WIRELESS ENGINEER

THE JOURNAL OF RADIO RESEARCH & PROGRESS

NOVEMBER 1947

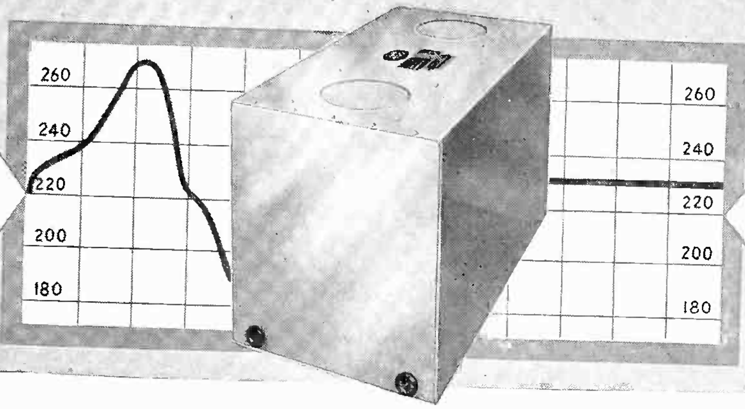
VOL. XXIV. TWO SHILLINGS AND SIXPENCE - - No. 290

B.A.T. 'Best After Test'

AUTOMATIC VOLTAGE REGULATORS

B.A.T. 'Best After Test'

ng Input Voltage :
-255 Volts.



Constant Output Voltage:
230 Volts ± 0·5%

General Characteristics

Constant A.C. Output

Example : 230 volts ± 0·5%—50-cycles/sec.—single phase. Any output voltage may be ordered (see below).

Wide A.C. Input Voltage Limits

Example : 190-255 volts, 50-cycles, 1-phase. Other single-phase voltages or frequencies can be dealt with, on special orders.

Entirely Automatic—Quick Action

There are no moving parts. No adjustments need ever be made and no maintenance is required. The regulating action is virtually instantaneous, the time required for adjustment to a new voltage, or load condition being so short that it is quite imperceptible by ordinary means.

Load Rating

Nine standard, nominal ratings are carried in stock as listed below. Others can be built, including models giving (example) 115 v. ± 1% on 190-255 v. input : or multiple outputs, all regulated. The regulators also stabilize well under all load conditions, from no-load to 100% load.

General Advantages and Uses, etc.

Constant A.C. input voltage is essential for the effective operation of many electrical devices, both industrial and laboratory patterns. Examples : X-ray apparatus, incandescent-lamp light sources (photometers, photo-printing, colour comparators, photo-electric cell applications, spectrography, etc.), laboratory test-gear (vacuum tube volt meters, amplifiers, oscillators, signal generators, standards of frequency, etc.) : the larger patterns for stabilizing a complete laboratory room or test - bench : the smaller units as integral components of equipment.

Priorities, Etc.

Owing to the increasingly difficult position of certain raw materials, especially transformer laminations, it is advisable for customers to state any "Priority" on their orders. Such endorsements will receive every consideration.

For Complete Data

Please request Bulletin VR 150147

NINE STOCK MODELS ARE OFFERED

Type	Watts	A.C. Input Voltage	Output Voltage	Net Wt.	List Price
VR-10	10	190-255 50~ 1-phase	230 v. ± 0·5 per cent. Or, as ordered (see text above)	3 lbs.	£6 - 15 - 0
VR-20	20			7 lbs.	£8 - 0 - 0
VR-60	60			17 lbs.	£10 - 10 - 0
VR-80	80			22 lbs.	£12 - 10 - 0
VR-150	150			42 lbs.	£13 - 10 - 0
VR-300	300			62 lbs.	£22 - 10 - 0
VR-500	500			68 lbs.	£29 - 10 - 0
VR-1000	1000			120 lbs.	£47 - 10 - 0
VR-2500	2500			450 lbs.	£175 - 0 - 0

THESE STABILIZERS ARE OF 100% BRITISH MANUFACTURE.

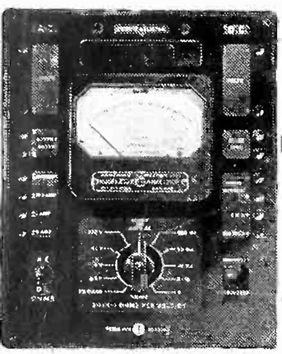
Claude Lyons Ltd.

ELECTRICAL AND RADIO LABORATORY APPARATUS ETC.

180, Tottenham Court Road, London, W.1 and 76, OLDHALL ST. LIVERPOOL, 3, LANCS.

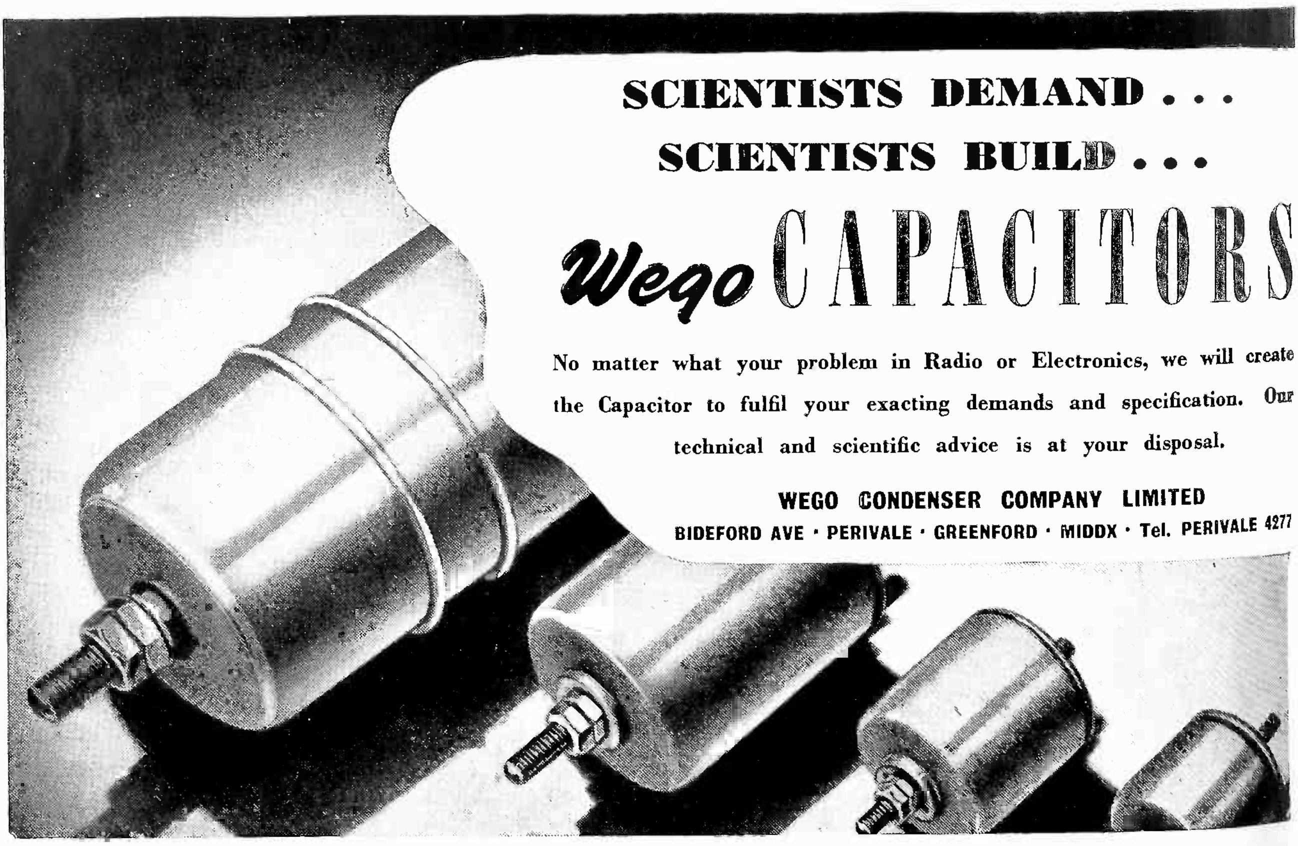
A WITCH DOCTOR MIGHT AS WELL TRY

A witch doctor might as well try to find certain faults in a defective wireless set as a skilled engineer without a good test instrument. A Weston Model E772 Analyser will help you to find radio faults in the easiest and quickest way. This instrument will save you time, trouble and money, and you will find it universally useful for a wide range of measurements. Features of the instrument are high sensitivity—20,000 ohms per volt on all D.C. ranges—simplified controls, robust construction, accuracy and dependability.



ANALYSE SYSTEMATICALLY WITH A **WESTON**

SANGAMO WESTON LTD., ENFIELD, MIDDX. Telephone: Enfield 3434 & 1242



SCIENTISTS DEMAND . . .
SCIENTISTS BUILD . . .

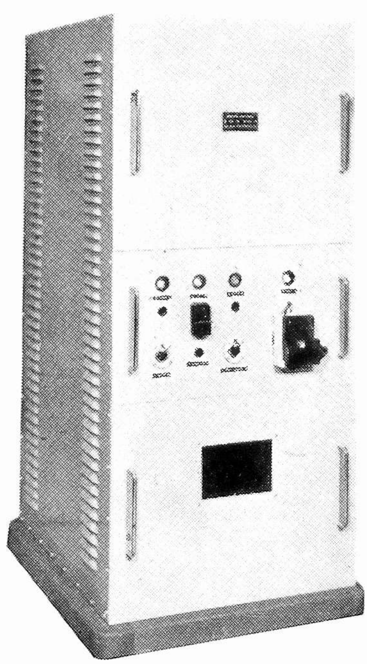
Wego CAPACITORS

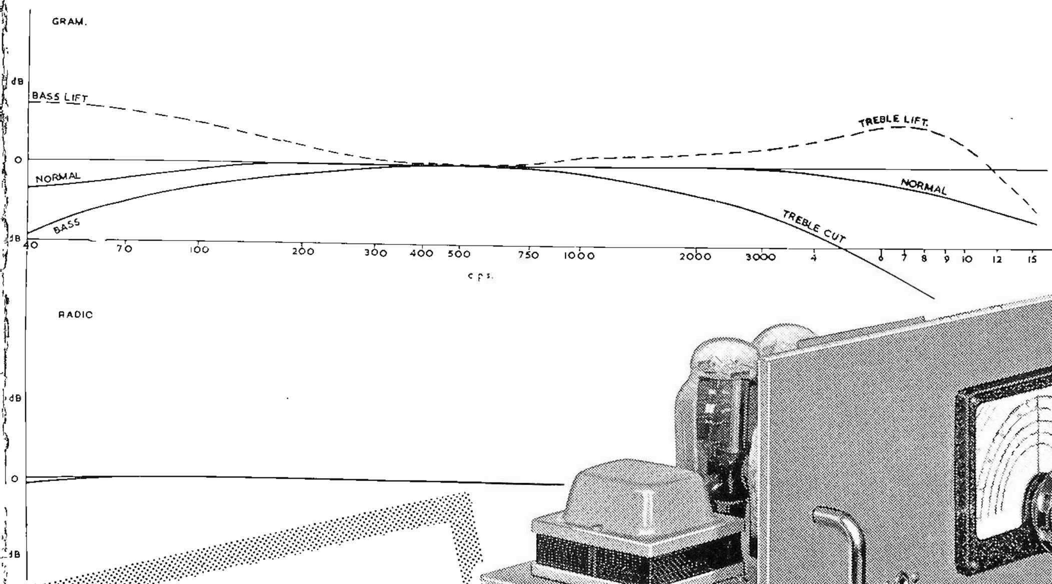
No matter what your problem in Radio or Electronics, we will create the Capacitor to fulfil your exacting demands and specification. Our technical and scientific advice is at your disposal.

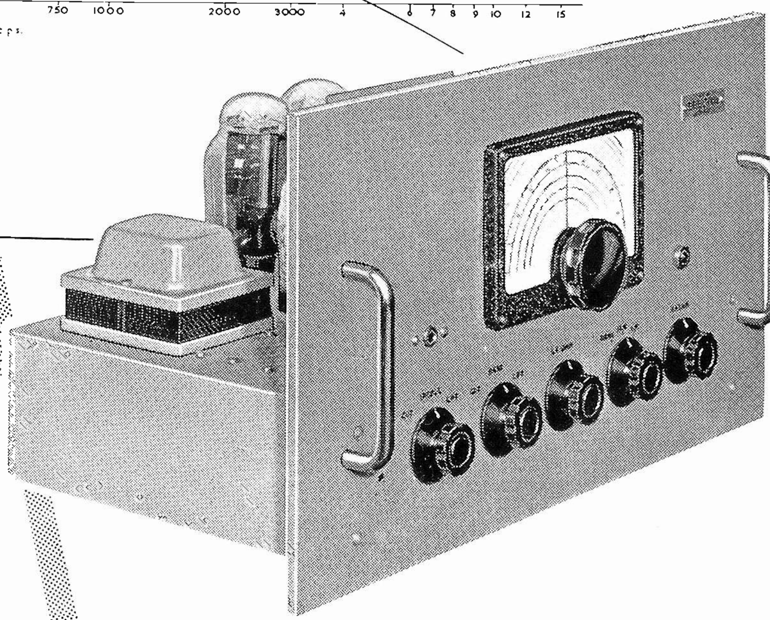
WEGO CONDENSER COMPANY LIMITED

BIDEFORD AVE · PERIVALE · GREENFORD · MIDDX · Tel. PERIVALE 4277


STABLE
to
1%
GRADE 1



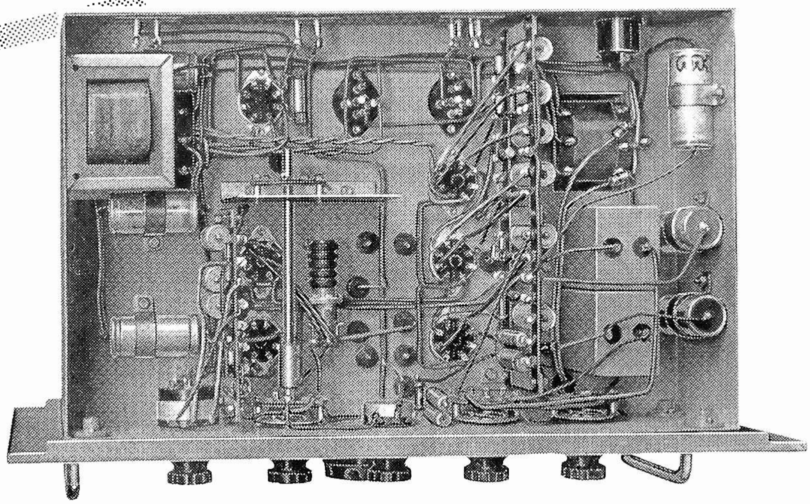




HIGH QUALITY LOCAL STATION RECEIVER

by RM

T.R.F. Circuit
For 19" Rack or Steel Cabinet
Push-Pull Triode Output
Bass and/or Treble Lift
Bass and/or Treble Cut



This receiver is specially built for the reception of local stations attaining the highest possible quality of reproduction. It incorporates a stage which restores the highest frequencies cut off in the tuned circuits. It also amplifies the bass to compensate for the lack of the lower register in recordings.

This receiver is also available as a feeder to drive large amplifiers.

Send for detailed information

.M. ELECTRIC LTD., TEAM VALLEY, GATESHEAD 11, ENGLAND

TELCON METALS

MUMETAL MAGNETIC SHIELDS

The high permeability of MUMETAL makes it the outstanding material for screening delicate instruments and equipment from uni-directional and alternating magnetic fluxes. A complete range of standard MUMETAL boxes and shields is available, and shields for special requirements can be made to order. If you have a screening problem our technical experts will be pleased to assist in its solution. Your enquiries are invited.

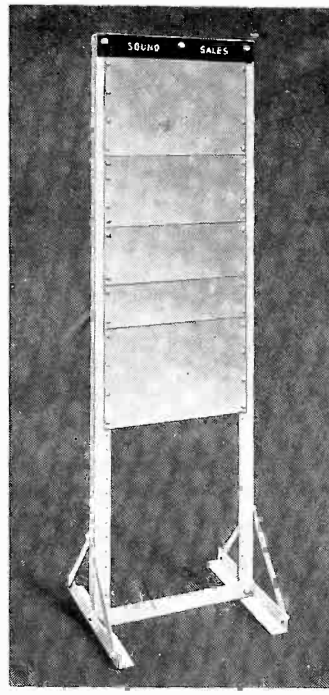
TELCON TM

THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO. LTD.

Founded 1864

Head Office : 22 OLD BROAD ST., LONDON, E.C.2. *Tel* : *LONdon Wall* 3141

Enquiries to : TELCON WORKS, GREENWICH, S.E.10. *Tel* : *GREenwich* 1040

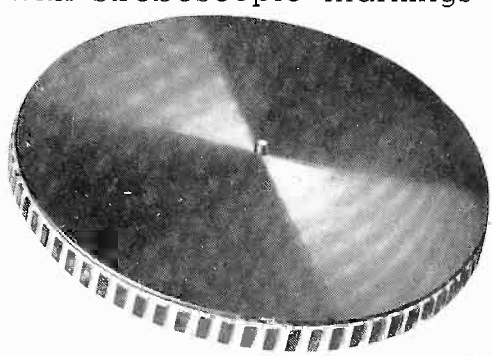


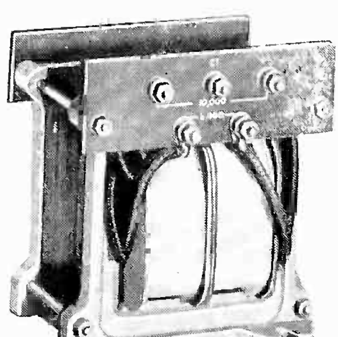
Racks and Panels

to standardised dimensions and interchangeable

Non-Magnetic Turntables

with stroboscopic markings





Transformers

of all types from 6 VA to 12 KVA including linear response output transformers

Sound Sales, Ltd.,

57, ST. MARTIN'S LANE, LONDON, W.C.2.

Temple Bar 4284.

Works: Farnham, Surrey. (Farnham 6461/2/3).

WIRELESS ENGINEER

The Journal of Radio Research & Progress

Editor W. T. COCKING, M.I.E.E. *Managing Editor* HUGH S. POCOCK, M.I.E.E. *Technical Editor* Prof. G. W. O. HOWE, D.Sc., LL.D., M.I.E.E.

NOVEMBER, 1947

Vol. XXIV. **No. 290**

CONTENTS

Published on the sixth of each month

SUBSCRIPTIONS

Home and Abroad: One Year 32/-. Six Months 16/-.

Editorial, Advertising and Publishing Offices :

DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1

Telephone : WATerloo 3333 (50 lines). Telegrams : Wirenger, Sedist, London.

Branch Offices :

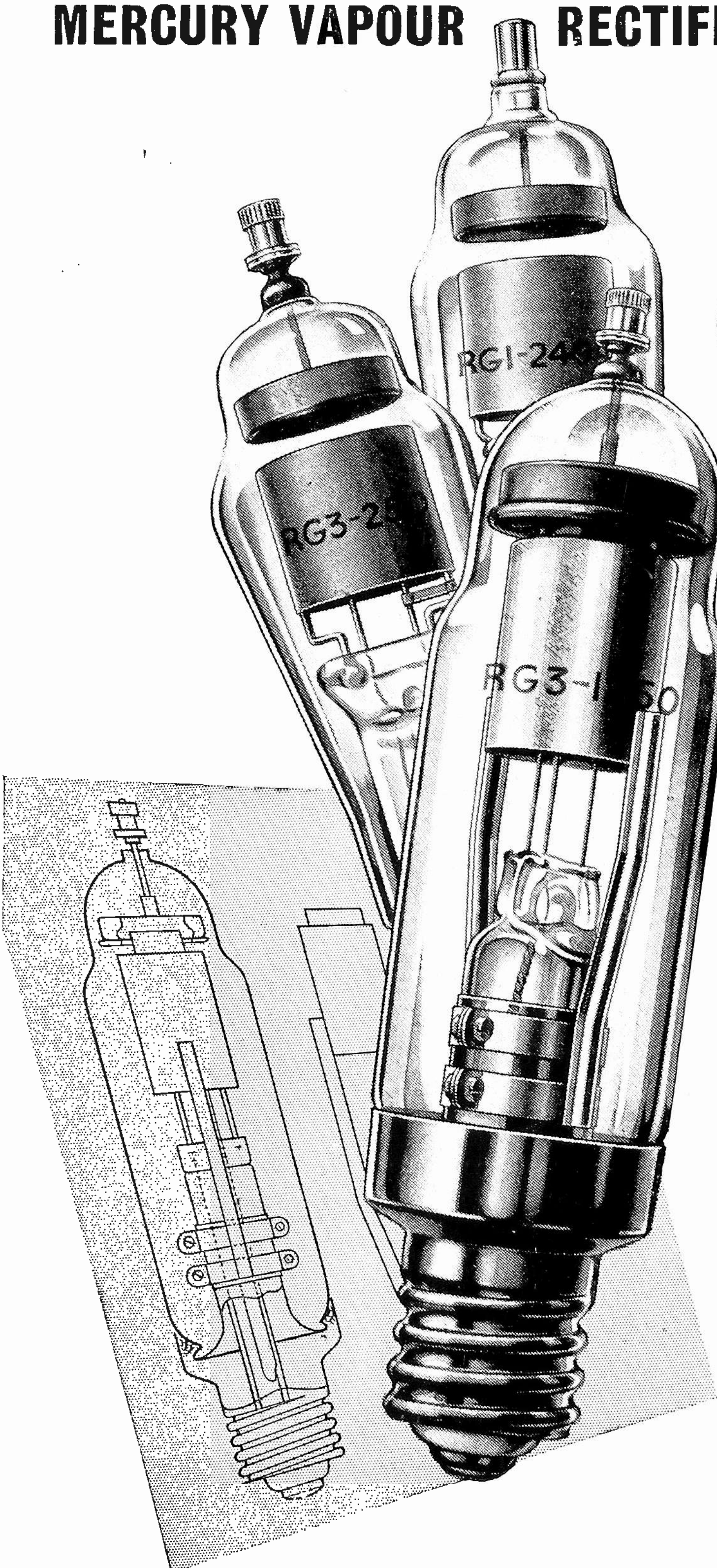
COVENTRY
8-10, Corporation Street.
Telephone: Coventry 5210.
Telegrams:
"Autocar, Coventry."

BIRMINGHAM 2
King Edward House,
New Street.
Telephone: Midland 719 (7 lines).
Telegrams:
"Autopress Birmingham 2."

MANCHESTER 3
260, Deansgate.
Telephone:
Blackfriars 4412 (4 lines).
Telegrams:
"Iliffe, Manchester 3."

GLASGOW C2
26B, Renfield Street.
Telephone: Central 4857.
Telegrams:
"Iliffe, Glasgow C2."

MERCURY VAPOUR RECTIFIERS WITH AN ASSURED *Long Life*



These three Mullard rectifiers owe their reputation for dependability to closely controlled manufacturing processes. Below are some of the reasons why more and more designers are specifying the "RG" range.

Stable Emission. The special double spiral filaments are so designed that the emissive coating is firmly keyed to the wire.

Long Life. The use of zirconium to eliminate "foreign" gases reduces positive ion bombardment of the cathode.

High Voltage Tests. All valves are subjected to rigorous back-arc tests.

RG1-240A

Peak Inverse Voltage	4,700 V
Mean Anode Current	-250 mA max.
Two Valves in a Single-Phase Full-Wave Circuit will give 1,500 Volts at 500 mA.	
Filament Voltage	4.0 V
Filament Current	2.7 A

RG3-250

Peak Inverse Voltage	10,000 V
Mean Anode Current	250 mA max.
Two Valves in a Single-Phase Full-Wave Circuit will give 3,150 Volts at 500 mA.	
Filament Voltage	2.5 V
Filament Current	5.0 A

RG3-1250

Peak Inverse Voltage	13,000 V
Mean Anode Current	1.25 A max.
Two Valves in a Single-Phase Full-Wave Circuit will give 4,140 Volts at 2.5 amps.	
Filament Voltage	4.0 V
Filament Current	7.0 A

Mullard

THE MASTER VALVE

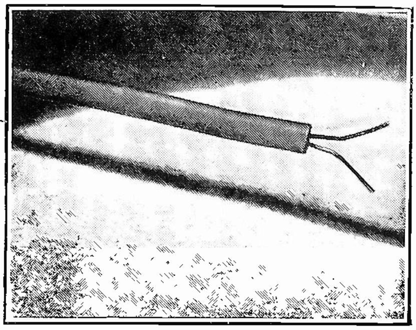
Mullard

THE MULLARD WIRELESS SERVICE CO., LTD. TRANSMITTING & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2.

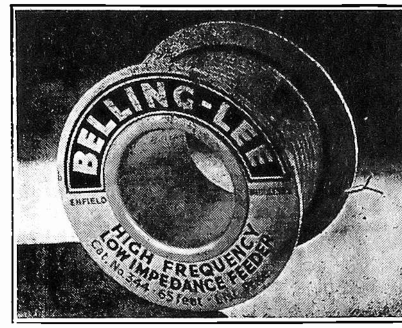
MVT20D


FIDELITY
EFFICIENCY

L.336 UNSCREENED TWIN TRANSMISSION LINE



L.336 twin unscreened feeder. Price 7½d. per yard



65 ft. of L336 feeder on reel. List No. L344 Price 13/6

This transmission line was developed in 1937 expressly for use with dipole receiving aerials for the reception of television broadcasts from the B.B.C. Station at Alexandra Palace.

It was undoubtedly the first scientifically designed line when considered in terms of this particular application.

The original design comprised a pair of enamelled copper conductors 0.036″ diameter spaced 0.630″ between centres and embedded in a bituminised gutta-percha compound. It was manufactured for us by The Telegraph Construction and Maintenance Co. Ltd. The characteristic impedance was 80 ohms and the attenuation loss (when correctly matched) at 46 Mc/s was of the order of 7.0 db per 100 ft. In the early stages of the 1939/45 war the product was in great demand by H.M. Service particularly for use with short-wave receiving dipoles and arrays and in fact was the only available unscreened twin line adaptable for this purpose. During the war the discovery of Polythene enabled the previous insulant to be replaced with this superior material, and this has been perpetuated in the design. The characteristic impedance remains, nominally, at 80 ohms while the attenuation loss is halved, at high radio frequencies, due to the lower power factor of Polythene as compared with the original insulant.

This transmission line is now in great demand for feeding television and short-wave receiving dipoles and arrays, and is becoming very popular with radio transmitting amateurs on account of its low cost and light weight as compared with similarly rated co-axial lines. For example, a flexible co-axial line possessing practically identical transmission characteristics, will weigh approximately twice that of our twin line and this is an extremely important point when one considers the centre feeding of horizontal short-wave dipoles at frequencies less than 30 Mc/s on account of mechanical sag. Apart from its properties when used in conjunction with aerials it is extremely useful, in short lengths, for link coupling between stages in radio transmitters and for cathode follower output connections in wide band amplifiers.

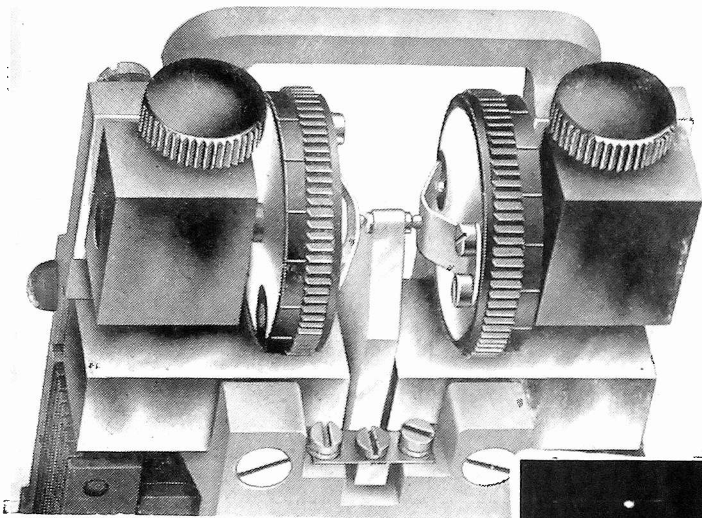
Useful data is as follows :—

Characteristic impedance	75-85 ohms (nominal 80 ohms).
Capacitance	18 $\mu\mu$F per foot.
Attenuation in db/100 ft.	Approximately $0.5\sqrt{f\text{Mc/s}}$ over the range 1 Mc/s—100 M/cs.
Power loading in watts	$\frac{1000}{\sqrt{f\text{Mc/s}}}$ over the range 1 Mc/s—100 Mc/s.
Electrical length	0.66 × physical length.
Weight per 100 yards.	4.5 lbs.
Overall diameter	0.25 inches.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

CARPENTER

High Speed Polarised RELAY

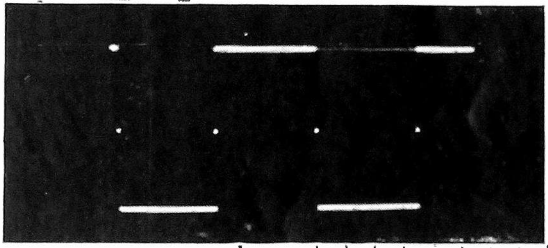


The Carpenter Relay in its standard adjustment reproduces, with a 5 AT input, square pulses from less than 2 milli-seconds upwards with a distortion of 0.1mS, i.e., 5% for 2mS pulses or 1% at 10mS.

