Bies. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 125–136.) The performance of various commonly used equalizer networks is discussed, and a chart method of computing their insertion loss is presented.

621.392.52 2595
Minimum Inductor or Capacitor Filters.—W. Saraga. (*Wireless Engr*, July 1953, Vol. 30, No. 7, pp. 163–175.) Known methods are surveyed and some new methods developed for designing equivalent filter networks having fewer inductors or capacitors than a given network. The

particular transformation appropriate in a given case depends on whether the given filter is an image-parameter type which can be split into separate *m*-derived sections, or is of a more general character. The methods presented are based on the values of the network elements, without reference to impedance/frequency functions of the network as a whole. Two practical examples of application of the methods to band-pass filters are treated in detail.

621.392.52 **2596**

The Effects of Terminations and Dissipation on the Insertion Loss of Some Simple Ladder Filters.—M. Strasberg. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 777–780.) By using special terminations, the selectivity of these filters can be improved and elements with relatively low values of Q can be used. Insertion-loss curves indicating the combined effects of the terminations and of dissipation in the filter elements are presented in a form applicable to low-pass, high-pass and band-pass filters of several types.

621.392.52 **2597**

Theory of Antimetrical Lattice Filters.—J. Oswald. (*Bull. Soc. franç. Élect.*, March 1953, Vol. 3, No. 27, pp. 116–124.) The theory of a class of lattice filters with inverse image impedances is a counterpart of that for symmetrical filters. These filters comprise two reactances and their inverses; the frequencies at which the modulus of the reactances is equal to the characteristic impedance correspond to the poles and zeros of the reactances in the symmetrical case. Calculations relative to the construction of such filters are explained and typical examples are described. A high-ratio impedance transformation is attainable with narrow-band circuits. See also 959 of 1940 (Piloty).

621.392.52 **2598**

Optimum Nonlinear Filters.—L. A. Zadeh. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 396–404.) Theory of optimum nonlinear filters is based on the consideration of a sequence of classes of nonlinear filters, N_1, N_2, N_3 . . . , such that each class in the sequence includes all the preceding classes, and also includes the class of linear filters. The characteristic function of the optimum filter within the class N_m is found to satisfy a linear integral equation of order $2m$. A detailed treatment of optimum filters of class N_1 is given, and methods of approximate realization of such filters in the form of nonlinear delay-line filters and power-series filters are indicated. The results are extended to the case of non-stationary time series.

621.392.54 : 621.392.26 **2599**

Construction and Calibration of an Inductive Attenuator.—L. Resegotti. (*Alta Frequenza*, Feb. 1953, Vol. 22, No. 1, pp. 17–31.) A h.f. attenuator is described which makes use of the properties of a waveguide at frequencies far below cut-off. For a frequency of 18 Mc/s the attenuation varies linearly to within 1%, between 20 and 120 db, with the distance between the source and the output coil. The attenuation can be calculated from the physical dimensions only.

621.396.6 **2600**

Novel Valve Circuits.—J. P. Oehmichen. (*Toute la Radio*, Feb.–April 1953, Vol. 20, Nos. 173 & 174, pp. 43–46 & 88–90.) A review of valve circuits operated under unusual conditions in respect of bias, anode and screen voltages, and of input and coupling arrangements, as in pulse squaring and gating circuits and electrometer applications.

621.396.61 **2601**

A Note on Moving Poles in Nonlinear Oscillating Systems.—W. B. Wrigley. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 774–777.) "Since poles of the complex immittance of a linear system represent the decrements and frequencies of rotating phasors in the linear time domain, it is suggested that a nonlinear system might be represented by moving poles whose instantaneous decrements and frequencies are associated with phasors rotating in the nonlinear or time-distorted phase space. This idea is applied to the analysis of a class of nonlinear oscillation generators of the second order which is described by the differential equation, $\ddot{X} - N_1(\dot{X}, X) = 0$."

621.396.611.1 **2602**

A Second Contribution to the Solution of the 'Rukop Problem'.—K. Steimel. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 73–76.) Re-examination of the problem of the dynatron-driven series circuit and the arc-driven parallel circuit (1931 Abstracts, p. 92). Nyquist's stability criterion is applied to the equivalent circuit, and the necessary and sufficient conditions for excitation of oscillations are determined.

621.396.611.2 : 621.319.4 **2603**

Compensation of the Temperature Effect in *LC* Circuits by means of Negative-Coefficient Capacitors.—P. A. Colavita. (*Rev. telegr. Electronica, Buenos Aires*, April 1953, Vol. 41, No. 487, pp. 199–203, 215.) Compensation at a given frequency is obtained by connecting in parallel with a variable capacitor a series arrangement of a fixed negative-coefficient capacitor and a variable capacitor. The experimental method of adjustment is described. Frequency variation with temperature for uncompensated settings is studied.

621.396.615 **2604**

More on the *RC* Oscillator.—W. J. Wray, Jr. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, p. 801.) Comment on 3512 of 1952 (Davidson).

621.396.615 **2605**

The Frequency Spectrum of a Pulled Oscillator.—A. G. Simms. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, p. 798.) The conclusions reached by Buchanan (3043 of 1952) are presented in a simpler and more precise form.

621.396.615 **2606**

Blocking Oscillators.—K. G. Beauchamp. (*Electronic Engng*, June 1953, Vol. 25, No. 304, pp. 239–243.) The use of blocking oscillators as generators of voltage or current pulses, or of repetitive sawtooth voltage or current waveforms, is examined in some detail, with a description of the mode of operation of the various circuits considered and discussion of the factors affecting their practical design.

621.396.615.12 : 621.316.726 **2607**

The Impulse-Governed Oscillator, a System for Frequency Stabilization.—E. H. Hugenholtz. (*Philips tech. Rev.*, Nov. 1952, Vol. 14, No. 5, pp. 130–140.) Detailed description. See 767 of 1951.

621.396.645 **2608**

Improved 'Lock-In' Amplifier.—H. L. Cox, Jr. (*Rev. sci. Instrum.* April 1953, Vol. 24, No. 4, pp. 307–308.) A stable sinusoidal voltage drives a square-wave generator, whose output is applied to the anodes of a pair of diodes in phase opposition. The signal is applied to the diode cathodes in equal phase. The d.c. output voltage developed between the two cathodes is directly proportional to the signal and is largely independent of the input noise level, the value of the stable voltage, and the valve parameters.

621.396.645 **2609**

Constant-Current Operation of Power Amplifiers.—H. T. Sterling & A. Sobel. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 16–21.) A Class-A_2 amplifier is discussed which is designed to be nearly independent of variations in valve characteristics. Cathode-follower drivers are used, together with balanced feedback and a separate feedback phase-inverter. See also 1635 of June.

621.396.645 : 621.3.018.78 **2610**

Distortion in Class-A Push-Pull Amplifiers.—S. Landesman. (*Alta Frequenza*, Feb. 1953, Vol. 22, No. 1, pp. 32–36.) The distortion is expressed in terms of the derivatives of the anode/grid characteristic at the operating point. The effect of the cathode resistance is to increase the distortion as compared with the effect due to the load resistance alone.

621.396.645 : 621.385.5 **2611**

Degenerative Pentode Equivalent Circuit.—H. Stockman. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, p. 801.) Analysis and discussion, based on two forms of equivalent circuit, of a pentode arrangement with feedback via cathode-lead impedance.

621.396.645.018.424 **2612**

Distributed Amplifier Theory.—D. V. Payne. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 759–762.) Matrix algebra is used to analyse operating conditions in the anode line. The manner in which the amplifier gain depends on grid- and anode-line terminations and propagation constants, number of valves and grid driving voltage is indicated. Experimental results obtained with a six-valve amplifier provide general confirmation for the theory.

621.396.645.029.3 **2613**

Analysis of a Single-Ended Push-Pull Audio Amplifier.—Chai Yeh. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 743–747.) Analysis is given for the circuit described by Peterson & Sinclair (1250 of 1952). Linear valve characteristics and small signals are assumed. Some experimental results are reported.

621.396.645.029.3 **2614**

Bypass and Decoupling Circuits in Audio Design.—L. S. Goodfriend. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 111–116.) The amplifier equation is put into a form which expresses the gain for ideal conditions of perfect bypassing and no reactive elements, with separate terms taking account of the actual reactive effects. These terms are evaluated for the limiting conditions at the low and high ends of the frequency band, and the real and imaginary parts are separated. Design of triode and pentode circuits is considered.

621.396.645.029.3 **2615**

Audio-Frequency Input Circuits.—W. B. Snow. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 87–94.) Careful design of input circuits is important, especially when the input level is low. Fundamental factors considered include signal/noise ratio of the source, optimum input impedance for resistive and reactive generators, noise in the amplifier valve, input-transformer and connecting-cable characteristics.

621.396.645.083.6 **2616**

A Differential Input Stage for Low-Frequency Amplifiers.—V. H. Attree. (*Electronic Engng*, June 1953, Vol. 25, No. 304, pp. 260–261.) An a.c.-coupled differential input stage is described in which the ratio of in-phase to anti-phase gain, i.e., the transmission factor, is theoretically infinite. In an actual circuit, the measured value of the transmission factor was 10^4 at an in-phase signal level of 1·0 V r.m.s. The frequency range of 0·1 c/s–20 kc/s is adequate for most applications.

621.396.645.35 **2617**

Cathode-Drift Compensation in D.C. Amplifiers.—J. W. Rittenhouse. (*Elect. Engng, N.Y.*, April 1953, Vol. 72, No. 4, p. 299.) Digest only. The Miller circuit has been found effective in compensating against cathode drift, but it has been assumed necessary to use a load resistance large enough to make the anode current of the output valve small compared with that of the other. Simple analysis is presented to show that this limitation is unnecessary; an improvement of the circuit based on this analysis is suggested.

621.396.615 **2618**

Vacuum Tube Oscillators. [Book Review]—W. A. Edson. Publishers: Chapman & Hall, London, 476 pp., 60s. (*Wireless Engr*, July 1953, Vol. 30, No. 7, p. 183.) Intended for senior and graduate students as well as for practising electrical engineers; the subject is treated mainly from the point of view of design.

GENERAL PHYSICS

53.05 : 519.24 **2619**

Successive Differentiation of Experimental Curves, and Method of Smoothing.—P. Vernotte. (*C. R. Acad. Sci., Paris*, 4th May 1953, Vol. 236, No. 18, pp. 1737–1739.)

530.145 : 51 **2620**

Mathematical Aspects of the Quantum Theory of Fields: Part 5—Fields modified by Linear Homogeneous Forces.—K. O. Friedrichs. (*Commun. pure appl. Math.*, Feb. 1953, Vol. 6, No. 1, pp. 1–72.) Part 4 : 1290 of May.

530.145 : 517.51 **2621**

Dirac's Function and its Utilization in Mathematical Physics.—S. Colombo. (*Ann. Télécommun.*, April 1953, Vol. 8, No. 4, pp. 131–144.)

534.1 + 538.56 **2622**

Some Exact Solutions in Nonlinear Oscillations.—K. Munakata. (*J. phys. Soc. Japan*, July/Aug. 1952, Vol. 7, No. 4, pp. 383–391.) A rigorous analysis is made of forced oscillations of mechanical or electrical systems for certain cases which are specified by the condition that the forced oscillation has a waveform similar to that of the external force. The stability conditions are derived from Hill's equation, which can be solved exactly for the present cases.

535.33 : 538.569.4.029.65 **2623**

One- to Two-Millimeter Wave Spectroscopy.—W. C. King & W. Gordy. (*Phys. Rev.*, 15th April 1953, Vol. 90, No. 2, pp. 319–320.) Spectral lines have been measured at many positions between 1·37-mm and 2·3-mm wavelength, using similar technique to that previously described [1896 of 1952 (Johnson et al.)]. Construction details of the new multiplier and detector used will be given elsewhere.

535.37 **2624**

The Mechanism of Phosphorescence in Crystal Phosphors.—D. Curie. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 154–155.) A summary of the results of the investigations described elsewhere in greater detail (1643 of June).

535.42 + 534.26 **2625**

Infinite Matrices Associated with Diffraction by an Aperture.—W. Magnus. (*Quart. appl. Math.*, April 1953, Vol. 11, No. 1, pp. 77–86.) The results obtained by Levine & Schwinger (83 and 1897 of 1950) are discussed, and it is shown that the algebraic properties of the matrix used are such as to permit determination not only of the transmission coefficient but also of the distribution of field across the aperture.

537.122 **2626**

A Note on the Application of Schwinger's Variational Principle to Dirac's Equation of the Electron.—H. E. Moses. (*Quart. appl. Math.*, April 1953, Vol. 11, No. 1, pp. 111–118.)

537.311.33 : [546.28 + 546.289 **2627**

Transistors: Theory and Application: Part 4—Transistor Action in Germanium and Silicon.—A. Coblenz & H. L. Owens. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 166–171.) A simple account of the physical structure and properties of Ge and Si crystals. Part 3: 2289 of August.

537.315 **2628**

Investigation of the Potential Barrier between Two Electrodes of the Same Metal with Different Applied Potentials.—N. Nifontoff. (*C. R. Acad. Sci., Paris*, 20th April 1953, Vol. 236, No. 16, pp. 1538–1540.) A theoretical investigation of the barrier transparency and tunnel effect. Analysis leads to formulae which for limiting cases give the known results corresponding to a rectangular or triangular type of barrier.

537.315 **2629**

Some Properties of Potential Barriers.—A. Blanc-Lapierre & N. Nifontoff. (*C. R. Acad. Sci., Paris*, 27th April 1953, Vol. 236, No. 17, pp. 1634–1636.) Matrices used in defining the wave function at the junction between different media are shown to be applicable for calculations relating to potential barriers of various forms.

537.525 **2630**

The Electrical Breakdown of Gases in Nonuniform Fields at Low Pressure.—F. L. Jones & G. C. Williams. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 345–361.) Breakdown voltages between coaxial cylinders were investigated for air, H and He. The results obtained support the view that the same primary and secondary ionization processes are involved as for uniform fields.

537.534.71 : 537.534.8 **2631**

The Reflection Coefficient of Positive Lithium Ions striking a Metal Surface, and the Energy Spectrum of the Secondary Electrons.—G. Couchet. (*C. R. Acad. Sci., Paris*, 11th May 1953, Vol. 236, No. 19, pp. 1862–1864.) Results obtained for targets of duralumin and nickel are shown graphically. See also 384 of February, for which the U.D.C. number should be 537.534.8 : 621.385.833.

537.583 : 621.385.032.21 **2632**

A Survey of Present Knowledge of Thermionic Emitters.—Wright. (See 2832.)

538.114 **2633**

The Zero-Point Susceptibility of a Linear Antiferromagnetic Atomic Chain.—E. Ledinegg & P. Urban. (*Acta phys. austriaca*, Jan. 1953, Vol. 6, No. 4, pp. 257–287.)

538.56 : 537.525 **2634**

Operation of the Penning Gauge.—M. Bayet & G. Dumas. (*C. R. Acad. Sci., Paris*, 27th April 1953, Vol. 236, No. 17, pp. 1648–1650.) Experiments were made to check results reported by Laffineur & Pecker (1139 of 1951) on the emission of h.f. waves from a gas discharge. A receiver tunable over the band 3–0·5 m and fixed-tuned receivers for 75, 10 and 3 cm were used. No radiation was detected on the last two wavelengths; on the other wavelengths continuous spectra were observed with a fairly sharp peak at a frequency less than half the gyromagnetic frequency. The effect of a component of electric field normal to the magnetic field is discussed.

538.566 : 534.21-14 **2635**

Longitudinal Magneto-hydrodynamic Waves.—N. S. Anderson. (*J. acoust. Soc. Amer.*, May 1953, Vol. 25, No. 3, pp. 529–532.) Alfvén's theory indicates that the velocity of sound waves in a conducting fluid will be changed by application of a strong magnetic field. Theory of this effect is presented for a fluid with finite conductivity and is applied to predict effects that should be obtained in propagation of sound (*a*) in Hg in a very strong field, (*b*) in sea water under the influence of the geomagnetic field.

538.566 : 537.562 **2636**

Generalized Magneto-hydrodynamic Formulae.—C. O. Hines. (*Proc. Camb. phil. Soc.*, April 1953, Vol. 49, Part 2, pp. 299–307.) The formulae of magneto-hydrodynamic theory are extended by the simpler methods of magneto-ionic theory, in which mean velocities and forces are used, and nonlinearities are avoided by perturbation treatment. The results are applied to the case of plane-wave propagation in the direction of a primary magnetic field.

538.566 : 537.562 **2637**

Interaction of Microwaves propagated through a Gaseous Discharge Plasma.—L. Goldstein, J. M. Anderson & G. L. Clark. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 151–152.) Experimental observations are reported on the interaction of 8·6-kMc/s and 9·4-kMc/s signals in discharge plasma produced in He, Ne, Ar, Kr, Xe and H gases over the pressure range 0·2–20 mm Hg, pulse excitation being used. The 8·6-kMc/s disturbing wave was pulse modulated, and the wanted c.w., transmitted through the decaying plasma, was detected by means of a cavity resonator, the amplified envelope being displayed on a c.r.o. Typical oscillograms, showing the modification of the envelope of the wanted wave due to the pulsed disturbing wave, are reproduced. When a magnetic field is applied, the interaction is observed at low signal levels for which no effect is found in the absence of the magnetic field. See also 914 of 1952 (Goldstein et al.) and back reference.

538 691 **2638**

The Characteristics of an Electron Beam entering a Coaxial Magnetic Field.—L. Brück. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 85–88.) The effect of nonuniformity of the focusing field on the convergence of an electron beam is studied by considering a particular field configuration and calculating the path of an electron at the edge of the beam. The radius of the beam is plotted as a function of distance travelled in the transition zone, for different values of a parameter which is dependent on current density, accelerating voltage and length of the transition zone.

621.3.011.4 **2639**

Calculation of the Electrostatic Capacitance of a Conductor by the Method of Excess and Deficit: Application to the Case of the Cube.—L. Daboni. (*R. C. Accad. naz. Lincei*, April 1953, Vol. 14, No. 4, pp. 461–466.) Using a method based on a theorem due to Fichera, the capacitance of a cube of side *a* is found to be between 0·654*a* and 0·676*a*.

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

523.72 : 621.396.822 : 621.396.677.1 **2640**

A High-Resolution Aerial for Radio Astronomy.—Christiansen. (See 2573.)

523.746 : 550.385 **2641**

On Sunspots and Magnetic Storms.—F. Moriyama. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 4, pp. 151–157.) Study of the correlation between active sunspots and geomagnetic storms shows that the effect of central-meridian passage of active sunspots on the occurrence of storms is more evident when the activity is defined by both the spot type and the magnetic character than by the spot type alone. This is particularly noticeable in the case of geomagnetic storms with gradual commencements.

523.746 : 550.386 **2642**

Control of Geomagnetic Activity by Sunspots.—J. F. Denisse. (*C. R. Acad. Sci., Paris*, 11th May 1953, Vol. 236, No. 19, pp. 1856–1858.) Statistical analysis of the sunspots observed in 1948, 1949 and 1950 shows that as regards their effect on geomagnetic activity they can be divided into two distinct classes: (*a*) radio-emissive spots, the source of relatively dense corpuscular jets and accompanied by marked peaks of mean geomagnetic activity; (*b*) sunspots with no corpuscular or radio emission, causing a marked reduction of geomagnetic activity. In the case of many spots of this latter type, the geomagnetic activity returns quickly to normal 3 to 4 days after the spots pass the central meridian.

550.384/.386 **2643**

Proposals for the Statistical Treatment of Geomagnetic Micropulsations.—O. Schneider. (*Arch. Met. A, Wien*, 1951, Vol. 4, pp. 403–412.) A system of classification is suggested in which the magnitude, duration and regularity of the pulsation trains are assessed semi-quantitatively.

550.385 **2644**

Some Characteristics of Magnetic Storms: Part 1—Magnetic Storm on August 3, 1949.—N. Fukushima. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 2, pp. 85–97.) Analysis of data from many observatories all over the world.

550.385 **2645**

The Morphology of Geomagnetic Storms: an Extension of the Analysis of D_s, the Disturbance Local-Time Inequality.—S. Chapman. (*Ann. Geofis.*, Oct. 1952, Vol. 5, No. 4, pp. 481–499. In English.)

550.385.001.11 **2646**

Further Notes on a New Theory of Magnetic Storm.—Y. Kato. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 2, pp. 75–83.)

551.510.53 : 537.311.37 : 550.384.4 **2647**

A Suggestion for the Electric Conductivity of the Upper Atmosphere from an Analysis of Diurnal Variations of Terrestrial Magnetism: Part 2.—M. Hasegawa & H. Maeda. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 4, pp. 167–178 & 1952, Vol. 6, No. 3, pp. 155–158.) Diurnal variations of the electric field and electrical conductivity of the upper atmosphere are deduced from the observed variations of the geomagnetic field.

551.510.53 : 551.594.51 **2648**

On the Auroral-Zone Current.—T. Nagata. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 2, pp. 87–101.) Analysis of eleven examples of auroral-zone disturbance of the geomagnetic field in the Second International Polar Year indicates that the height of the zone currents may be 100 km or less, the current intensity for moderate magnetic disturbances being of the order of 400–800 A/km, a very large increase in the electron density of the D and E layers being thus indicated.

551.510.534 **2649**

The Mean Vertical Ozone Distribution resulting from the Photochemical Equilibrium, Turbulence and Currents of Air.—H. K. Paetzold. (*J. atmos. terr. Phys.*, April 1953, Vol. 3, No. 3, pp. 125–131.)

551.510.535 + 523.74 **2650**

Ursigrams.—(*U.R.S.I. Inform. Bull.*, Jan./Feb. 1953, No. 77, pp. 31–39.) Abbreviated codes are given for European ursigrams, and modifications in the French ursigram transmissions are tabulated.

551.510.535 **2651**

The Continuous Layer Formation in the Atmosphere under the Influence of Solar Radiation.—H. K. Kallmann. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 153–154.) The formation of ionized layers in the atmosphere under the influence of (*a*) a quiet sun, (*b*) a disturbed sun, is found possible in both cases if account is taken of the variation with height of (*a*) the dissociation of the molecular constituents, (*b*) the ionization of the different constituents at various altitudes. The expression 'continuous layer formation' signifies continuous increase and decrease of the electron density with height throughout the ionosphere.

551.510.535 **2652**

Formation of the D Layer.—K. Watanabe, F. Marmo & E. C. Y. Inn. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 155–156.) Measurements of absorption cross-sections of various gases are described. The results favour the assumption that absorption of solar radiation by NO is largely responsible for the formation of the D layer.

551.510.535 **2653**

Determination of the Coefficient of Recombination in the Ionosphere.—Y. V. Somayajulu. (*Sci. & Cult.*, April 1953, Vol. 18, No. 10, pp. 494–496.) A simple method is suggested in which the recombination coefficient α is determined from night-time observations, in terms of the gyrofrequency, the mean observation frequency, and the time interval between the disappearance of the ordinary-and extraordinary-ray echoes. The value of α for the F region found by this method, using records of Radio Ceylon transmissions on 11·98 Mc/s, is $4{\cdot}16\times10^{-10}$ cm³/sec. Using vertical-incidence measurements at Calcutta, a value of $13{\cdot}16\times10^{-11}$ cm³/sec is obtained, compared with $13{\cdot}14\times10^{-11}$ cm³/sec calculated by the usual method.

551.510.535 **2654**

A Statistical Study on the Minimum Frequency in h'/f Curve for the E Region of the Ionosphere.—H. Kamiyama. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 1, pp. 13–24.) The diurnal and seasonal variation of the minimum frequency in the h'/f curve for the E region is investigated, and also its relation to the sunspot number. The diurnal variation suggests the existence below the E layer of an absorbing layer which is ionized by solar radiation. The electron density in the D layer is estimated to be $1{\cdot}5\times10^{4}$/cm³.

551.510.535 **2655**

Wave Hypothesis of Moving Irregularities in the Ionosphere.—C. O. Hines. (*Nature, Lond.*, 30th May 1953, Vol. 171, No. 4361, p. 980.) A preliminary discussion of magneto-hydrodynamic effects which may afford an alternative explanation of the motion of ionospheric irregularities, usually referred to as 'winds', in terms of the propagation of a wave-like disturbance. It is found that travelling atmospheric disturbances, governed by pressure oscillations and gravitational forces, will be accompanied by e.m. oscillations which can, under special resonance conditions, become large. The corresponding amplification of the associated electron motions would render such disturbances particularly susceptible to detection by radio methods. Gravity tends to confine the movement of these disturbances to the horizontal plane, but a secondary vertical component is possible. A full treatment is to be published later.

551.510.535 **2656**

An Analysis of Electron-Density Variations in the F_2 Layer after Sunset.—T. Yonezawa. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 1, pp. 1–12.) Analysis of data obtained at Kokubunji, taking temperature variations into account and assuming a linear law for the rate of disappearance of electrons, indicates that the nocturnal variation of electron density in the F_2 layer is explained more satisfactorily by the attachment theory than by the recombination theory. The corresponding temperature variations deduced are not satisfactory for the winter months, for which other factors must be taken into account.

551.510.535 : 523.746 **2657**

Critical-Frequency Variations.—T. W. Bennington. (*Wireless Engr*, July 1953, Vol. 30, No. 7, pp. 175–179.) Twelve-month running averages of f_0F_2 are plotted against twelve-month running averages of the sunspot number for two stations in the northern hemisphere, two in the southern hemisphere, and one near the equator. For the northern-hemisphere stations the slope of the curve is less at the higher values of sunspot number, for the southern-hemisphere stations the slope is constant, and for the equatorial station the slope varies in an intermediate manner. These differences may be related to the differences in the annual variation of f_0F_2 in the various regions considered.

551.510.535 : 523.78 **2658**

Effects on the F Regions of the Ionosphere of the Solar Eclipse of May 9, 1948.—Y. Nakata. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 1, pp. 21–30.) Observations indicated the development during the eclipse of a new layer between the F_1 and F_2 layers. Discontinuities of the F_2-layer critical-frequency and virtual-height curves and of the F_1-layer critical-frequency curve were noted for a period of about 30 min before and after the first contact. Estimates are made of the electron-density variations involved.

551.510.535 : 523.78 **2659**

The *h't* Measurement of Ionosphere at the Time of the Annular Eclipse of May 9, 1948, at Wakkanai, Hokkaido, in Japan.—H. Uyeda, H. Kudo, T. Shimizu & R. Sato. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 2, pp. 75–77.) Measurements were made at frequencies of 2·1, 4·5 and 7·05 Mc/s. The results obtained show that (*a*) the absorption in and below the E layer decreased as the eclipse approached its maximum and increased again after the maximum phase; (*b*) the maximum F_1-layer electron density began to decrease immediately after first contact and continued to decrease to a minimum about 15 min after the maximum phase of the eclipse, then recovering.

551.510.535 : 535.34 **2660**

27-Day Variations in the Absorption of the D Region of the Ionosphere over Singapore and Slough.—G. Lange-Hesse. (*J. atmos. terr. Phys.*, April 1953, Vol. 3, No. 3, pp. 153–162. In German.) Appreciable variations of D-layer r.f. absorption, with a 27-day period, are found throughout the year at Singapore, but only during the summer months at Slough. Other variations of absorption, of larger amplitude than in summer, are found at Slough in the winter months, but are not related to the solar-rotation period of variations of particle radiation. The bearing of these results on radio communication and on ionospheric forecasting is discussed briefly. See also 3538 of 1952.

551.510.535 : 535.34 **2661**

Measurement of Ionospheric Absorption.—P. Dominici. (*Ann. Geofis.*, Oct. 1952, Vol. 5, No. 4, pp. 561–568.) The significance of ionospheric absorption is discussed, and commonly used methods of measurement are examined.

551.510.535 : 537.567/.568 **2662**

The Recombination Coefficient and the Temperature Variation in the Upper Atmosphere at Night.—T. Yonezawa. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 2, pp. 79–85.) The value of the F_2-layer recombination coefficient at Kokubunji, near Tokyo, shows a marked seasonal change, the maximum being in January and the minimum in June–July. Calculation of the corresponding relative temperatures indicates that in winter some mechanism other than temperature variation must be taken into account.

551.510.535 : 550.386 : 523.75 **2663**

The Solar-Flare Type Variation in Geomagnetic Field and the Integrated Electrical Conductivity of the Ionosphere: Part 1.—T. Nagata. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 3, pp. 155–172.) Assuming that the solar-flare type of variation of the geomagnetic field is caused by anomalous increase of the electrical conductivity of the ionosphere, treatment based on the dynamo theory gives a value for the integrated conductivity of the ionosphere of the order of 5×10^{-8} e.m.u., which is in good agreement with the value deduced from ionospheric observations.

551.510.535 : 550.386 : 523.75 **2664**

The Solar-Flare Type Variation in Geomagnetic Field and the Integrated Electrical Conductivity of the Ionosphere: Part 2 — Effect of F layer.—T. Nagata & T. Suzuki. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 4, pp. 201–205.) Analysis of mutual-inductance effects between different ionosphere layers shows that, as regards the effect of layer currents on the geomagnetic field, a single layer can be assumed, the conductivity of which is equal to that of the various layers integrated vertically throughout the whole conductive region. The previous estimate of about 5×10^{-8} e.m.u. for the integrated conductivity of the whole ionosphere is thus confirmed. Part 1: 2663 above.

551.510.535 : 550.386 : 523.75 **2665**

The Solar-Flare Type Variation in Geomagnetic Field and the Integrated Electric Conductivity of the Ionosphere: Part 3 — Effect of the Earth.—T. Nagata & M. Tazima. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 3, pp. 113–121.) Further discussion, taking account of the electrical conductivity of the earth. Part 2: 2664 above.

551.510.535 : 550.386 : 523.75 **2666**

The Solar-Flare Type Variation in Geomagnetic Field and the Integrated Electric Conductivity of the Ionosphere: Part 4 — The Conductivity of the Ionosphere over Japan.—T. Nagata. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 3, pp. 123–128.) Statistical analysis of data obtained at Kakioka during 1936–1942 gave the average value of the integrated electrical conductivity of the ionosphere over Japan as 7×10^{-8} e.m.u. Part 3: 2665 above.

551.510.535 : 621.3.013.783 **2667**

The Shielding Effect of the Ionosphere.—M. Sugiura. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 1, pp. 31–36.) Analysis of the effect of the ionosphere in screening the earth from external e.m. fields, taking account of the conductivity of the earth.

551.510.535 : 621.396.72 : 621.3.087.47 **2668**

Ionospheric Stations.—(*U.R.S.I. Inform. Bull.*, Jan./Feb. 1953, No. 77, pp. 19–29.) A list is given of all stations from which results of observations are regularly received at Slough; in a second list, which replaces those previously published, ionospheric stations are grouped according to the country controlling them.

551.594.6 : 621.396.11 **2669**

Atmospherics with Very Low-Frequency Components.—Hepburn & Pierce. (See 2771.)

551.510.535(410) **2670**

Radio Research Special Report No. 23. Characteristics of the Ionosphere observed in Great Britain, 1930–46. [Book Notice]—Publishers: H.M. Stationery Office, London, 1952, 1s. 6d. (*Govt Publ., Lond.*, April 1953, p. 23.) Report of measurements at Slough, 1930–1946, and at Burghead, 1941–1946.

LOCATION AND AIDS TO NAVIGATION

621.396.9 **2671**

The Effective Number of Pulses per Beamwidth for a Scanning Radar.—L. V. Blake. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 770–774.) As regards signal/noise ratio, the optimum value for the angle over which the pulses are integrated, assuming a beam of Gaussian form, is $0{\cdot}84\ \beta$, where β is the half-power beam width. The equivalent rectangular beam has a width of $0{\cdot}47\ \beta$; hence the equivalent number of full-amplitude pulses is 0·47 times that usually assumed, corresponding to a value of system sensitivity lower by 1·6 db than that calculated on the assumption of integration over the angle β.

621.396.9 **2672**

M.T.I. in Pulse Radar Systems and the Doppler Myth.—J. F. Bachman. (*Tele-Tech*, April 1953, Vol. 12, No. 4, pp. 86–88 . . 172.) The operation of a p.p.i. system providing a display only of moving targets, and its dependence on echo delay, not on frequency shift, is explained.

621.396.9 : 551.311.17/.18 **2673**

Radar and Ice.—L. S. Le Page & A. L. P. Milwright. (*J. Inst. Nav.*, April 1953, Vol. 6, No. 2, pp. 113–127. Discussion, pp. 128–130.) Data collected during a voyage on an ice-breaker between Quebec and Port Churchill in the summer of 1952 show that, in a calm sea, ice formations of all types are detectable at distances of 2 miles or more. Under conditions of rough sea and bad visibility it is unsafe to rely upon the radar display when sea clutter extends to distances $>$ 1 mile. Suggestions for the provision of various anti-clutter devices are made.