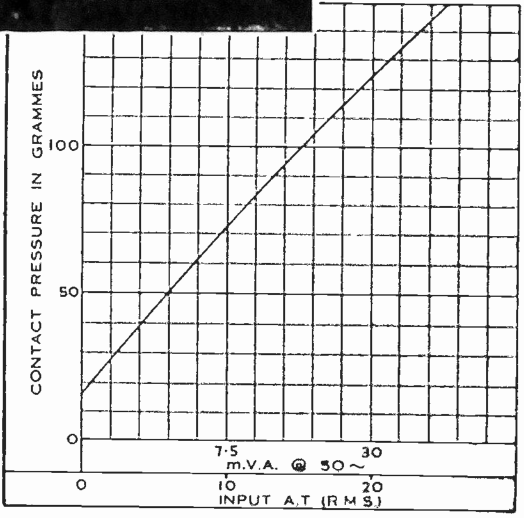
This unequalled performance is due to inherent features of the design of the relay, ensuring short transit time, high sensitivity and low hysteresis.

● (Above) *Contact mechanism of Relay showing damped compliant mountings of side contacts.*

● (Right) *Unretouched photograph (3 sec. exposure) of oscillogram showing contact performance of Relay in special adjustment for a measuring circuit; coil input 18 AT (25 mVA) at 50 c/s.*



(Below) *Graph showing contact pressures developed at 50c/s against mVA and ampere turns input for type 3E Carpenter Relay.*



There is complete absence of contact rebound at any input power and contact pressures are exceptionally high *(see graph)*. Adjustment can be made with great ease. Moreover, since the armature is suspended at its centre of gravity, the relay has high immunity from effects of mechanical vibration and there is no positional error. Effective screening is provided against external fields. Because of these characteristics, the Carpenter Relay has many applications in the fields of measurement, speed regulation, telecontrol and the like, in addition to the obvious use in telegraph circuits; details of models suitable for such purposes will be supplied willingly on request.

DIMENSIONS IN COVER: $2\frac{3}{8} \times 1\frac{5}{16} \times 4\frac{1}{4}$. WEIGHT with standard socket: 22 ozs.

Ask for Booklet 1017 W.E.

TELEPHONE MANUFACTURING CO. LTD.

HOLLINGSWORTH WORKS · DULWICH · LONDON · S.E.21

Telephone: GIPsy Hill 2211 (10 lines)

R.F. ATTENUATOR
TYPE D-239

DELIVERY FROM STOCK

B R I E F   S P E C I F I C A T I O N

ATTENUATION RANGE: TYPE D-239-A: 0—61·5 db variable in steps of 0·5 db. TYPE D-239-B: 0—80 db variable in steps of 1 db. CHARACTERISTIC IMPEDANCE: 75 ohms ("T"-network). PERFORMANCE: At frequencies up to 5 Mc/s and for any setting of the switches the error in attenuation will not exceed ± 0·2 db. Reasonable accuracy is maintained up to 10 Mc/s. TERMINATIONS: Coaxial connectors. INPUT: 3 volts maximum. DIMENSIONS: 6½ in. × 2⅝ in. × 5¼ in. WEIGHT: 2½ lbs.
Manufactured to a design of the Radio Branch of the Post Office Engineering Department.

Full details are given in Bulletin B-562-A, a copy of which will be sent on request.

THIS small compact attenuator is characterized by a relatively high insertion loss and outstanding accuracy of attenuation at high frequencies. Wire wound resistance elements ensure accuracy, good stability and freedom from noise. It can be used as a bench instrument or for incorporation in other apparatus where its small size is a considerable asset. Two types, giving alternative values of total attenuation, are available.

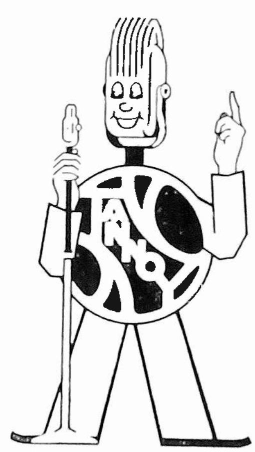
MUIRHEAD

Muirhead & Co. Ltd., Elmers End, Beckenham, Kent. Telephone: Beckenham 0041-2.
FOR OVER 60 YEARS DESIGNERS AND MAKERS OF PRECISION INSTRUMENTS.

C.R.C. 63b

ACOUSTICAL RESEARCH

THE TANNOY LABORATORY can provide a skilled and specialised service in the investigation of all problems connected with vibration and sound. This covers most aspects of acoustical research and is available to industry and Government Departments engaged on priority projects.



TANNOY
RESEARCH LABORATORY
GUY R. FOUNTAIN, LTD.
"THE SOUND PEOPLE"

"TANNOY" is the registered Trade Mark of Equipment manufactured by
GUY R. FOUNTAIN, LTD.
"THE SOUND PEOPLE"
WEST NORWOOD, S.E.27 and Branches.
'Phone - - Gipsy Hill 1131

M&P

for Quality

RADIO CABINETS

M & P WOODWARE MANUFACTURERS LTD.

We are pleased to announce that we are again producing the well-known M & P Radio Cabinets of fine quality and excellent value.

Let us know your requirements and we shall be pleased to quote you and supply full particulars of our present productions.

M & P

WOODWARE MANUFACTURERS LTD.

STERLING WORKS, ALEXANDRA ROAD, PONDERS END, MIDDLESEX

'Phone : Howard 2214-5 and 1755

Telegraphic Address : Emanpe, Enfield

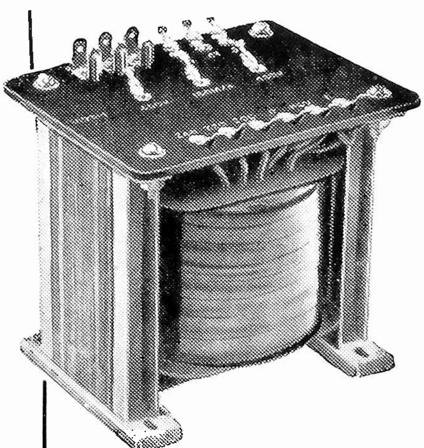
BROOKES CRYSTALS

EST. 1929 —— LTD.

FOR YOUR *Crystal* requirements

51/53, GREENWICH CHURCH STREET, LONDON, S.E.10. 'Phone: GRE. 1828

You get years of faultless service from



because they are :—

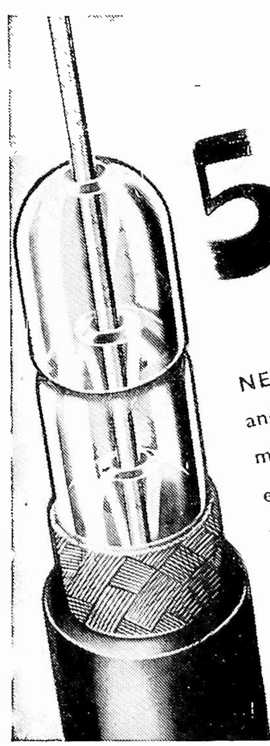
INDIVIDUALLY DESIGNED
RIGOROUSLY TESTED
MECHANICALLY SOUND
ELECTRICALLY PERFECT

"PURPOSE-BUILT"

Savage TRANSFORMERS LTD.

51, NORTHGATE STREET, DEVIZES. Phone 536

12113A



5 mmf/ft

NEW LOW LEVELS in capacity and attenuation of CO-AX Cables mean new possibilities in electronic equipment design both for the war effort and for the post-war electronic age.

BASICALLY BETTER
AIR-SPACED

CO-AX LOWLOSS CABLES

TRANSRADIO LTD. 16 THE HIGHWAY · BEACONSFIELD · 7 · BUCKS

'MADE TO MEASURE'

UNIVERSAL IMPEDANCE BRIDGE, MODEL UB 202

This instrument measures resistance at D.C., Capacity and Inductance at 1000 cycles. Measurements can be made with superimposed D.C.

Another two BPL Instruments of Pioneer Design and Proved Efficiency.

RESISTANCE TUNED OSCILLATOR, MODEL LO63B

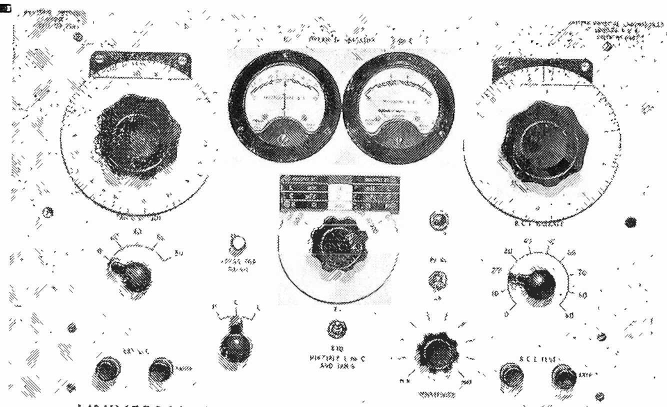
This instrument produces a wide range of audio and supersonic frequencies with an exceptionally low distortion factor and hum level. A calibrated attenuator and output meter are incorporated.

Note New Address:

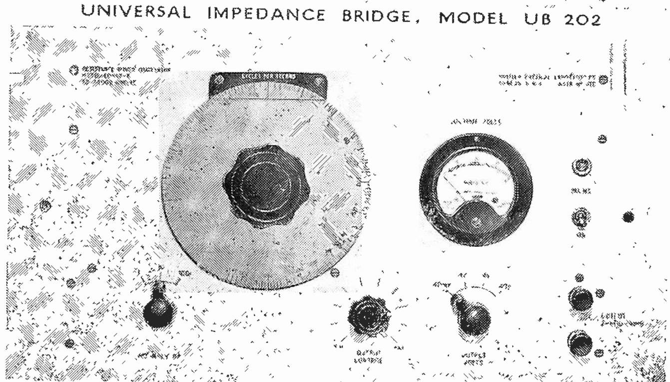
BRITISH PHYSICAL LABORATORIES

HOUSEBOAT WORKS, RADLETT, HERTS.

'Phone: Radlett 5674/5/6.



UNIVERSAL IMPEDANCE BRIDGE, MODEL UB 202



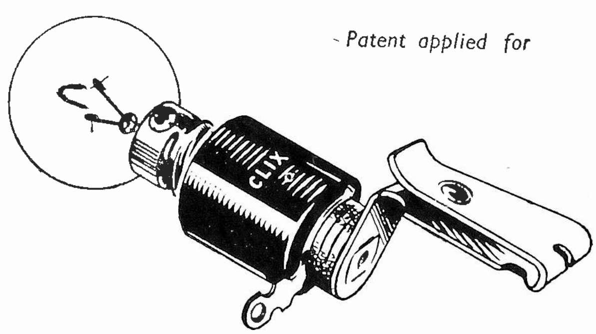
RESISTANCE TUNED OSCILLATOR, MODEL LO-63-B

CLIX

make AND *keep* GOOD CONTACTS

A New Moulded M.E.S. LAMPHOLDER

Patent applied for



Designed to eliminate all possibility of intermittent contact through the lamp becoming loose in its holder. All parts are plated and keyed to the body. Alternative types available, i.e., bracket or clip-fixing.

Another outstanding example of **CLIX** *design.*

BRITISH MECHANICAL PRODUCTIONS LTD. 21 BRUTON ST. LONDON W.1. MAYfair 5543

SOUND SYSTEMS USED

BSR

THROUGHOUT THE WORLD

BIRMINGHAM SOUND REPRODUCERS LTD

CLAREMONT WORKS, OLD HILL, STAFFS. TEL : CRADLEY HEATH 6212/3

LONDON OFFICE : 115 GOWER STREET, W.C.1. TEL : EUSTON 7515

M-W.88

WHY

IRON POWDER ?

To improve the performance of nductances ; to permit a smaller oil to be used and thereby to ecrease manufacturing costs ; to ary easily the inductance of coils y means of movable powder-iron ores ; to pre-set fixed inductances accurate limits.

WHY

CARBONYL

IRON POWDER ?

Because the carbonyl process produces a powder with the appropriate characteristics required by core-makers. Because each particle is spherical and the powder has therefore a high packing density, and is easily insulated. Because no heat treatment at high temperatures after pressing is required.

WHY

TWO GRADES ?

Because two grades cover the majority of requirements.

Grade ME is very fine and hard, spherical and remarkably uniform; primarily suitable where electromagnetic losses are required to be very small, and especially for high-frequency applications.

Grade MC is also fine and spherical but is softer and therefore more easily compressible. Useful in cases where higher permeabilities are required. Further information freely given on request.

The Mond Nickel Company, Ltd.

Grosvenor House, Park Lane, London, W.1

13B/M/1

APPOINTMENTS

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagement Order, 1947.

SENIOR ELECTRICAL ENGINEER OR PHYSICIST, with Honours degree, required for work on the development of machines for use with high frequency heating sets. Experience in the application of H/F heating an advantage. Apply by letter only, stating age, academic qualifications and experience to the Director, Research Laboratories of the General Electric Co. Ltd., North Wembley, Middx.

RADIO ENGINEER required for development of Marine Radio Transmitters. Preferably graduate with at least five years' experience of medium and low power transmitter design. Apply stating experience and salary required to Ref. 235, Siemens Brothers & Co., Limited, London, S.E.18.

RADIO AND ELECTRICAL BUYER for nation-wide multiple retail business. Excellent prospects. Permanency. Box No. 3769.

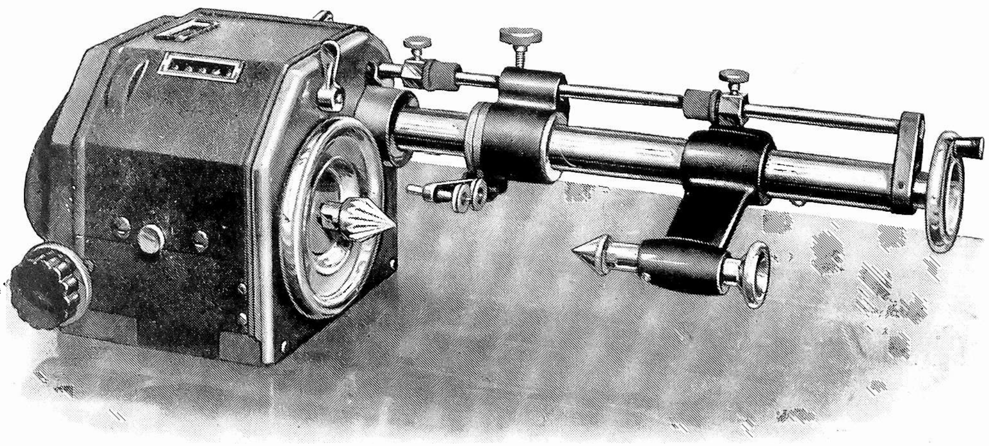
EXPERIMENTAL ENGINEER capable of assisting in development of electro-acoustical apparatus and sound recording systems. B.Sc. or equivalent qualification preferred. West Middlesex district. Apply stating age, details of education and experience to Box 3770.

The English Electric Valve Company, Chelmsford, require for their Research Laboratory, various grades of scientifically trained men ranging from graduates direct from the University to men with very considerable experience. A knowledge of Vacuum technique, Photo-emissive surfaces, Electron optics, Ultra short wave valves and allied subjects, would be advantageous. Remuneration according to qualifications. Please address applications to Central Personnel Services, English Electric Company, Ltd., Queen's House, Kingsway, W.C.2.

Murphy Radio Limited have a vacancy for a Senior Engineer having considerable experience in the development and design of communication receivers and allied equipment. Apply in the first place in writing, giving full particulars and stating salary required, to Personnel Department, Murphy Radio Limited, Welwyn Garden City, Herts.

THE NEW KOLECTRIC HIGH SPEED PRECISION AUTOMATIC COIL WINDING MACHINE

TYPE A1/1



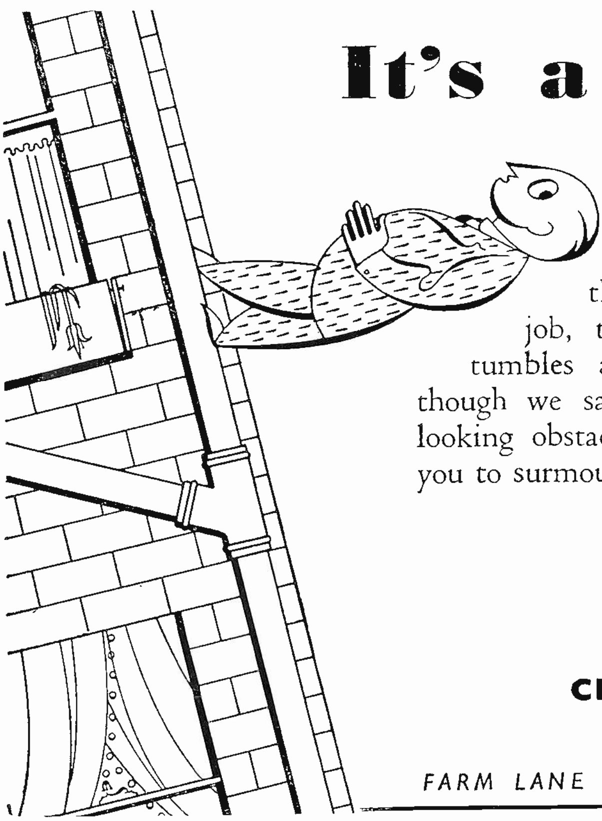
A Few Features :

- Totally enclosed head stock.
- Ease of operation and setting.
- Winding of 2 coils simultaneously.
- Clear wire gauge indicator
- Wire feed from back of coil — ease of paper insertion.
- Hand brake wheel.
- Carriage setting handle.
- Enclosed drive, with ped control.

Write us for full information of this NEW MACHINE

KOLECTRIC LTD 20, Avonmore Road, London, W.14.

It's a bit difficult



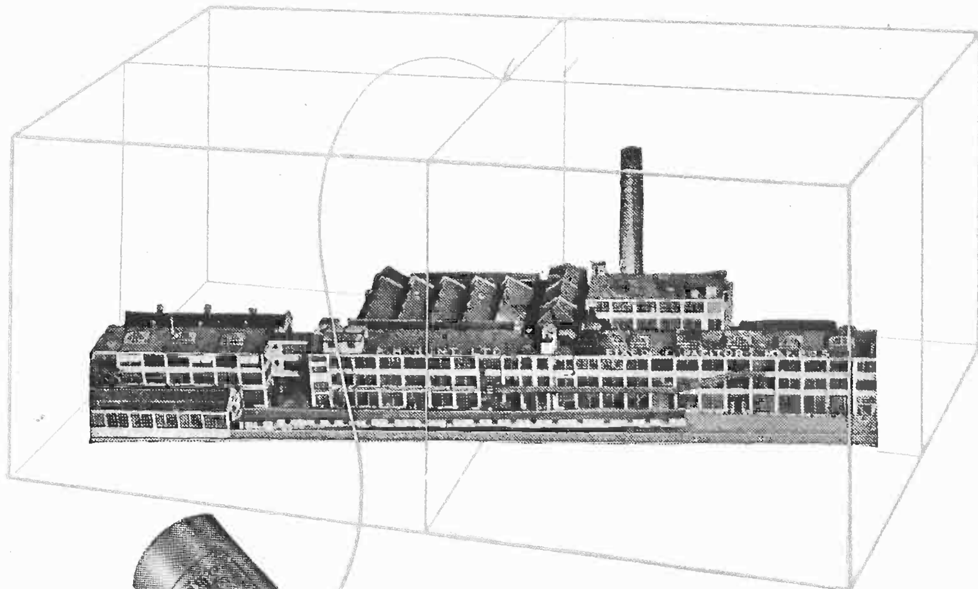
Of course, we could trudge stolidly along the beaten track, turning out standard stampings and pressings to order. In fact, we do quite a lot of that. But we're always on the look-out for the difficult job, the intricate and complicated design. It makes for tumbles and bruises maybe—but never for boredom! And, though we say it as shouldn't, we have got over some incredible looking obstacles. Pretty quickly and cheaply, too. Can we help you to surmount your problems?

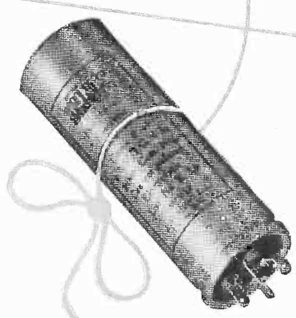
Walter J & H. LTD RADIO

CHASSIS STAMPINGS PRESSINGS

FARM LANE · FULHAM · S.W.6. TELEPHONE: FULHAM 523

C.R.C.I





Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by The Cornwall Press Ltd., Paris Garden, Stamford Street, London, S.E.1.

WIRELESS ENGINEER

Vol. XXIV. NOVEMBER 1947 No. 290

EDITORIAL

An Interesting Electromagnetic Problem

WE have referred on several occasions to the succession of electromagnetic conundrums which have been appearing in the correspondence columns of the American journal *Electrical Engineering*. In the May number the following interesting problem was propounded by Professor E. G. Culwick. In Fig. 1 Q represents a charge moving as shown with a velocity v past a stationary circuit C. The moving charge produces a magnetic field which can be calculated at any point by replacing the moving charge by a current element Ids, where $Ids = Qv$, and applying the Biot-Savart law. The magnetic flux through the ring C could be calculated for each position of Q; it will evidently increase as the charge approaches and decrease as it recedes. An e.m.f. will therefore be induced in C in one direction as Q approaches and in the reverse direction as it recedes, passing through zero at the moment when Q is nearest to C. In the Editorial of March 1944 we showed how the magnetic field of such a moving charge can be regarded as the result of a toroidal distribution of displacement currents in the space around the charge.

If now the charge Q is at rest and the coil C is moving to the left with the velocity v, the relative motion is the same as before and the result must therefore be the same; it is, in fact, the same phenomenon but described by two observers, one at rest with regard to C and the other at rest with regard to Q. Although the result must be the same, the explanations may be very different. If the charge Q is at rest, the coil C is merely moving through an electrostatic field, and at first sight one might say that there can be no induced electromotive force, but, although the charge Q is at rest, there are charges which are not at rest and which cannot be neglected. As the coil approaches Q the part of the coil nearest to Q will become charged negatively and the more remote part positively, assuming Q to be positive.

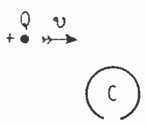


Fig. 1.

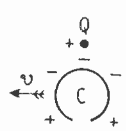


Fig. 2.

At the moment of nearest approach the conditions will be as shown in Fig. 2, and the moving charges will produce a magnetic field through the ring in the same direction as in Fig. 1; viz., downwards into the paper. As before, this magnetic flux will increase as the coil approaches Q and decrease as it recedes. Although the calculation of the charge distribution and the application of the Biot-Savart formula would enormously complicate the determination of the induced electromotive force as compared with the case when the coil is at rest and the charge moving, there can be no doubt that the result would be the same. If one imagines a voltmeter connected between the open ends of C, the reading on it would be the same in both cases. In many problems involving the relative motion of conductors and magnetic fields, of the two alternative assumptions, one gives a simple solution and the other a very complicated one.

It may be objected that Fig. 1 has been unduly simplified by omitting the electrostatic charges induced on the ring. It is, of course, true that the same charges will be induced on the ring in both cases, but as the ring in Fig. 1 is at rest the charges will be purely electrostatic and will have no effect on the magnetic field, which is produced entirely by the moving charge Q.

G. W. O. H.

TRANSMISSION-LINE CALCULATIONS*

Use of Impedance Circle Diagrams

By W. C. Vaughan, M.B.E., B.Sc., Ph.D., A.M.I.E.E.

ALTHOUGH Circle Diagrams have been widely used during recent years for the solution of transmission-line problems, it has been the writer's experience that many radio engineers are unfamiliar with the derivation of these valuable constructions. There appears to be a widespread tendency to use these devices as means of obtaining ready-made solutions by purely rule-of-thumb operations. In the same way that the user of a slide rule who is not familiar with its basic theory may gain facility without appreciating the range of versatility of the instrument, so the possibilities of applying Circle-Diagram technique to new problems cannot be fully realized unless one has, at least, some knowledge of the derivation of the constructions employed. Comprehensive accounts of the Cartesian and polar forms of the Impedance-Circle Diagram have been given by Willis Jackson and G. H. Huxley[1], but it is believed that these expositions may not be simple enough to appeal to the engineer possessing limited mathematical ability or experience. The following treatment, therefore, aims at providing, for those whose needs do not go much beyond the practical, a simplified approach and an indication of proofs of construction which require little more than a knowledge of elementary geometry.

Fundamentally, the Impedance-Circle Diagram provides solutions to the problem of determining the input impedance of a transmission line of known constants and specified length when it is terminated by a given complex impedance. The well-known relation,

$$Z'_i = Z_0 \frac{Z'_t + Z_0 \tanh Pl}{Z_0 + Z'_t \tanh Pl} \quad \cdots \quad \cdots \quad (1)$$

which gives in complex ohms Z'_i, the input impedance of a length l of a line of surge impedance Z_0 and propagation constant P when terminated in any load impedance Z'_t complex ohms, forms the basis of most transmission line calculations.† It is by no means evident that this relation can be translated into graphical form which will permit ready solution of a variety of problems which are apt to be encountered. Furthermore, textbooks rarely emphasize the fact that any complex impedance Z'_t may be regarded as equivalent to a length δ of

* MS accepted by the Editor, October 1946.

[1] Willis Jackson and G. H. Huxley, *J. Instn elect. Engrs*, 1944, Part III, Vol. 91, pp. 105–116.

† For most practical purposes in radio engineering, Z_o may be regarded as purely resistive and it is then convenient to express Z'_i and Z'_t in terms of this quantity. This may be done by rewriting equation (1) as

$$\frac{Z'_i}{Z_0} = \frac{\dfrac{Z'_t}{Z_o} + \tanh Pl}{1 + \dfrac{Z'_t}{Z_o}\tanh Pl}$$

or $$Z_i = \frac{Z_t + \tanh Pl}{1 + Z_t \tanh Pl}$$

in which $Z_i = \dfrac{Z'_i}{Z_o}$ and $Z_t = \dfrac{Z'_t}{Z_o}$. The unprimed symbols Z_i and Z_t now represent the input and terminating impedances expressed in terms of Z_o as unit and are known as the "normalized" values of Z'_i and Z'_t.

transmission line of known characteristics terminated in a purely resistive load R'_t, although this concept has a great deal to commend it when the impedance in question forms the termination of a transmission line. Thus, as indicated in Fig. 1, the input

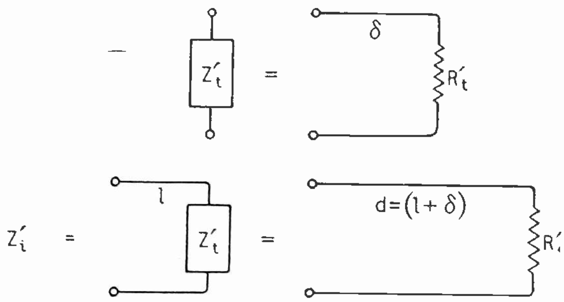


Fig. 1. *As shown, an impedance can be represented by a line terminated by a resistance.*

impedance Z'_i of a length l of line terminated in any impedance Z'_t will be identical with that of a line of similar characteristics and length $d = (l + \delta)$ terminated in a resistance R'_t. Before this conception can be of any practical significance however, it is necessary to ascertain the length δ of line of surge impedance Z_0 and propagation constant P and the resistance which must be used as its terminating load to give an input impedance equal to Z'_t. From equation (1) it is apparent that.

$$Z'_t = Z_0 \frac{R'_t + Z_0 \tanh P\delta}{Z_0 + R'_t \tanh P\delta}$$

so that,

$$\frac{Z'_t}{Z_0} = \frac{\frac{R'_t}{Z_0} + \tanh P\delta}{1 + \frac{R'_t}{Z_0}\tanh P\delta} \quad \ldots \quad \ldots \quad (2)$$

In general, the propagation constant P is a complex quantity $\left(\alpha + j\frac{2\pi}{\lambda}\right)$ in which α is the attenuation constant and λ is the length of the wave propagated down the line. In most cases with which the radio engineer is concerned, α is small and the surge impedance Z_0 may be regarded as a pure resistance. Under these circumstances $\frac{R'_t}{Z_0}$ is, of course, a pure number and may be replaced by $\tanh \kappa$. The impedance Z'_t may be represented by $(r' + jx')$ so that (2) becomes,

$$\frac{Z'_t}{Z_0} = \frac{1}{Z_0}(r' + jx') = \frac{\tanh \kappa + \tanh P\delta}{1 + \tanh \kappa \tanh P\delta} \quad \ldots \quad \ldots \quad (3)$$

$$= \tanh(\kappa + P\delta)$$

$$= \tanh(\kappa + j\theta)$$

$$= \frac{\sinh(\kappa + j\theta)}{\cosh(\kappa + j\theta)}$$

$$= \frac{\sinh \kappa \cos \theta + j \cosh \kappa \sin \theta}{\cosh \kappa \cos \theta + j \sinh \kappa \sin \theta}$$

$$\text{where } \theta = \frac{2\pi\delta}{\lambda}$$

If the right-hand side of this equation is now rationalized by multiplying numerator and denominator by $[\cosh \kappa \cos \theta - j \sinh \kappa \sin \theta]$ the real and imaginary parts may be separated out, giving

$$\frac{r'}{Z_0} = \frac{\tanh \kappa}{\cos^2\theta + \tanh^2\kappa \sin^2\theta}$$

$$= \frac{\frac{R'_t}{Z_0}}{\cos^2\theta + \left(\frac{R'_t}{Z_0}\sin\theta\right)^2}$$

$$= \frac{\frac{R'_t}{Z_0}\left[\tan^2\theta + 1\right]}{1 + \left[\frac{R'_t}{Z_0}\tan\theta\right]^2}$$

and

$$\frac{x'}{Z_0} = \frac{\sin\theta\cos\theta\,(1 - \tanh^2\kappa)}{\cos^2\theta + \tanh^2\kappa\sin^2\theta}$$

$$= \frac{\sin\theta\cos\theta\left[1 - \left(\frac{R'_t}{Z_0}\right)^2\right]}{\cos^2\theta + \left(\frac{R'_t}{Z_0}\right)^2\sin^2\theta}$$

$$= \frac{\left[1 - \left(\frac{R'_t}{Z_0}\right)^2\right]\tan\theta}{1 + \left[\frac{R'_t}{Z_0}\tan\theta\right]^2}$$

It is now convenient to rewrite these relations in normalized form, using Z_0 as the unit of impedance and substituting $r = \frac{r'}{Z_0}$, $x = \frac{x'}{Z_0}$ and $R_t = \frac{R'_t}{Z_0}$, so that they become

$$r = \frac{R_t(\tan^2\theta + 1)}{1 + (R_t\tan\theta)^2} \quad \ldots \quad \ldots \quad (4)$$

and

$$x = \frac{(1 - R_t^2)\tan\theta}{1 + (R_t\tan\theta)^2} \quad \ldots \quad \ldots \quad (5)$$

In the subsequent arguments it is important that the reader should remember that all unprimed symbols for resistance and reactance must be ascribed values expressed in terms of Z_0, the surge impedance of the line with which they are associated; i.e., the line is assumed to have unit surge impedance. Thus equations (4) and (5) give the components of the input impedance $(r + jx)$ of a line of length $\delta = \frac{\theta}{2\pi}\lambda$ and unit surge impedance when terminated in a resistance R_t. Considerable interest attaches itself to these relations, but whilst they readily permit the calculation of r and x when R_t and θ are known, the alternative of determining a length of line with a terminating resistance which will have a given input impedance is not an immediately obvious process. In the latter case graphical solution by means of a Circle Diagram offers the most promising method of dealing with the problem. Two forms of Circle Diagram, the first plotted in Cartesian co-ordinates and the second in polar form are commonly used and their development will now be illustrated.