621.396.9 : 681.142 **2674**

Punched-Card-Controlled Aircraft Navigation Computer.—E. H. Fritze. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 734–742.) Theory and description of a course-line computer for use with the available U.S. v.h.f. omnirange system or with the proposed omnirange–d.m.e. system. A position fix can be obtained with the equipment by triangulation, using line-of-bearing data from two omniranges. A further computation then gives course and distance indications with respect to a ground point selected by the pilot. Alternatively, position-fix information derived from one omnirange–d.m.e. ground station may be used for course-line computation. The punched-card system and pictorial course-display instrumentation associated with the computer are described.

MATERIALS AND SUBSIDIARY TECHNIQUES

533.5 : 621.3.032.461 **2675**

Sorption of Gases at Very Low Pressures by Thorium Powder.—S. Wagener. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 400–413.) Measurements were made of the rate of sorption of oxygen and hydrogen at pressures between 10^{-7} and 10^{-3} mm Hg as a function of the temperature of the thorium and of the period of its exposure to the gas. The significance of the results is discussed in relation to the gettering of valves.

535.215 : 537.311.33 **2676**

Electrolytic Conduction in Cs_3Sb.—H. Miyazawa & S. Fukuhara. (*J. phys. Soc. Japan*, Nov./Dec. 1952, Vol. 7, No. 6, pp. 645–647.) Measurements were made of the conductivity of thin layers of Cs_3Sb over a range of temperatures; the current was found to decrease slowly with time for a constant applied voltage. A detailed study indicated that electrolytic action occurred when the field strength exceeded a threshold value, the Cs ion being mobile.

535.215.4 : 546.817.221 **2677**

The Photoelectric and Optical Properties of a Special Type of Lead-Sulphide Layer.—L. Genzel & H. Müser. (*Z. Phys.*, 25th March 1953, Vol. 134, No. 4, pp. 419–424.) The preparation of photo-resistors for use in the range of visible light and up to $1{\cdot}8\mu$ is described. The photoelectric current i resulting from an illumination intensity I is given by $i \propto I^{\gamma}$, with $0{\cdot}5 < \gamma < 1$, γ being independent of λ. The response to illumination of varying modulation frequency falls from 80% of maximum at 10 c/s to 4·5% at 2 kc/s.

535.343 : 535.61-15 : 546.289 **2678**

The Infrared Absorption Characteristics of Thermiated Germanium.—D. H. Rank & D. C. Cronemeyer. (*Phys. Rev.*, 15th April 1953, Vol. 90, No. 2, pp. 202–203.) Ge crystals when heated to 900°C and quenched in air show marked absorption in the infrared region. Subsequent annealing at 500°C reduces the absorption to the value prior to heat treatment.

535.37 : 546.472.21 **2679**

Electronic Transitions in the Luminescence of Zinc-Sulfide Phosphors.—R. H. Bube. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 70–80.) The transitions involved in the processes of (*a*) absorption, (*b*) excitation, (*c*) emission, (*d*) trapping, (*e*) photoconductivity, at room temperature, have been measured for ZnS phosphors without impurity, and with Ag, Cu or Mn as impurity. A tentative energy-level diagram, based on the results of the measurements, is presented for the excitation and emission processes in ZnS phosphors.

535.376 **2680**

Decay of Long-Period Afterglow of Alkali Halides under Cathode-Ray Excitation.—H. N. Bose & J. Sharma. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 371–376.) The results obtained at room temperature and at that of liquid oxygen show that, for the period 10–100 sec after cessation of excitation, the decay follows the law $I \propto t^{-n}$, the value of n lying between 0·7 and 1·1. The decay rates are different for different parts of the spectrum.

537.228 : 537.226 2681

The Relation between the High-Voltage Polarization of Dielectrics and the Intensity of the Electric Field.—V. A. Presnov. (*Zh. tekh. Fiz.*, June 1952, Vol. 22, No. 6, pp. 955–960.) It is shown that measurements of the electrical conductivity of dielectrics in strong electric fields for various short time intervals can be used for investigating the high-voltage polarization of dielectrics.

537.311.3 : 539.23 2682

Capacitance Effects in Thin Conductive Films.—J. N. Humphrey, F. L. Lummis & W. W. Scanlon. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 111–114.) For some films of PbS or Te, the observed frequency dependence of resistance can be explained by distributed capacitance alone, but in some films both distributed and intercrystallite capacitance must be assumed.

537.311.3 : 546.824-31 2683

Influence of Impurities on Electrical Conductivity of Rutile.—G. H. Johnson. (*J. Amer. ceram. Soc.*, March 1953, Vol. 36, No. 3, pp. 97–101.) The addition of certain oxides to TiO_2 increases its conductivity. Reduction has the same effect but produces an imperfect lattice. The insulating properties of a contaminated crystal can be partly restored by incorporating into its lattice cations of a lower valency, such as Al or Y.

537.311.3 : 666.76 2684

Electrical Resistance of some Refractory Oxides and their Mixtures in the Temperature Range 600° to 1500°C.—J. R. Hensler & E. C. Henry. (*J. Amer. ceram. Soc.*, March 1953, Vol. 36, No. 3, pp. 76–83.) Results of measurements indicate the predominance of surface conduction in SiO_2, Al_2O_3 and their mixtures, and show the effects of adding SiO_2, Cr_2O_3 and NiO respectively to TiO_2, Al_2O_3 and MgO. Al_2O_3-Cr_2O_3 mixtures with more than 35% Cr_2O_3 appear suitable as heating elements.

537.311.31 : 539.234 2685

Deviations from Ohm's Law in Very Thin Metal Layers.—M. Perrot & J. P. David. (*C. R. Acad. Sci., Paris*, 27th April 1953, Vol. 236, No. 17, pp. 1641–1643.) Experimental results obtained with films of Ag, Al and Si at ordinary temperatures do not confirm the empirical law found e.g. by van Itterbeek et al. (2828 of 1952) relating the resistance of thin films to the strength of the applied field at low temperatures. The results show that the deviations from Ohm's law increase as the surface resistivity of the film increases and as the thickness of the film decreases.

537.311.33 2686

The Influence of the Surface on the Type of Electrical Conduction of a Semiconductor.—S. G. Kalashnikov & Ya. E. Pokrovski. (*Zh. tekh. Fiz.*, May 1952, Vol. 22, No. 5, pp. 883–884.) A comparison was made between ordinary solid samples and pressed-powder samples of a semiconductor. It appears that with finer powders the original electron conduction alters into hole conduction.

537.311.33 2687

Theory of Contact Phenomena in Semiconductors.—A. I. Gubanov. (*Zh. tekh. Fiz.*, May 1952, Vol. 22, No. 5, pp. 729–735.) The limits of applicability of the various aspects of the theory previously published by the author are determined. A comparison is made of the theoretical and experimental results for the case of a contact between Cu_2O (p-type) and TiO_2 (n-type). The most effective model of a metal rectifier is indicated.

537.311.33 2688

Semiconducting Intermetallic Compounds.—R. G. Breckenridge. (*Phys. Rev.*, 1st May 1953, Vol. 90, No. 3, pp. 488–489.) Brief preliminary note of investigations on InSb, GaSb and AlSb; these compounds are semiconductors with high charge-carrier mobilities.

537.311.33 2689

D.C. Field Distribution in a 'Swept Intrinsic' Semiconductor Configuration.—R. C. Prim. (*Bell Syst. tech. J.*, May 1953, Vol. 32, No. 3, pp. 665–694.) A system is considered consisting of an intrinsic semiconductor sandwiched between n-type and p-type extrinsic semiconductors. If a large reverse bias is applied to this system, making the n-type material positive with respect to the p-type material, the field set up in the intrinsic semiconductor sweeps away most of the mobile carriers. Analysis is presented for such a system. Curves are plotted showing the potential and field distribution in the intrinsic-semiconductor layer for different values of thickness and bias voltage.

537.311.33 : 546.23 2690

The Electrical Properties of Multicrystal Selenium.—M. I. Iglitsyn. (*Zh. tekh. Fiz.*, May 1952, Vol. 22, No. 5, pp. 885–887.) The dark conductivity and the Hall effect were investigated. The results obtained do not conform to the band theory.

537.311.33 : [546.28 + 546.289 2691

Temporary Traps in Silicon and Germanium.—J. R. Haynes & J. A. Hornbeck. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, pp. 152–153.) Experimental evidence of the existence of traps is described, with particular reference to effects observed with a uniform crystal of 28-Ω.cm p-type Si. After illumination is cut off, the decay of photoconductivity of the crystal takes place in three well-defined steps: (a) a rapid decrease for about 20 μs; (b) a slower decrease, asymptotically exponential, for about 10 ms; (c) a very slow decrease for about 260 sec. An explanation of these effects, involving the assumption of shallow traps and deep traps, is given.

537.311.33 : 546.289 2692

Recombination Rate in Germanium by Observation of Pulsed Reverse Characteristic.—E. M. Pell. (*Phys. Rev.*, 15th April 1953, Vol. 90, No. 2, pp. 278–279.) When a square voltage pulse is applied to a Ge diode, a forward current pulse is followed by one in the reverse direction which gradually decays to the reverse saturation current. The shape of the decay curve is used to determine the recombination rate of the minority carriers injected during the forward pulse. Results agree well with those obtained by the light-beam method.

537.311.33 : 546.289 2693

Observations of Dislocations in Lineage Boundaries in Germanium.—F. L. Vogel, W. G. Pfann, H. E. Corey & E. E. Thomas. (*Phys. Rev.*, 1st May 1953, Vol. 90, No. 3, pp. 489–490.)

537.311.33 : 546.289 : 534.321.9 2694

Ultrasonic Attenuation Measurements in Germanium.—R. Truell & J. Bronzo. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, p. 152.) Large differences in attenuations were found for samples of Ge differing as regards impurity content, heat treatment, etc. The frequencies used ranged from 15 to 100 Mc/s. Attenuation measurements may possibly be used to indicate the relative amounts of defects in various samples.

537.311.33 : 546.289 : 621.396.822 2695

Theory of Magnetic Effects on the Noise in a Germanium Filament.—H. Suhl. (*Bell Syst. tech. J.*, May 1953, Vol. 32, No. 3, pp. 647–664.) The redistribution of carriers over the cross-section of a rectangular Ge filament due to application of a magnetic field perpendicular to one pair of its sides is analysed, and calculations are made of the resulting variation of noise power to be expected in some special cases, on the basis of the theory advanced by Montgomery (122 of January) that the noise originates at least partly from variations in concentration of the minority carriers.

537.311.33 : 546.682.86 : 537.312.8 **2696**

The Magnetoresistance Effect in InSb.—G. L. Pearson & M. Tanenbaum. (*Phys. Rev.*, 1st April 1953, Vol. 90, No. 1, p. 153.) The method used in the preparation of the compound, and the results of magnetoresistance measurements, are described. With the field H perpendicular to the current I, $\Delta\rho/\rho = 8.10^{-9} H^2$ at room temperature over the range 0–13 000 gauss. The effect decreases with decreasing angle between H and I and approaches zero when H and I are parallel. This is in agreement with simple theory which assumes spherical energy surfaces.

537.311.33 : 621.314.632 : 546.289 **2697**

The Influence of Mobility Variation in High Fields on the Diffusion Theory of Rectifier Barriers.—R. E. Burgess. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 430–431.) Shockley has reported (1011 of 1952) that in Ge the electron drift velocity for fields > 3 kV/cm has a constant value. The effect this constant drift velocity has in the diffusion equation for a rectifying contact between a metal and *n*-type Ge is examined, some simplifying assumptions being made. The expression derived for the current density from metal to semiconductor is found to have the form associated with a Mott layer; it involves no specific assumption about the distribution of ions in the barrier, i.e., about the spatial variation of the e.s. potential for electrons. For reverse voltages the expression for the current density takes the usual ideal form.

537.311.33 : 621.314.632 : 546.289 **2698**

The Barrier Layer of a Germanium Plate Rectifier with Forward Current.—W. Bösenberg & E. Fues. (*Z. Naturf.*, Nov. 1951, Vol. 6a, No. 11, pp. 741–744.) Calculations are made of the field and concentration distribution of electrons and holes in the Schottky barrier layer of a metal/Ge contact; the results facilitate understanding of the saturation effect in the neighbourhood of a transistor emitter electrode. For high values of forward current the concentration of electrons and holes in the semiconductor is greatly increased.

537.311.33 : 621.314.634 **2699**

The Blocking Mechanism of Selenium Rectifiers.—S. Poganski. (*Z. Phys.*, 25th March 1953, Vol. 134, No. 4, pp. 469–482.) Experiments with specially prepared Se rectifiers are described. The variation of the properties of Se/metal barrier layers with the difference between the work functions of Se and the metals Bi, Zn, Pb, Cd, In, is in agreement with Schottky's boundary-layer theory. For rectifiers with an intermediate CdSe layer, the barrier-layer properties were practically independent of the electrode metal used, indicating that in this case the barrier layer was at the CdSe/Se boundary, i.e., between an excess and a defect semiconductor.

537.582 **2700**

Thermionic Constants of Metals and Semiconductors: Part 3 — Monovalent Metals.—S. C. Jain & K. S. Krishnan. (*Proc. roy. Soc. A*, 21st May 1953, Vol. 217, No. 1131, pp. 451–461.) An account is given of measurements on Cu, Ag and Au, using the effusion method. The value found for the coefficient A in Richardson's equation is only slightly less than the theoretical value of 120 A/cm² per deg². Part 2: 1392 of May.

538.221 **2701**

Magnetic Compounds with Perovskite Structure: Part 3 — Ferromagnetic Compounds of Cobalt.—G. H. Jonker & J. H. van Santen. (*Physica*, Jan./Feb. 1953, Vol. 19, Nos. 1/2, pp. 120–130. In English.) Polycrystalline mixed crystals of $(La,Sr)CoO_3$ have been prepared. Perovskite structure is found for all compositions. Ferromagnetism is observed for intermediate Sr concentrations. Part 2: 656 of 1951.

538.221 **2702**

Applications and Properties of Ferroxcube.—(*Electronic Applic. Bull.*, Nov./Dec. 1952, Vol. 13, Nos. 11/12, p. 201.) Correction to paper noted in 750 of March.

538.221 **2703**

On the A.C. Magnetization Characteristics of a Perminvar Wire.—T. Hirone, H. Watanabe, T. Iwata & K. Ikeda. (*J. phys. Soc. Japan*, Nov./Dec. 1952, Vol. 7, No. 6, pp. 593–598.) Observations made on a wire under tension are discussed on the basis of the pipe-domain theory. The existence of an effect other than eddy currents is indicated. The results are in general agreement with those of Williams et al. (855 of 1951).

538.221 : 548 **2704**

The Anisotropy of the Coercive Force in Monocrystals of Silicon-Iron Alloys.—V. V. Druzhinin & R. I. Yanus. (*Zh. tekh. Fiz.*, April 1952, Vol. 22, No. 4, pp. 848–857.) Experimental results indicate that the coercive force in crystallites of these alloys has a maximum along the digonal axis of the crystal and not the trigonal axis, as has been previously assumed on the basis of limited observations by Williams (1210 of 1938).

538.662 : 549.517.2 **2705**

Thermomagnetic Properties of Rhombohedric Ferric Oxide.—H. Bizette, R. Chevallier & B. Tsaï. (*C. R. Acad. Sci., Paris*, 27th May 1953, Vol. 236, No. 21, pp. 2043–2045.) Results of measurements in the range 73–293°K on two samples cut from a crystal of haematite are shown graphically and discussed. The λ transformation extends over the range 173–253°K. See also 3125 of 1952 (Néel & Pauthenet).

546.817.221 : [535.34 + 535.215 **2706**

Optical and Photoelectric Properties of Microcrystalline Layers of Lead Sulphide in the Visible and Infrared Regions.—P. Vernier. (*J. Phys. Radium*, March 1953, Vol. 14, No. 3, pp. 175–178.) Measurements on PbS layers are reported and the photoelectric sensitivity and absorption coefficient k of different layers are compared. Overall sensitivity varies considerably from layer to layer; k decreases rapidly with increasing λ and is not dependent on layer thickness. In layers prepared by distillation or chemical action, sensitivity is generally high; the sharpest fall in k and also in sensitivity occurs in the ranges 0·9–1·4 μ and 2·5–3 μ.

548.55 : 546.289 **2707**

Apparatus for Drawing Single Crystals.—J. Malsch & F. W. Dehmelt. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 121–122.) Description of high-vacuum equipment for manufacturing Ge crystals of extreme purity.