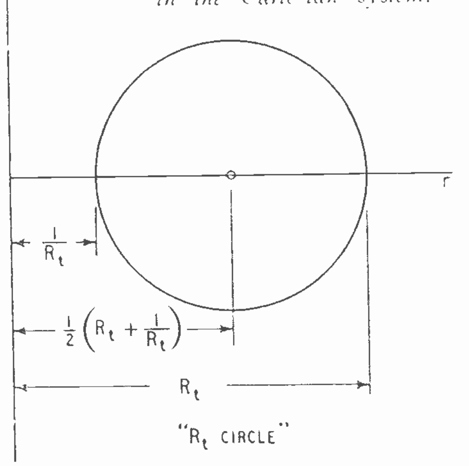


Fig. 2. *The "R_t Circle" in the Cartesian system.*

Cartesian Form

If $\tan^2\theta$ is eliminated between equations (4) and (5) a single relation connecting r, x and R_t is obtained. From (4)

$$\tan^2\theta = \frac{R_t - r}{R_t(R_t r - 1)}$$

and since from (5)

$$x^2 = \frac{(1 - R_t^2)^2 \tan^2\theta}{(1 + R_t^2 \tan^2\theta)^2}$$

it follows that,

$$x^2 = R_t r - 1 - r^2 + \frac{1}{R_t} r$$

i.e.,

$$x^2 + \left[r^2 - r\left(R_t + \frac{1}{R_t}\right)\right] = 1$$

If now a quantity $\left[\frac{1}{2}\left(R_t + \frac{1}{R_t}\right)\right]^2$ is added to both sides of this equation it becomes,

$$x^2 + \left[r - \frac{1}{2}\left(R_t + \frac{1}{R_t}\right)\right]^2 = \left[\frac{1}{2}\left(R_t - \frac{1}{R_t}\right)\right]^2 \quad \ldots \quad \ldots \quad (6)$$

This relation plotted with r and x as Cartesian co-ordinates represents a circle of radius $\frac{1}{2}\left(R_t - \frac{1}{R_t}\right)$ with its centre at $\left[r = \frac{1}{2}\left(R_t + \frac{1}{R_t}\right), x = 0\right]$ as shown in Fig. 2. This circle prescribes all possible values of r and x which can appear in the expression for input impedance of a line terminated in a resistance R_t. It will therefore be seen that the resistive component in this expression must lie between $\frac{1}{R_t}$ and R_t, whilst the reactive component may have a value between $\pm\frac{1}{2}\left(R_t - \frac{1}{R_t}\right)$. A series of circles of this type corresponding to different values of R_t may be constructed and these will be termed "R_t Circles." Each member of this series will have a different centre and all will cut the r axis at the appropriate values of $\frac{1}{R_t}$ and R_t.

Referring back to equations (4) and (5), a similar process can be followed to determine the relationship between r, x and $\tan\theta$ by eliminating R_t. Thus from equation (5),

$$R_t^2 = \frac{\tan\theta - x}{\tan\theta(x\tan\theta + 1)}$$

and if this is substituted in (4) the relations,

$$r^2 = \frac{R_t^2(\tan^2\theta + 1)^2}{(1 + R_t^2\tan^2\theta)^2}$$

$$= x\tan\theta - x^2 - 1 - \frac{x}{\tan\theta}$$

$$\text{or } r^2 + \left[x^2 - x\left(\tan\theta - \frac{1}{\tan\theta}\right)\right] = 1$$

are obtained. If now the quantity $\left[\frac{1}{2}\left(\tan\theta - \frac{1}{\tan\theta}\right)\right]^2$ is added to both sides, this becomes,

$$r^2 + \left[x - \tfrac{1}{2}\left(\tan\theta - \frac{1}{\tan\theta}\right)\right]^2 = \left[\tfrac{1}{2}\left(\tan\theta + \frac{1}{\tan\theta}\right)\right]^2 \quad \ldots \quad (7)$$

Referred to the system of co-ordinates previously specified, this represents a circle of radius $\frac{1}{2}\left(\tan\theta + \frac{1}{\tan\theta}\right)$ with centre at $r = 0,\ x = \frac{1}{2}\left(\tan\theta - \frac{1}{\tan\theta}\right)$ as shown in Fig. 3. A family of such circles—which may be described as "θ Circles"—corresponding

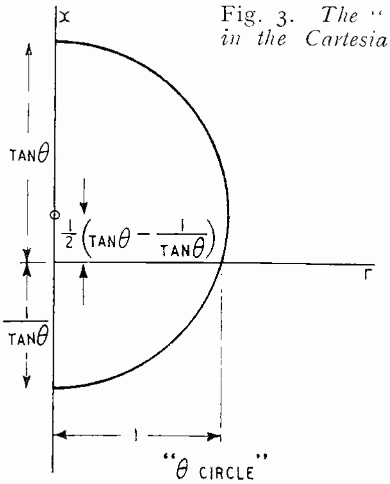


Fig. 3. *The "θ Circle" in the Cartesian system.*

to different values of θ, may now be drawn. Clearly each "θ Circle" will cut the x axis in $\tan\theta$ and $-\frac{1}{\tan\theta}$ and all will intersect the r axis at $r = 1$. Every member of this family of circles prescribes all the possible values of r and x which can appear in the input impedance expression $(r + jx)$ for a transmission line of length $\theta = \frac{2\pi\delta}{\lambda}$ when the terminating resistance is varied from zero to infinity.

If therefore, the two systems of circles are superimposed as in Fig. 4 it is apparent that the co-ordinates r and x of the intersection of any "R_t Circle" with any "θ Circle" must satisfy the two equations (4) and (5). The "R_t Circle" corresponding to, say R_{t1} passes through all values of r and x which may appear in the expression for the input impedance of a transmission line of unspecified length when it is terminated in a load resistance R_{t1}. Similarly, the "θ Circle" for a line of length θ_1 passes through all values of r and x which can feature in the input impedance expression for this length of line regardless of its terminating resistance. Thus any point which lies on both the "R_{t1} Circle" and the "θ_1 Circle" must satisfy both these requirements so that $Z_1 = (r_1 + jx_1)$ is the impedance which appears at the input of a transmission line of length θ_1 having a terminating resistance R_{t1}, where the latter are the values inscribed on the two circles which intersect at the point (r_1, x_1).

It will be observed that each "θ Circle" intersects each "R_t Circle" in two points and since both cannot represent the input impedance of the line, the nature of this ambiguity must now be examined. Referring to Fig. 4, suppose that P is any point (r, x) on a particular "R_t Circle," the diameter of which is $\left(R_t - \frac{1}{R_t}\right)$ and whose centre is at $\left[r = \frac{1}{2}\left(R_t + \frac{1}{R_t}\right),\ x = 0\right]$ and that PQ produced meets the x axis at T. It is at once clear that $ON = r$, $OQ = R_t$ and $OS = \frac{1}{R_t}$.

Now since

$$\frac{ON}{OQ} = \frac{r}{R_t} = \frac{TP}{TQ} = 1 - \frac{PQ}{TQ}$$

$$= 1 - \frac{\dfrac{SQ\cos\psi}{OQ}}{\cos\psi}$$

$$= 1 - \frac{\left(R_t - \dfrac{1}{R_t}\right)\cos^2\psi}{R_t}$$

$$= 1 - \frac{\left(R_t - \dfrac{1}{R_t}\right)}{R_t} \cdot \frac{OQ^2}{(OQ^2 + OT^2)}$$

$$= 1 - \frac{\left(R_t - \dfrac{1}{R_t}\right)}{R_t} \cdot \frac{R_t^2}{(R_t^2 + OT^2)}$$

then $r = \dfrac{R_t(OT^2 + 1)}{R_t^2 + OT^2}$

from which it is obvious that if OT is made equal to $\frac{1}{\tan\theta}$ the relation shown in equation (4) is reproduced. Furthermore since,

$$x = OT\,\frac{NQ}{OQ}$$

$$= OT\left(1 - \frac{R_t}{r}\right)$$

$$= OT\left[\frac{(R_t^2 - 1)\tan^2\theta}{R_t^2\tan^2\theta + 1}\right]$$

the same assumption in respect of OT yields equation (5), providing x is given the negative significance which the diagram indicates. It is also clear that if SP is produced to meet the x axis in T', OT' must be the reciprocal of OT on account of the similarity of the triangles OST' and OQT. If follows that

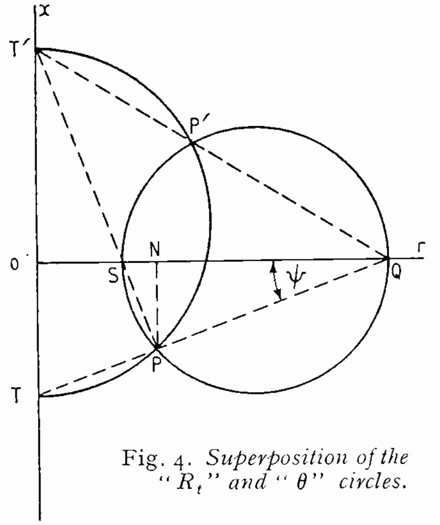


Fig. 4. *Superposition of the "R_t" and "θ" circles.*

since $T\hat{P}T'$ is a right angle, a circle can be drawn having TT' as its diameter and passing through the point P. This is, of course, the "θ Circle" cutting the x axis in $-\dfrac{1}{\tan\theta}$ and $\tan\theta$. Similar reasoning shows that the point P' at which QT' intersects the "R_t Circle" also lies on this "θ Circle" and it may be readily shown that,

$$r = \frac{R_t\,(OT'^2 + 1)}{R_t^2 + OT'^2}$$

and since, $OT' = \tan\theta$

$$r = \frac{R_t(\tan^2\theta + 1)}{R_t^2 + \tan^2\theta}$$

$$\text{or } r = \frac{\dfrac{1}{R_t}(\tan^2\theta + 1)}{\left(\dfrac{1}{R_t}\right)^2\tan^2\theta + 1}$$

The "R_t Circle" therefore has reciprocal properties and yields results for a termination $\dfrac{1}{R_t}$ as well as R_t. Attempts to make the construction serve this dual role are liable to result in confusion and it is preferable to regard points in both the first and fourth quadrants as referring to terminating resistances greater than the surge impedance of the line. Now since a resistance $\dfrac{1}{R_t}$ placed at the end of a line of length θ gives exactly the same input impedance as a termination R_t at the end of a line of length $\left(\theta + \dfrac{\pi}{4}\right)$, arcs of "$\theta$ Circles" in the first quadrant should be labelled with values of θ between 90° and 180° as shown in Fig. 5.

The method of using the Cartesian form of Circle Diagram should now be clear. Suppose that it is desired to find the input impedance of a transmission line of length l and unit surge impedance, terminated in a complex impedance $Z_t = (r_t + jx_t)$ which may be represented in the system of co-ordinates by the point P_t in Fig. 6. This point lies at the intersection of an "R_t Circle" designated by, say, R_{t1} and a "θ Circle" labelled θ_1. Thus Z_t is equivalent to the input impedance of a line of length $\delta = \dfrac{\theta_1}{2\pi}\cdot\lambda$ terminated in a resistance R_{t1}. The addition of a further length of line l corresponds to an increase from θ_1 to $\left(\theta_1 + \dfrac{2\pi l}{\lambda}\right)$ so that it is only necessary to

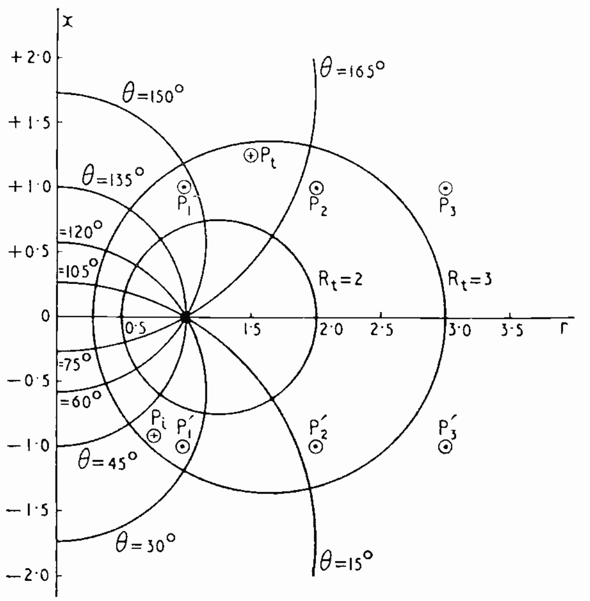


Fig. 5. *General form of the Cartesian Circle diagram.*

traverse the "R_{t1} Circle" in a clockwise direction until the point P_i at which this intersects the "θ Circle" marked with the value of $\left(\theta_1 + \dfrac{2\pi l}{\lambda}\right)$ is located. This intersection P_i defines the values of r_i and x_i which appear in the input expression $Z_i = (r_i + jx_i)$. It will now be appreciated that one complete traverse of any "R_t Circle" corresponds to an increase of $\frac{\lambda}{2}$ in the length of the line.

In order to deal with problems in which the terminating resistance is a fraction of the surge impedance of the line, it is advisable to add one-quarter of a wavelength thereby converting the fraction $\frac{1}{R_t}$ to R_t. Any problem of this nature may now be dealt with as before, and this method of treatment obviates confusion in the nomenclature of the "θ Circles." Comparison of Figs. 7(a) and 7(b) which show the variation in the components of input impedance of lines terminated in resistances $2Z_0$ and $\frac{Z_0}{2}$ respectively for different lengths of line, with the Cartesian Circle Diagram shown in Fig. 5 clearly illustrate the working of this method.

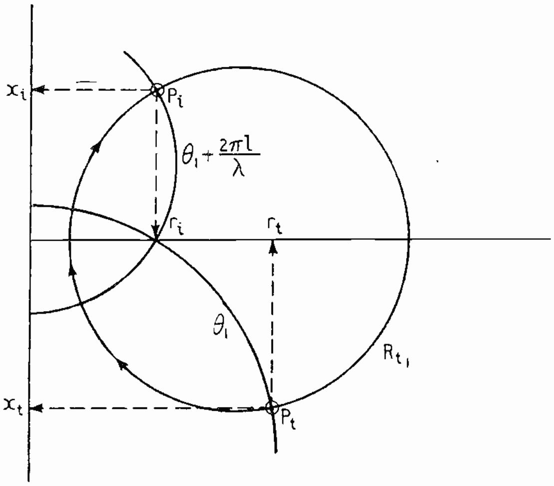


Fig. 6. *An example of the use of the Cartesian diagram.*

Polar Form

The equations,

$$r = \frac{R_t(1 + \tan^2 \theta)}{R_t^2 \tan^2 \theta + 1}$$

and

$$x = \frac{(1 - R_t^2) \tan \theta}{R_t^2 \tan^2 \theta + 1}$$

may be written in the form,

$$r = \frac{2R_t}{(1 - R_t^2) \cos \phi + (1 + R_t^2)} \quad \cdot\cdot \quad (8)$$

and

$$x = \frac{(1 - R_t^2) \sin \phi}{(1 - R_t^2) \cos \phi - (1 + R_t^2)} \quad \cdot\cdot \quad (9)$$

where, $\phi = 2\theta$. Equation (8) may now be rewritten,

$$r(1 - R_t^2) \cos \phi + r(1 + R_t)^2 - 2rR_t = 2R_t$$

or

$$\frac{(1 - R_t)}{(1 + R_t)} \cos \phi = \frac{2R_t}{(1 + R_t)^2}\left(\frac{r + 1}{r}\right) - 1$$

$$= \tfrac{1}{2}\left[1 - \left(\frac{1 - R_t}{1 + R_t}\right)^2\right]\frac{r + 1}{r} - 1$$

It is now necessary to seek some method of representing the above relation in graphical form. Since interest in θ is concerned with a range of half a wavelength, graphical representation involving ϕ must cover a range of 0 to 2π for the latter variable.

If the co-ordinates (u, v) define a point in relation to a pair of axes at right angles and if this point satisfies the relations,

$$u = \frac{(1 - R_t)}{(1 + R_t)} \cos \phi \quad \cdot\cdot \quad \cdot\cdot \quad (10)$$

and

$$v = \frac{(1 - R_t)}{(1 + R_t)} \sin \phi \quad \cdot\cdot \quad \cdot\cdot \quad (11)$$

it will trace out a circle with centre at the origin and with radius $(u^2 + v^2)^{\frac{1}{2}} = \pm\left(\frac{1 - R_t}{1 + R_t}\right)$. Such a circle may again be termed an "R_t Circle" since its radius is a

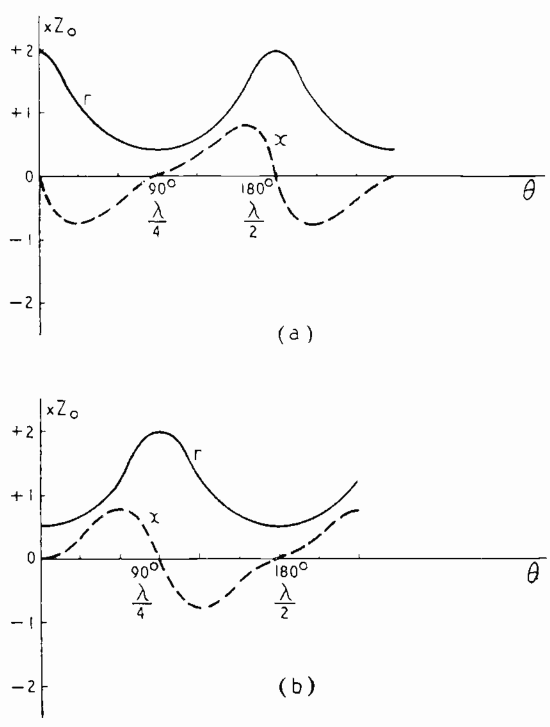


Fig. 7. *The components of input impedance of a line terminated by a resistance $2Z_0$ is shown at* (a) *and by a resistance $Z_0/2$ at* (b).

function of R_t. If the above substitutions are made in equation (8) it becomes,

$$u = \frac{1}{2}\left[1 - (u^2 + v^2)\right]\frac{r + 1}{r} - 1$$

or

$$v^2 + u^2 + 2u\frac{r}{r + 1} = 1 - \frac{2r}{r + 1}$$

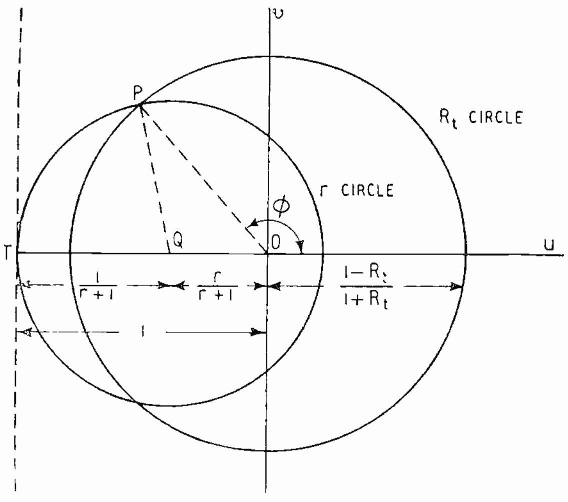


Fig. 8. *The "R_t" and "r" Circles in the polar coordinate system.*

If now a quantity $\left(\frac{r}{r + 1}\right)^2$ is added to both sides of this relation it becomes,

$$v^2 + \left(u + \frac{r}{r + 1}\right)^2 = \left(\frac{1}{r + 1}\right)^2$$

which represents a circle of radius $\frac{1}{r + 1}$ having its centre at a point $\left(0 - \frac{r}{r + 1}\right)$ on the u axis. Such a circle may be termed an "r Circle." Fig. 8 shows the construction of typical R_t and r circles in relation to the axes u and v. Every point P in the plane defined by these axes can be prescribed in two separate ways. Firstly it lies on the circumference of a particular "R_t Circle" and this identifies it as representative of a resistance R_t placed across the ends of a line of length $\theta = \frac{\phi}{2}$, the angle ϕ being, of course that which the radius drawn through P makes with the u axis. Secondly, an "r Circle" can be drawn which will pass through P, and the particular value of r which must be used to construct such a circle will be that which appears in the input impedance expression for such a line. For practical purposes it is desirable to draw a number of circles corresponding to a range of values of R_t and r, so that the location of any particular point in the plane can be estimated in relation to them with accuracy. As an aid to construction it should be noted that the distance OT is equal to unity.

The second equation (9) now calls for representation in the diagram. This may be written,

$$x(1 - R_t^2)\cos\phi + x(1 + R_t)^2 - 2xR_t = (1 - R_{t2})\sin\phi$$

i.e.,

$$\frac{(1 - R_t)}{(1 + R_t)}\cos\theta + 1 - \frac{1}{2}\left[1 - \left(\frac{1 - R_t}{1 + R_t}\right)^2\right] = \frac{1}{x}\frac{(1 - R_t)}{(1 + R_t)}\sin\theta$$

Making the transformation for u and v as in equations (10) and (11) above, this becomes,

$$u + 1 - \frac{1}{2}\left[1 - (u^2 + v^2)\right] = \frac{1}{x}v$$

or,

$$u^2 + 2u + 1 + v^2 - \frac{2v}{x} = 0.$$

Adding $\frac{1}{x^2}$ to each side, the relation,

$$(u + 1)^2 + \left(v - \frac{1}{x}\right)^2 = \left(\frac{1}{x}\right)^2$$

is obtained. This represents a circle—which may be described as an "x Circle"—having

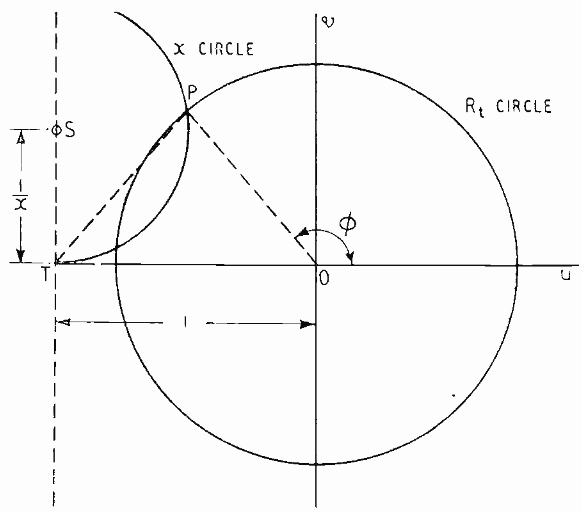


Fig. 9. *"R_t" and "x" Circles.*

a radius $\frac{1}{x}$ and centred at a point $\left(u = -1, v = \frac{1}{x}\right)$ as shown in Fig. 9. The reactance x may, of course, have either a positive or negative significance so that two sets of circles should be constructed. Each of these will clearly pass through the point ($u = -1$, $v = 0$). Every point P in the u, v plane may now be further defined in relation to the "x Circle" and the "r Circle" which pass through it, so that any impedance $Z = (r + jx)$ may be represented by the intersection of a pair of these circles which bear the values indicated in the impedance expression. The values of R_t and ϕ which satisfy equations (8) and (9) may now be found from the "R_t Circle" which passes through this intersection and the angle which the radius through the latter makes with the u axis.

Having developed the above construction it is a simple matter to show that this satisfies the fundamental relations (8) and (9). Referring once more to Fig. 8, in the triangle QPO,

$$QP^2 = PO^2 + QO^2 - 2\,PO.QO \cos P\hat{O}Q$$

so that,

$$\left(\frac{1}{r+1}\right)^2 = \left(\frac{1-R_t}{1+R_t}\right)^2 + \left(\frac{r}{r+1}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi\ ;$$

$$\frac{1-r}{r+1} = \left(\frac{1-R_t}{1+R_t}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi$$

Thus,

$$1 - \frac{1-r}{r+1} = \frac{2r}{r+1} = 1 - \left(\frac{1-R_t}{1+R_t}\right)^2 - 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi$$

$$\frac{2r}{r+1}\left[1 - \left(\frac{1-R_t}{1+R_t}\right)\cos\phi\right] = \frac{4R_t}{(1+R_t)^2}\ ; \qquad \frac{r}{r+1} = \frac{2R_t}{(1+R_t)^2 + (1-R_t^2)\cos\phi}$$

$$1 + \frac{1}{r} = \frac{(1+R_t)^2 - (1-R_t^2)\cos\phi}{2\,R_t}$$

Whence,

$$r = \frac{2R_t}{(1-R_t^2)\cos\phi + (1-R_t^2)}$$

Fig. 9 leads to the following relation,

$$TP^2 = (TO - OP\cos T\hat{O}P)^2 + (OP\sin T\hat{O}P - TP)^2$$

i.e.,

$$\left(\frac{1}{x}\right)^2 = \left[1 + \left(\frac{1-R_t}{1+R_t}\right)\cos\phi\right]^2 + \left[\left(\frac{1-R_t}{1+R_t}\right) - \frac{1}{x}\right]^2$$

Thus,

$$\frac{2}{x}\left(\frac{1-R_t}{1+R_t}\right)\sin\phi = 1 + \left(\frac{1-R_t}{1+R_t}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\cos\phi$$

$$= 2\frac{(1+R_t^2)}{(1+R_t)^2} + 2\left(\frac{1-R_t}{1+R_t}\right)\cos\phi \qquad \frac{1}{x} = \frac{(1+R_t^2) + (1-R_t^2)\cos\phi}{(1+R_t)^2\dfrac{(1-R_t)}{(1+R_t)}\sin\phi}$$

Whence,

$$x = \frac{(1-R_t^2)\sin\phi}{(1+R_t^2) + (1-R_t^2)\cos\phi}$$

The practical form of polar Circle Diagram consists of a mesh of r, x, and R_t Circles as shown in Fig. 10, although it is not unusual to replace the latter system by a suitably calibrated cursor centred at O. As in the previous case the diagram is concerned with the normalized values of r, x, and R_t. Suppose it is desired to determine the input impedance Z_i of a length of line $l = \frac{\lambda}{2} \cdot \frac{\phi_l}{2\pi}$ terminated in an impedance $Z_t = (r_t + jx_t)$. The intersection of the "r Circle" corresponding to the value r_t with the "x Circle" corresponding to x_t locates the point P_t which represents this impedance. This lies on an "R_t Circle" which gives the value of the resistance which when used as the termination of a line of length $\delta = \frac{\lambda}{2}\frac{\phi_1}{2\pi}$ will give an input impedance equal to Z_t — ϕ_1 being, of course, the angle which OP_t makes with the u axis. If now a length of line l is added, this is equivalent to increasing the value of ϕ by an amount $\phi_l = \frac{2l}{\lambda} \cdot 2\pi$. Thus the required input impedance is represented by the point P_i located by traversing the "R_t Circle" through a further angle ϕ_l in an anticlockwise direction. In the diagram resulting from the method described, the labelling of the "R_t Circles" with terminating resistance values is unnecessary.