549.325.2 : [537.311.3 + 538.632 **2708**

Electrical Properties of Molybdenite.—R. Mansfield & S. A. Salam. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 377–385.) Conductivity, Hall coefficient and thermoelectric power of natural crystals of MoS_2 were measured over the temperature range from − 183° to 500°C. The change of conductivity on applying a magnetic field was measured at room temperature. The majority of the specimens were p-type semiconductors. The results are discussed in relation to the theory of charge carriers in semiconductors.

621.318.2 : 669.255.231 **2709**

Permanent-Magnet Properties of Cobalt-Platinum Alloys.—D. L. Martin & A. H. Geisler. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, p. 498.) Comment on 1035 of April (Adams et al.), pointing out that the properties of Co-Pt alloys, which depend on composition and heat treatment, compare very favourably with those of bismanol.

621.396.62 + 621.397.62].002.2 **2710**

Mechanized Dip-Soldering of Television Receivers.—K. M. Lord. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 130–137.) Detailed account of the production technique developed for the automatic assembly and soldering of the chassis of either television or radio receivers.

666.1.037.5 **2711**

Hermetic Glass/Kovar Seals.—W. Düsing. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 111–120.) The application of kovar for glass/metal seals in high-power transmitter valves, particularly u.h.f. valves, is described. Different types of seal are illustrated and limiting ratios of expansion coefficients are noted. The occurrence of strain in the glass due to electrolysis, the influence of the lead content of the glass and advantages of coating the kovar with a highly conductive metal are discussed.

666.1.037.5 **2712**

Fundamentals of Glass-to-Metal Bonding: Part 1—Wettability of some Group-I and Group-VIII Metals by Sodium-Silicate Glass.—V. F. Zackay, D. W. Mitchell, S. P. Mitoff & J. A. Pask. (*J. Amer. ceram. Soc.*, March 1953, Vol. 36, No. 3, pp. 84–89.) The degree of wetting of Cu, Ag, Au, Pd, Pt and Ni by molten glasses containing different amounts of soda was observed in vacuo and in various atmospheres. Differences of contact angle may be related to the polarizing power of the metal. In O_2 and H_2, chemical reactions are possible which tend to increase spreading.

MATHEMATICS

517.941.9 **2713**

Use of Tschebyscheff-Polynomial Operators in the Numerical Solution of Boundary-Value Problems.—G. Shortley. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 392–396.) Discussion of techniques suitable for obtaining, on automatic computers, numerical solutions of boundary-value problems arising from linear partial differential equations such as those of Laplace and Poisson.

518.5 : 512.99 **2714**

A New Vector Slide Rule.—E. Friedlander. (*G.E.C. J.*, April 1953, Vol. 20, No. 2, pp. 91–94.) A description is given of the design principles, construction and operation of a slide rule which should greatly simplify the manipulation of complex quantities. Its most direct application in electrical engineering is the conversion of resistance and reactance into impedance and phase angle, which can be read directly. It also eliminates many of the transformations necessary in the analysis of real and complex electrical networks by means of a convenient combination of direct and reciprocal scales.

519.271.3 : 620.113.2 **2715**

The Efficiency of Sequential Sampling for Attributes: Part 1—Theory.—H. C. Hamaker. (*Philips Res. Rep.*, Feb. 1953, Vol. 8, No. 1, pp. 35–46.) For practical purposes, Wald's 3-parameter probability-ratio sequential plans may be reduced to a 2-parameter set of plans with decision lines symmetrical with respect to the origin.

681.142 **2716**

Micro-programming and the Design of the Control Circuits in an Electronic Digital Computer.—M. V. Wilkes & J. B. Stringer. (*Proc. Camb. phil. Soc.*, April 1953, Vol. 49, Part 2, pp. 230–238.)

681.142 **2717**

The Relative Merits of A.C. and D.C. as a Signal Source in Analogue Computers.—K. H. Simpkin. (*Electronic Engng*, June 1953, Vol. 25, No. 304, pp. 230–233.)

681.142 **2718**

Analog Computer solves Geophysical Problems.—S. Kaufman. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 174–177.) Description of equipment for rapid calculations from the large number of field observations for an extensive region.

681.142 **2719**

Fourier Analyzer.—F. J. McDonal. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 272–276.) An analogue computer is described which provides Fourier analyses of transients encountered in seismic research.

681.142 **2720**

A Five-Channel Analog Correlator.—M. J. Levin & J. F. Reintjes. (*Tele-Tech*, March 1953, Vol. 12, No. 3, pp. 70–72 . . 125.) The operation and circuit details are described of equipment which determines simultaneously five points on the correlation curve of a time series and displays the approximate curve on a c.r.o. The value for the time increment can be set between 1 and 400 μs by adjusting the rate at which the sampling-pulse generator is triggered.

681.142 : 517.941.4 **2721**

A Useful Theorem in Linear-Differential-Equation Theory, its Proof and its Application to Analogue Computors.—D. O. Burns. (*Trans. Soc. Instrum. Technol.*, Dec. 1952, Vol. 4, No. 4, pp. 173–176.) A theorem is given relating the generalized differential equation $f(D)x = \phi(D)y$ to the simpler form $f(D)x = y$ for certain initial conditions, where y represents a suddenly applied disturbance of the step type, or of a type that can be represented by a rational algebraic operation on the step function.

681.142 : 538.691 **2722**

Analogue Computer for Study of Trajectories in Electron Lenses.—A. Hampikian. (*C. R. Acad. Sci., Paris*, 11th May 1953, Vol. 236, No. 19, pp. 1864–1866.) Description of a computer comprising an 8-stage network based on principles given by Grivet & Rocard (2810 of 1950), and of its use in determining the parameters of magnetic electron lenses.

681.142 : 621.396.9 **2723**

Punched-Card-Controlled Aircraft Navigation Computer.—Fritze. (See 2674.)

MEASUREMENTS AND TEST GEAR

621.317.3 : 621.396.822 **2724**

A Simple Proof of the Formula for the Relative Accuracy of a Noise-Power Measurement with a Quadratic Detector.—A. van der Ziel. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 800–801.) It is shown that, for certain stated conditions, the relative accuracy of a single noise-power measurement is $(2B\tau)^{-\frac{1}{2}}$, where B is the noise bandwidth and τ the time constant of the indicating instrument. If a critically damped galvanometer is used, the formula becomes $(4B\tau)^{-\frac{1}{2}}$.

621.317.3 : 621.396.822 **2725**

Measurement of the Constants of the Flicker Effect.—H. Rothe, W. Dahlke & J. Schubert. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 77–84.) A quick investigation of the low-frequency noise characteristic of a series of valves can be made by the method described. This is based on the determination of the constants c and α in the equation $\overline{u^2} = (c/f^{\alpha})^2 \Delta f$, where $\overline{u^2}$ represents noise voltage and f frequency. Measurements are reported on a number of Type-EF804 valves connected as pentode and as triode.

621.317.321 **2726**

Electronic Device for the Precision Measurement of Direct Voltages by Comparison.—R. Aumont & J. Romand. (*Rev. gén. Élect.*, April 1953, Vol. 62, No. 4, pp. 210–216.) The device has high input impedance and can be used for comparing voltages from sources of high internal resistance, possibly with widely different values, or as a null detector in bridge circuits for the measurement of low voltages or of resistances. The two input voltages are applied to the measurement circuit alternately via a vibrator.

621.317.333.4.015.7 : 621.315.2 **2727**

Location of Cable Faults and Irregularities using Pulse-Echo Methods.—W. Kroebel. (*Z. angew. Phys.*, Feb. 1953, Vol. 5, No. 2, pp. 48–52.) The design of suitable equipment is discussed particularly for measurements on power cables in Germany, where the distance between accessible points on earth cables is generally < 10 km and the propagation velocity is $1{\cdot}46$–$1{\cdot}54 \times 10^8$ m/s, corresponding to a maximum pulse delay of about 10^{-4} sec and an accuracy to within about $1{\cdot}3 \times 10^{-8}$ sec.

621.317.333.4.015.7 : 621.315.2 **2728**

Experimental Investigations with Direct-Voltage Pulses on Wide-Band Cables.—C. W. Busch. (*Z. angew. Phys.*, Feb. 1953, Vol. 5, No. 2, pp. 52–60.) Using the equipment mentioned by Kroebel (2727 above) an investigation was made of the smallest observable irregularity in characteristic impedance. The experimental results, which are in good agreement with theory, show that for available wide-band cables an indication can be obtained of real reflection factors of about 1×10^{-4} at distances up to 1 km and of about 3×10^{-3} at distances up to 10 km. At these low values it is necessary to have an auxiliary display corresponding to a fault-free line, for comparison purposes. The accuracy of location for small faults is a function of the magnitude of the fault. A correction factor is derived to take account of uncertainty introduced by pulse deformation over long distances. Use of rectangular pulses is recommended.

621.317.335.029.63/.64 : 547.476.3 **2729**

On the Dielectric Constant of Rochelle Salt at 3 000 Mc/s.—H. Akao, T. Takakura & T. Sasaki. (*J. phys. Soc. Japan*, July/Aug. 1952, Vol. 7, No. 4, pp. 361–363.) A resonant-cavity method of measurement is described.

621.317.336 : 621.315.212 **2730**

Reflections in a Coaxial Cable due to Impedance Irregularities.—G. Fuchs. (*Câbles & Transm.*, April 1953, Vol. 7, No. 2, pp. 122–141.) Translation. See 3495 of 1952.

621.317.34 : 621.396.645 **2731**

An Instrument for Measuring Complex Voltage Ratios from 1 to 100 Mc/s.—G. Thirup & F. A. Vitha. (*Commun. News*, Feb. 1953, Vol. 13, No. 1, pp. 1–12.) See 1735 of June (Thirup).

621.317.343 : 621.315.212 **2732**

Determination of the Local and Mean Characteristic Impedance of Coaxial Cables by means of the Unit-Step Signal.—G. Comte & A. Ponthus. (*Câbles & Transm.*, April 1953, Vol. 7, No. 2, pp. 97–121.) Mathematical theory is presented for the voltages produced by impedance irregularities in a coaxial cable to which is applied a unit-step signal or a rectangular type of periodic signal. Apparatus suitable for measurement of the local or mean characteristic impedance of production lengths of coaxial-pair cables is described and experimental results are given. The method used enables a direct relation to be established between transient and steady-state measurements on coaxial pairs.

621.317.343 : 621.392 **2733**

Transmission-Line Impedance Measurements.—H. Sutcliffe. (*Wireless Engr*, July 1953, Vol. 30, No. 7, pp. pp. 180–181.) For $\lambda > 1$ m it is convenient to find the impedance from measurements of current or potential at three fixed points rather than from standing-wave measurements which involve moving the detector over a distance $\geqslant \lambda/2$. A method of calculating the impedance is indicated for the case of measurement points separated by $\lambda/8$, and a generally applicable graphical method is described which gives the solution in terms of the coordinates of a point on a Smith chart.

621.317.35 : 621.3.018.78 **2734**

Measurement of Nonlinear Distortion.—A. Bloch. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 62–67.) A comparison is made of the harmonic, heterodyne (C.C.I.F.) and intermodulation (S.M.P.T.E.) methods of measuring distortion. All three methods yield equivalent information when properly applied, but the intermodulation method is the most practical for giving a quantitative indication.

621.317.35 : 621.3.018.78 **2735**

Comparative Study of Methods for Measuring Nonlinear Distortion in Broadcasting Audio Facilities.—D. E. Maxwell. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 68–78.) A comparison is made of the harmonic, heterodyne (C.C.I.F.) and intermodulation (S.M.P.T.E.) methods as applied to studio a.f. equipment. For systems with sharply limited response at the upper end of the frequency band, e.g., sound-recording systems, the C.C.I.F. method is superior to the other two. For wide-band low-noise systems the harmonic method is satisfactory. A generator for simulating common distortion conditions is described.

621.317.35 : 621.3.018.78 : 534.851 **2736**

Distortion in Phonograph Reproduction.—H. E. Roys. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 78–85.) A comparison is made of the harmonic, heterodyne (C.C.I.F.) and intermodulation (S.M.P.T.E.) methods. The intermodulation method is useful for studying tracing distortion, while the heterodyne method has the advantage of enabling measurements to be made right up to the cut-off frequency of the system.

621.317.353.3 : 621.3.018.78 **2737**

Intermodulation Measurements.—H. H. Scott. (*J. audio Engng Soc.*, Jan. 1953, Vol. 1, No. 1, pp. 56–61.) Intermodulation measurements are recommended as a basis for correlating measured values of nonlinearity with subjective assessments of reproducing systems. Known methods of measurement are described and their field of application is discussed.

621.317.61 + 621.317.772 2738

A Gain and Phase-Angle Measuring Set.—F. B. Anderson. (*Elect. Engng, N.Y.*, March 1953, Vol. 72, No. 3, p. 245.) Digest only. Equipment is described which has an accuracy sufficient for circuit design purposes. The frequency range is 10 c/s to 10 Mc/s, the gain range − 18 to + 68 db, and the phase-angle range 0 to ± 180°.

621.317.729 2739

The Accurate Mapping of Electric Fields in an Electrolytic Tank.—K. F. Sander & J. G. Yates. (*Proc. Instn elect. Engrs*, Part II, April 1953, Vol. 100, No. 74, pp. 167–175. Discussion, pp. 176–183.) A new technique for electrolyte-tank measurements is described. Square-wave excitation is used with two pairs of liquid probes and a specially designed differential amplifier, the detailed circuit of which is shown. Field strengths can be measured to within 0·1%. The relative merits of various electrode-electrolyte combinations are assessed.

621.317.733 : [621.316.86 : 537.312.6 2740

A Direct-Reading Thermistor Bridge.—W. B. W. Alison & J. C. E. Taylor: R. M. Pearson & F. A. Benson. (*Electronic Engng*, June 1953, Vol. 25, No. 304, p. 262.) Comment on 1749 of June and authors' reply.

621.317.733 : [621.317.332.029.3 + 621.317.37 2741

Audio Impedance and Phase-Angle Meter.—J. E. Hansen. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 172–173.) This direct-reading instrument measures impedances up to 100 kΩ at frequencies between 30 c/s and 15 kc/s. A simple bridge arrangement, incorporating two equal arms and a calibrated resistor, together with a balanced-rectifier system is used in a null-indication method. A switch is then operated so that the phase change across the impedance may be determined by comparing the bridge unbalance voltage with that across the calibrated resistor.

621.317.755 2742

Trapezoidal Distortion in Oscillograph Tubes.—E. Gundert. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 89–94.) An e.s. deflection system is described by which trapezoidal distortion is avoided with both balanced and unbalanced input. The deflection plates nearer the screen have a curved edge on the side at which the beam enters; the radius of curvature is about 80% of the distance of this edge from the centre of the deflection system nearer the cathode. Pincushion distortion is eliminated by edge bending where the beam enters the plate system.

621.317.755 2743

Modern High-Voltage Oscillographs with Cold Cathode.—G. Induni. (*Arch. tech. Messen*, April 1953, No. 207, pp. 83–86.) Descriptions are given of one-, two- and four-beam types.

621.396.91 2744

Time Signals: Observatoire National de Paris, Bureau International de l'Heure.—(*U.R.S.I. Inform. Bull.*, Jan./Feb. 1953, No. 77, p. 30.) A table is given of transmission times, call signs, wavelengths and frequencies of rhythmic time signals radiated from the Pontoise station.

621.397.62 : 621.317.755 2745

A Television-Waveform Display Apparatus.—G. N. Patchett. (*Electronic Engng*, May & June 1953, Vol. 25, Nos. 303 & 304, pp. 184–188 & 248–250.) Equipment is described, with full circuit details, for selecting any number of lines, from two upwards, from the television signal; so that the detail of the frame synchronizing period or of any other portion of the waveform may be examined easily. Typical results obtained with the equipment are illustrated.

621.397.62.001.4 2746

A Transmitter for Production Testing of Television Receivers.—J. M. Silberstein. (*Electronic Engng*, June 1953, Vol. 25, No. 304, pp. 224–229.) Description of equipment for producing and distributing to various testing points a composite test-pattern signal. A block diagram illustrates the way in which all the different pulse frequencies required are derived from a frequency of 60·75 kc/s. Circuit diagrams of particular units are also given.

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

531.775 2747

Development of an Electronic Tachometer.—I. Dujardin, M. Hoyaux, M. Mary & E. Symon. (*Rev. gén. Élect.*, April 1953, Vol. 62, No. 4, pp. 191–197.) Equipment designed primarily for testing small electric motors is described; pulses are generated photoelectrically and are counted by means of circuits similar to those commonly used in electronic computers.

538.569.2.047 2748

Certain Physiologic and Pathologic Effects of Microwaves.—J. F. Herrick & F. H. Krusen. (*Elect. Engng, N.Y.*, March 1953, Vol. 72, No. 3, pp. 239–244.) Investigations in connection with the use of microwaves for therapy are discussed. A cavity magnetron operating at 2·4–2·5 kMc/s with a maximum output of 125 W was used, and three different energy-directing systems were tried. The principal effects observed are due to the heating. Some harmful effects were noted, particularly in connection with treatment of the eye.

550.83 : 621.3 2749

Instrumentation for Geophysical Exploration.—D. H. Clewell, R. A. Broding, G. B. Loper, S. N. Heaps, R. F. Simon, R. L. Mills & M. B. Dobrin. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 243–266.) Descriptions are given of various pieces of special equipment used in oil prospecting, including transducers for converting earth vibrations into electrical signals, amplifiers, radiation detectors and magnetometers.

621.317.755 : 771.36 2750

Electronic Instrument for Production Testing of Camera Shutters.—R. W. Lavender. (*Elect. Engng, N.Y.*, April 1953, Vol. 72, No. 4, pp. 336–340.) The main piece of equipment described is a photocell-and-c.r.o. arrangement for indicating the relative timing of flash lamp and shutter.

621.383.001.8 : 535.61-15 : 778.37 2751

High-Speed Photography by means of the Image Converter.—J. A. Jenkins & R. A. Chippendale. (*Philips tech. Rev.*, Feb. 1953, Vol. 14, No. 8, pp. 213–225.) See 1693 of 1952.

621.384.612 2752

Characteristics of the Synchrotron Beam.—M. Camac. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 290–297.)

621.384.612 2753

Effects of Magnetic Defects in a Strongly Converging Cosmotron [proton synchrotron].—J. Seiden. (*C. R. Acad. Sci., Paris*, 27th April 1953, Vol. 236, No. 17, pp. 1657–1659.)

621.384.613 2754

Betatron Monitor and Integrator.—R. D. England & W. E. Ogle. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 267–268.)

621.384.622.1 **2755**

Principle of the Theory of the Motion of Ions in Linear Accelerators.—M. Y. Bernard. (*C. R. Acad. Sci., Paris*, 27th April 1953, Vol. 236, No. 17, pp. 1655–1657.)

621.385.833 **2756**

The Design of Small [electron] **Microscopes.**—E. Kinder. (*Optik. Stuttgart*, 1953, Vol. 10, No. 4, pp. 171–191.) General discussion, with details of an instrument designed for an accelerating voltage of 50 kV.

621.385.833 **2757**

Emission-Microscope Surface Images obtained with Electrons due to Oblique Bombardment by Ions.—G. Möllenstedt & H. Düker. (*Optik, Stuttgart*, 1953, Vol. 10, No. 4, pp. 192–205.)

621.385.833 **2758**

New External Objective Aperture Centering and Interchanging Device for the R.C.A. EMU Electron Microscope.—F. W. Bishop. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 269–271.)

621.385.833 **2759**

Direct Measurement of Images in the Electron Microscope.—H. Froula. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 304–306.)

621.385.833 : 621.392.5 : 001.362 **2760**

Analogy between Electron Lenses and Electrical Quadripoles.—F. Bertein. (*C. R. Acad. Sci., Paris*, 27th May 1953, Vol. 236, No. 21, pp. 2047–2049.) Discussion shows that every electron lens has an equivalent quadripole network to which the same equations apply.

621.396.62 : 536.55 **2761**

The Sensitivity of Radio Thermometers.—V. S. Troitski. (*Zh. tekh. Fiz.*, March 1952, Vol. 22, No. 3, pp. 455–460.) Sensitive radio receivers which can separate weak signals with a wide continuous spectrum from the background noise inherent in the receiver are considered; the possibility of using them for temperature measurements is discussed, and formulae are derived for calculating the sensitivity of these radio thermometers.

621.398 + 621.317.083.7] : 621.396.61 **2762**

Broadcast Transmitter Remote-Control System.—G. W. Lee. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 138–141.) Description of control and telemetry equipment for Canadian 1-kW transmitters. Two pairs of telephone wires are required between studio and transmitter. Indications of the state of all important transmitter circuits, and of the r.f. output level and carrier-frequency drift can be obtained. An alarm circuit giving warning of overmodulation is included. Interruption of communication between studio and transmitter automatically switches off the transmitter.

621.398 + 621.317.083.7] : 621.396.61 **2763**

Broadcast Remote Control.—(*Electronics*, June 1953, Vol. 26, No. 6, pp. 200 . . 204.) Two types of equipment are briefly described, both requiring two pairs of telephone wires and providing facilities for control and for telemetry via a dial-impulse selector switch. In one system the meter indications are corrected for variations of line resistance. In the other, audible tones are used for control switching.

PROPAGATION OF WAVES

534.24/.25 + 538.566.2 **2764**

Total Reflection of Waves from a Point Source.—Gerjuoy. (See 2540.)

538.566 **2765**

Reflection of Waves from Varying Media.—C. O. Hines. (*Quart. appl Math.*, April 1953, Vol. 11, No. 1, pp. 9–31.) The wave propagation equation $d^2f/dx^2 + g(x)f = 0$ is studied for functions $g(x)$ which are everywhere real, finite and continuous, have a constant positive value for large values of $|x|$ and smaller values in the neighbourhood of $x = 0$. Solutions are obtained in terms of a new variable $r = r(x)$ which is itself a solution of a Riccati equation. Exact formulae are derived for the reflection coefficient of a medium in terms of r. The curve of $r(x)$ is traced by inspection of the determining differential equation. Many media which might be expected to be highly reflecting are shown to be completely transparent to certain frequencies. The method gives an approximate evaluation of the exact solution rather than, as with the B.W.K. method, an exact evaluation of an approximate solution. E.m. waves are treated principally, but the method is applicable also to mass waves.

538.566.2 **2766**

Propagation of Plane Electromagnetic Waves in the Ionosphere.—R. Jancel & T. Kahan. (*C. R. Acad. Sci., Paris*, 27th May 1953, Vol. 236, No. 21, pp. 2045–2047.) The propagation is considered of plane e.m. waves in an ionized medium characterized by a certain dielectric tensor. The property of double refraction of such a medium is deduced and the corresponding refractive indices are determined for directions respectively coincident with and perpendicular to that of the magnetic field. Formulae for the attenuation and group velocity of the waves are also obtained.

621.396.11 **2767**

The Value of Forecasts.—D. A. Bell: C. M. Minnis. (*Wireless Engr*, July 1953, Vol. 30, No. 7, p. 184.) Comment on 2110 of July and author's reply.

621.396.11 : 551.510.52 : 001.891 **2768**

Tropospheric Propagation Research.—(*Tech. News Bull. nat. Bur. Stand.*, Aug. 1952, Vol. 36, No. 8, pp. 120–124.) An outline of the N.B.S. programme of theoretical and experimental investigations of the effects of climatic conditions, terrain, aerial characteristics, transmission frequency, etc., on the propagation of v.h.f. and u.h.f. signals over distances extending far beyond the horizon. A map is given which shows the location of N.B.S. field stations, commercial radio installations, and F.C.C. monitor stations.

621.396.11 : 551.510.535 : 523.75 **2769**

Observations on the Propagation of Very Long Radio Waves Reflected Obliquely from the Ionosphere during a Solar Flare.—W. C. Bain. (*J. atmos. terr. Phys.*, April 1953, Vol. 3, No. 3, pp. 141–152.) Anomalies in the field of GBR (16 kc/s) observed at ranges of 400–550 km during the occurrence of solar flares are discussed. The main effect is due to a sky wave, varying in phase but not in amplitude, that reaches the observation point by single reflection from the ionosphere. An explanation of the magnitude of the effect is based on the assumption of two layers below the ionosphere E layer. The layer usually the lower of the two is normally responsible for oblique-incidence propagation of very long waves; the other layer is affected by the solar radiation during a flare. From the observed field-strength changes a value of 70 km is deduced for the apparent height of the layer responsible for oblique-incidence reflection of 16-kc/s waves. See also 2804 (Bracewell & Bain) and 2871 (Bain et al.) of 1952.

621.396.11 : 551.510.535 : 523.78 **2770**

Study of Propagation Characteristics of Obliquely Incident Impulse Wave in Time of the Solar Eclipse.—K.

Miya, T. Murata & H. Wada. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 1, pp. 1–20.) A report of observations on and around 9th May 1948. Pulses of duration 0·1 ms, frequency 9·24 Mc/s, peak power 2 kW and repetition frequency 50/sec were transmitted from an aerial at Hiraiso directed towards Yamakawa, and were received at three stations in approximately the same direction at distances of 99, 542 and 1 659 km respectively. The observed variations of waveform, attenuation and angle of incidence of the waves reflected from the F layer during the eclipse are shown graphically and discussed, with particular reference to the effect of distance between transmitter and observation point.

621.396.11 : 551.594.6 **2771**

Atmospherics with Very Low-Frequency Components.—F. Hepburn & E. T. Pierce. (*Nature, Lond.*, 9th May 1953, Vol. 171, No. 4358, pp. 837–838.) Brief report of an extensive series of observations made at the Cavendish Laboratory. For distances up to 5 000 km, simple linear formulae are derived for the average values of the parameters t and $\tau/4$ of the low-frequency ('slow-tail') component as defined by Watson-Watt et al. (419 of 1938). The constants in these formulae have different day-time and night-time values. The features of the atmospheric waveform are discussed in terms of the waveguide theory of propagation between the earth and a homogeneous ionosphere [2773 below (Budden)]. Using theory developed by Hales (2888 of 1948), interrelated solutions are obtained for the ionosphere height h and conductivity σ; combining these with available estimates of the variation of σ with h, the 'slow-tail' observations indicate 65 km and 5×10^3 e.s.u. as the day-time values of h and σ respectively, and 90 km and 11×10^3 e.s.u. as the night-time values.

621.396.11 : 621.396.812 **2772**

Correlations of 100-Mc/s Radio Propagation with Certain Meteorological Variables.—K. H. Jehn & R. C. Staley. (*J. atmos. terr. Phys.*, April 1953, Vol. 3, No. 3, pp. 163–171.) Observations are reported of signal-strength measurements for paths of 78 and 175 miles in Texas. High signal strengths are in general associated with maritime tropical air, and lower strengths with air of polar (continental) origin. A correlation is found between signal strength and the vertical gradient of the refractive index. Atmospheric turbulence also has an effect on the propagation of 100-Mc/s signals, a scattering mechanism being possibly involved.

621.396.11.029.45 **2773**

The Propagation of Very Low-Frequency Radio Waves to Great Distances.—K. G. Budden. (*Phil. Mag.*, May 1953, Vol. 44, No. 353, pp. 504–513.) Experimental results obtained by Weekes (1491 of 1950) with 16-kc/s signals transmitted over distances of 340–3 640 km are discussed, using the theoretical approach in which the region between the earth and the ionosphere is considered as a waveguide (1108 of April). The measurements can be explained in terms of the four least-attenuated waveguide modes. Neglecting the geomagnetic field, and assuming the ionosphere to be a homogeneous sharply bounded medium, the height of the boundary is found to be 69·1 ± 0·5 km.

621.396.81 **2774**

On the Study of Attenuation Characteristics for H.F. and M.F. and its Application to Calculation of Field Intensity.—K. Miya, S. Ouchi & S. Kanaya. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 1, pp. 25–41.) From analysis of experimental results, formulae for the attenuation of waves reflected from the E and F layers of the ionosphere are developed, and are applied to the problem of calculating the field strength of radio waves once reflected from the ionosphere or undergoing multi-reflection between ionosphere and earth.

621.396.81 **2775**

Field Intensity of Scattered Wave in Radio Wave Propagation.—K. Miya, T. Kobayashi & N. Wakai. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 2, pp. 55–73.) Waves travelling via multi-hop paths were always found to be accompanied by scattered waves arising from irregular reflection at the earth's surface. Observations of these scattered waves enabled calculations to be made of the scattering coefficients for ground and for a sea surface with small islands. The delay and waveform of the scattered waves, as deduced from the scattering coefficient, agreed well with observational results.

621.396.81 **2776**

Experimental Study on Scattered Echoes.—T. Kono. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, Nos. 3 & 4, pp. 127–135 & 189–199.) Investigations are described from which it is concluded that scattered echoes are due to irregular reflection at the surface of the earth during the course of multi-reflection paths. A formula for the field strength of scattered echoes gives results in agreement with measured values.

621.396.81 **2777**

A Tentative Method of Calculation of H.F. Radio Sky-Wave Field Intensity by use of Transmission Curve.—K. Maeda, Y. Aono & T. Kobayashi. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 2, pp. 61–70.) A graphical method of determining field strength is proposed which utilizes a curve for field strength as a function of vertical-incidence limiting frequency and also the normal height/frequency curve.

621.396.81 **2778**

Field Intensity for Long-Distance Transmission deduced from the Long Time Measurement.—H. Uyeda & T. Obayashi. (*Rep. Ionosphere Res. Japan*, 1950, Vol. 4, No. 2, pp. 71–73.) A method of calculating field strength for long transmission paths, taking account of E-layer and F-layer attenuations and F-layer critical frequency for vertical incidence, is applied to the paths from Tokyo to San Francisco and London. Better agreement with observation is found for the San Francisco path than for that to London.

621.396.81 **2779**

Calculation of Field Intensity about the Antipode of the Transmitting Station.—K. Furutsu. (*Rep. Ionosphere Res. Japan*, 1951, Vol. 5, No. 4, pp. 159–165.) Formulae are derived for the field strength in the neighbourhood of the antipode, taking account of ionospheric conditions.

RECEPTION

621.396.621 **2780**

Noise Limiter for Mobile V.H.F. — N. Bishop. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 164–165.) A conventional full-wave shunt-type diode limiter with self-rectified bias, connected across the primary circuit of the final i.f. transformer of the receiver, improves the intelligibility of a.m. speech signals under conditions of strong impulse interference.

621.396.621 : 621.396.822 **2781**

Study of a Signal, consisting of Periodic Rectangular Pulses, superposed on Thermal Noise. The Combination being Clipped, Investigation of the Optimum Amount of Clipping.—L. Robin. (*Ann. Télécommun.*, April 1953, Vol. 8, No. 4 pp. 127–130.) A large number of samples of the voltage of the combination of signal and noise are added, each sampling being coincident with one of the signal pulses. Analysis is presented, for the case when a limiter is applied, in order to determine the conditions under which the ratio of the mean value of the output voltage to the noise-voltage standard deviation should be as great as possible. An optimum degree of clipping is determined and a curve is constructed which shows the ratio of the variation of output voltage to the square of its mean value, as dependent on the ratio of the clipping height to the noise-voltage standard deviation.

621.396.621 : 621.396.822 **2782**

Statistical Criteria for the Detection of Pulsed Carriers in Noise: Part 1.—D. Middleton. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 371–378.) A theory for the detection of pulsed carrier waves, of constant amplitude, in narrow-band random noise is based on several optimum tests of a statistical hypothesis against a single alternative, i.e., signal and noise *vs* noise. Siegert's concept of the betting curve whereby, for a finite integration time, the minimum detectable signal is uniquely defined, is introduced. Three types of observer are considered, the Neyman-Pearson, the ideal and the sequential type, whose characteristics are determined by the test method adopted. In all cases it is found that the best second detector is a $\log I_0$ rectifier, which in practice is closely approached by the usual half-wave linear envelope detector.

621.396.621 : 621.396.822 **2783**

Statistical Criteria for the Detection of Pulsed Carriers in Noise: Part 2.—D. Middleton. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 379–391.) Specific betting curves are determined for weak signals for the three types of observer considered in part 1 (2782 above) and some approximate curves for the case of strong signals are included. The input signal/noise (power) ratio corresponding to the minimum detectable signal at the output, with an arbitrary probability of a correct decision, is found to vary as $n^{-\frac{1}{2}}$ for weak signals and as n^{-1} for strong signals, n being the number of pulses integrated. Comparison of the three types of observer, on the basis of the minimum detectable signal and the approximate distribution of sample size, favours the Neyman-Pearson type.