For the purpose of comparing the two systems which have now been described, the function of R_t. If the above substitutions are made in equation (8) it becomes,

$$u = \tfrac{1}{2}\left[1 - (u^2 + v^2)\right]\frac{r + 1}{r} - 1$$

or

$$v^2 + u^2 + 2u\frac{r}{r + 1} = 1 - \frac{2r}{r + 1}$$

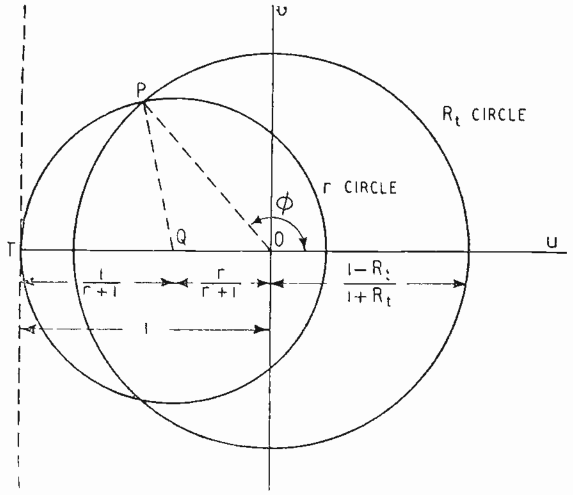


Fig. 8. *The "R_t" and "r" Circles in the polar coordinate system.*

If now a quantity $\left(\frac{r}{r + 1}\right)^2$ is added to both sides of this relation it becomes,

$$v^2 + \left(u + \frac{r}{r + 1}\right)^2 = \left(\frac{1}{r + 1}\right)^2$$

which represents a circle of radius $\frac{1}{r + 1}$ having its centre at a point $\left(0 - \frac{r}{r + 1}\right)$ on the u axis. Such a circle may be termed an "r Circle." Fig. 8 shows the construction of typical R_t and r circles in relation to the axes u and v. Every point P in the plane defined by these axes can be prescribed in two separate ways. Firstly it lies on the circumference of a particular "R_t Circle" and this identifies it as representative of a resistance R_t placed across the ends of a line of length $\theta = \frac{\phi}{2}$, the angle ϕ being, of course that which the radius drawn through P makes with the u axis. Secondly, an "r Circle" can be drawn which will pass through P, and the particular value of r which must be used to construct such a circle will be that which appears in the input impedance expression for such a line. For practical purposes it is desirable to draw a number of circles corresponding to a range of values of R_t and r, so that the location of any particular point in the plane can be estimated in relation to them with accuracy. As an aid to construction it should be noted that the distance OT is equal to unity.

The second equation (9) now calls for representation in the diagram. This may be written,

$$x(1 - R_t^2)\cos\phi + x(1 + R_t)^2 - 2xR_t = (1 - R_{t2})\sin\phi$$

i.e.,

$$\frac{(1 - R_t)}{(1 + R_t)}\cos\theta + 1 - \tfrac{1}{2}\left[1 - \left(\frac{1 - R_t}{1 + R_t}\right)^2\right] = \frac{1}{x}\frac{(1 - R_t)}{(1 + R_t)}\sin\theta$$

Making the transformation for u and v as in equations (10) and (11) above, this becomes,

$$u + 1 - \tfrac{1}{2}\left[1 - (u^2 + v^2)\right] = \frac{1}{x}v$$

or,

$$u^2 + 2u + 1 + v^2 - \frac{2v}{x} = 0.$$

Adding $\frac{1}{x^2}$ to each side, the relation,

$$(u + 1)^2 + \left(v - \frac{1}{x}\right)^2 = \left(\frac{1}{x}\right)^2$$

is obtained. This represents a circle—which may be described as an "x Circle"—having

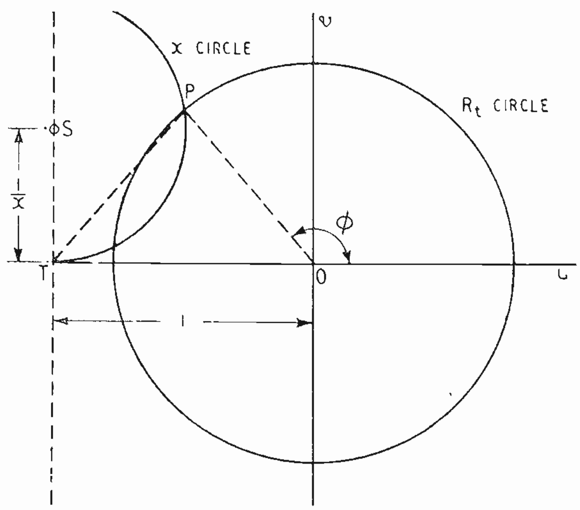


Fig. 9. *"R_t" and "x" Circles.*

a radius $\frac{1}{x}$ and centred at a point $\left(u = -1, v = \frac{1}{x}\right)$ as shown in Fig. 9. The reactance x may, of course, have either a positive or negative significance so that two sets of circles should be constructed. Each of these will clearly pass through the point ($u = -1$, $v = 0$). Every point P in the u, v plane may now be further defined in relation to the "x Circle" and the "r Circle" which pass through it, so that any impedance $Z = (r + jx)$ may be represented by the intersection of a pair of these circles which bear the values indicated in the impedance expression. The values of R_t and ϕ which satisfy equations (8) and (9) may now be found from the "R_t Circle" which passes through this intersection and the angle which the radius through the latter makes with the u axis.

Having developed the above construction it is a simple matter to show that this satisfies the fundamental relations (8) and (9). Referring once more to Fig. 8, in the triangle QPO,

$$QP^2 = PO^2 + QO^2 - 2\,PO.QO \cos P\hat{O}Q$$

so that,

$$\left(\frac{1}{r+1}\right)^2 = \left(\frac{1-R_t}{1+R_t}\right)^2 + \left(\frac{r}{r+1}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi\ ; \qquad \frac{1-r}{r+1} = \left(\frac{1-R_t}{1+R_t}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi$$

Thus,

$$1 - \frac{1-r}{r+1} = \frac{2r}{r+1} = 1 - \left(\frac{1-R_t}{1+R_t}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\left(\frac{r}{r+1}\right)\cos\phi$$

$$\frac{2r}{r+1}\left[1 - \left(\frac{1-R_t}{1+R_t}\right)\cos\phi\right] = \frac{4R_t}{(1+R_t)^2}\ ; \qquad \frac{r}{r+1} = \frac{2R_t}{(1+R_t)^2 + (1-R_t^2)\cos\phi}$$

$$1 + \frac{1}{r} = \frac{(1+R_t)^2 + (1-R_t^2)\cos\phi}{2\,R_t}$$

hence,

$$r = \frac{2R_t}{(1-R_t^2)\cos\phi + (1+R_t^2)}$$

Fig. 9 leads to the following relation,

$$TP^2 = (TO - OP\cos T\hat{O}P)^2 + (OP\sin T\hat{O}P - TP)^2$$

i.e.,

$$\left(\frac{1}{x}\right)^2 = \left[1 + \left(\frac{1-R_t}{1+R_t}\right)\cos\phi\right]^2 + \left[\left(\frac{1-R_t}{1+R_t}\right) - \frac{1}{x}\right]^2$$

Thus,

$$\frac{2}{x}\left(\frac{1-R_t}{1+R_t}\right)\sin\phi = 1 + \left(\frac{1-R_t}{1+R_t}\right)^2 + 2\left(\frac{1-R_t}{1+R_t}\right)\cos\phi$$

$$= 2\frac{(1+R_t^2)}{(1+R_t)^2} + 2\left(\frac{1-R_t}{1+R_t}\right)\cos\phi \qquad \frac{1}{x} = \frac{(1+R_t^2) + (1-R_t^2)\cos\phi}{(1+R_t)^2\dfrac{(1-R_t)}{(1+R_t)}\sin\phi}$$

hence,

$$x = \frac{(1-R_t^2)\sin\phi}{(1+R_t^2) + (1-R_t^2)\cos\phi}$$

The practical form of polar Circle Diagram consists of a mesh of r, x, and R_t Circles as shown in Fig. 10, although it is not unusual to replace the latter system by a suitably calibrated cursor centred at O. As in the previous case the diagram is concerned with the normalized values of r, x, and R_t. Suppose it is desired to determine the input impedance Z_i of a length of line $l = \frac{\lambda}{2}\cdot\frac{\phi_l}{2\pi}$ terminated in an impedance $Z_t = (r_t + jx_t)$. The intersection of the "r Circle" corresponding to the value r_t with the "x Circle" corresponding to x_t locates the point P_t which represents this impedance. This lies on an "R_t Circle" which gives the value of the resistance which when used as the termination of a line of length $\delta = \frac{\lambda}{2}\,\frac{\phi_1}{2\pi}$ will give an input impedance equal to Z_t — ϕ_1 being, of course, the angle which OP_t makes with the u axis. If now a length of line l is added, this is equivalent to increasing the value of ϕ by an amount $\phi_l = \frac{2l}{\lambda}\cdot 2\pi$. Thus the required input impedance is represented by the point P_i located by traversing the "R_t Circle" through a further angle ϕ_l in an anticlockwise direction. In the diagram resulting from the method described, the labelling of the "R_t Circles" with terminating resistance values is unnecessary.

For the purpose of comparing the two systems which have now been described, the ringed points in Fig. 5 are also represented in Fig. 10. It is scarcely necessary to discuss the relative merits of the Cartesian and polar forms of Circle Diagram since the user will quickly become acquainted with these after a

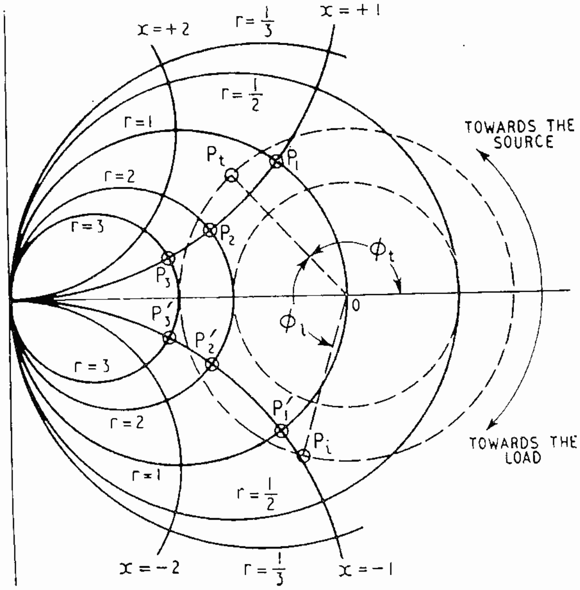


Fig. 10. *The general form of the polar Circle diagram.*

little experience. One aspect of the polar construction is, however, worthy of mention—its accuracy need not be limited by difficulties of interpolation. Furthermore it offers a method of construction suitable for solving individual problems with any desired degree of accuracy. Consider the following example as an illustration. Suppose it is desired to find the input impedance Z'_i of an 80-Ω transmission line of length $l = \frac{\lambda}{6}$ terminated in an impedance $Z'_t = [120 + 100j]$ complex ohms. In this case,

$$r_t = \frac{120}{80} = 1.5, \; x_t = \frac{100}{80} = 1.25$$

$$\theta_l = 60° \text{ or } \phi_l = 120°$$

and these values may be used to locate P_t as the point representing Z_t in both Fig. 5 and Fig. 10. Adding the specified length of line, P_i is seen to be representative of the required input impedance Z_i. The result obtained is, of course an approximation since the interpretation of the diagram depends upon interpolation.

The problem is, however, capable of more accurate solution by the following direct graphical method based on the polar construction. Construct a pair of axes TU and TV at right angles (Fig. 11) and mark a point Q_t a distance $\frac{1}{r_t + 1} = 0.4$ units along the former. Using this as centre, construct the appropriate "r Circle." Similarly, using as centre a point S_t at a distance $\frac{1}{x_T} = 0.8$ units along the vertical axis the "x Circle" may be constructed. With centre O at unit distance along TU, the R_t circle passing through the intersection P_t of the two other circles may be drawn. Making $P_t\hat{O}P_i$ equal to $\phi_l = 120°$, the point P_i on the "R_t Circle" now represents the input impedance Z_i. If Q_sS_s, a line bisecting TP_i at right angles meets the horizontal axis in Q_s and the vertical axis in S_s, then it is evident that TQ_s is equal to $\frac{1}{r_i + 1}$ and TS_s represents $\frac{1}{x_i}$. The normalized values of r_i and x_i are therefore 0.75 and − 0.94 respectively. The required input impedance is accordingly $Z'_i = (60 - 75j)$ complex ohms.

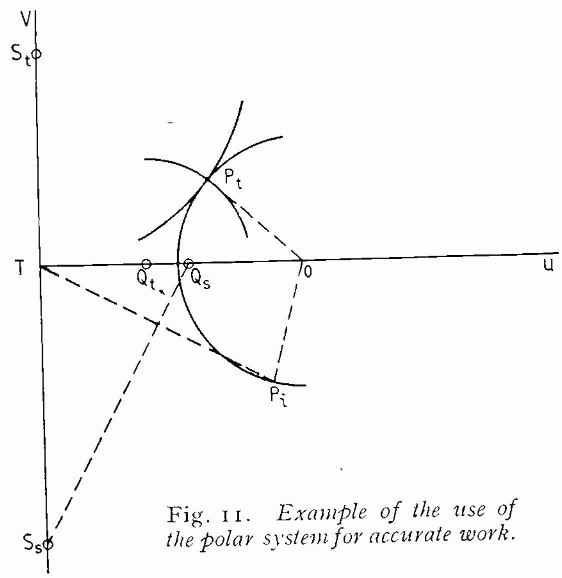


Fig. 11. *Example of the use of the polar system for accurate work.*

A similar process based on the construction of the Cartesian Circle Diagram cannot be developed, since in this case the "R_t Circles" are not concentric.

MICROWAVE COMMUNICATION LINK*

By H. R. L. Lamont,† M.A., Ph.D., A.M.I.E.E., R. G. Robertshaw,† and T. G. Hammerton,‡ B.Sc., Ph.D., A.Inst.P., A.M.I.E.E.

SUMMARY.—A description is given of a single-channel duplex radio-telephone on a wavelength of 3.2 cm. A single parabolic mirror is used as aerial for both transmitted and received signals which are separated in a waveguide system. The transmitter is a klystron oscillator of about 75 mW output. The superheterodyne receiver is fitted with automatic-frequency control and automatic-gain control. Operation over optical paths up to 70 miles long is described. A signal-to-noise ratio of about 55 db is obtained over a 57-mile path.

1. Introduction

THE intensive research and development programmes carried out during the war to provide radiolocation equipment operating on centimetre wavelengths have opened up the possibility of using these wavebands to extend existing communication channels.

Magnetron and klystron valve oscillators have been designed for use in transmitters and superheterodyne receivers, and they are robust, stable and easily replaceable. The theory and practice of circuits, transmission lines, and aerials for centimetre waves are well established.

Much theoretical and experimental work has been carried out on the propagation of centimetre waves, some of which has been described[1,2]. As is to be expected, the reflection, diffraction and absorption effects of obstacles are large at these wavelengths, so that aerials must be elevated above their surroundings, and the path from transmitter to receiver should be an optical one. This does not mean that signals cannot be received over non-optical paths; indeed, under suitable meteorological conditions signals can be received over paths which are several times greater than optical. For a signal reasonably free from fluctuation, however, the optical limit should not be exceeded. For aerials placed 10 metres above the earth's surface the optical distance is 26 km and for aerials at 100 metres the distance is 82 km. It will be shown that with aerials of a reasonable size such distances can be covered with a transmitted power of less than a watt.

A recent paper[3] describes transmitting and receiving equipment, developed in 1940 as part of a programme of investigation on centimetre-wave propagation carried out for the Admiralty. In addition to its normal use for absolute measurements this equipment could also be used as a single-way radio-telephone. The results obtained showed the feasibility of such a system, and from the experience gained a duplex radio-telephone operating on a wavelength of 3.2 cm was built. This will now be described in some detail.

2. Description of Equipment

The terminal station equipment consists of a number of rack-mounted units housed in a cabinet, and an aerial system on which is mounted the r.f. duplex circuit. The duplex circuit also carries the transmitting valve, and the mixer and first i.f. stage of the receiver. The cabinet contains the following main units: (a) transmitter power supply and modulator; (b) receiver local-oscillator unit, with automatic-frequency control circuit; (c) i.f. amplifier, second detector, audio stages, and a.f.c. discriminator; (d) and (e) telephone, signalling and monitoring circuits. Front and back views of the equipment are shown in the photographs, and the layout of the panels in Fig. 1. The telephone desk set is separate from the main equipment.

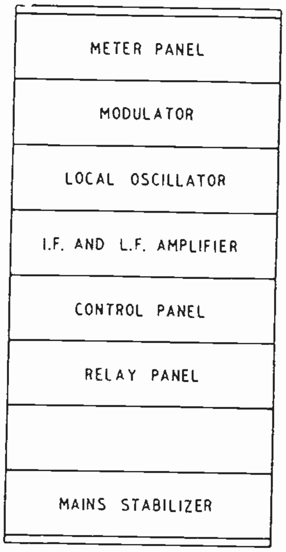


Fig. 1. *Panel layout.*

---

* MS accepted by the Editor, October, 1946.

† Research Laboratories of The General Electric Co., Ltd., Wembley, England.

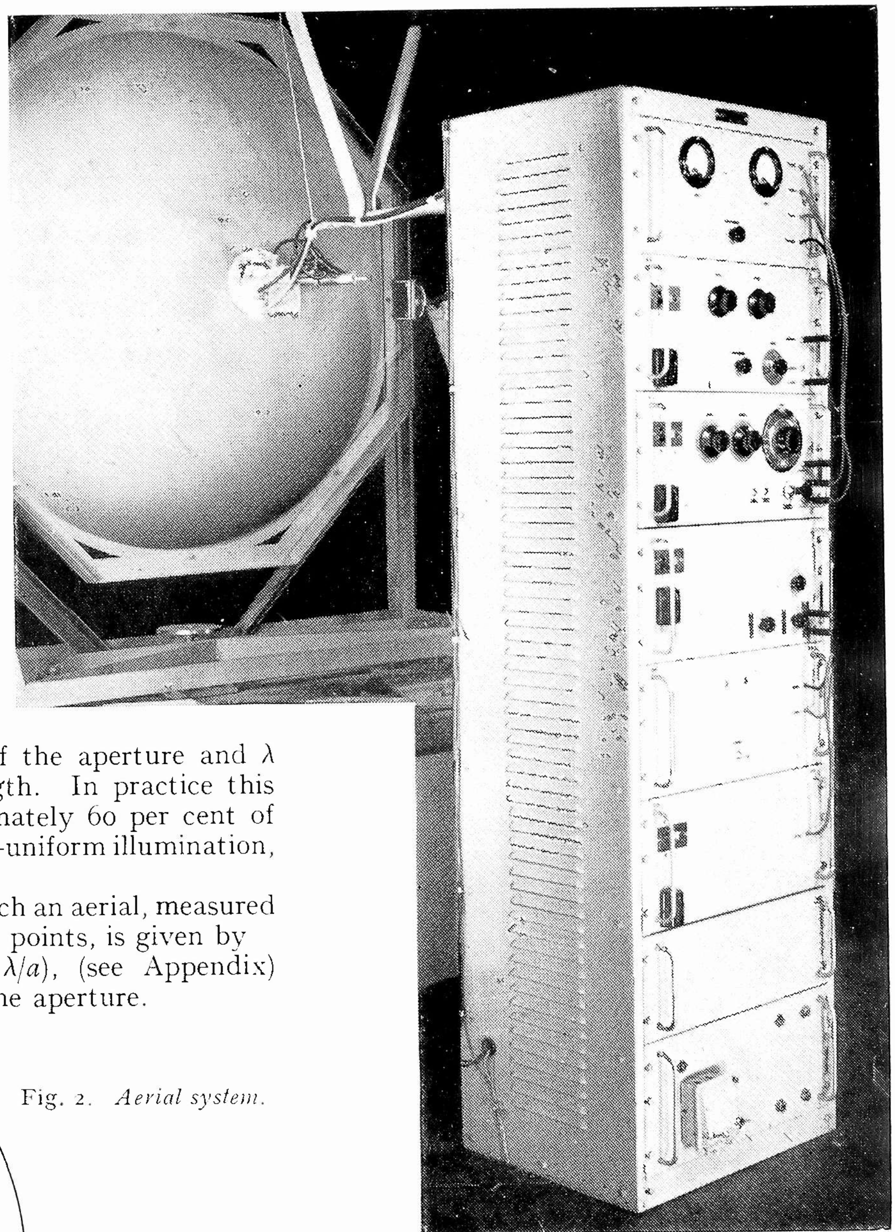
‡ The Plessey Co., Ilford, formerly The General Electric Co., Ltd., Bradford.

2.1. *Aerial System*

In a point-to-point radio link a high-gain aerial may be used, with a beam which is narrow in both azimuth and elevation. A paraboloid radiator fed from a dipole or waveguide is generally the most convenient form. The power gain of a circular paraboloid with reference to a Hertzian dipole is given by

$$G = \frac{8\pi}{3} \cdot \frac{A}{\lambda^2},$$

(see Appendix)



Front view of cabinet, and rear of aerial.

where A is the area of the aperture and λ the operating wavelength. In practice this is reduced to approximately 60 per cent of its value because of non-uniform illumination, giving $G' = 5A/\lambda^2$.

The beam width of such an aerial, measured between the half-power points, is given by

$$2\theta = 2 \sin^{-1}(0.26\ \lambda/a), \quad \text{(see Appendix)}$$

a being the radius of the aperture.

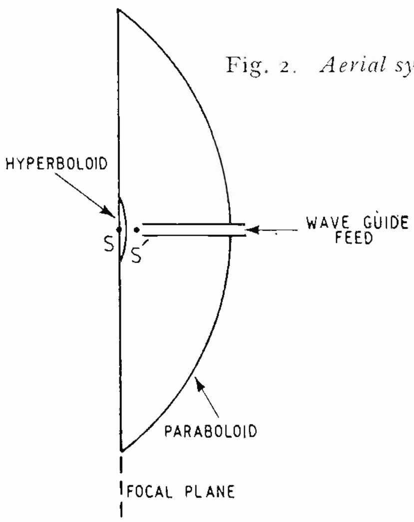
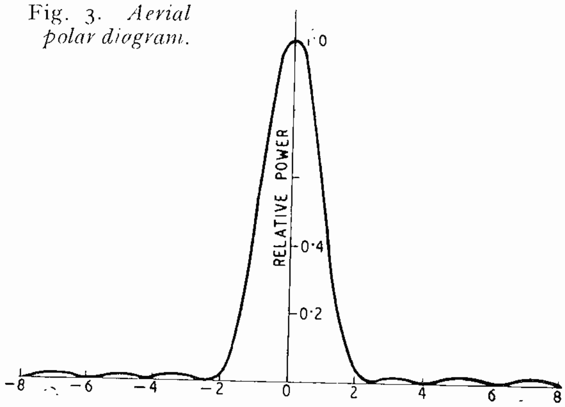


Fig. 2. *Aerial system.*

For long-distance working a paraboloid of aperture 4 ft in diameter has been used. From the above formulae this gives a gain of 5,700 (37.5 db) and a beam width of 1.6° for $\lambda = 3.2$ cm.

Fig. 2 shows the exciting system, consisting of a waveguide which projects through the mirror, and a reflecting plate in the form of a hyperboloid. From the standpoint of geometrical optics a plane wave incident on the mirror would converge at the focus S, which is in the plane of the aperture. If, however, the hyperboloid is placed with one of its foci also at S then the rays will be reflected from it and converge to a point image at S', the other focus of the hyperboloid. The practical problem is not nearly so simple, since it is a diffraction one involving dimensions comparable with the wavelength, and measurements must be made of the shape of the wavefronts for various sizes of hyperboloid and distances from the end of the waveguide. A 6-in diameter hyperboloid of eccentricity[3] was found to give optimum results. A polar diagram of the complete system is given in Fig. 3. Its shape is the same whether the aerial is transmitting or receiving. In each case the wave in the waveguide is an H_{11} type.

Fig. 3. *Aerial polar diagram.*



In order to avoid the necessity of having different aerials for transmitting and receiving, a single mirror is used and the polarizations of the transmitted and received signals are arranged to be mutually perpendicular. A circular waveguide—which will transmit all polarizations—is therefore used to feed the mirror. Behind the mirror this waveguide separates into two branches, one carrying the received signal, whose plane of polarization (electric vector) is parallel to the plane of the branch, and the other the transmitted signal, with polarization perpendicular to it.

A diaphragm of the shape shown in Fig. 4, placed in a waveguide, can transmit an H_{11} wave polarized with its diametral electric vector perpendicular to the long dimension of the slot. There is little reflection if the dimensions of the slot are correctly chosen. This "polarization filter" will reflect waves polarized parallel to the slot. Such a filter is placed in each limb of the branch as shown in section in

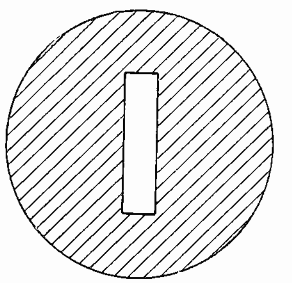
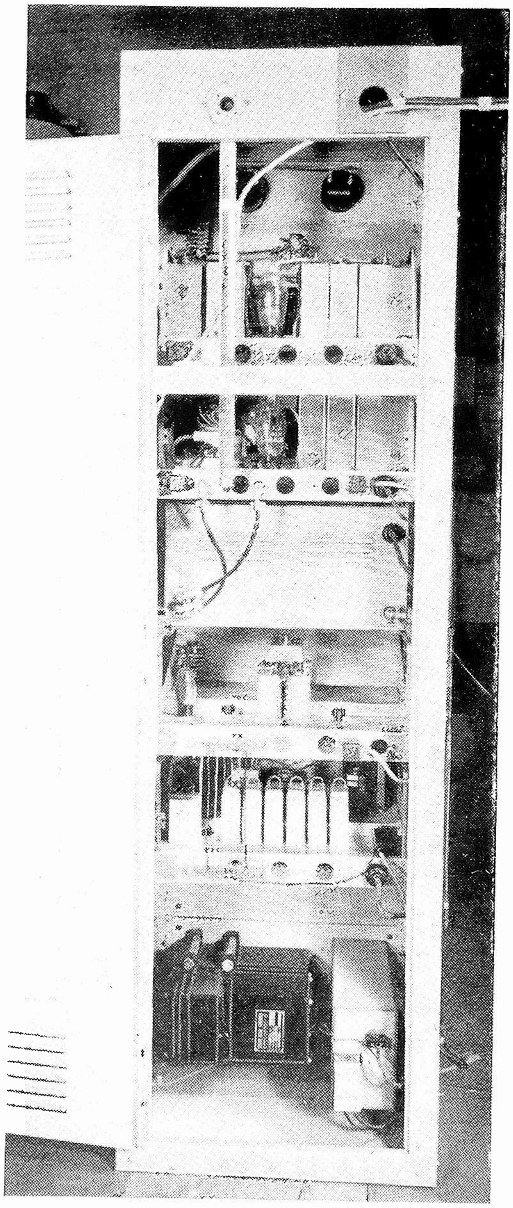


Fig. 4. *Polarization filter.*



Rear view of cabinet (door open).

Fig. 5. For a wave polarized in the plane of the figure the voltage between the guide walls is divided at the branch, while the conduction currents are unaltered, so that the branch appears as a series junction. Thus, to get free transmission into the limb R the reflecting element in the limb T must present zero series impedance at the branch, and so must be situated at a distance from the equivalent plane of the branch equal to $\lambda_g/2$ (or a number of half-wavelengths), where λ_g is the wavelength in the guide. For a wave

polarized perpendicularly to the plane of Fig. 5, the branch appears as a parallel junction and the reflecting element must be placed at $\lambda_g/4$ distance (or an odd number of quarter-wavelengths) from the equivalent plane in order to provide a high parallel

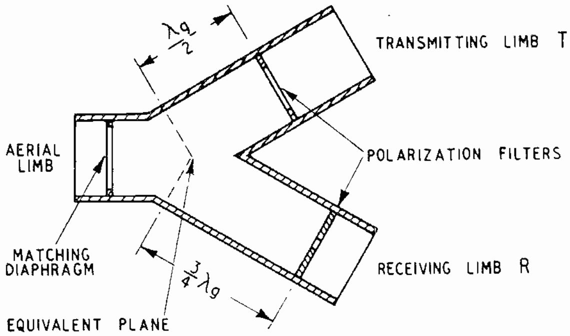


Fig. 5. *Section of* Y-*branch.*

impedance at the entrance to the unwanted limb.