621.396.621 : 621.396.822 **2784**

***RC* Memory Commutator for Signal-to-Noise Improvement.**—C. I. Beard & E. N. Skomal. (*Rev. sci. Instrum.*, April 1953, Vol. 24, No. 4, pp. 276–280.) Description of a simple electromechanical device for detecting and displaying, with only a short time delay, periodic signals of frequency 1–10 c/s received in the presence of noise of amplitude up to 100 times that of the signal. The signal is chopped by applying it through a resistor and rotating brush to successive capacitors arranged round the commutator, and the average value over the charging interval is stored and displayed on an oscilloscope. A rejection ratio of 85 : 1 for 60-c/s interference has been achieved.

STATIONS AND COMMUNICATION SYSTEMS

621.39 : 06.04(100) **2785**

International Organization of Radio Communications and the World Problem of Frequency Allocation.—L. Bramel de Clejoulx. (*Onde élect.*, Feb. 1953, Vol. 33, No. 311, pp. 77–84.) The organization of the International Telecommunications Union is described and the functions of its component bodies, in particular the International Frequency Registration Board, are defined with reference to the decisions of the 1947 Atlantic City Conference. Subsequent conferences and the operation of this Board are reviewed.

621.39.001.11 : 621.396.619 **2786**

A Comparison of the Informational Capacities of Amplitude- and Phase-Modulation Communication Systems.—N. M. Blachman. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 748–759.) Calculations indicate that the capacity of a channel as given by Shannon (1649 of 1949) is fully realized only if a.m. and ph.m. are used simultaneously, both at transmitter and receiver. For very high signal/noise ratios, a.m. and ph.m. alone each account for half the channel capacity. For signal/noise ratios $\ll 1$, ph.m. alone provides 79% and a.m. no more than about 17% of the full capacity; but if the receiver responds to both a.m. and ph.m. the full capacity is effective whatever the type of transmitter. An a.m. signal received on a ph.m. receiver at low signal/noise ratio can convey as much information as a ph.m. signal; but for large signal/noise ratios the information capacity of this system is of a smaller order of magnitude than that of the other systems.

621.395.828 : 629.135 **2787**

Noise Reduction in Intercom Systems.—R. J. Stahl & G. A. Walters. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 214 . . 222.)

621.396.41 : 621.3.018.78 **2788**

Reducing Distortion in Microwave Systems.—W. L. Firestone & J. S. Byrne. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 184–188.) Analysis of second-, third- and fourth-order distortion terms shows that limiting the applied peak-to-peak voltage, maintaining the individual channel voltages equal in magnitude, and restricting the frequency spectrum to one octave, reduces distortion in frequency-division multiplex systems. Measurements made on a 24-channel system support the theoretical results.

621.396.61.029.64 : 621.396.8 **2789**

Physical and Technical Bases for the Planning of U.S.W. Transmitters.—W. Nestel & E. Schwartz. (*Funk u. Ton*, April 1953, Vol. 7, No. 4, pp. 165–178.) The laws governing the propagation of u.h.f. waves over land and sea paths are discussed and atmospheric effects on the field strengths obtainable at a distance from an u.s.w. transmitter are considered. The problem of obtaining adequate coverage over a large area by means of a system of common-wave transmitters is discussed, and curves are given showing the coverage to be expected in the case of transmitter powers of 1 kW–1 MW, with adequate signals for 99% and for 90% of the time. 26 references.

621.396.619 **2790**

A Generalization of Modulation Spectra.—H. Chang & V. C. Rideout. (*Quart. appl. Math.*, April 1953, Vol. 11, No. 1, pp. 87–100.) Theory applicable to both a.m. and f.m. is developed. The modulation products are shown to be harmonics of the highest common factor of the carrier and modulation frequencies. Fourier analysis is used where there is an integral relation between carrier and modulation frequencies; where this relation does not hold, Bohr's method for nearly periodic functions is applicable.

621.396.619 : 621.396.65 **2791**

Comparison of the Principal Methods of Modulation for Directional Radio Links, taking account of Recent Developments.—H. Holzwarth. (*Arch. elekt. Übertragung*, May 1953, Vol. 7, No. 5, pp. 213–222.) Various modulation methods are discussed with particular reference to the signal/noise ratios obtainable and to crosstalk and distortion characteristics. The discussion indicates that the following methods are about equally good for links with many channels: p.c.m. and p.p.m. with a.m. of the h.f. carrier; s.s.b. and p.a.m. with f.m. of the h.f. carrier. For links with fewer channels (up to about 24), the second of each of these pairs, namely, p.p.m.-a.m. and p.a.m.-f.m., is about 10 db the better as regards noise.

621.396.65 : 621.385.029.6 **2792**

The Travelling-Wave Tube as Output Amplifier in Centimetre-Wave Radio Links.—Rogers. (See 2829.)

621.396.71 : 621.396.5(45) **2793**

The New Radiotelephony Terminals of the Centro Radio Nazionale P.T.—G. Bronzi. (*Poste e Telecomunicazioni*, March 1953, Vol. 21, No. 3, pp. 107–115.) Description of the circuits in use at the transmitting and receiving stations at Prato Smeraldo and Tor San Giovanni. The equipment includes VOGAD (voice-operated gain adjustment) and VODAS (voice-operated device anti-singing) arrangements, whose action is explained.

621.396.721 **2794**

Ferroxcube + Westectal = Simultaneous Translation.—E. Aisberg. (*Toute la Radio*, Feb. 1953, Vol. 20, No. 173, pp. 58–60.) To make translations available to delegates at the Palais de Chaillot, two 5-W transmitters radiate on 300 kc/s (French) and 400 kc/s (English) from two parallel metal strips along the walls of the conference room. Pocket receivers comprise a 1 850-μH ferroxcube coil and Ge crystal detector operating into headphones, and can be switched simply to the required channel.

621.39.001.11 **2795**

Information Theory and its Engineering Applications. [Book Review]—D. A. Bell. Publishers: Pitman & Sons, London, 138 pp., 20s. (*Wireless Engr*, July 1953, Vol. 30, No. 7, pp. 182–183.) Developments in the theory published since 1948 are presented; the mathematics used is 'within the range associated with an honours degree in electrical engineering or physics'.

SUBSIDIARY APPARATUS

621.3.013.783 **2796**

Development of an Absorber for Electromagnetic Waves.—R. Müller. (*Arch. elekt. Übertragung*, May 1953, Vol. 7, No. 5, pp. 223–229.) Theory is given relative to the design of mesh networks suitable for screening electrical equipment from e.m. radiation within a specified frequency band.

621.311.6 : 621.314.7 **2797**

Power Requirements for Transistor Circuits.—J. Dalfonso. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 204 . . 214.) Primary requirement for transistor power supply is constancy of voltage or current with time. Long life and small size are next in importance. These requirements are all satisfied by RM HgO cells [2048 of 1952 (Clune)].

621.311.6.027.3 : [621.397.62 + 621.317.755 **2798**

High-Voltage Generation for Television Equipment and Oscillographs.—H. Lennartz. (*Funk u. Ton*, April 1953, Vol. 7, No. 4, pp. 179–191.) A review of various methods described in the literature on the subject.

621.311.62 ; 621.314.6 **2799**

Effective Current and Efficiency of Small Mains Supply Units with Capacitively Terminated Rectifiers.—H. Schweitzer. (*Funk u. Ton*, April 1953, Vol. 7, No. 4, pp. 192–198.) When a mains transformer is wholly or partially loaded by a capacitively terminated rectifier network, the effective value of the rectifier current pulses is determinative for the copper losses, and the waveform distortion for the magnetic losses. Effective-current and efficiency curves are presented for various simple types of rectifier circuit.

621.311.62 : 621.314.67 : 621.316.722.1 **2800**

A Stabilised Extra-High-Tension Rectifier for 5 000 V, 50 mA.—P. Perilhou & J. Cayzac. (*Philips tech. Rev.*, Jan. 1953, Vol. 14, No. 7, pp. 190–199.) Description of equipment using a triode control valve which functions as a variable resistor in the d.c. circuit. The 300-V reference voltage is provided by a dry battery. The output-voltage fluctuations are only 1/3000th of those of the mains supply. The output voltage is variable between 900 and 5 100 V in four overlapping 1 200-V stages, each subdivided into 200-V steps which can be varied continuously. Protective measures are described.

621.314.64.011.21 **2801**

Impedances of the Electrolytical Rectifier.—J. W. A. Scholte & W. C. van Geel. (*Philips Res. Rep.*, Feb. 1953, Vol. 8, No. 1, pp. 47–72.) The impedance characteristic of an Al-Al_2O_3-electrolyte rectifier is investigated experimentally. A method for calculating an equivalent circuit of the oxide layer from the frequency dependence of its impedance is described. It is concluded that rectification occurs by means of contact between *p*-type and *n*-type semiconducting layers.

621.316.722.1 **2802**

Voltage Stabilization with Series Valve Control.—R. D. Trigg. (*Electronic Engng*, June 1953, Vol. 25, No. 304, pp. 254–256.) Analysis of the operation of equipment taking a large load current.

621.316.722.1 : 621.387 **2803**

Corona Discharge Tubes for Voltage Stabilization.—A. M. Andrew : E. E. Shelton & F. Wade. (*Electronic Engng*, June 1953, Vol. 25, No. 304, p. 263.) Comment on 1136 of April and authors' reply.

TELEVISION AND PHOTOTELEGRAPHY

621.397.24/.26 **2804**

[Coronation] **Television Arrangements.**—T. H. Bridgewater. (*Wireless World*, July 1953, Vol. 59, No. 7, pp. 317–319.) Vision and sound signals from the five mobile control rooms disposed along the processional route, including that at Westminster Abbey, were brought to a temporary central control room at Broadcasting House. Some details are given of particular camera equipment used, including zoom lenses, two of which were of the Watson type with interchangeable back elements giving a choice of two 5 : 1 magnification ranges with angles of view of 3°–15° and 6°–30°, another new design, due to Taylor, Taylor & Hobson, having a range of 5°–25°. Another special lens, the Dallmeyer 40-in. double-folded telephoto lens, was used with an image orthicon for close views of the Royal Family during their appearances on the balcony at Buckingham Palace. This lens has a viewing angle of under 2°.

The use of the new B.B.C. derivative equalizers [1936 of July (Gouriet)] gave a noticeable enhancement of picture definition. The pictures relayed to France, Holland and Western Germany were the same as those broadcast in Britain, but commentaries in the different languages were provided, French commentators being stationed alongside the British at several of the main camera positions and using independent microphones connected to a separate control point. Five cm-wave links were operated between London and Cassel (France), a special feature being the use of space-diversity reception with two parabolic aerial systems, one about 15 ft above the other, to obtain fading-free reception.

621.397.5 : 535.623 **2805**

Note on the Channel Required for Colour-Television Transmission.—E. Labin. (*Onde élect.*, Feb. 1953, Vol. 33, No. 311, pp. 85–92.) Basic formulae of information theory relating channel capacity, bandwidth, power and noise level are applied to determine the bandwidth required for transmission of monochrome signals. This bandwidth is compared with that required for a colour system. The alternatives to a much increased bandwidth are discussed, with particular reference to the R.C.A. dot-interlacing system.

621.397.5 : 535.767 **2806**

Stereoscopic Television.—(*Wireless World*, July 1953, Vol. 59, No. 7, pp. 296–298.) Discussion of the practicability of a system using a slotted mask, a little distance in front of the c.r. tube screen, so that a viewer's left eye sees only one set of interlaced images on the screen while the other set is visible only to the right eye.

621.397.611 : 535.623 **2807**

Measurement and Control of the Color Characteristics of a Flying-Spot Color-Signal Generator.—R. C. Moore, J. F. Fisher & J. B. Chatten. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 730–733.) The particular colour characteristics required to suit the N.T.S.C. system are indicated; since these have negative lobes, the required result is obtained in practice by finding an equivalent combination of characteristics without negative lobes. For this purpose, the colour characteristics of the flying-spot signal generator are determined by passing its light output through a system of splitters to a set of photocells whose output is measured electrically; appropriate correcting colour filters are then inserted in the respective paths.

621.397.611.2 **2808**

The French Origin of the Image-Orthicon Target.—R. Barthélemy. (*Électronique, Paris*, Feb. 1953, No. 75, pp. 37–41.) Experiments on thin-film targets carried out in 1930 are noted and the process of charge transfer in thin slightly conducting targets is analysed by considering an equivalent *CR* network and the current-density distribution in the target. The optimum ratio of target thickness to beam diameter is discussed. See also 1755 of 1952 and back reference.

621.397.62 **2809**

A 427/45-Mc/s Converter for the Society's Television Transmissions.—D. N. Corfield. (*J. Televis. Soc.*, Jan./March 1953, Vol. 7, No. 1, pp. 19–27.) The converter comprises two units: (*a*) mixer, amplifier and oscillator circuits; (*b*) power supply unit. Reception is possible between 420 and 450 Mc/s; the tuning range for a 45-Mc/s output is 425–436 Mc/s. Full circuit details are given, including the specification and arrangement of components. Alignment procedure is described and details of the dimensions and construction of 3 types of aerial suitable for the reception of 427-Mc/s signals are shown.

621.397.62 **2810**

Modernizing the *Wireless World* Television Receiver.—(*Wireless World*, May–July 1953, Vol. 59, Nos. 5–7, pp. 215–217, 279–284 & 306–310.) Modifications of the original design (1186 of 1948 and back references) are described, including new frame and timebase units needed for obtaining a picture of adequate brightness on a 12-in. or 15-in. c.r. tube. A new deflector-coil assembly [574 of February (Cocking)] is also required, these new units necessitating minor alterations in other parts of the equipment. Reprints of the articles describing the original superheterodyne receiver are still available from Iliffe & Sons, Ltd.

621.397.62 : 535.88 **2811**

The Design of a Large-Screen Receiver.—P. D. Saw. (*J. Televis. Soc.*, Jan./March 1953, Vol. 7, No. 1, pp. 3–11.) The receiver is designed to use a 2·5-in. c.r. tube and is built on three separate chassis with inter-connecting plugs and sockets so that alternative units can be easily substituted. The r.f. unit is a straight s.s.b. receiver. Circuit details and descriptions of the timebase and power-supply units are given. Different front-projection arrangements for 20, 30, 40 and 50-in. screens are described and developments in the design of projection screens are discussed.

621.397.62 + 621.317.755] : 621.311.6.027.3 **2812**

High-Voltage Generation for Television Equipment and Oscillographs.—H. Lennartz. (*Funk u. Ton*, April 1953, Vol. 7, No. 4, pp. 179–191.) A review of various methods described in the literature on the subject.

621.397.62 : 621.314.7 **2813**

A Study of Transistor Circuits for Television.—G. C. Sziklai, R. D. Lohman & G. B. Herzog. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 708–717.) The use of transistors in television receivers was studied, using an experimental battery-operated set including 37 transistors and a 5-in. kinescope housed in a cabinet 13 × 12 × 7 in., with self-contained loop aerial. The various stages are described in detail; both point-contact and junction-type transistors are used. The design of several of the circuits makes use of the symmetrical properties of transistors discussed in 2583 above.

621.397.621 **2814**

A Single-Valve Line Timebase.—J. Greenhalgh. (*J. Televis. Soc.*, Jan./March 1953, Vol. 7, No. 1, pp. 12–18.) The operation of a self-running timebase circuit is explained and methods of ensuring effective control of scan amplitude, good linearity and satisfactory flyback voltage are described. 'Shadowing' due to spurious deflection of the beam may be eliminated by use of a d.c. component in the scan coils.

621.397.9 **2815**

A Survey of Some Applications of Television in Industry, Scientific Research and Education.—J. E. Telfer. (*A.W.A. tech. Rev.*, Jan. 1953, Vol. 9, No. 3, pp. 173–207.) Reprint. Original noted in 1512 of May.

TRANSMISSION

621.396.61 : 621.316.726 **2816**

Synchronization of a Variable-Frequency Oscillator at Discrete, Stabilized Frequencies with the E80T Tube.—J. Bruijsten, H. Groendijk & M. R. Mantz. (*Electronic Applic. Bull.*, Nov./Dec. 1952, Vol. 13, Nos. 11/12, pp. 169–174.) See 2817 below.

621.396.61 : 621.385.83 **2817**

Simplification of Multi-channel V.H.F. and U.H.F. I.G.O.-Circuits by the Use of the Phase-Discriminator Valve, Type E80T.—J. Bruijsten, H. Groendijk & M. R. Mantz. (*Commun. News*, Feb. 1953, Vol. 13, No. 1, pp. 13–20.) A simplified I.G.O. circuit [767 of 1951 (Hugenholtz)] is described based on use of the specially developed Type-E80T beam-deflection valve. This combines the functions of pulse generator and phase discriminator, making possible the direct synchronization of oscillators operating in the v.h.f. and u.h.f. bands and enabling frequency-multiplication factors as high as 100 to be used. Both the electrical design of the valve and its constructional requirements for use in mobile installations are discussed.