This is an idealized explanation of the operation of the branch, and the exact positions of the diaphragms must be found by experiment. Because of distortion of the wave at the discontinuities in the tube perfect transmission is not obtained, and as a result standing waves are set up. These may be largely removed by a suitable reactance in the form of a diaphragm placed at the junction. With a waveguide of $\frac{7}{8}$in diameter and a branch angle of 60°, the standing-wave ratios obtained were 1.6 in the series junction and 1.3 in the parallel junction. The loss of power due to reflections of this order is only about 5 per cent and 2 per cent respectively. Fig. 6, (a) and (b), shows the arrangement of the components mounted on the branch.

2.2. *Transmitter*

It is not usually practicable to use amplitude modulation with centimetre-wave oscillators because of the associated frequency modulation produced. A method of overcoming this difficulty is fully to modulate the carrier with a rectangular wave of a constant supersonic frequency, whose pulses are modulated in width by the audio frequency. The transmitter is then oscillating at constant amplitude during the "on" period of the rectangular wave and not oscillating during the "off" period. With this method the mean carrier power is modulated at audio frequency, and the signal can be detected on a receiver designed for the reception of normal amplitude-modulated signals provided it has sufficient bandwidth. This is the simplest of several possible methods of pulse modulation.[4]

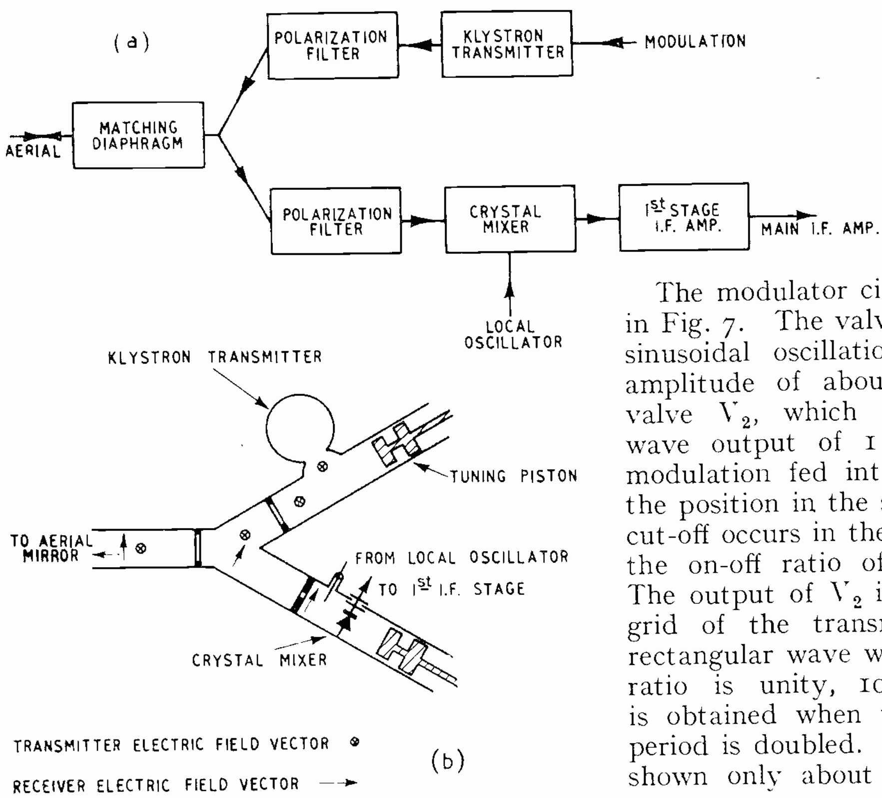


Fig. 6 (left) (a) *Duplex branch schematic.* (b) *Section of duplex branch.*

The modulator circuit is shown in outline in Fig. 7. The valve V_1 generates a 17-kc/s sinusoidal oscillation. This is fed at an amplitude of about 50 V into a limiting valve V_2, which produces a rectangular wave output of 1 : 1 on-off ratio. Audio modulation fed into the grid of V_2 alters the position in the sine-wave cycle at which cut-off occurs in the valve, and hence varies the on-off ratio of the rectangular wave. The output of V_2 is applied directly to the grid of the transmitting valve. With a rectangular wave whose unmodulated on-off ratio is unity, 100 per cent modulation is obtained when the value of the "on" period is doubled. With the simple system shown only about 75 per cent modulation depth can be reached before noticeable speech distortion occurs. This is due to the fact that modulation is done on a sinusoidal oscillation. If the circuit of V_1 is replaced by a saw-tooth oscillator followed by more perfect squaring stages, linear modulation up to 100 per cent may be obtained.

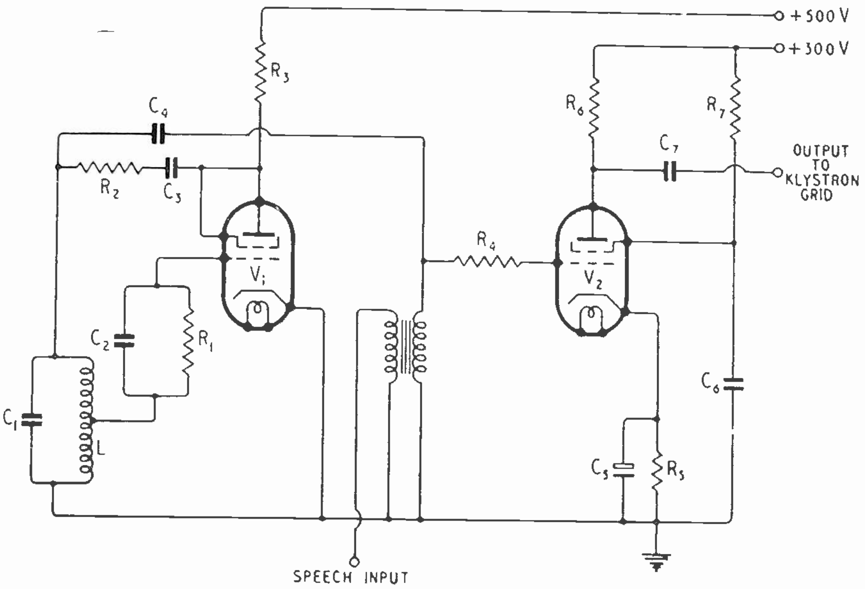


Fig. 7. *Modulator circuit:* $V_{1,2}$ 6V6; R_1 100kΩ, R_2 47kΩ, R_3 33kΩ, R_4 100kΩ, R_5 470Ω, R_6 3kΩ, R_7 15kΩ; C_1 0.0005 μF, $C_{2,3}$ 0.1μF, C_4 0.0005μF, C_5 25μF, C_6 1μF, C_7 2μF; L 150 mH.

The transmitting valve is a reflex klystron, a CV129 modified to have a waveguide output, which covers a frequency range of about 4 per cent around 9,400 Mc/s (3.2 cm). Tuning is done by mechanical deformation of the resonator cavity. The valve is mounted on the transmitting limb of the aerial system, the resonator being bolted directly to the waveguide as shown in Fig. 6(b). The power is fed into the waveguide through a tapered slot, and matching adjustment is made by the adjustable piston shown in the figure. The mean power output is about 75 milliwatts.

The power supply for the transmitter, which is combined in one unit with the modulator, provides a resonator-cathode voltage of 1,600 V, and a variable supply (300-500 V negative to cathode) for the reflector electrode. The potential of the latter must be adjusted to the appropriate value to produce oscillation. The controls are two potential dividers, one a bias control, the other the reflector voltage control. There is also a gain control for the speech amplifier, and a switch by which the 17-kc/s square-wave modulation can be altered to kc/s, for use as a test signal.

2.3. Receiver

The superheterodyne receiver consists of three units: the crystal mixer and first stage i.f. amplifier; the local oscillator and power supply; the i.f. amplifier and l.f. stages.

The first unit is mounted on the receiving branch of the aerial system, Fig. 6 (b). The crystal mixer valve (CV112) is placed across the waveguide and tuned by a filter piston situated behind it. The crystal impedance at this frequency is such that in a $\frac{7}{8}$-in guide a single tuning reactance is sufficient to ensure an adequate match. The live end of the crystal is connected through an r.f. filter to the input circuit of an i.f. amplifying stage. The output of this amplifier is transformer-coupled to a coaxial cable leading to the main i.f. amplifier.

The main i.f. amplifier has four stages with an overall bandwidth of 3 Mc/s centred on 13.5 Mc/s and is followed by the second detector and two l.f. stages. With the type of modulation used at the transmitter both the speech signals and the 17-kc/s square wave are present in the output after detection. The two are separated by a filter in the last l.f. stage. The 17-kc/s signal is rectified and used to provide automatic-gain control on all stages. This gives an output characteristic which rises sharply with input voltage for small signals, and flattens off to give a substantially constant output amplitude for signals stronger than about 20 db above noise level.

For automatic-frequency control a double-diode discriminator with a bandwidth of 0.2 Mc/s is fed from the fourth i.f. stage through a further stage of amplification and is connected by blocking capacitors to a second double-diode rectifier as shown in Fig. 8. With this arrangement the a.f.c. voltage is derived from the 17-kc/s modulation and not directly from the carrier. The removal of the d.c. component by the blocking capacitors largely prevents the unbalanced noise voltage, which arises from any asymmetry in the frequency-response

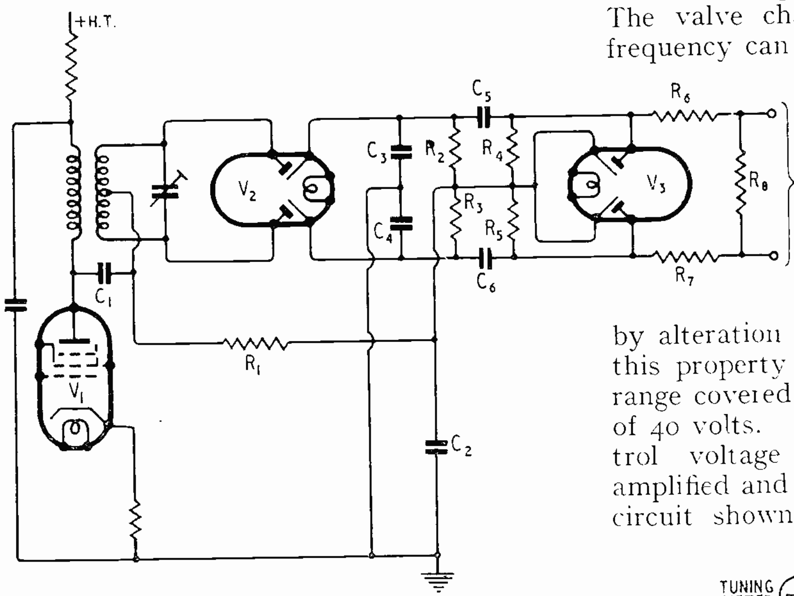


Fig. 8. *Receiver a.f.c. circuit;* V_1 *VR91*, $V_{2\cdot3}$ *D63*: R_1 $47k\Omega$, $R_{2\cdot3}$ $100k\Omega$, $R_{4\cdot5\cdot6\cdot7\cdot8}$ $220k\Omega$; $C_{1\cdot2}$ $0.0005\mu F$, $C_{3\cdot4}$ $0.0002\mu F$, $C_{5\cdot6}$ $0.01\mu F$.

characteristic of the receiver, from taking control of the discriminator at low signal levels with consequent loss of the signal. The frequency-control voltage, obtained after rectification in the second double-diode, is applied to the local oscillator through a d.c. amplifier on the oscillator panel.

The valve used as local oscillator (CV130) is also a reflex klystron. It requires a resonator-cathode voltage of 1,200 V, with the reflector approximately 300 V negative to cathode. It is supported from the panel on a mounting plate removable from the front. The power is fed from the resonator output slot into a waveguide fitted with a choke cavity C to minimize external leakage at the junction. The waveguide feeds a coaxial cable through a probe transformer P, and coupling to this is varied by means of a reflecting piston R adjustable from the panel. This arrangement is shown schematically in Fig. 9.

The coaxial cable feeds a waveguide fixed to the back of the cabinet, and this terminates close to the aerial system. To allow flexibility for adjustments of mirror direction the connection to the crystal is made by another short length of coaxial cable. This terminates in a probe projecting into the aerial receiving branch close to the crystal and loosely coupled to it. The local-oscillator drive is adjusted to produce a rectified crystal current of between 50 and 500 μA; within these limits the actual value is not critical.

The screw mechanism which tunes the local-oscillator valve by deformation of the resonator is operated by a knob on the panel. The valve characteristic is such that the frequency can be varied over a small range by alteration of the reflector potential, and this property is used for fine tuning. The range covered is about 20 Mc/s for a change of 40 volts. The automatic-frequency control voltage from the discriminator is amplified and applied to the reflector by the circuit shown in simplified form in Fig. 9.

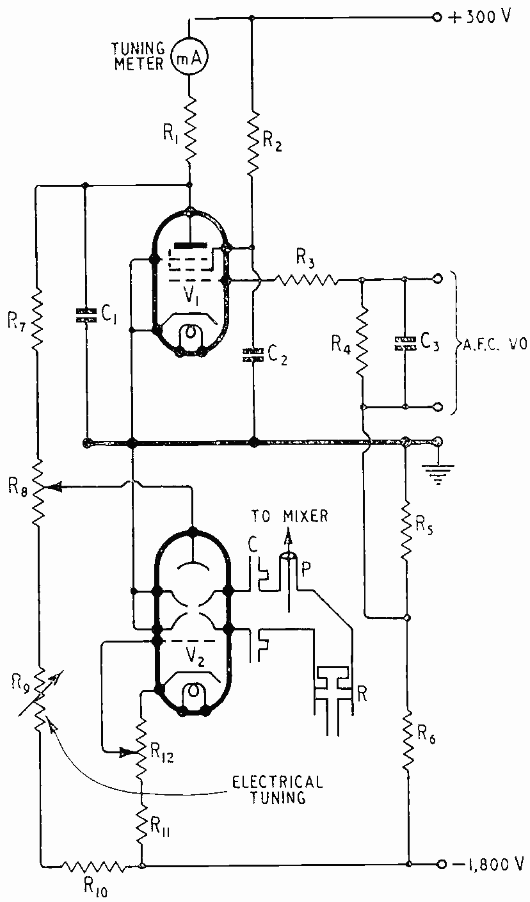


Fig. 9. *Local oscillator circuit;* V_1 *VR91*, V_2 *CV130*; $R_{1,2}$ $47k\Omega$, R_3 $10k\Omega$, R_4 $470k\Omega$, R_5 680Ω, R_6 $220k\Omega$, R_7 $1.5M\Omega$, R_8 $250k\Omega$, R_9 $50k\Omega$, R_{10} $150k\Omega$, R_{11} $48k\Omega$, R_{12} $15k\Omega$; C_1 $0.002\ \mu F$, C_2 $0.1\mu F$, C_3 $0.002\ \mu F$.

The output voltage change from the d.c. amplifier is used to vary the current through the potential-divider chain which supplies the steady reflector potential, and hence to produce voltage variations of suitable magnitude between reflector and cathode. A meter measuring the anode current of the d.c. amplifier serves as a tuning indicator. The deviation of the meter from its normal value is an indication of the amount and sign of frequency compensation being supplied by the control circuit.

2.4. *Relay and Control Circuits*

With any radio-telephone system the design of the terminal equipment will depend entirely on individual requirements, which may range from a single telephone termination to a multichannel carrier-telephony system. The

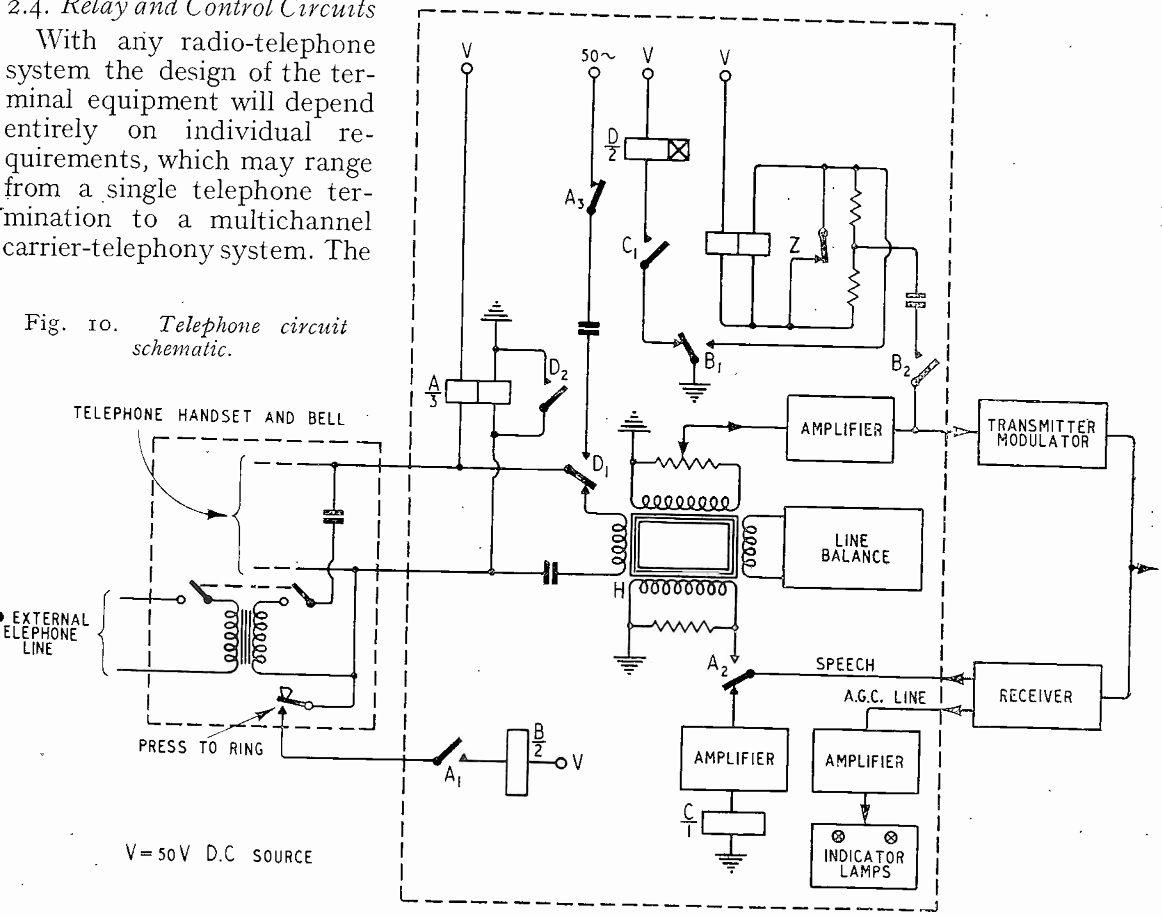


Fig. 10. *Telephone circuit schematic.*

resent equipment is intended to carry nly a single speech channel, but this may e presented in a number of forms. The equirement in one instance was for a telehone at a short distance from the equipnent, with facilities for the extension of the all through a small private branch exchange o an external two-wire line. The circuit rrangement used in this case is shown in mplified form in Fig. 10.

The telephone instrument is similar to a .P.O. type, but differs internally in having connection for an external line through a transformer and switch, a push-button key for ringing and a bell operating from the 50-c/s a.c. supply. The other components shown in the figure are contained in two units on the rack.

The two-wire line from the telephone is connected to the transmitter modulator and receiver output through a hybrid transformer H. Removal of the handset from its cradle at the station originating a call operates a balanced-relay A/3, disconnecting the incoming ringing circuit and making the circuit connections for outgoing ringing. The "ring" button on the telephone is now pressed, thereby operating, by means of a relay B/2, a tone vibrator Z which transmits a 120-c/s note to the modulator. This note received at the other end of the link operates the vibrator C/1 tuned to the same frequency as vibrator Z. When C/1 has built up a sufficient amplitude its contacts operate a slow-operating relay D/2 which applies a ringing voltage to the bell. Lifting of the handset at this station cuts off ringing and switches over the receiver output to the handset earpiece; contact between the two stations is then established.

The operator can extend the call to an internal or external line by means of the switch on the telephone instrument.

The equipment is provided with a simple signal-strength indicator. The automatic-gain control voltage is amplified and made to operate a relay controlling a red and a green lamp. If the received signal-strength falls below a predetermined value the green light changes to red, indicating that the signal is below good operational level.

In its existing form the equipment suffers somewhat by the retention of features from earlier experimental apparatus. It is considerably larger than need be, and has since been redesigned to be housed in a 3-ft cabinet instead of a 6-ft one. Again, if intended to work within a small assigned waveband, the duplex filter and feeding system could be reduced in size, and made in a simpler mechanical form.

The low-frequency part is entirely dependent on particular requirements. It could be arranged to operate on any normal telephone system of ringing and exchange working, or as a link in a repeater chain.

3. Operation

It has been pointed out that with centimetre waves it is desirable that there should be an optical path between the aerial mirrors. For a short link it may be easy to locate the equipment rack close to the aerial, but for a long link, where considerable aerial height is necessary, the aerial may have to be situated on a tower or on the roof of a high building remote from the rest of the equipment. Under the latter circumstances the equipment already described would have to be modified, but the sites on which this system has been used allowed the equipment rack to be placed close to the aerial, which radiated through an aperture in the wall of the room, the opening being covered with Perspex or water-proofed canvas.

In setting up, the aerials must be directed visually or by compass bearing to an accuracy of $\pm 1°$ in azimuth and elevation. After the signal is received, tuning is adjusted until the a.f.c. amplifier meter indicates exact tune. During the first hour after switching on, the transmitter and local oscillator will drift in frequency by a few megacycles per second, and tuning may have to be re-adjusted. Thereafter the changes are small and well within the holding range of the automatic-frequency control. Correction of frequency drift can be made at intervals by the fine tuning control.

The power supplies are not fully stabilized internally, but it is advantageous to have the mains power supplied through a constant-voltage transformer.

The ringing relays will operate on a signal with a mean power about 10 db above noise level, but as speech is not fully intelligible below a signal-to-noise ratio of about 20 db the warning light relay is best set to operate somewhat above the latter level.

4. Performance

Most of the experience with the radio-telephone equipment has been gained on a path of some 57 miles over sea, where the link has been in operation for over a year. This equipment was built for the Ministry of Supply, to provide telephone communication between two S.R.D.E. experimental stations.[1] The ends of the link are at Rhiw, near Pwllheli, in North Wales, and a site near Strumble Head in South Wales, the respective heights of the stations above sea level being 825ft and 540ft.

If h_1 and h_2 are the heights of the transmitting and receiving aerials, the maximum optical distance between them is given by

$$d = (2R_e)^{\frac{1}{2}} (\sqrt{h_1} + \sqrt{h_2}),$$

where R_e is the effective radius of the earth. The effective radius, which allows for the bending of the rays due to the variation with height of the refractive index of the atmosphere, has an average value of about 1.3 times the actual radius of the earth.

Thus the optical distance for aerials at the heights quoted above is 73 miles. The actual path length of 57 miles across Cardigan Bay is thus well within the optical range.

The carrier power P_r received by a receiver situated in free space at a distance d from a transmitter of radiated power P_t is given[5] by

$$P_r = \left(\frac{3\lambda}{8\pi d}\right)^2 P_t G_t G_r,$$

where G_t and G_r are the actual aerial power gains referred to a Hertzian dipole. It has been shown[1] that over a path of the nature considered the calculated free-space field gives a good approximation to the average field actually received.

With a mean transmitted power of 75 milliwatts, and aerial gains of 5,700 the received energy over a 57-mile path in free space should be about 4,200 $\mu\mu$W (which would correspond to a voltage in a 75-ohm cable of 55 db above a microvolt). With a receiver noise factor[5] N of 10 db, and a bandwidth B of 3 Mc/s, the effective noise power p at the input will be given by $N = 10 \log_{10} (250\, p/B)$; i.e., $p = 0.12$ $\mu\mu$W. Hence the signal-to-noise ratio at the second detector will be about 45 db. The subsequent improvement due to the l.f. bandwidth of 5 kc/s is given approximately by a factor equal to the square root of the ratio of i.f. to l.f. bandwidths, and is thus about 14 db. The signal-to-noise ratio at the receiver output will therefore be about 59 db.

At these wavelengths no interference has been experienced from electrical machinery or atmospheric static, and in practice overall signal-to-noise ratios of the order of 55 db were consistently obtained. In this installation the telephone is situated beside a small exchange board to which the extension line is connected. By this means calls can be extended to an external G.P.O. line. The signal-to-noise ratio is adequate for this purpose, and long extensions by trunk lines have been made, for example, to Scotland and London.

Over a path of this length, even though it is optical, transmission is not constant, and both rapid and slow fading do occur. The effect for this path has been described in detail elsewhere.[1] Generally the variations, which occur mainly during fine weather, are within a range of $\pm$ 10 db and the effectiveness of the automatic-gain control makes them unobservable. Under certain atmospheric conditions, however, very deep rapid fading takes place. When this occurs the signal falls in two or three seconds from its normal value to a value often below noise level, and rises almost immediately and just as rapidly to its former level. This may take place at several-minute intervals over a period of perhaps an hour. In practice such fades are not particularly troublesome, for their incidence is always obvious by the sharp rise in noise level, and one merely stops speaking for the few seconds until the carrier rises sufficiently to suppress the noise. Fading of this nature is not common, and represents a loss of not more than 0.1 per cent of communication time.

Short-range tests have been made over distances of a few miles. In these cases the signal-to-noise ratio was extremely high, the noise being almost completely suppressed by the automatic-gain control.

In its earlier experimental form, apparatus of this type has worked successfully from the top of Mt. Snowdon to Aberporth in Cardiganshire, a distance of about 70 miles over land and sea, and from the roof of the G.E.C. Research Laboratories at Wembley to a building in an Admiralty Establishment at Haslemere, Surrey. The latter path[1] is only 38 miles long, but is obstructed by houses and trees near the Wembley end, so that the signal is received after diffraction round these obstacles. In these circumstances the received signal was only some 12 db above noise level, which is near the limit of intelligibility.

The general conclusion is that, with an output power of about a tenth of a watt, optical distances of the order of 60 miles can be covered satisfactorily with a single channel link. For much shorter distances the diameter of the mirror could be reduced. As the distance is increased, with corresponding increase of aerial height, the degree of fading will also increase, so that very long paths, even though they are optical, are likely to give somewhat variable results, particularly over sea. For these a longer wavelength will be more satisfactory, but the compactness of the duplex aerial system will be lost.

APPENDIX

Gain of a Paraboloid Reflector

An approximate formula for the gain of a paraboloid can be simply derived as follows. Let the total power radiated from the paraboloid be P, and let the source be such that all the energy from it is directed towards the reflector so that the radiated power density is uniform over the aperture. Then the energy density W_0 across the aperture area A is given by $W_0 = P/A$. If the electric field corresponding to W_0 is E_0, then, by the optical theory of diffraction from a circular opening of radius a, the field E received at a distance d and angle θ to the normal is known to be

$$E = \frac{E_0 a}{d \sin \theta} J_1 \{(2\pi a/\lambda) \sin \theta\}$$

$$= \frac{A}{\lambda d} E_0, \text{ when } \theta \to 0.$$

Hence the energy density W at a point along the normal is

$$W = \left(\frac{A}{\lambda d}\right)^2 W_0.$$

The energy density W_1 received at a distance d from an omni-directional source also radiating a power P would be

$$W_1 = \frac{P}{4\pi d^2}.$$

Hence the power gain is

$$G = \frac{W}{W_1} = \frac{4\pi A}{\lambda^2}.$$

Expressed with respect to a Hertzian dipole this is reduced by a factor of 2/3 to $8\pi A/3\lambda^2$.

When $x = 1.616$, $J_1(x)/x$ is reduced to a value of 0.707 times its value at $x = 0$; hence the above expression for E shows that the half-power points occur at an angle θ given by

$$(2\pi a/\lambda) \sin \theta = 1.616\text{; i.e., at } \theta = \sin^{-1} (0.26\lambda/a).$$

REFERENCES

[1] E. C. S. Megaw, "Experimental Studies of the Propagation of Very Short Radio Waves." *J. Instn elect. Engrs*, 1946, Vol. 93, Part IIIA, p. 79.

[2] H. G. Booker, "Elements of Radio Meteorology: How Weather and Climate Cause Unorthodox Radar Vision Beyond the Geometrical Horizon," *J. Instn elect. Engrs*, 1946, Vol. 93, Part IIIA, p. 69.

[3] H. Archer-Thomson and E. M. Hickin, "Radio Technique and Apparatus for the Study of Centimetre Wave Propagation," *J. Instn elect. Engrs*, 1946, Vol. 93, Part IIIA (in process of publication.)