621.396.61 : 621.396.932 **2818**

Modern Transmitting Equipment for Mercantile-Marine Vessels.—L. 't Hart & C. Strässer. (*Commun. News*, April 1953, Vol. 13, No. 2, pp. 50–60.) Equipment for A_1 or A_2 radiotelegraphy is described comprising crystal-controlled 30-channel h.f. (4–22 Mc/s) and 10-channel m.f. (405–535 kc/s) transmitters with common power-supply unit using a d.c./a.c. converter, and an emergency m.f. transmitter with auto-oscillator, fed from a 24-V battery.

621.396.61.029.55 : 621.396.712 **2819**

A 100-kW Short-Wave Broadcast Transmitter.—A. G. Robeer. (*Commun. News*, Feb. 1953, Vol. 13, No. 1, pp. 22–40.) This transmitter is designed on the same general principles as the 40-kW transmitter previously described [1461 of 1952 (Robeer & Swets)], the most important modification being the use of two water-cooled valves in the penultimate stage.

621.396.619.23 : 621.396.619.13 **2820**

Fundamentals of Frequency Modulation by means of Reactance Units.—H. Fick. (*Funk u. Ton*, April 1953, Vol. 7, No. 4, pp. 199–204.) Formulae are derived for the parameters of various simple types of reactance unit and for the frequency swing obtained.

VALVES AND THERMIONICS

621.314.7 + 621.314.632 **2821**

Theory of the Germanium Rectifier and the Transistor.—H. Krömer. (*Z. Phys.*, 25th March 1953, Vol. 134, No. 4, pp. 435–450.) Expressions are derived for the charge density in the boundary layers of a metal/semiconductor junction in a strong field. The carrier density is found to increase proportionally to field strength and current density; the boundary-layer potential deviates appreciably from the simple Schottky parabolic form. The corrected potential is used to calculate Ge-transistor and Ge-diode characteristic curves.

621.314.7 : 546.28 **2822**

Some Properties of Silicon Point-Contact Transistors.—J. W. Granville & W. Bardsley. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, p. 429.) Preliminary report on Si transistors giving a voltage gain at 90°C about 50% of that at room temperature, with a fall to 20% at 150°C, the current gain remaining substantially constant over this temperature range. High-resistivity *p*-type Si is used, with phosphor-bronze or tungsten probes about 0·002 in. apart.

621.314.7 : 546.28 **2823**

On the Transistor Action of Silicon Crystals.—Y. Kanai. (*J. phys. Soc. Japan*, July/Aug. 1952, Vol. 7, No. 4, pp. 435–436.) Characteristics measured for transistors made from *p*-type Si differed from those obtained by Bardeen & Brattain (2979 of 1949) for Ge transistors, in that collector voltage was not a double-valued function of collector current for a given value of emitter current. Results are analysed using Hunter's method (1311 of 1950) with appropriate modifications.

621.383.2 : 537.311.33 **2824**

On the Composition of Antimony-Caesium Photocathode.—H. Miyazawa, K. Noga, S. Chikazumi & A. Kobayashi. (*J. phys. Soc. Japan*, Nov./Dec. 1952, Vol. 7, No. 6, pp. 647–649.) Report of an experimental investigation of the effect on the photoelectric emission, the conductivity and the Cs-vapour pressure of varying the concentration of Cs in the Sb layers. The high photoelectric sensitivity of the semiconducting compound Cs_3Sb is ascribed to its electron structure.

621.383.5 : 546.289 **2825**

The Properties of Germanium Phototransistors.—J. N. Shive. (*J. opt. Soc. Amer.*, April 1953, Vol. 43, No. 4, pp. 239–244.) The point-contact, *p-n*-junction and *n-p-n*-junction types of phototransistor are described and compared. The point-contact type has a high value of dark current and a yield of 3 or 4 electrons per quantum. The *p-n* type has a dark current of the order of microamperes and a quantum yield of about unity. The *n-p-n* type has a yield which may be as high as several hundred electrons per quantum. All three types have long-wave thresholds around 1·8μ.

621.385.029.6 **2826**

Characteristics of the Travelling-Wave Valve in the Dispersive Region of its Delay Line.—W. Klein & W. Friz. (*Arch. elekt. Übertragung*, May 1953, Vol. 7, No. 5, pp. 236–248.) Analysis is presented in which the travelling-wave valve, together with its input and output circuits, is treated as an active quadripole. The transfer coefficient is discussed as regards both magnitude and phase, and the effect of the helix dispersion on the amplification bandwidth is investigated. The way in which amplification and group delay are affected by mismatch at input and output is discussed and means of reducing the effect are described. The frequency dependence of the phase constant and of the group delay for the active case is different from that for the passive helix. The results of the analysis enable travelling-wave valves to be designed with optimum amplification, bandwidth and group delay.

621.385.029.6 **2827**

Magnetic Electron Optics in Long-Beam Amplifier Valves.—M. Müller. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 95–101.) Principles of design of travelling-wave valves are discussed. Methods of screening the electron gun and of calculating the required field intensity are outlined. The lens effect of the transition zone and the effects of space charge are considered. The plane in which the beam diameter is a minimum with no field applied should coincide with the plane in which the applied field reaches 70% of its full intensity.

621.385.029.6 : 621.392.22 **2828**

High-Power Delay Line for a Traveling-Wave Amplifier or Oscillator.—J. F. Hull, G. Novick & B. D. Kumpfer. (*Proc. nat. Electronics Conf., Chicago*, 1952, Vol. 8, pp. 313–320.) Analysis is presented for a delay line similar to that considered by Fletcher (3275 of 1952), with interleaved sets of fingers projecting from the wider walls of a rectangular waveguide, a ribbon beam being directed along the sides of the fingers or a round beam sent through holes in the fingers. An accurate expression is derived for the line impedance and for the guide wavelength. The breaking-up of the fields between the teeth into an infinite number of Hartree space harmonics is discussed. For each order of space harmonic there are two phase velocities in opposite directions. The desirable characteristics of delay lines for either space-harmonic amplifiers or backward-wave oscillators are discussed. Experimental results confirm the theory.

621.385.029.6 : 621.396.65 **2829**

The Travelling-Wave Tube as Output Amplifier in Centimetre-Wave Radio Links.—D. C. Rogers. (*Proc.*

Instn elect. Engrs, Part III, May 1953, Vol. 100, No. 65, pp. 151–156.) The requirements for the output amplifier at the relay stations of a f.m. 4-kMc/s radio link are discussed and the relative merits of klystron, disk-seal triode, and travelling-wave valves for this service are considered. Details are given of the construction, operating conditions and performance of the Type-CV2188 travelling-wave valve which is used at the relay stations of the Manchester-Edinburgh television link as output amplifier. With an input signal power of 25 mW from a Ge crystal mixer, the valve delivers about 1·5 W to the aerial. Improvements to effect still better performance are being investigated.

621.385.029.6 : 621.396.65 **2830**

British TV Relay uses Traveling-Wave Tubes.—D. C. Rogers & P. F. C. Burke. (*Electronics*, June 1953, Vol. 26, No. 6, pp. 156–160.) See 2829 above.

621.385.029.64 **2831**

A Space-Harmonic Traveling-Wave Amplifier.—P. M. Lally. (*Proc. nat. Electronics Conf., Chicago*, 1952, Vol. 8, pp. 73–80.) Spatial harmonics obtained in the case of a wave travelling along a periodically loaded waveguide structure are discussed, mathematical theory being given in an appendix. The design is described of an amplifier valve for the range 4–6 kMc/s. This uses a waveguide loading structure consisting of teeth projecting inwards from opposite walls of the waveguide, the teeth being tapered down for a length of 1 in. at each end of the valve. With a normal beam current, oscillations could be obtained at nearly all beam voltages $>$ 200 V. Such valves can be used as electrically tunable filters or oscillators, the frequency varying with beam voltage. See also 547 of 1952 (Millman).

621.385.032.21 : 537.583 **2832**

A Survey of Present Knowledge of Thermionic Emitters.—D. A. Wright. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 125–139. Discussion, pp. 140–142.) Factors affecting the work function of metals are discussed, the work functions of the elements are tabulated and the effects of adsorbed films are considered particularly for emitters with monatomic layers of Th, Cs or Ba. The emission from compounds, especially from semiconductors, is described. Difficulties in the way of using the emissive properties of certain metallic borides and carbides are noted. LaB_6 and ThC_2 are likely to be valuable as practical emitters. The general properties of oxides are discussed, a table of work-function data being given for the oxides of metals in the first four groups. The properties of the (Ba, Sr)O cathode are discussed in detail and the performance of thoria as an emitter is described. 70 references.

621.385.032.216 **2833**

Investigations on Oxide Cathodes with a Resistive Interface Layer.—A. P. Weber. (*Telefunken Ztg*, March 1953, Vol. 26, No. 99, pp. 123–127.) By means of a special microscope technique, tightly adhering vitreous crusts have been discovered on the cathode core in cathodes which have developed an interface resistance; their average thickness is 3 μ. The general roughening of the cathode core is not connected with the resistive layer.

621.385.032.216 **2834**

Dissociation of Oxide-Coated Cathode by Primary Electron Bombardment.—S. Yoshida, I. Takeda & H. Arata. (*J. phys. Soc. Japan*, July/Aug. 1952, Vol. 7, No. 4, pp. 430–431.) An experimental investigation leads to a value of 10·5 eV for the energy of dissociation of solid-state BaO.

621.385.032.216 : 537.311.3 **2835**

A Retarding-Potential Method for Measuring Electrical Conductivity of Oxide-Coated Cathodes.—I. L. Sparks & H. R. Philipp. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 453–461.) The method described cannot be used at very low temperatures or for coatings with a conductivity/thermionic-emission ratio > 2 cm/V. It can, however, be used for coatings in a normal state for thermionic emission, as probes or other devices which might impair emission are not used, and conductivity and thermionic emission measurements can be made simultaneously. Results obtained for BaO and (BaSr)O coatings are given.

621.385.032.216 : 537.533.8 **2836**

Secondary Electron Emission from Oxide-Coated Cathode.—S. Yoshida & I. Takeda. (*J. phys. Soc. Japan*, Nov./Dec. 1952, Vol. 7, No. 6, pp. 639–640.) An experimental investigation is made of the variation of the secondary-emission ratio due to (*a*) formation of excess Ba when the BaO suffers dissociation as a result of electron bombardment (see 2834 above), (*b*) variation of primary-electron-current density, and (*c*) variation of temperature

621.385.032.216 : 537.583 : 537.533.1 **2837**

The Velocity Distribution of Electrons of Thermionic Emitters under Pulsed Operation: Part 1 — Apparatus and Measuring Technique.—C. G. J. Jansen & R. Loosjes. (*Philips Res. Rep.*, Feb. 1953, Vol. 8, No. 1, pp. 21–34.) The construction of a tube for determining the electron velocity distribution, particularly of oxide coatings at high current densities, is described. Electron-velocity measurements are accurate to within $\sim$ 1%. Complete i/V characteristics of an emitting surface of area 8 mm², and points on the characteristics of the small portions (0·03 mm²) whose velocity spectra are observed, can be determined by pulse methods. Typical (BaSr)O, BaO, and SrO velocity spectra are shown. Using tubes with L cathodes, peak voltages can be determined to within $\pm$ 1 V.

621.385.032.216 : 621.317.332 **2838**

The Dependence of Mutual Conductance on Frequency of Aged Oxide-Cathode Valves and its Influence on their Transient Response.—J. R. Tillman, J. Butterworth & R. E. Warren. (*Proc. Instn elect. Engrs*, Part III, May 1953, Vol. 100, No. 65, pp. 175–176.) Digest only. The interface-layer impedance, represented as a parallel RC combination, is determined from measurements of the apparent mutual conductance at three frequencies, the first so high that C renders the interface impedance negligible, the second so low that only R is important, the third at an intermediate frequency. The values of R and C can then be determined. A diagram of the test circuit is given. Measurements on some aged h.f. pentodes show that the interface impedance is frequency dependent. This is confirmed by the results of measurements of the transient responses of the valves. A more complex network may be needed to represent interface impedance. See also 2839 below.

621.385.032.216 : 621.317.332 **2839**

A Simple Method for Measuring Interface Impedance.—A. van der Ziel. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, p. 496.) The method described is an adaptation of that used by Strutt & van der Ziel (3211 of 1938). The components of a variable impedance, connected between grid and anode of the valve under test, which is connected as an amplifier, are successively adjusted to obtain zero output (*a*) at 5 Mc/s, (*b*) at 1 kc/s, (*c*) from a wide-band receiver connected across the load resistor. The values of the components then give the valve transconductance and the resistance and parallel capacitance of the cathode-interface layer.

621.385.032.216.1 : 546.841.4-31 **2840**

Contribution to the Study of Thoria Cathodes.—G. Mesnard. (*J. Phys. Radium*, March 1953, Vol. 14, No. 3, pp. 179–191.) Résumé of a thesis. See 2506–2508 of August and back references.

621.385.33.026.445 **2841**

High-Power Transmitting Valve with Thoriated-Tungsten Cathodes.—E. G. Dorgelo. (*Philips tech. Rev.*, Feb. 1953, Vol. 14, No. 8, pp. 226–234.) A description is given of two models of a new transmitting triode, Types TBW 12/100 and TBL 12/100, the former with water cooling and the latter with forced-air cooling. Thoriated-tungsten filaments are used, three specially prepared Zr getters ensuring the necessary very high vacuum. Power consumption in the filaments is 3·5 kW and maximum output power 105 kW for telegraphy, 65 kW for telephony, with an efficiency of 80% at frequencies up to 30 Mc/s and 60% at 68 Mc/s.

621.385.83 : [537.291 + 538.691 **2842**

Electron-Beam Deflection Systems and their Aberrations. Dynamic Systems Symmetrical in Two Planes.—G. Wendt. (*Onde élect.*, Feb. 1953, Vol. 33, No. 311, pp. 93–106.) Different systems are classified. The chief factors governing uniformity in dynamic systems, i.e., when the deflection field is variable, are angle of deflection, principal plane of deflection, and deflecting power; these are defined. Distortion, astigmatism, curvature of field and coma are third-order aberrations. Their dependence on beam width and deflection angle is discussed and methods of eliminating them are noted. Detailed mathematical treatment of field equations is given in an appendix.

621.385.83 **2843**

The E80T Beam Deflection Tube.—(*Electronic Applic. Bull.*, Nov./Dec. 1952, Vol. 13, Nos. 11/12, pp. 175–177.) Details are given of the construction and characteristics of this ribbon-beam valve. See also 2816 above.

621.385.83 : 621.396.61 **2844**

Simplification of Multi-channel V.H.F. and U.H.F. I.G.O.-Circuits by the Use of the Phase-Discriminator Valve, Type E80T.—Bruijsten, Groendijk & Mantz. (See 2817.)

621.385.832 **2845**

Development of an Improved Graphechon Storage Tube.—W. T. Dyall, G. R. Fadner & M. D. Harsh. (*Proc. nat. Electronics Conf., Chicago*, 1952, Vol. 8, pp. 535–542.) See 1539 of May.

621.385.832 : 537.563 **2846**

Positive and Negative Ions in Cathode-Ray Tubes.—C. H. Bachman, G. L. Hall & P. A. Silberg. (*J. appl. Phys.*, April 1953, Vol. 24, No. 4, pp. 427–433.) Ion formation in c.r. tubes has a deleterious effect. Investigations show that the greatest offender is hydrogen, which forms both positive and negative ions. Other ions identified are C^+, C^-, O^+, O^-, $C_2H_2^-$, CO^+. Aluminized screens were found to afford little protection to the ion-bombarded phosphor.

621.396.615.141.2 **2847**

Application of the Thermodynamics of Irreversible Processes to the Theory of the Magnetron.—P. A. Lindsay & G. D. Sims. (*Proc. phys. Soc.*, 1st May 1953, Vol. 66, No. 401B, pp. 423–425.) Discussion of the possibility of building a satisfactory theory of magnetron conduction and oscillations on the foundation of Onsager's thermodynamics of irreversible processes.

621.396.615.141.2 **2848**

Calculation of a Waveguide-Loaded Resonator for Interdigital Magnetrons.—G. Hok. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, pp. 763–769.) The electromagnetic-field configuration in the various parts of the resonator is considered, as well as the boundary relations at the junctions between them. The result is used to relate resonance frequency and Q to the geometry and to design the output transformer so that the desired slot conductance is obtained for the electronic operation of the magnetron.