[4] F. F. Roberts and J. C. Simmonds, "Multichannel Communication Systems," *Wireless Engineer*, 1945, Vol. 22, p. 538.

[5] R. J. Clayton, J. E. Houldin, H. R. L. Lamont and W. E. Willshaw, "Radio Measurements in the Decimetre and Centimetre Wavebands," *J. Instn elect Engrs*, 1946, Vol. 93, part III, p. 97.

CORRESPONDENCE

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

Amplitude and Frequency Modulation

SIR,—I should like to take issue with the apparent implication of the Editorial appearing in the July 1947 issue of *Wireless Engineer*. Although it is desirable to view new methods with a conservative eye before pressing for their general adoption, the comparison between frequency modulation and amplitude modulation often seems obscured by a confusion as to their end use. It is sometimes helpful to consider whether the use is communications or entertainment broadcasting.

For a direct comparison between an a.m. and an f.m. system, may I direct your attention to a two-part article entitled "Field Tests of Frequency and Amplitude-Modulation With Ultra-High Frequency Waves," by I. R. Weir in the *General Electric Review*, Vol. 42, No. 5, May 1939, page 188; and Vol. 42, No. 6, June 1939, page 270.

For your convenience, the advantages reported are summarized below:

"(1) Improved signal-plus-noise to noise ratio. Under some conditions this improvement is as high as 20 to 25 db. This means there is a remarkable freedom from atmospherics and man-made static, such as X-rays, automobile- and aircraft-engine ignition, commutator sparking, etc.

"(2) A more definite and uniform service area of a transmitter is established because frequency modulation signal-plus-noise to noise ratio remains high until the field intensity reaches a very low value.

"(3) Comparatively much smaller geographical interference area is obtained when two frequency-modulated transmitters are operated simultaneously on the same frequency than when amplitude-modulated transmitters are so operated.

"(4) A frequency-modulated radio-frequency amplifier is more efficient than one for amplitude modulation because frequency modulation can be accomplished at low level followed by class C power amplification.

"(5) A given service area can be covered with considerably less power than with amplitude modulation because of the improvements in signal-plus-noise to noise ratio obtained with frequency modulation.

"(6) For a given power output, small radio-frequency amplifier tubes can be used."

So far as broadcasting is concerned, you are doubtless by this time in possession of the brief paper by C. M. Jansky, Jr., entitled "The Demonstrated Potentialities of Frequency Modulation Broadcasting on Very High Frequencies." The paper was prepared for delegates to the International Telecommunications Conferences for use in connection with the f.m. demonstration given August 6th, 1947, at the Ambassador Hotel, Atlantic City, New Jersey.

Mr. Jansky's paper summarized the advantages inherent in f.m. broadcasting and particularly describes the conditions under which a test programme was broadcast to the delegates. The programme was heard in Atlantic City via station WBAB-FM which has employed a special receiving location to pick up the original broadcast from W2XEA-W2XMN at Alpine, New Jersey. The distance covered by radio was 110 miles. Special receiving antennas were 160 feet above sea level and the transmitting array 350 feet above sea level. However, the receiving antennas were 7,400 feet below lines-of-sight. W2XEA operates on 92.1 Mc/s. with approximately 20 kilowatts.

Before the war, the writer was employed by the Yankee Network, one of the pioneer f.m. broadcast organizations, and had an opportunity there to observe the success of the f.m. technique.

ALEXANDER A. MCKENZIE
Associate Editor,
New York, U.S.A. *Electronics.*

ADVISORY COUNCIL OF SCIENTIFIC RESEARCH

Professor P. I. Dee, C.B.E., F.R.S., formerly Superintendent of the Telecommunications Research Establishment, has been appointed a member of the Advisory Council of Scientific and Industrial Research. He is Professor of Natural Philosophy at the University of Glasgow.

Sir William Griffiths, D.Sc., F.R.I.C., F.Inst.P., F.I.M., has also been appointed a member. He is Chairman and Managing Director of the Mond Nickel Co. and a Past-President of the Institute of Metals.

Professor Sir Lawrence Bragg, O.B.E., M.C., D.Sc., F.R.S., Professor Sir John Lennard-Jones, K.B.E., D.Sc., F.R.S., Sir Andrew McCance, D.Sc., F.R.S., and Sir Raymond Streat, C.B.E., retired on completion of their terms of office.

RADIOLYMPIA 1947

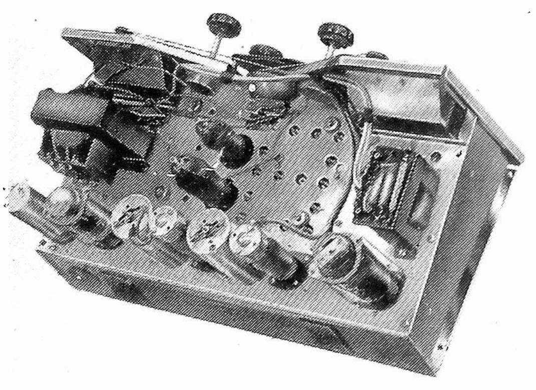
Fifteenth National Radio Exhibition

THE fifteenth National Radio Exhibition, in spite of restrictions and shortages, was much larger than its predecessors, and although broadcast receivers were still the staple exhibit, the scope of the show was much wider than hitherto. Whereas in the past the home market has always received first consideration, export models were very prominent this year and such sets are noteworthy for the considerable degree of tropicalization incorporated in them. This tendency was so general that it has been thought unnecessary to mention it in the individual sets referred to below.

Broadcast Receivers

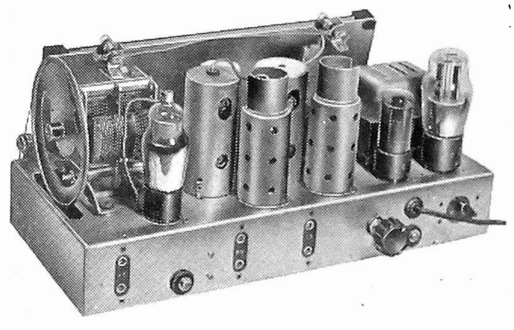
Although the stereotyped 4 + 1 valve set was the "bread-and-butter" line with most exhibitors, and will be taken for granted, the signs of a break-away from this austere framework were more numerous and varied than one had dared to expect. The outstanding tendencies were better short-wave reception, higher quality of reproduction, and in all kinds of apparatus a greatly improved standard of mechanical design and construction. Progress could also be seen towards more economical production and easier servicing.

Instead of trying to cover all short waves in one band, many set makers now split them up into anything from two to ten. Although this is sometimes used to extend the total frequency coverage, the main object is to facilitate tuning. Some models provide continuous coverage in several broad bands, sometimes with the further tuning aid of mechanical band-spread such as a two-speed drive and auxiliary logging scale (Peto-Scott), while others select the narrow broadcast allocations only, spreading each over the full tuning scale.



Bush export model EBS4 chassis.

The H.M.V. Model 1700 does both, giving the option of tuning all short waves in three bands, or the broadcast sections only in seven bands, in addition of course to the usual medium and long. Spreading the broadcast bands over the full tuning scale necessitates some circuit device for reducing the tuning ratio. In the Ace Model A600 the lowest in frequency of the seven short-wave bands (6 Mc/s) is permeability-tuned, and the remainder are covered by switching coils in parallel. Others, such as Aerodyne and Alba, employ a split gang-capacitor. The full capacitance is used for long, medium, and 3-7.5 Mc/s, and the small section for six broadcast bands up to 27 Mc/s. Murphy, Ekco and R.G.D. are other examples of multiple band-spread. The work of searching over all these bands is in some cases alleviated by fly-wheel tuning.



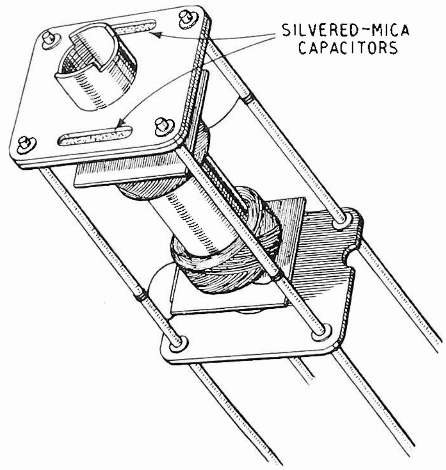
Regentone Type A358 broadcast receiver chassis.

Concurrently with band spreading is a very general increase in size and clarity of scales. The Ultra T44T, for example, has six bands scaled on a horizontal cylinder rotating with the band-change switch, giving for each band a scale 11in × 2in, clearly marked in station names, metres and frequencies.

To provide the needed signal/noise ratio and image ratio for short waves, a number of models include an r.f. stage on these bands only.

The foregoing improvements would, of course, be largely nullified by inconstancy of tuned circuits, and the stringent requirements of war have provided valuable experience. Temperature compensation by negative-coefficient capacitors has long been used, of course, but there are also some examples of inductance stabilization, and the design of trimmers has noticeably improved. The trend towards iron cores for i.f. and even r.f. coils, largely for compactness but also to simplify adjustment, is very marked. And permeability tuning is slowly gaining ground; an example is the very low-priced Pye car receiver.

Push-button tuning, so common before the War, has largely had to drop out or be simplified, in the interests of economy. Motor tuning has almost entirely disappeared, and the number of pre-selected stations is generally small. In the Ferranti sets two are provided by extra positions on the waveband switch, and selection is facilitated by calibration scales on the iron-core adjusters. As an overwhelming proportion of listening is done on Home and Light services, this is a common-sense arrangement. The desirability of push-button control for car radio is obvious, and in the Radiomobile model tone and band-change are effected in this way, and the station selected by any of the four remaining buttons which, acting mechanically on the gang capacitor, can quickly be changed from the front of the panel by slackening the button and retightening after tuning-in the new station.



United Insulators i.f. transformer embodying silvered-mica capacitors in the end plate.

It is an almost daily experience for many listeners to miss some desired programme by failing to remember to switch on in time. Several receivers are now available with clock-controlled switches. The most elaborate system is in the H.M.V. Model 1700, with three clocks enabling any 24-hour combination of three sessions from two stations to be selected in advance. In the Ekco " Radiotime " a single clock switches on and off for reception from any of six stations, and, in the absence of a carrier wave, sounds an alarm. The Bennet and Goblin models switch on any programme to which the set is tuned, a facility that can be added to existing sets by the Ekco CC65 switching clock, which is rated to control up to 300 watts. As the systems mentioned all use 12-hour clock faces, a 2 : 1 gear is used, in conjunction with an indicator, to enable a.m. and p.m. to be distinguished.

A good example of the way in which servicing has been provided for in the design is the Ultra T49. The chassis is mounted entirely on a strong baseboard, so that the moulded cabinet is not only quickly removable, but, as it carries no part of the weight, is less likely to be broken. The chassis is hinged in two places, and, when opened out, all the important points for testing and adjustment are easily accessible. Although plug-in electrolytic capacitors are still rare, provision is made in some sets (Ferranti) for easy replacement by slackening the clip and withdrawing the flex leads.

In spite of shortage of materials, the standard of external appearance is undoubtedly higher than before the War. Some fine examples of wood cabinet were seen, such as the Decola " Knightsbridge." But the most general advance is in the mouldings, which in both colour and design contrast brightly with the lumpy brown affairs of pre-war days.

The miniature trend not only has obvious advantages when exemplified in portables, " personal " sets, and deaf aids, but it contributes to economy in materials. A good example of economy both in materials and labour is the United Insulators silvered-mica twin capacitor made up into the form of an i.f. transformer end-plate. The four corner wires of the transformer have only to be soldered to the four eyelets in the plate to complete the framework and at the same time the connections of primary and secondary tuning capacitors (which incidentally are kept away from the magnetic field) to their respective coils. Ceramic capacitors, so increasingly used for v.h.f., are now available more cheaply and compactly in flat form. Bush or " feed-through " capacitors simplify the assembly in many positions. Economy in production is combined with diversity of style in the Plessey " Universal " tuning drive, whereby standard parts produced from a single set of tools can be assembled to give a great variety of units, with scales horizontal, vertical, " clock," or arc, and with various arrangements and numbers of fixed or moving pilot lamps.

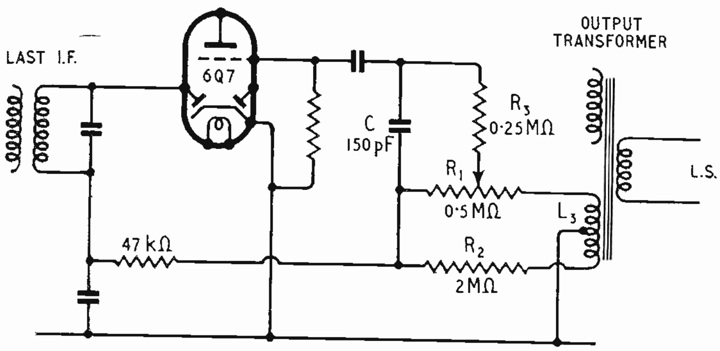
A useful component in a.c./d.c. sets is the Brimar thermistor, in appearance like an ordinary carbon resistor, which can be connected in series with the heater circuit to prevent heavy mortality among pilot lamps owing to the low resistance of the circuit when cold.

Attention devoted to audio reproduction can be considered under three heads—variable-selectivity and tone control systems, output stages, and loudspeakers.

The general purpose set, intended for receiving a large number of stations, must necessarily be more selective than is desirable for the local station ; and, even if variable selectivity is fitted, few listeners can be relied upon to use it intelligently. In the Bush " Bi-Focal " system, some degree of audio bandwidth expansion is automatically obtained by a volume control that introduces negative feedback. On account of the limited effectiveness of a.g.c. in the simpler types of receiver, it can be assumed that it is necessary to reduce gain manually when listening to the local station, thereby bringing the feedback into operation.

The Kolster-Brandes volume control forms part of a bridge circuit in which negative feedback is progressively increased as the control is turned towards minimum. At the same time the proportion of top frequencies is augmented by a by-pass capacitor.

An example of the more elaborate models, where flexible control is appropriate, is the Dynatron, in which a selectivity control, operating on a tertiary i.f. winding, provides i.f. bandwidths up to 25 kc/s. To enable this to be used without heterodyne interference there is a whistle filter giving 35 db attenuation from the level at 9,000 ± 500 c/s. The tertiary-winding method is also used by R.G.D. in a 3-position selectivity switch; while the tone control switch in the Ace sets has a fourth position in which bottom-capacitance i.f. coupling is introduced to broaden the bandwidth to 20 kc/s.



Kolster-Brandes volume control with negative feedback.

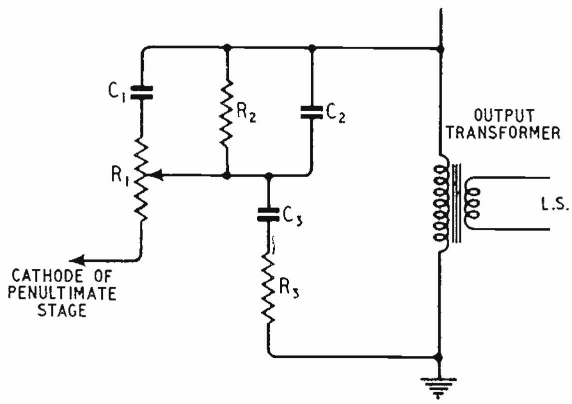
The R.G.D. tone control employs frequency-discriminating negative feedback. With the slider in the lowest position, the resistance-capacitance potential divider feeds back both top and bottom frequencies, narrowing the audio band but preserving a reasonable balance. At the other end, top is restored and there is some bass boost due to C1.

Push-pull output is used in practically all the more luxurious models and even in some of the cheaper ones where a single pentode used to be standard; and the varieties of negative feedback are very numerous. The Regentone push-pull stage is its own phase inverter, as one of the output valves derives its grid drive from the screen of the other. The Lowther A10F and A15F amplifiers, on the other hand, have an exceptionally elaborate push-pull system, with a cathode-coupled phase inverter followed by a push-pull driver stage in which a pentode in the common cathode lead stabilizes the balance.

Most of the devices used for improving the frequency range and reducing non-linear and transient distortion in loudspeakers are well-known in principle, but have not hitherto been put into practice in so many exhibits. Several examples of the high-note diffuser and acoustic labyrinth or similar treatment for the bass were shown. Instead of cutting away the baffle board over the whole area of the cone, Kolster-Brandes leave only a vertical slot about 1¾-in wide (i.e., not more than λ/2 for the high a.f.), giving better diffusion in the horizontal plane, and at the same time the extra air loading lowers the bass resonance slightly. In another model, the loudspeaker axis is downward and diffusion is obtained by a conical reflector. Murphy use an acoustic resistance of corrugated cardboard to avoid resonance in large cabinets; while their "baffle-board" receivers have frequency-discriminating negative feedback to boost the otherwise insufficient bass. Loudspeaker and cabinet resonance are controlled in the Acoustical "Concert Labyrinth" by an acoustic network adjusted to suit ordinary room environment. The Wharfedale "Varitone" has a bass phase-inversion opening at the foot of the cabinet which can be closed when listening to speech.

In a number of reproducers, from two to four loudspeaker units are used, with a cross-over filter to prevent overloading and intermodulation. In the General Electrical Radio GER/G24 separate channels are provided for 16–2,000 c/s and 2,000–16,000 c/s, and there are three speaker units with separate controls for bass, middle, and top frequencies. The Tannoy dual loudspeaker consists of two concentric units energized by the same magnet—a central horn-loaded unit for frequencies above 1,000 c/s, and a cone type for those below. The cone is shaped to continue the horn contour as a flare.

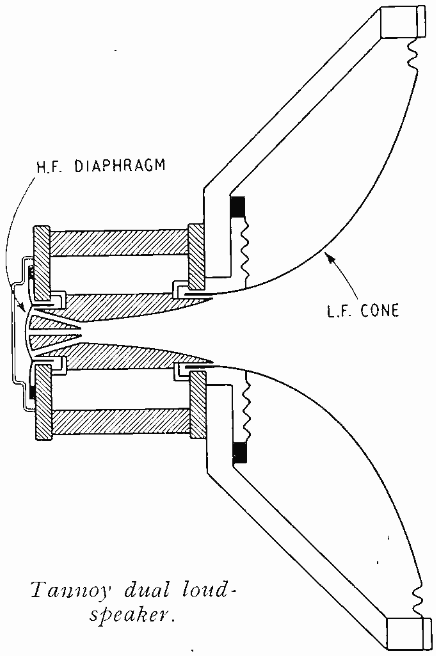
Twin-diaphragm technique is exemplified by one of the many Goodman models. Another is the Lowther-Voigt, which is notable also for the remarkable flux density of 19,000 gauss, obtained by skilful use of Ticonal alloy.



Negative feedback tone control used by R.G.D.

Although not directly connected with fidelity, the central-magnet construction adopted by Plessey and others minimizes the external field, which is otherwise apt to be troublesome in television sets. A similar result, with unusual compactness, is achieved in the Truvox "Wafer" loudspeaker, in which the cone contains the magnet.

In the absence of a regular service of frequency-modulation broadcasting in this country, provision for it is not to be expected in receivers; but a prototype 14-valve Ambassador was shown, which included f.m. and a.m. reception on 32–52 and 72–112 Mc/s. Reception of the B.B.C. experimental f.m. on 90 Mc/s is also provided in the H.M.V. Model 1700 radio-gramophone, which would need a whole article for a mere description. It is a 43-valve 12-waveband set, and besides the band-spread and time-switching already mentioned, its features include gramophone reproduction up to 14,000 c/s, two r.f. stages on short waves, motor push-button tuning and cruise tuning, a.f.c. on all wavebands, muting until within 2 kc/s of resonance, output



Tannoy dual loud-speaker.

stage comprising four KT66 valves in parallel-push-pull feeding a horn-loaded ribbon loud speaker above 5,000 c/s and one medium cone and two larger ones for the lower frequencies. Remote control of stations and automatic record changing is provided at a chair-side pedestal.

At the opposite extreme a broadcast receiver, permeability-tuned over the medium band, using a B.T-H. silicon detector, was shown in the form of a pen.

Gramophones and Sound Equipment

Few exhibitors of radio-gramophones did not include automatic record-changing models, and nearly half showed no other kind. This is because of the much simpler and more compact changers now available. The Plessey model differs little in size or appearance from the ordinary turntable, except for the centre spindle, which projects to a maximum height of 4¼in above the motor board, and has a collapsible collar on which up to eight mixed 10-in and 12-in records can be placed. Any record can be repeated or rejected.

In many radio-gramophones the turntable is on a floating mounting to avoid motor rumble.

The tendencies in pick-up design are: to use sapphire points, to reduce the pressure on the record, and to widen the range of uniform frequency response. There are several new Truvox models, oi whfch details of mechanical construction are not yet available, but the BP20A is stated to have a ribbon type of movement with a total weight, including sapphire stylus, of only 40 mgm, and to be within 3 db from 25 to over 20,000 c/s. There are also two Truvox moving-coil types with sapphire points and wide frequency response.

The high-fidelity Decca pick-up hitherto fitted only in the luxurious Decola reproducer is now available separately and also in a moderately priced table model.

A moving-coil pick-up based on Voigt's design is now offered by Lowther; and Tannoy have two new models, one with a response up to 10,000 c/s, requiring miniature needles, and the other taking standard needles and substantially level up to 7,000 c/s.

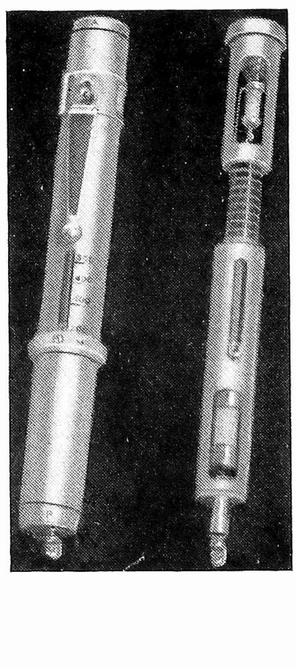
Lightness and freedom of movement is achieved in the H.M.V. Model 1700 radio-gramophone pick-up by a gimbal mounting. The weight on the record is only 8 grams.

Although the Plessey pick-up is of the conventional moving-iron type, its magnet is interesting, being made of the new magnetic material, "Caslox," which consists of a mixture of iron and cobalt oxides and a small quantity of plastic binder.

High fidelity in pick-ups and microphones is generally at the expense of output. The Truvox ribbon type, for example, when used with bass correction for standard recordings, yields only 8mV at the secondary of a 1 : 60 transformer. With high audio gain it is difficult to avoid hum from a.c. valve heaters; but in the McMurdo 10-watt amplifier this problem is solved by heating the first three valves with a 1-Mc/s supply obtained from a screened oscillator.

Public-address and other audio amplifiers follow mainly well-known practice; but the Trix U885 is notable with an output of 20/25 watts from 200/250-volt a.c./d.c. supplies, using an output stage of four CL33 valves in parallel-push-pull. Volume expansion, for giving a wider dynamic range from records, was not conspicuous at the Show; but the opposite process, volume compression, to prevent overloading of public-address equipment, is included in the Acoustical M91 90-watt amplifier, in which the limiting output is adjustable.

The extensive war-time use of sound recording has led to the appearance of a large amount of well-engineered equipment in this category.



B.T-H. permeability tuned "fountain-pen" crystal set.

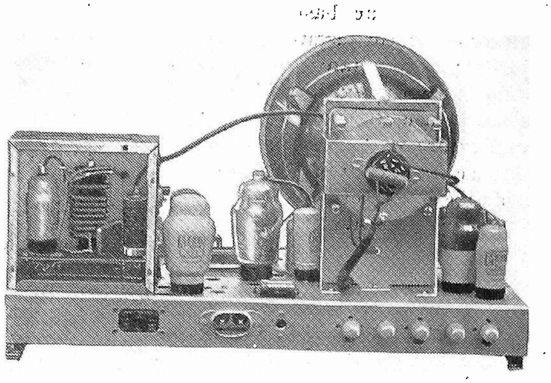
Acetate disk recorders follow mainly familiar lines, and chief interest attaches to those using iron-oxide-impregnated plastic film. Two examples were shown by G.E.C.; one for home use, with "medium fidelity" (i.e., up to 6,000 c/s), giving 30 minutes playing time on one reel of tape; the other, with tape travelling at a higher speed (but equal playing time) reproduces up to 10,000 c/s.

An entirely different use of similar material is seen in two E.M.I. recorders for dictating, one for office use and the other portable. In both, the plastic film is in disk form, and the spiral path of the magnetizing head is controlled by a grooved solid disk of small diameter placed on top of the plastic. A coupled indicator enables any point on the record to be marked for the guidance of the typist. One miniature unit serves both as microphone and play-back earpiece. Each disk provides three minutes recording, and can be wiped clean and used at least 1,000 times. The portable model has a 3-valve all-dry-battery driven amplifier.

E.M.I. portable recorder for dictation; a flexible magnetic plastic disk is used.

Television

Although there is now little variety in the type of screen, nearly all being directly-viewed 9-in or 12-in c.r. tubes (with a small sprinkling of 10-in and 15-in), circuit arrangement is so far from standardized that it is difficult to find two makes alike even in valve sequence. Straight sets outnumber superheterodynes; but Cossor combines both, with a 2.2-Mc/s i.f. superheterodyne for sound and a 5-stage straight r.f. amplifier for vision. Ferranti and Bush have four r.f. stages for vision, with a sound superheterodyne branching off after the second stage. In most of the superheterodynes the frequency changer is common to sound and vision, but the Philips sets have separate frequency changers preceded by one common r.f. stage. In the straight types, some (e.g., Philco and Sobell) have separate channels; others have one (Pilot) or more (Ferguson) stages in common. There is a tendency to use vestigial sideband reception in both straight and superheterodyne types, for combining adequate vision bandwith with freedom from sound interference. Various sound channel filters are used in the dual-sideband types.

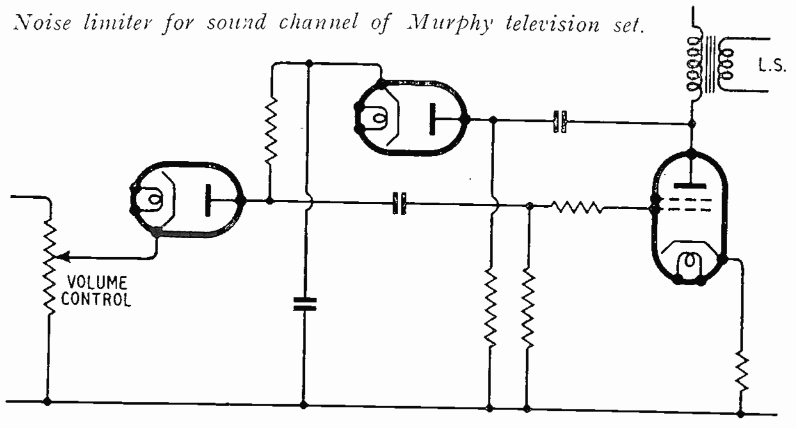


Ekco television set with 140-kc/s oscillator for e.h.t. source.

One v.f. stage is usual. The Cossor set uses a cathode follower, and Baird is notable in having two diode detectors in push-pull feeding a push-pull v.f. stage driving cathode and grid of the c.r.t. oppositely. The object is to ensure sufficient output to modulate the tube fully, notwithstanding 7 kV on the anode for giving an exceptionally bright picture.

Most models have some form of noise suppression on sound and/or vision, if only a simple limiter to prevent the c.r. tube from being driven beyond normal maximum white. A few, notably Murphy are designed to follow the sound modulation in order to maintain a more constant signal/noise ratio.

Noise limiter for sound channel of Murphy television set.



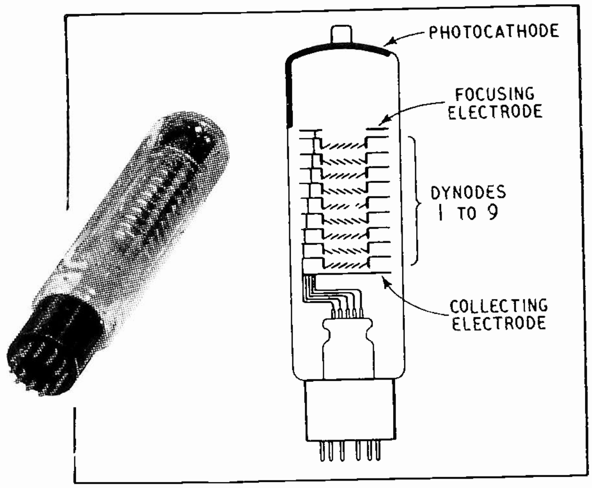
Hard-valve time bases, mostly working on the blocking-oscillator system, are slightly in the majority; but many examples of conventional gas-filled types exist. The Philips hard-valve generators are unusual in using triode-hexodes in a multivibrator circuit; and the Ferranti line time base in having only one valve, feeding a high-impedance deflector coil.

E.h.t. supply for the tube anode is still generally conventional, but there is a tendency towards obtaining it by rectifying the line fly-back (Kolster-Brandes and Philips) or separate r.f. oscillator Ekco and McCarthy), which confers the considerable advantage of safety to life.

In the Baird models, focusing is stabilized by passing the magnet current through a pentode. Several makes (Cossor, Kolster-Brandes) focus with a permanent magnet. Ion burn is prevented in the Cossor models by arranging for the beam produced by the gun to be off the axis of the c.r. tube. A small permanent magnet clipped each side of the tube between cathode and anode produces a relative deflection between electrons and ions enabling the latter to be excluded from the beam and the former to be brought on to the axis.

The Ekco TSC48 is exceptional in having an indirectly-viewed tube, using an inclined mirror. Only two examples of large screens were to be seen; these represented quite different approaches to the problem. The Baird "Grosvenor" televisor employs an enormous c.r. tube, with flat metal screen and offset gun as in a camera tube. The picture, 19in × 22in, is viewed from the beam side, so not only is curvature of the screen absent but it is exceptionally brilliant. Keystone distortion is prevented by frame modulation of line scanning, as in camera tubes. This televisor is combined with an 11-waveband receiver, auto-radio-gramophone, and sound recorder. The H.M.V. large-screen model is of the projection type, with a high-intensity c.r. tube picture enlarged by a Schmidt lens system.

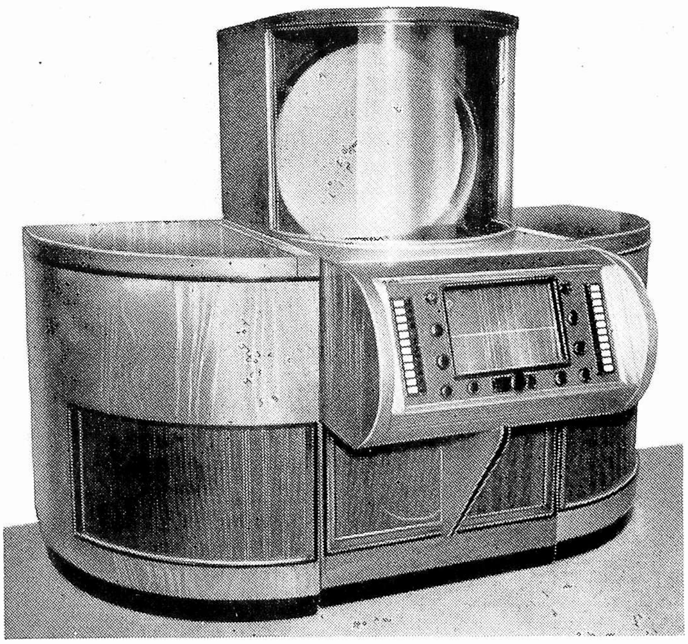
The difficulties caused by "tilt and bend" in



Electron multiplier used in the E.M.I. television film scanner.

television camera tubes are appreciable even for studio work, where complete changes of light and shade distribution are infrequent and under control. But the task of compensation is much harder with film broadcasting, which hitherto has also depended on Emitron cameras. A new method developed by E.M.I. is a development of the spot-light principle, in which the object is scanned by a beam of light confined at each instant to one picture element, and the resulting light applied to a photo-cell. The difficult problem of sensitivity has been solved by a 9-stage electron-multiplier photo-cell, having an overall sensitivity of 10 amperes per lumen. The multiplier consists of the usual succession of electrodes held at progressively more positive voltages, and direct passage of primary electrons is prevented by the venetian-blind shape of the electrodes.

Interlaced scanning is effected in an ingenious manner. A raster is set up on a 15-kV c.r. tube, its dimensions being approximately 3¼in × 1¼in; i.e., an aspect ratio of 10 : 4 instead of 5 : 4. A horizontally split lens focuses this raster on the continuously travelling film in two places, one of which is covered during a frame period by a revolving shutter. The frame motion of scanning, combined with the movement of the film in the opposite direction, spreads out the 10 : 4 raster into the 5 : 4 picture aspect ratio. When one frame has been scanned, the return of the beam



Baird Grosvenor television set giving a picture 22in by 19in.

to the start, combined with the movement of the shutter, brings the second raster into the correct position for interlacing the same frame on the film.

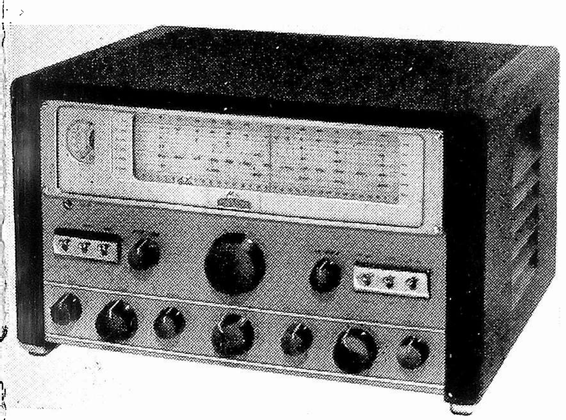
Non-Broadcasting Equipment

General-purpose communication receivers differ little in principle from pre-war types; but there are detail refinements, and improvements resulting from wartime techniques. The G.E.C. BRT400 is an example; a 13-valve superheterodyne with two r.f. stages and six wavebands from 150 kc/s to 31 Mc/s. Some of the valves are used in the a.g.c. system and in stabilizing and smoothing the power supply, which includes no electrolytic capacitors. A less elaborate model is the Eddystone 680, with two r.f., f.c., two i.f. (the first with crystal filter), combined detector, a.g.c. and a.f. amplifier, tetrode output, noise limiter, and beat oscillator. A signal strength meter is fitted.

The Standard Telephones STR9 aircraft transmitter-receiver is a good example of miniature construction (contrastingly exhibited alongside the final stage of a 135-kW short-wave broadcast transmitter), weighing only 22 lb. It has four interchangeable crystals to control spot frequencies in the band 115–145 Mc/s, and one fixed crystal produces the correct i.f. difference for stabilizing the receiver oscillator.

The Murphy-made portable Wireless Set No. 31 provides 40 v.h.f. f.m. speech channels for Army use. The same firm's radio telephone for small aircraft weighs 16.5 lb and has only one control—the on/off switch.

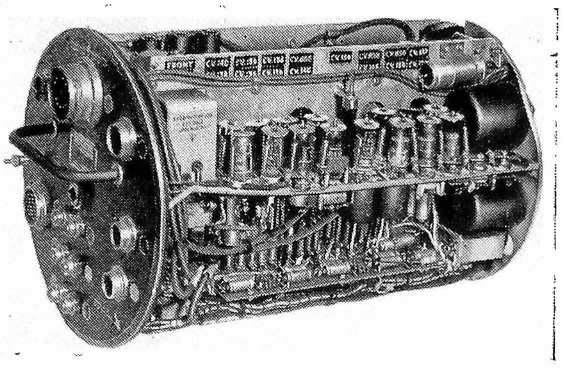
Marine radar installations, generally conforming to the Ministry of Transport specification, were shown by Marconi, E.M.I., Cossor, Metrovick and



G.E.C. Type BRT400 communications receiver.

B.T-H. These all operate in the 3-cm band and enable objects to be detected as close as 50 yards from the scanner. Presentation is by p.p.i., but the form differs considerably. The miniaturized Rebecca Mk IV, a radar interrogator used as a navigational aid, includes 48 valves and is contained in a pressurized cylindrical box 18in long by 10in diameter.

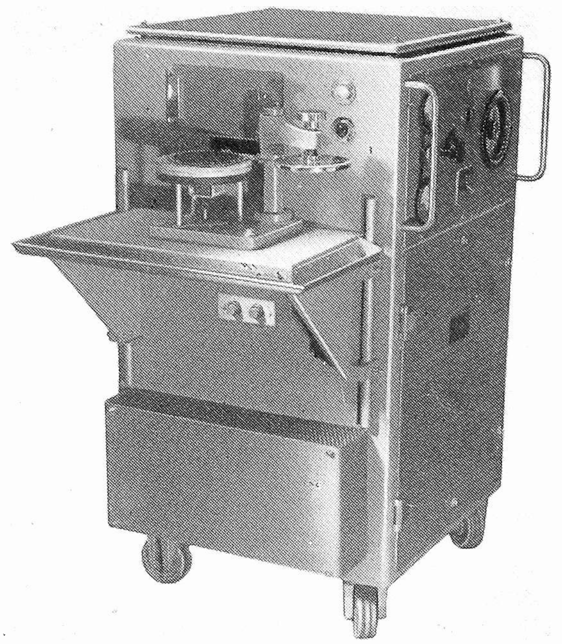
Dielectric and eddy-current heating are now accepted practice in many industrial processes, and the generators shown by several manufacturers



An example of miniature technique as applied to Rebecca Mk. IV.

incorporate many refinements, such as process timers, as standard fittings. An interesting application of induction heating in the radio industry itself was demonstrated on the E.M.I. stand. The process of sticking loudspeaker cones to their spiders had previously required a 20-minute pressing operation; in the induction heater $1\frac{1}{2}$ seconds is sufficient, and the result is more reliable. The generator operates at 1 Mc/s, and is well screened and filtered to prevent interference. The same firm has a laboratory-type 4-kW dielectric heater at 15-45 Mc/s, provided with comprehensive metering and separate applicator; also 1- and 3-kW factory types. The Philips induction heater has an output of 50 kVA and a frequency range from 350 to 1,000 kc/s.

Miscellaneous industrial electronic applications included the Ferranti yarn-breakage detector, in which a wire stretched across the textile machine is attached at one end to a piezo-electric crystal. The slightest touch of a broken thread trips a relay which actuates an alarm or a knock-off device on the machine. Response to factory vibration is prevented by low-frequency attenuation of the crystal output. A photo-electric unit, for automatically adjusting the edge position of a moving belt of cloth or paper, is provided with an anti-hunting control which enables the damping of the movement to be critically adjusted. The same firm showed an experimental model of a hyperbolic computor, into which are fed the data received from a hyperbolic navigational aid such as Decca, Gee, or Loran. If the polar coordinates of the destination relative to the navigational ground master station are set up on the instrument's dials, it computes and continuously indicates the range and bearing of that destination from the ship or aircraft. A model now under development is expected to be accurate to 0.1 per cent in range and 0.3° in bearing.



E.M.I. eddy-current r.f. heater for the high-speed manufacture of loudspeakers.

A trigger unit for attachment to the well-known G.E.C. magnetic sorting bridge enables particles of ferrous metals to be detected in manufactured products. G.E.C. also showed a direct-reading moisture-percentage indicator for timber, depending on the resistance of the timber when a pointed electrode is pushed into the sample.

The Dynatron electronic counter is a scale-of-two instrument for Geiger-Muller work, counting up to 10^6 at a maximum speed of 300 pulses per second. The B.T-H. industrial process timer covers the range 0.6-120 seconds with an accuracy of ± 5 per cent ; and the Metrovick timer provides for six stages in sequence, each 0.5-20 seconds. The switches, rated at 5A, 230V, are controlled by relays in the screen circuits of Blumlein-Miller integrator valves. Models are available for times up to several hours, and they are stabilized against mains voltage variations.

The Marconi Instruments TF884 plating thickness meter indicates directly the thickness of metal plate or paint, from 10^{-4} to 10^{-2} in, on a ferrous metal base, with an accuracy of ± 20 per cent. The probe, which is held against the surface to be tested, consists of a ball-ended centre pole in a transformer core having an annular air gap close to the ball. The primary winding is supplied with 50 c/s, and the secondary voltage, which depends on the influence of the plating thickness, is taken to a valve voltmeter.

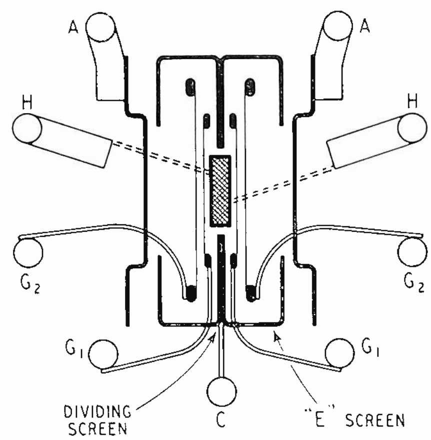
Valves and Cathode-Ray Tubes

It is too soon to discern what will be the ultimate effect of the introduction of the two new standard British bases, B8A and B8B. Ediswan and Mullard have already produced a range of types (with and without spigots respectively) on the B8A base, which is a miniature standard for all except the higher power types ; and Tungsram have announced their intention to do so. The majority of miniature valves at present listed, however, have B7G bases, as in America.

Regardless of bases, the general tendency, stimulated by television and other v.h.f. requirements, is towards all-glass envelopes. Concurrently with this, top connections are abolished in r.f. pentodes and tetrodes, being now reserved for extra-high voltages and other exceptional requirements.

It is easier to introduce a new type or range of valves than to liquidate an old one ; the result being that the number which have to be regarded as current builds up to what is now a highly uneconomic level. With this in view the Sargrove-Tungsram UA55 valve has been introduced. It consists of a double tetrode of very economical construction, unfortunately on yet another base, with nine pins. By varying the electrode connections and voltages it can be used for every purpose in a receiver, and even to provide characteristics—such as variable variable-mu—not obtainable with other types.

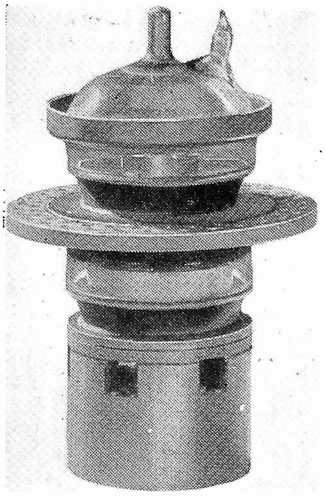
The Osram ACT22 and ACT23 are both earthed-grid triodes for use up to 1,000 Mc/s, and are key components in the future London-Birmingham television link. The former has a stage gain of 8, a dissipation of 75 watts, and an efficiency of 40 per cent at maximum frequency and 60 per cent at 600 Mc/s. The anode dissipation of the ACT23 is 250 watts. Both are used in coaxial tuning circuits, as in certain wartime radar transmitters.



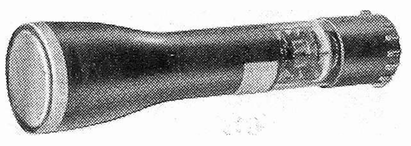
Electrode arrangement and base connections of the Sargrove-Tungsram UA55 all-stage valve.

New types of power and control valves have been produced for industrial equipment. The well-known Mullard silica construction has been extended at both ends of the power range to include the TYS2–250 giving 500 watts output at 75 Mc/s, and the TYS5–3000, giving 10 kW at 30 Mc/s. Small electronic devices, such as photo-electric relays, are at a disadvantage if cathode heating power has to be supplied continuously. More attention is therefore due to the Ferranti cold-cathode gas-filled valves—the K3 and K3A triodes and NSP1 and NSP1E tetrodes. The latter have been used hitherto mainly as stroboscopic light sources, but are useful in many relay applications.

An unusual "valve" is the Mullard DDR100, which is an accelerometer double-diode. The anodes are elastically supported, so that the anode impedances of the two change differentially when accelerated mechanically. Arranged in a bridge circuit, the out-of-balance voltage produced is a linear function of the acceleration.



Osram ACT23 u.h.f. triode giving 75 W output at 30 cm.

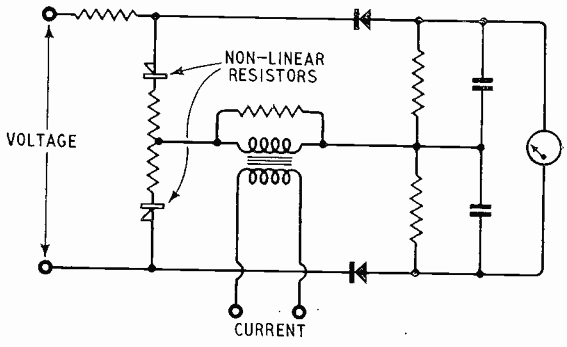


Cossor Type 89 cathode-ray tube with flat screen.

Flat-ended c.r. tubes are now being produced by Cossor (Type 89, 3½in) and G.E.C. (9in) for precision oscilloscopes and televisors respectively. Apart from these, and the giant Cinema-Television tube in the Baird "Grosvenor," c.r. tube developments are confined to internal details, to which intensive wartime research has contributed largely.

Instruments

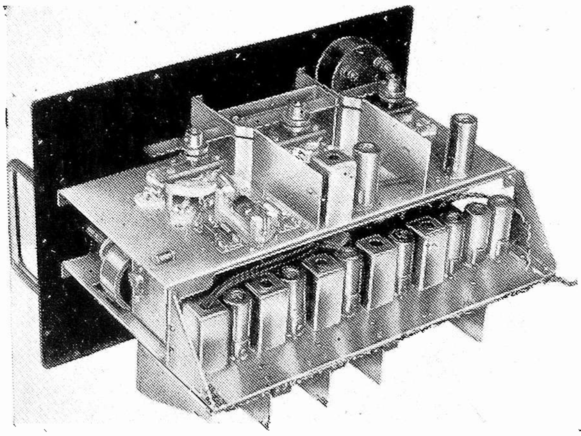
The B.T-H. silicon crystal rectifiers, developed primarily as centimetre-wave detectors, have greatly extended the frequency range for which direct-reading meters without power supplies are available. For example, a.c. voltmeters of apparently conventional type have been constructed for use up to 1,000 Mc/s, at 10,000 ohms per volt. B.T-H. germanium rectifiers have a smaller effective frequency range, but are capable of handling more power, and are convenient substitutes for diodes in all except high-impedance circuits. The range of "Westalite." rectifiers has been extended to include types of particular interest to electronic instrument designers, notably in the 16K series, which is a more compact (wire-ended) version of the 16HT type, and is obtainable for outputs of a few milliamperes with input voltages in multiples of 15 up to 135. Vacuum-mounted quartz crystals for all fundamental frequencies up to the v.h.f. band were shown by Standard Telephones and Marconi; and in addition to crystals, Salford Electrical Instruments now have a crystal-controlled frequency calibrator with its fundamental at 100 kc/s and useful harmonics up to 30 Mc/s, with provision for a.f. modulation.



Vampire low-consumption wattmeter (Everett Edgcumbe).

Very interesting possibilities are opened up by the Everett Edgcumbe "Vampire" multi-range volt-amp-power meter. The present model is for power frequencies, and embodies a wattmeter having a far lower consumption—of the order of 0.25 VA—than the conventional dynamometer type. It is an adaptation of the phase discriminator circuit. With no current in the current coil, the 2-phase input to the meter from the supply voltage is balanced and there is no reading. When current flows, the input to the meter is proportional to $I \cos \phi$. To make the readings proportional to $EI \cos \phi$, Westalite 16K rectifiers are used in the bridge; their non-linearity causes the current into the meter to rise with voltage. With the use of germanium rectifiers it is hoped to produce a low-consumption wattmeter suitable for high radio frequencies,

Marconi Instruments TF899 valve millivoltmeter covering 20—2,000 mV at frequencies up to 100 Mc/s.



Chassis of Murphy FSM23 field-strength measuring set.

and therefore applicable to industrial r.f. heaters.

Another interesting new meter is the Marconi Instruments TF899, which is a valve millivoltmeter using one active and one balancing EL91 triode in a bridge circuit, and is scaled from 20–2,000 mV in three ranges. Accuracy is given as ± 1 db to 50 Mc/s and ± 2 db to 100 Mc/s. It responds to peak voltages and is scaled in r.m.s. values with sine waveform.

The Murphy field-strength and noise meter, FMS23, is a sensitive superheterodyne receiver covering 30–150 Mc/s, calibrated directly in μV, and adjusted with reference to first-stage noise. Bandwidth is 100 kc/s at 6 db down.

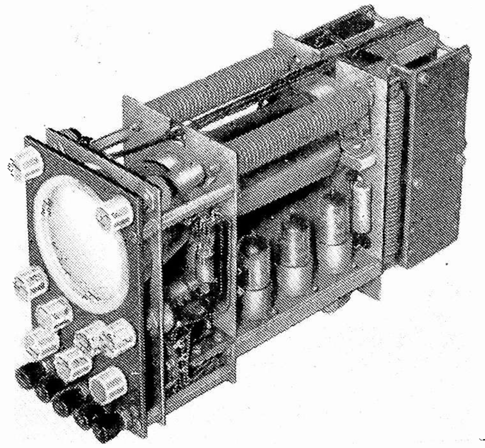
A Marconi Instruments policy is to introduce combination instruments where frequency of use justifies them. The TF888 portable receiver tester is an example. It includes signal generator, output power meter, and crystal calibrator; with mains or battery supply.

In the Dawe Instruments Modulated R.F. Oscillator, covering 10 kc/s to 50 Mc/s, the output is fed through an aperiodic buffer amplifier.

For television-receiver servicing, the Sobell TE. 123A generator supplies a complete synchronizing waveform, with a pattern of squares for checking time-base linearity.

The functions of insulation and continuity tester are conveniently combined in the Everett Edgcumbe portable "Hum Metrohm." A small internal dry battery acts directly on the 0.1-20-ohm range, and is stepped up to 500 volts by a buzzer and rectifier for the 0.05–25-megohm range. The instrument can be held and operated in one hand, leaving the other free for probing.

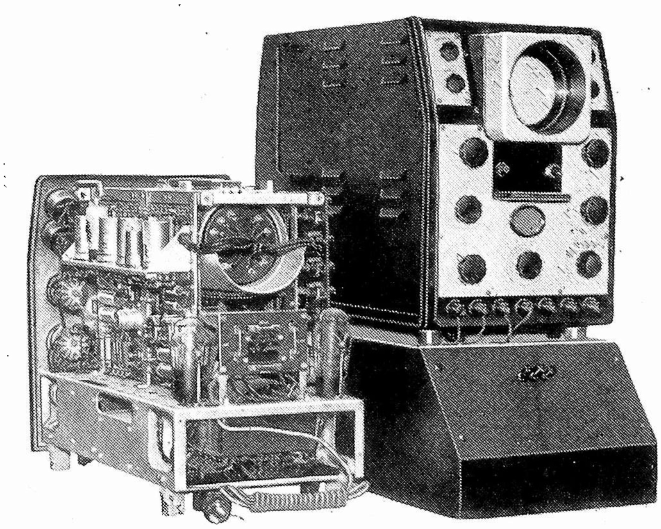
Oscilloscopes tend in two directions; the general-purpose instrument is becoming smaller, and the full-size instrument is becoming more precise and specialized. An example of the former is the Metrovick Type 244, which although only 10½in. × 5½in × 3½in has all the usual facilities, including a time base 20 c/s to 100 kc/s and a deflection amplifier effective up to 3.5 Mc/s. The latter are represented



Metropolitan Vickers miniature oscilloscope Type 244.

by two new Cossor models, the 1035 and 1049. Both use flat-screen double-beam tubes, and the controls are calibrated in time and voltage, while there are many special facilities. The first is for general laboratory use; the second more especially for industrial purposes.

There is now available for the Salford Miniscope an extra c.r. tube unit. This plugs into the top of the oscilloscope and derives its power supplies and time-base deflection voltage from it. It thus converts the oscilloscope into a two-tube instrument, in which the tubes have a common time base but which can display independent signals.



Cossor Model 1035 oscilloscope.

NEW BOOKS

Fundamentals of Radio

By JORDAN, NELSON, OSTERBROCK, PUMPHREY and SMEBY. Edited by W. L. EVERITT. Pp. 400 + xiii. Constable and Co. Ltd., 10, Orange Street, London, W.C.2. Price 27s. 6d.

It is a favourite technique with authors of the "Made Easy" type of book to ensure that at least the first page is within the capacity of the dimmest reader. It is presumed that his inertia, having been overcome by the encouraging discovery that he can actually understand what he reads, will keep him reading while the author gradually quickens the pace as much as he dare in order to cover the allotted subject-matter in the time allowed.

The authors of "Fundamentals of Radio" start almost at rock-bottom, with a simple outline of our system of digits; and the subject-matter (as the editor's preface says) is "the basic material of radio required for all types of radio work, both civil and military." To accomplish the feat in 400 pages it is obvious that there must be considerable acceleration, or considerable omissions, or both.

The editor does, in fact, keep his promise that "the reader need have only an elementary knowledge of algebra, which is reviewed briefly in Chapter 1," and he does cover a surprisingly wide field, including transmitters and receivers in some detail (f.m. as well as a.m.), sound reproducers, aerials, transmission lines, d.f., electromagnetic waves, and propagation. Some parts of television are briefly treated, but radar and waveguides are not mentioned.

The claim to have "covered each topic in such a way as to make clear the functioning of a complete radio system" might be questioned at a few points, but can broadly be conceded. That the authors "have also laid the foundation for a more advanced study of the subject," however, is a statement that seems to need some qualification. It is obvious all the way through that the authors have been very afraid of allowing unrelieved theory to go on for more than a page or two at a time. The editor even suggests omitting the first three chapters, on elementary algebra and d.c. and a.c. circuits, until "the need arises." This desire to keep the reader's feet on the ground by introducing applications as often and as early as possible is no doubt necessary and desirable for those whom he assumes will read the book. But to reach an engineering standard in radio it would be necessary to have rather more solid foundations of mathematics and electricity.

The trouble about explaining the first step very simply and fully is that the reader may expect his difficulties to be as well met throughout. If so, he is likely to be disappointed. Thus Ohm's Law, which is stated to be the basis of a "large portion of electrical circuit theory," is given as "The current in amperes is equal to the pressure in volts divided by the resistance in ohms," but as resistance has already been defined as the ratio of voltmeter reading to ammeter reading the importance of the Law is not clear, especially as the reader is warned not to worry when he finds it has many exceptions. What the writer is evidently trying to say is "In d.c. circuits the pressure in volts divided by the current in amperes (i.e., what is called the resistance, in ohms) is very often constant." This failure to bring out clearly the essential point is not uncommon. For example, decibels are explained twice; the first time on a subjective basis as "a unit of sound intensity" and "a unit of sound level," and loudness is taken as synonymous with power. The numerator in the power ratio must, it appears, always be larger than the denominator. Fortunately the second explanation (in the chapter on sound) indicates that sound is not necessarily involved wherever db are used.

The general scheme is well adapted for the instruction of intending servicemen and technical assistants, but the writing would benefit from some revision.

M. G. S.

Radio (3rd Edition)

By ELMER E. BURNS. Pp. 293 + xvi. Macmillan and Co., Ltd., St. Martins St., London, W.C.2. Price 15s.

This book is of American origin and was first published in 1928. The third edition appeared in 1938 and the copy under review is a seventh printing of this third edition. The book is thus admittedly nine years old, but a glance through it gives the impression that it is at least 20 years behind the times.

The first chapter contains circuits and pictorial wiring diagrams of crystal sets, valve amplifiers and complete receivers. The five-tube receiver of Figs. 18 and 19 is an historical gem. There are two r.f. stages with three tuned transformer couplings, a grid detector, and two transformer-coupled a.f. stages. All the valves are triodes and each one is provided with a separate filament rheostat! The r.f. stages are not neutralized and no valve has grid bias beyond the volt or so provided by the drop across the rheostats!

This is seriously put forward as a set for the beginner to experiment with. It is not even representative of 1928 practice, for the reviewer well remembers using neutralized circuits at least two years earlier, and in 1928 the screen-grid valve was coming into general use after its appearance in the autumn of 1927.

The screen-grid valve is not completely forgotten, however, for it is given 50 lines of description and there is one circuit of a straight receiver embodying it and one of a superheterodyne. Beam tetrodes and such matters as Class A, B, AB and C amplifiers are mentioned, but only just, and it is obvious that they have been added in a "revision" to make the book appear up-to-date.

The book is mainly devoted to fundamental theory of an elementary kind and the author would no doubt say that this does not change with time. In this he would be right, but when the theory is riddled with references to out-of-date practice, it removes any excuse for having failed to revise the practise. There are many statements in the theoretical part which are now incorrect, although they may have been right when they were written; e.g., "The output of a detector tube under proper operating conditions is nearly proportional to the square of the input voltage." Proper conditions for most purposes today are those which make it directly proportional to the input.

There are many characteristic curves of triode valves which are used to illustrate their operation. Fig. 226 shows cut-off at about −3 V grid potential but is carried on to + 24 V and in Fig. 126, which shows cut off at − 9 V, the curve is carried up to + 16·5 V and exhibits distinct signs of saturation.

The reviewer failed to find a single characteristic curve of a tetrode or pentode. The index gives two references to the pentode, one is precisely a page in length, the other is two lines. The superheterodyne has some 2½ pages.

Further extracts or comment would be superfluous.

W. T. C.

The Principles and Practice of Wave Guides

By L. G. H. Huxley, M.A., D.Phil. Pp. 328 + xi, with 148 illustrations, Cambridge University Press, Bentley House, 200, Euston Road, London, N.W.1. Price 21s.

This is the first book of a new Cambridge series on "Modern Radio Technique" under the general editorship of J. A. Ratcliffe. Its aim is to provide an introduction to the great practical developments in the use of waveguides which have taken place during the war years, and it is based on courses given by the author at the Radar School of the Telecommunications Research Establishment.