621.396.615.141.2 **2849**

Inverted Magnetron.—F. Lüdi. (*Proc. Inst. Radio Engrs*, June 1953, Vol. 41, No. 6, p. 799.) Comment on paper noted in 3621 of 1952 (Hull), with reference to numerous previous publications by the author dealing with the planar magnetron, this form being closely approached by the single-cavity magnetron known as the 'turbator' (2518 of August and back reference).

621.396.615.141.2 : 621.365.55† **2850**

Tubes for Dielectric Heating at 915 Mc/s.—R. B. Nelson. (*Trans. Amer. Inst. elect. Engrs*, 1952, Vol. 71, Part I, pp. 72–80.) For a shorter account see 3292 of 1952.

621.396.615.141.2(091) **2851**

Genesis of a Generator — The Early History of the Magnetron.—R. L. Wathen. (*J. Franklin Inst.*, April 1953, Vol. 255, No. 4, pp. 271–287.) Early types are noted and a detailed account is given of the development in England by Boot & Randall of the multicavity magnetron, and of the improvements, such as Sayers' method of segment strapping for mode suppression, which resulted in the practical designs which contributed so largely to the efficiency of wartime radar equipment. Developments in the United States since 1940, when information on the British design was disclosed, are not considered, as they have been well covered by Collins (588 of 1949) and by Fisk et al. (293 of 1947). See also 891 (Megaw) and 892 (Willshaw et al.) of 1948.

621.396.615.141.2(43) **2852**

The State of Magnetron Development in Germany.—K. Fritz. (*Funk u. Ton*, March 1953, Vol. 7, No. 3, pp. 133–138.) Brief descriptions are given of typical magnetrons, including one with a c.w. output of 1 kW on a wavelength of 12·5 cm and an efficiency > 50%.

621.396.615.142.2 **2853**

Design Features of a New 14·5–17·5-kMc/s Reflex Klystron.—G. C. Dalman. (*Proc. nat. Electronics Conf., Chicago*, 1952, Vol. 8, pp. 50–55.) Description of a mechanically tuned valve, Type SRU-55, which is designed for direct connection to a standard 0·622 × 0·311-in. waveguide without insertion of a transformer section. Minimum output throughout the range with 300-V beam voltage, is 20 mW, over 100 mW being given in parts of the range.

MISCELLANEOUS

621.396 + 621.396.9 **2854**

Radio and Radar Technique. [Book Review]—A. T. Starr. Publishers: Pitman & Sons, London, 812 pp., 75s. (*Wireless Engr*, July 1953, Vol. 30, No. 7, p. 182.) A concise account of the essentials; the reader is assumed to have a knowledge of the subject approaching that of a university degree.

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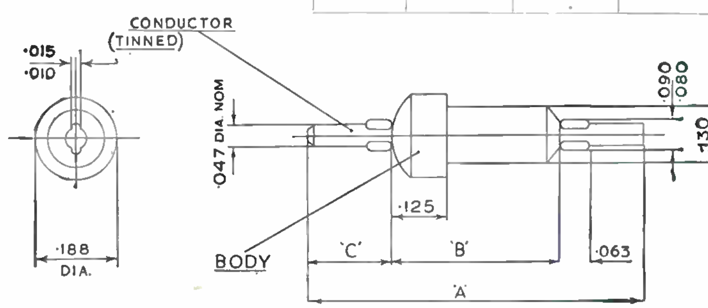

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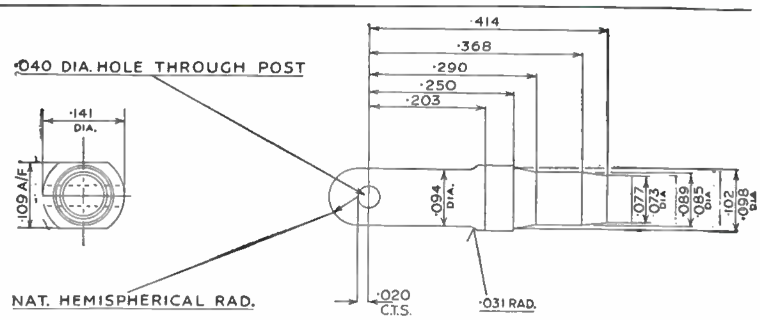

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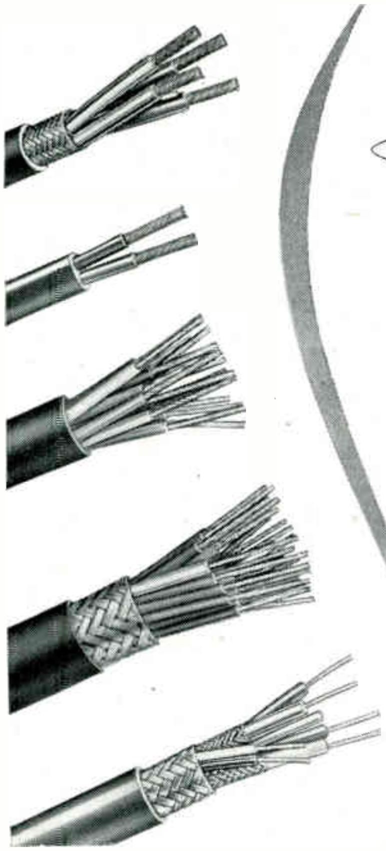

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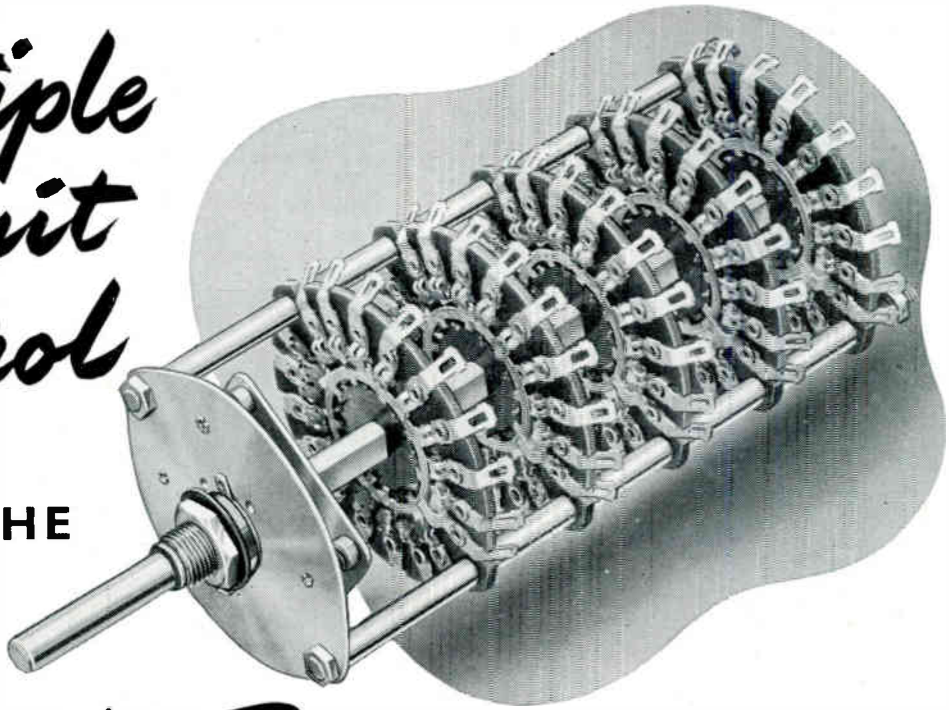

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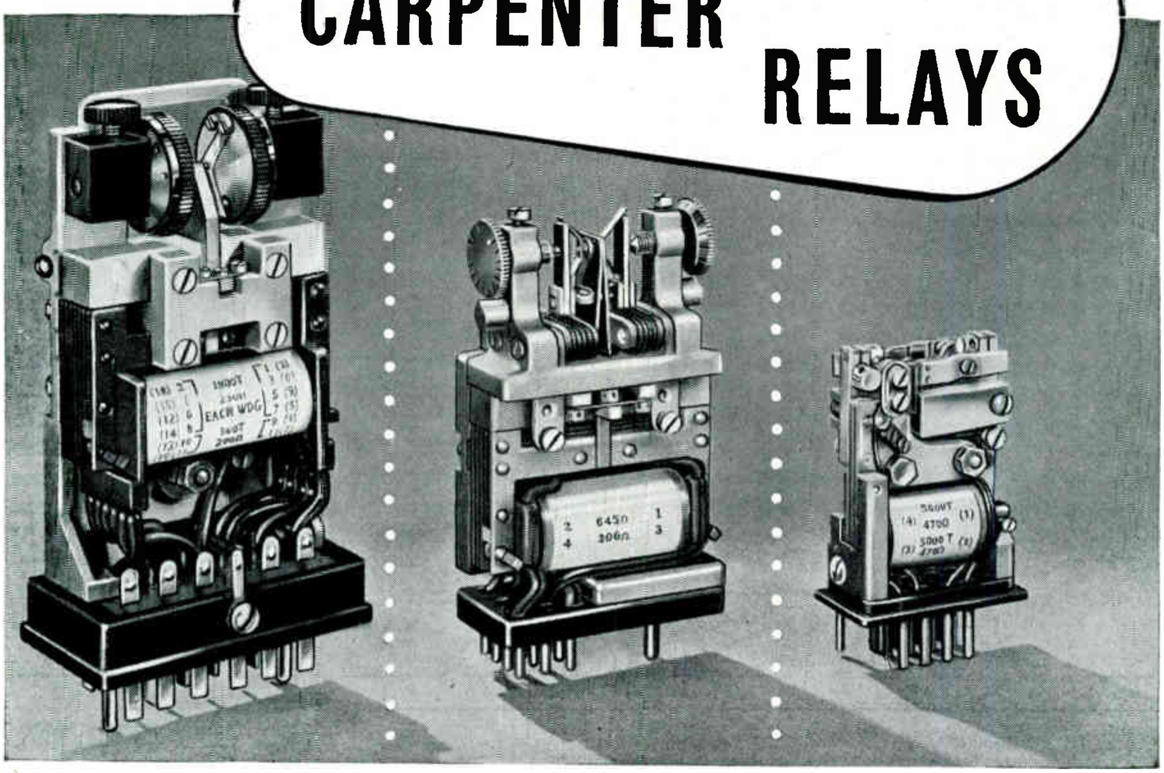

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(*c*) **Electronic Trials Engineers** at a salary of up to £750 p.a. Applicants should have experience of high frequency communication equipment and be prepared to accept responsibility for its installation and subsequent trial at locations in U.K. other than Luton. Ref. 456N.

(*d*) **Electronic Trials Assistants** at a salary up to £12 per week. These assistants will be formed into teams under the leadership of electronic trials engineers (see above) and will be required to assist in the installation and subsequent trial of H.F. communication equipment. Ref. 456P.

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or

(ii) The preparation of information for drawing office and production department from circuit diagrams. Ref. 1066C.

Applications should be sent to Dept. C.P.S., 336/7 Strand, London, W.C.2, quoting appropriate reference.

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Electrical Engineers wanted by Ministry of Supply for Experimental Establishments mainly at Malvern, Worcs.; Farnborough, Hants.; Sevenoaks, Kent. Duties chiefly concerned with research, development or design in telecommunications, radar, electronics, instrumentation or light electrical measurements. Posts graded according to age, qualifications and experience in Scientific Officer class (requiring 1st or 2nd class honours degree in Electrical Engineering or equivalent) or Experimental Officer class (requiring Higher School Certificate (Science) or equivalent—although H.N.C. or pass degree may be an advantage). Salaries:—S.O. £417 to £675; E.O. (min. age 26) £649 to £799; Asst. E.O. £264 (age 18) to £576. Women somewhat less. Appointments unestablished. F.S.S.U. benefits may be available for S.O. class. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D 232/53A.

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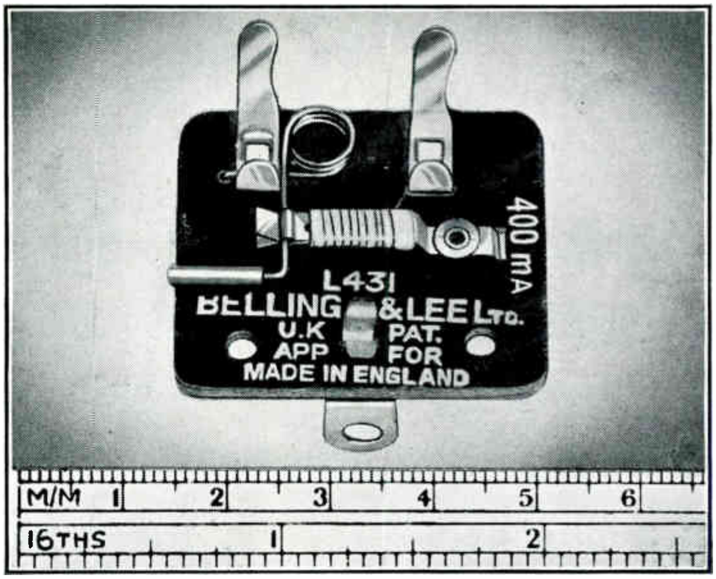

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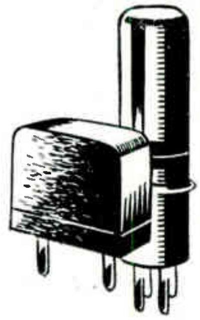

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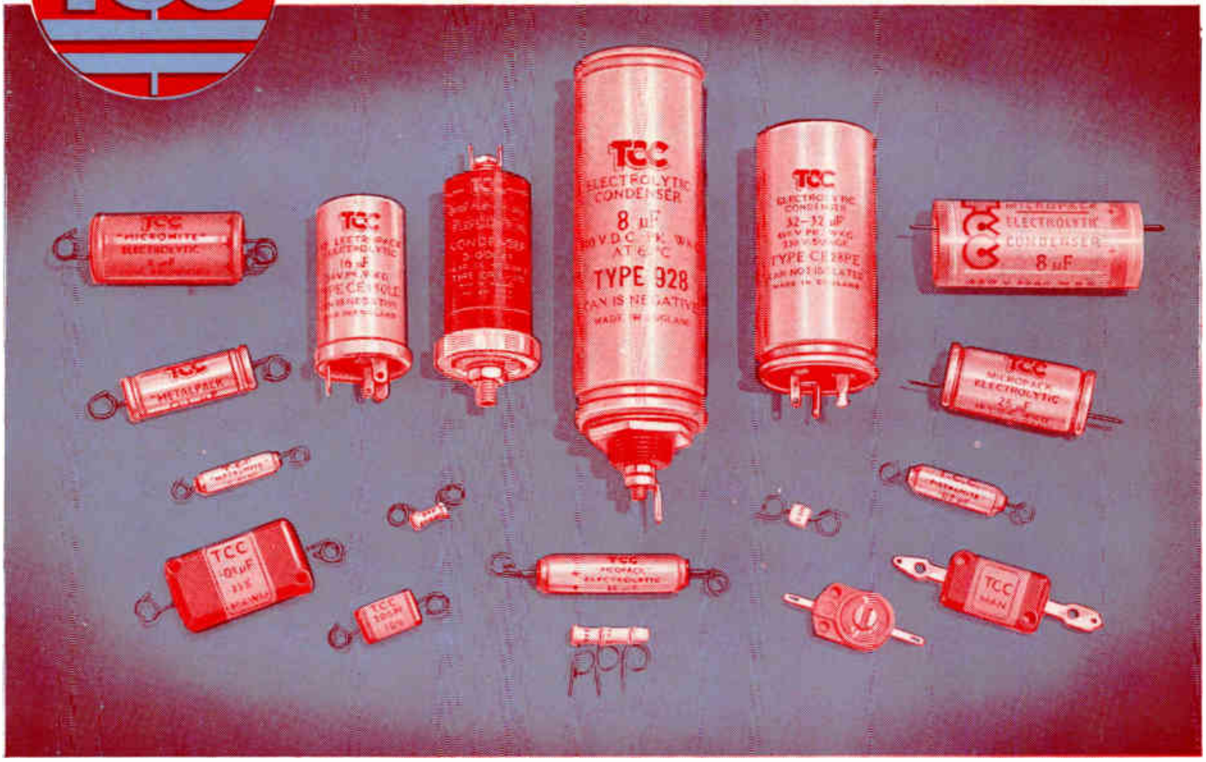

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