The first chapter is a short introduction to general properties of the electromagnetic field. The second and third chapters deal with the propagation of waves in rectangular and circular guides. The existence and elementary properties of the E- and H-waves in a rectangular guide are deduced by synthesis of their plane-wave components with the aid of only simple mathematics. The reasoning is easy to follow and is aided by excellent diagrams, leaving the reader with a clear physical understanding of these waves. The many well-drawn diagrams are a feature throughout the book. Incidentally a statement near the beginning should be of assistance in emphasizing what is present practice, "The TE and TM nomenclature is American and the E and H nomenclature is British." The latter form is therefore used in this book.

For the higher wave types and for the circular waveguide the synthetic method does not go far, and here the various formulae are simply quoted without proof.

The fourth chapter gives details of the use of bends, couplings, etc., and of some associated microwave apparatus. Again the drawings are to be commended. It is to be doubted whether readers will appreciate the point of the choke coupling from the description. The principle of transference of poor contact from a low-impedance to a high-impedance point is not mentioned.

Chapter 5 occupies one-third of the book and is concerned firstly with impedance in waveguides, then with the effect of obstacles, irises, junctions, etc. in terms of impedance. Next propagation in corrugated waveguides, a recent and important aspect, is considered, and finally the important research work on slot couplings and radiating slots is briefly dealt with. The treatment of impedance based on standing-wave ratios is good, but trouble arises when on p. 119 total impedance is defined in terms of intrinsic impedance, with a reference to a later section §7.16. Some search locates this reference in §7.17, where one finds (p. 303) that the sides a, b of a guide become interchanged in the argument, resulting in the factor b/a becoming inverted in the formula for total impedance. Then on p. 196 the formula for total impedance (correct this time) is rightly used in connection with impedance matching, but this is continually referred to as intrinsic impedance and the symbol for intrinsic impedance is used in the formula. On p. 137 in the formula for the admittance of an inductive iris the factor λ_g/W is omitted, but the reader has no means of detecting this error since the formula is quoted without proof.

The next chapter on cavity resonators and their applications is clear, but suffers from the simplified treatment which leads the author to state that the lowest E-mode in a rectangular resonator is the E_{111}, whereas in fact it is the E_{110}. Again the E_{011}-type appears as the lowest E-mode in the cylindrical resonator, instead of the E_{010}. The latter is an important wave type in this resonator, but appears only casually some pages later.

The final chapter, in the form of appendices, is strictly mathematical, being intended as a more formal approach to the subject, and in it most of the results previously quoted are proved. The author has adopted the best approach through the Hertzian vectors, and the treatment for the various solutions of the wave equation is quite standard. Once again, however, resonators prove a stumbling block, for the characteristic values given for the spherical cavity contain errors: on p. 275 the value 5.8 quoted for ρ_{11} is actually that for ρ_{21}, and should be 4.49. The value for ρ_{12} should be 7.64, not 7.72. The chapter continues with short treatments of diverse subjects of which the most interesting are Babinet's principle and Lorentz's reciprocal theorem.

The physical approach, using only simple mathematics, is maintained up to the last chapter and the result is very clear, but the reviewer feels that the relevant parts of the rigid treatment would have had a much better chance of being read and understood had they been mixed in throughout the book. It is a pity that so many errors should have been allowed to mar an otherwise excellent book. Unfortunately the simplified approach, which uses so much material proved only in the last chapter, makes it difficult for the reader to detect these errors.

The material is quite up-to-date; in fact much of the work has hitherto been contained in secret reports, which are only now appearing in various journals.

The author's position during the war has kept him in close touch with both the theoretical and the experimental sides, so that the book is essentially practical—one can hardly blame it for being a little biased towards T.R.E. practice. A pleasing feature is the number of calculations involving actual experimental results.

The printing and binding are good, and this, with the other books of the series, should form a handsome addition to British technical literature.

H.R.L.L.

Guide to Broadcasting Stations (3rd Edition)

Pp. 64. Compiled by *Wireless World*, Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1. Price 1s. (postage 1d.).

WIRELESS PATENTS

A Summary of Recently Accepted Specifications

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

DIRECTIONAL AND NAVIGATIONAL SYSTEMS

584 496.—Radiolocation system of the frequency-modulated type in which distance is indicated by the relative amplitude of the sidebands grouped around two selected harmonic frequencies.

Sperry Gyroscope Co. Inc. (Assignees of R. H. Varian). Convention date (U.S.A.) 10th April, 1943.

584 573.—Cathode-ray direction-finder in which the radius of the circular time-base is momentarily increased near the critical phase-position.

Svenska Akt. Gas Accumulator. Convention date (Sweden) 4th January, 1944.

584 606.—Relaxation circuit for generating marking-pulses and scanning-waves for measuring time-intervals on a c.r. indicator, say in radiolocation.

Standard Telephones and Cables Ltd. (Communicated by International Standard Electric Corpn.) Application date 24th November, 1943.

584 670.—Radio-navigational system in which the pulses radiated from a fixed transmitter are automatically modulated by the corresponding echo-signals from an aeroplane in such a way as to indicate to the pilot whether or not he is keeping to a pre-determined course.

A. H. Reeves and F. C. Williams. Application date 1st October, 1943.

584 727.—Radio-navigational system in which two or more spaced transmitters radiate waves which produce a radiation-pattern to allow the pilot of a moving craft to identify his position in terms of their relative phasing.

H. F. Schwarz, W. J. O'Brien, and Decca Radio and Television Ltd. Application date 4th June, 1941.

584 786.—Radiolocation system in which the exploring pulses from a central transmitter are time-modulated to convey signals indicative of the bearing and distance of a target to outlying stations.

Standard Telephones and Cables Ltd. and W. A. Beatty. Application date 29th December, 1939.

584 848.—Skiatron type of c.r. tube arranged for the large-scale reproduction of positional data derived, say, from radiolocation equipment.

R. A. R. Tricker, A. Tutchings, J. C. C. Stewart and C. S. Wright. Application date 14th April, 1943.

585 057.—Deriving a monitoring-signal, and preventing undesirable interaction, in a d.f. system in which N.S. and E.W. signals are fed through separate amplifiers to a cathode-ray indicator.

Amalgamated Wireless (Australasia) Ltd. Convention date (Australia) 10th July, 1943.

585 207.—Radiolocation equipment in which a klystron oscillator is operated at one natural frequency for the transmitted pulses, and at another natural frequency for heterodyning the echo-signals.

J. Sayers, M. L. E. Oliphant and C. S. Wright. Application date 5th March, 1941.

585 347.—Radiolocation system of interrogation and response for establishing the identity of unknown mobile craft in which the required information is masked from unauthorized listeners.

F. C. Williams. Application date 13th March, 1943.

585 353.—Super-regenerative receiver, particularly for the i.f.f. system in a radiolocation set, in which the "prevailing-noise" voltage is utilized to control stability (divided from No. 585 347).

F. C. Williams. Application date 13th March, 1943.

585 393.—Course-indicating system of the overlapping-beam type designed to provide maximum discrimination between the "on-course" and "off-course" signals.

Marconi's W.T. Co. Ltd. and E. Green. Application date 27th January, 1944.

585 473.—Radiolocation device of the variable-frequency type in which a grounded-grid triode is used to develop the required beat frequency between outgoing and reflected signals.

Standard Telephones and Cables Ltd. and E. O. Willoughby. Application date 1st August, 1944.

585 656.—Blind-landing system, in which the aircraft is steered by the beacon signals when "off-course," and by a magnetic compass or gyroscope when "on-course."

N. F. S. Hecht and G. W. H. Gardner (Secret Patent first published 29th January 1947). Application date 24th May, 1938.

RECEIVING CIRCUITS AND APPARATUS

(See also under Television)

585 365.—Method of stabilizing the frequency of a tunable circuit comprising capacitances, reactances, and inductances in shunt.

A. C. Lynch. Application date 10th July 1944.

585 588.—Frequency-discriminating circuit, including a valve with a reverse feedback reactance, for receiving frequency-modulated signals.

Marconi's W. T. Co. Ltd. (assignees of M. G. Crosby). Convention date (U.S.A.) 27th April, 1943.

585 613.—Super-regenerative circuit for selecting a desired train of signal-pulses from other pulses, and from fortuitous disturbances.

Standard Telephones and Cables Ltd. and C. W. Earp. Application date 15th September, 1944.

585 624.—Receiver with an input circuit designed to allow conveniently the alternative use of a rotatable frame-aerial or an outside aerial.

A. F. Burgess (communicated by Zenith Radio Corpn.). Application date 24th October, 1944.

585 723.—Receiver in which the tuning is periodically swept over a wide frequency-range to give a cathode-ray indication of the presence of all signals within that range.

Auto-Ordnance Corpn. Convention date (U.S.A.) 20th July, 1943.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

584 494.—Rotary-disc or shutter device for protecting the fluorescent screen of a television tube from extraneous light.

The General Electric Co. Ltd., and L. C. Jesty. Application date 28th February, 1944.

584 916.—Reducing "flicker" in a television receiver where light from a separate source is projected through a sensitive fluid-film, which is scanned by an electron stream.

Ges. Zur Forderung Der Forschung &c., Technischen Hoch Schule. Convention date (Switzerland) 25th January, 1943.

584 969.—Arrangement of the focusing and deflecting electrodes in a television tube of the mosaic-screen type.

Western Electric Co. Inc. Convention date (U.S.A.) 30th January, 1943.

584 970.—Construction and method of scanning the mosaic screen of a television transmitting tube.

Western Electric Co. Inc. Convention date (U.S.A.) 30th January, 1943.

584 997.—Television system in which the signals generated on one mosaic screen are fed to a second screen, where they are reversely scanned, in order to offset the so-called "tilt" effect.

H. G. Lubszynski. Application date 16th March, 1944.

SIGNALLING SYSTEMS OF DISTINCTIVE TYPE

585 263.—Multiplex signalling system in which a number of interleaved pulse-trains are produced by keying a frequency-modulated carrier-wave.

Standard Telephones and Cables Ltd. (assignees of L. Dubin). Convention date (U.S.A.) 12th February, 1944.

585 688.—Frequency-selective arrangement, comprising two resonant circuits of equal tuning, but different magnification factors, the output from each being combined in opposition, for multi-channel signalling.

B. M. Hadfield. Application dates 22nd May and 28th October, 1944.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

584 334.—Cathode-ray tube with two or more target electrodes for use in phase or frequency modulation.

The Telephone Manufacturing Co. Ltd. and W. Saraga. Application date 20th September, 1944.

584 787.—Construction lending itself to the mass-production of ultra-high-frequency oscillators of the resonant cavity-type.

The British Thomson-Houston Co. Ltd. Convention date (U.S.A.) 28th March, 1942.

584 944.—Velocity-modulation tube in which a magnetized ring is arranged to be rotated in order to align the electron stream with respect to an aperture in the hollow resonator.

Ferranti Ltd., W. R. J. Mayes and E. J. Whitmore. Application date 26th June, 1944.

585 208.—Construction of high-powered klystron oscillator in which the hollow resonators are formed in a block-anode and the electron-stream is confined to a relatively-thin lamina.

J. Sayers, M. L. E. Oliphant and C. S. Wright. Application date 5th March, 1941.

585 447.—Construction of high-frequency triode in which the control-grid is formed with an external disc which acts as a screen between resonant transmission-line input and output circuits.

Standard Telephones and Cables Ltd. and S. G. Tomlin. Application date 10th May, 1941.

585 448.—Construction of high-frequency amplifier wherein the anode and cathode are contained in separate envelopes, associated with a metallic disc to which the grid is connected.

Standard Telephones and Cables Ltd. and J. Foster. Application date 13th June, 1941.

585 449.—Construction of a high-frequency amplifier in which an external screening-disc is sealed-in, through the glass envelope, into contact with the grid.

Standard Telephones and Cables Ltd., F. D. Goodchild and W. H. Wolsey. Application date 24th October 1941.

SUBSIDIARY APPARATUS AND MATERIALS

584 810.—Means for minimizing eddy-currents in a magnetic induction chamber for accelerating the speed of electrons over a circular orbit.

The British Thomson-Houston Co. Ltd. Convention date (U.S.A.) 10th September, 1943.

585 066.—Adjustable transmission-line element designed to give maximum electrical length for a given geometrical length.

Hazeltine Corporation (assignees of H. A. Wheeler). Convention date (U.S.A.) 28th January, 1944.

585 151.—Hand appliance, comprising a hollow resonator and adjustable plunger, for measuring wavelengths of the order of centimetres.

The General Electric Co. Ltd., W. A. Bourne and R. W. Sloane. Application date 13th October, 1943.

585 419.—Phase-shifting device for stabilizing the operation of a relay comprising a galvanometer, a gas-filled amplifier and a photo-electric cell.

D. C. Gall. Application date 4th August, 1944.

585 478.—Electronic switching circuit, reponsive to a train of pulses, and adapted to count or give an indication of the frequency of the switching wave.

Standard Telephones and Cables Ltd. and J. D. Weston. Application date 1st September, 1944.

ABSTRACTS AND REFERENCES

Compiled by the Radio Research Board and published by arrangement with the Department of Scientific and Industrial Research

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. The abbreviations of the titles of journals are taken from the World List of Scientific Periodicals. Titles that do not appear in this List are abbreviated in a style conforming to the World List practice.

ACOUSTICS AND AUDIO FREQUENCIES

: 534 3386

eferences to Contemporary Papers on Acoustics. Taber Jones. (*J. acoust. Soc. Amer.*, March , Vol. 19, No. 2, pp. 374–388.) Continuation of of August.

21 3387

he Propagation of an Acoustic Wave along a ndary.—I. Rudnick. (*J. acoust. Soc. Amer.*, h 1947, Vol. 19, No. 2, pp. 348–356.) The d field of a point source near the boundary of media cannot be obtained by assuming plane es and using the plane wave reflection cient. A more rigorous solution is obtained ar to that given by Sommerfeld for the ogous electromagnetic case. The discussion of solution is restricted to cases in which the d source is at the boundary. It is shown that the boundary medium has a high real specific stic impedance, non-zero fields are obtained at oints along the boundary. Calculations of the d pressure as a function of height, when the a are air above and Quietone (an absorbing rial) below, reveal a minimum some distance the boundary.

13 3388

pagation of Sound through a Liquid containing es.—E. L. Carstensen & L. L. Foldy. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 481–501.) "Experimental data on the transmission, scattering, and reflection of sound by screens of bubbles are presented and shown to agree with theory. A parameter, related to the damping of acoustic energy by bubbles and which cannot be satisfactorily predicted from theory, is evaluated empirically from the data."

534.231 : 621.396.11 3389

A Device for plotting Rays in a Stratified Medium.—A. W. Lawson, P. H. Miller, Jr, & L. I. Schiff. (*Rev. sci. Instrum.*, Feb. 1947, Vol. 18, No. 2, pp. 117–120.) A description of an instrument used during the war for the computation of sound fields in water; it could also be applied to the propagation of radar signals in a stratified atmosphere.

534.26 3390

Sound Diffraction by Rigid Spheres and Circular Cylinders.—F. M. Wiener. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 444–451.) Measurements with a probe microphone gave agreement with theory for a sphere over the range $1/3 < ka < 10$ where k is the wave number of the incident wave and a the radius. Similar results were obtained for a cylinder. Tables of results are given for the cylinder showing the magnitude and phase of the pressure at the surface of the obstacle relative to the undisturbed sound pressure.

534.321.9 3391

Measurement and Specification of Ultrasonic Lenses.—P. J. Ernst. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, p. 474.) Methods analogous to those approved in optics are suggested.

534.321.9 : 621.317.49 3392

Comparison of Supersonic Intensities by means of a Magnetostriction Gauge.—Smith & Weimer. (*See* 3580.)

534.321.9 : [666.1 + 669.71 3393

Attenuation and Scattering of High Frequency Sound Waves in Metals and Glasses.—W. P. Mason & H. J. McSkimin. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 464–473.)

534.322.1 : 621.395.623.8 3394

Identification of Musical Instruments when heard directly and over a Public-Address System.—H. V. Eagleson & O. W. Eagleson. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 338–342.) Comparison of the success of two groups of musicians and one group of non-musicians in identifying nine different musical instruments (*a*) directly and (*b*) over a public-address system.

534.41 + 534.781 3395
The Portrayal of Visible Speech.—J. C. Steinberg & N. R. French. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 215.) Summary of 3516 of 1946.

534.41 + 534.781 3396
The Sound Spectrograph.—W. Koenig, H. K. Dunn & L. Y. Lacy. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 214.) Summary of 3517 of 1946.

534.41 + 534.781] : 535.37 3397
Visible Speech Translators with External Phosphors.—H. Dudley & O. O. Gruenz, Jr. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 213.) Summary of 3519 of 1946.

534.41 + 534.781] : 621.385.832 3398
Visible Speech Cathode-Ray Translator.—R. R. Riesz & L. Schott. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 214.) Summary of 3520 of 1946.

534.417 : 620.193.85 3399
Some Acoustic Properties of Marine Fouling.—J. W. Fitzgerald, M. E. Davis & B. G. Hurdle. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 332–337.) Quantitative measurements of the acoustic effects of fouling of underwater transducers by marine organisms. The acoustic attenuation of certain anti-fouling paints is found to be negligible.

534.43 : 621.395.61 3400
Measurement of Mechanical Compliance and Damping of Phonograph Pick-Ups.—B. B. Bauer. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 319–321.) The apparatus described can be adapted to measure vertical as well as lateral compliance and resistance of pickups, and the mechanical impedance of certain types of structures and damping materials.

534.612.4 3401
Measurement of Electromotive Force of a Microphone.—R. K. Cook. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 503–504.) A discussion of the conditions under which, in the substitution method, the calibrating voltage equals the microphone e.m.f. The analysis is limited to a linear electromechanical transducer operated at a frequency low enough to permit the use of lumped parameters.

534.64 3402
Some Notes on the Measurement of Acoustic Impedance.—L. L. Beranek. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 420–427.) A modified form of an earlier impedance tube (1410 of 1942) is described, capable of measuring the normal impedance of a sample by the variable length, variable frequency or travelling microphone methods. Diagrams are given for the graphical calculation of the impedance from the measurements.

534.78 : 621.396.645 3403
The Theory and Design of Speech Clipping Circuits.—Dean. (*See* 3477.)

534.782 3404
On an Artificial Voice for Acoustic Measurements.—P. Chavasse. (*C. R. Acad. Sci., Paris*, 9th June 1947, Vol. 224, No. 23, pp. 1620–1622.) Essentially a source of current with a continuous and uniform spectrum, formed by a neon tube working in a zone of unstable equilibrium. The tube is polarized by a d.c. voltage through a resistor and capacitor favouring l.f. oscillations. Change from a male voice, with a maximum voltage near 550 c/s, to a female voice, with maximum near 1 100 c/s, is effected by a simple switch.

534.83 : 629.135 3405
Acoustical Materials and Acoustical Treatments for Aircraft.—R. H. Nichols, Jr, H. P. Sleeper, Jr, R. L. Wallace, Jr, & H. L. Ericson. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 428–443.) A comprehensive paper on the methods of reducing the cabin noise level. The functional properties of various treatments in attenuating the transmitted sound and in absorbing reverberant sound are considered in detail and a method for estimating the effectiveness of a material from the 'flow resistance' is described.

534.84 3406
Acoustical Tests in the Scala Theater of Milan.—E. Paolini. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 346–347.) A short account of tests conducted in the rebuilt theatre. They include tests for echoes, reverberation, articulation and loudness levels.

534.851 + 534.861] : 621.396.813 3407
High-Fidelity Reproduction of Music.—E. Toth. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 108–113.) Practical suggestions for reducing various types of distortion which occur in a.m. and f.m. receivers and in gramophone record reproduction.

534.851 : 621.395.625.2 3408
A Distortion Reducing Stylus for Disk Reproduction.—E. F. McClain, Jr. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 326–328.)

534.861/.862].1 3409
Recording Studio Acoustics.—L. Green, Jr, & J. Y. Dunbar. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 412–414.) Summary noted in 2307 of August. A general discussion, with some details of the treatment of several studios to obtain improved reverberaton characteristics.

534.861/.862].1 3410
Convex Wood Splays for Broadcast and Motion Picture Studios.—M. Rettinger. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 343–345.) Summary noted in 2307 of August.

534.861.1 3411
A Review of Criteria for Broadcast Studio Design.—H. M. Gurin & G. M. Nixon. (*J. acoust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. 404–411.) Summary noted in 2307 of August.

534.862.3"1857/1926" 3412
Historical Development of Sound Films: Parts 1 & 2.—E. I. Sponable. (*J. Soc. Mot. Pict. Engrs*, April 1947, Vol. 48, No. 4, pp. 275–303.) A review covering the period 1857–1926.

621.395.61 3413
Mechano-Electronic Transducers.—H. F. Olson. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 307–319.) Summary noted in 2307 of August. See also 2624 of August. A system whereby a voltage is developed by the direct action of acoustical vibrations on one of the electrodes of a valve.

[T]he vibrating element can be made very small, [w]ith a low mechanical impedance. Various [e]lectrode arrangements are discussed and expres[si]ons derived for their electrical characteristics. [F]or small amplitudes the output voltage is pro[p]ortional to the displacement. Equivalent mechani[ca]l circuits are shown and discussed in relation to [th]e amplitude/frequency characteristic. A success[fu]l transducer is illustrated, consisting of a small [d]iode in which the anode is the vibrating element. [D]etails are also given of a gramophone pickup [an]d two microphones. Their response character[ist]ics are derived theoretically from the equivalent [m]echanical circuits and measured characteristics [ar]e shown.

[62]1.395.625.2 **3414**

[Tech]nics of Sound Recording with Embossed [Gr]oove Methods.—L. Thompson. (*Tele-Tech*, May [19]47, Vol. 6, No. 5, pp. 48–51..115.) Discusses [th]e advantages of these methods for business use. [Re]asonable fidelity and volume are obtained at [lo]w track speed. Photographs and frequency [res]ponse curves are given.

[62]1.395.625.3 **3415**

Some Factors influencing the Choice of a Medium [for] Magnetic Recording.—L. C. Holmes. (*J. [Ac]ust. Soc. Amer.*, May 1947, Vol. 19, No. 3, pp. [39]5–403.) Summary noted in 2307 of August. [A] definition of signal/noise ratio for magnetic [rec]ording systems is offered to stimulate discussion. [Mo]dulation noise, background noise, cross talk and [uni]formity are considered. The ratio of coercivity [to] retentivity is suggested as a figure of merit for [eva]luating the h.f. response of a recording medium.

[621].395.625.3 : 778.5 **3416**

[R]ecent Developments in Magnetic Recording [on] Motion Picture Film.—M. Camras. (*J. acoust. [Soc]. Amer.*, March 1947, Vol. 19, No. 2, pp. 322–325.)

[621].395.625.6 : 534.862.4 **3417**

[A] New Method of counteracting Noise in Sound-[Fil]m Reproduction.—W. K. Westmijze. (*Philips [Tech]. Rev.*, April 1946, Vol. 8, No. 4, pp. 97–104.) [Wh]en the incident light beam is replaced by a series [of e]quidistant light spots moving with high velocity [per]pendicular to the sound track, noise arising from [dus]t and scratches on the film is considerably [red]uced.

[621].395.645 : 621.395.614] : 621.395.623.8 **3418**

[M]icrophone Pre-Amplifier.—Selby. (*See* 3457.)

[621].395.813 : 621.395.66 : 621.396.97 **3419**

[C]ompensation of Temperature Effects on Music [Circ]uits.—F. J. Stringer & G. Stannard. (*B.B.C. [Qua]rt.*, April 1947, Vol. 2, No. 1, pp. 41–50.) An [acc]ount of apparatus and technique developed by [the] B.B.C. and G.P.O. to compensate for changes [in] response characteristics of long-distance line [circ]uits due to seasonal changes in temperature. [The]se changes in response characteristics are calcu[late]d theoretically and compared with actual [mea]surements made on particular circuits.

AERIALS AND TRANSMISSION LINES

[621.]315.687 **3420**

[C]able Terminations.—D. B. Irving. (*J. Instn [Elect]. Engrs*, Part II, April 1947, Vol. 94, No. 38, [pp.] 123–128.) Discussion on 3360 of 1945.

621.392+537.291] : [621.385.029.63/.64 **3421**

On the Theory of Progressive-Wave Amplifiers.—A. Blanc-Lapierre, R. Lapostolle, J. P. Voge & R. Wallauschek. (*Onde élect.*, May 1947, Vol. 27, No. 242, pp. 194–202.) An integration and amplification of previous papers (1317 and 1330 of May, 1999 and 2003 of July).

621.392.029.64 **3422**

Wave-Guide Coupler.—G. Ashdown. (*J. sci. Instrum.*, March 1947, Vol. 24, No. 3, p. 79.) For aligning and joining sections.

621.392.029.64 **3423**

Transmission in Waveguides.—A. M. Woodward. (*Wireless Engr*, July 1947, Vol. 24, No. 286, pp. 192–196.) "The theory of transmission of an H_{01} wave in a rectangular waveguide containing longitudinal slabs of solid dielectric is developed. Formulae are given for phase constant and attenuation which take into account imperfect conductivity of the guide walls as well as losses in the dielectric. Numerical values are given for polythene as dielectric. At high frequencies most of the energy travelling down the guide is confined to the dielectric slabs. The phase constant and attenuation are then nearly equal to their values for a completely-filled guide."

621.392.2 **3424**

Use of [transmission] **Lines as Resonant Circuits.**—A. Fournier. (*Rev. sci., Paris*, 1st/15th Dec. 1946, Vol. 84, Nos. 3262/3263, pp. 624–629.) The lines are considered as having lumped constants and the equations of propagation are derived. Other sections discuss (*a*) characteristic impedance, (*b*) reflection of waves and stationary waves, (*c*) impedance transformation, (*d*) equivalence of quarter-wave line and resonant circuit, (*e*) lines matched to valve capacitances, (*f*) charged lines, (*g*) coupled lines and (*h*) link coupling.

621.396.67 **3425**

Circularly-Polarised Omnidirectional Antenna.—G. H. Brown & O. M. Woodward, Jr. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 259–269.) The combination of a vertical dipole and horizontal loop requires too critical adjustment. Four dipoles spaced around the circumference of a horizontal circle and inclined to its plane give a good approximation. A theoretical discussion is followed by the results of tests over a frequency range of 106–134 Mc/s.

621.396.67 **3426**

Antenna Focal Devices for Parabolic Mirrors.—G. Reber. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 731–734.) The measured characteristics of cone and cylindrical aerials in parabolic mirrors are given. The relationships between geometrical and electrical characteristics are discussed.

621.396.67 **3427**

Gain *vs.* Element Spacing in Parasitic Arrays.—R. G. Rowe. (*QST*, April 1947, Vol. 31, No. 4, pp. 30–35.) Results are given of measurements showing the relation between gain and spacing under controlled conditions and with a definite technique. Wider spacing than is commonly used is shown to give greater gain.

621.396.67 3428
Input Impedance of a Folded Dipole.—W. van B. Roberts. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 289–300.) A theoretical discussion of the cases in which the dipole has equal and unequal elements. Consideration is also given to finite spacing of the elements.

621.396.67 : 517.512.2 3429
Fourier Transforms in Aerial Theory : Part 2.—Ramsay. (*See* 3561.)

621.396.67 : 621.317.772.029.64 3430
Phase-Front Plotter for Centimeter Waves.—Iams. (*See* 3590.)

621.396.67 : 621.396.712 : 621.396.619.13 3431
Antennas for F.M. Broadcasting : Part 2.—N. Marchand. (*Communications*, May 1947, Vol. 27, No. 5, pp. 24–26 . . 37.) Discussion of the principles of operation and construction of the clover-leaf, slot, and turnstile aerials. For part 1 see 3030 of October.

621.396.67.002.72 : 621.397.5 3432
The WABD Super-Turnstile TV Antenna Installation.—A. W. Deneke. (*Communications*, May 1947, Vol. 27, No. 5, pp. 12–15 . . 38.) Consideration of the factors influencing the installation and testing of an aerial and feeder system on an 80-ft. tower on the roof of a skyscraper.

621.396.67.029.62 : 621.396/.397].62 3433
Aerials for Ultra-Short Waves : Part 1 — A Double Dipole for Television and F.M.—R. D. A. Maurice. (*B.B.C. Quart.*, April 1947, Vol. 2, No. 1, pp. 59–62.) The dipole receives 45-Mc/s and 90-Mc/s transmissions simultaneously. Its performance when suitably oriented differs little from that of an ordinary dipole.

621.396.672.029.62 : 621.396.65 3434
Aerials for Ultra-Short Waves : Part 2 — A Simple Omnidirectional Aerial with Concentric Feeder.—H. L. Kirke. (*B.B.C. Quart.*, April 1947, Vol. 2, No. 1, pp. 62–64.) An end-fed, vertical $\lambda/4$ folded dipole is used to ensure correct impedance matching to the feeder ; this is particularly important for the receiving aerial in u.s.w. radio links. A circular polar diagram is obtained by means of an 'artificial earth'.

621.396.675 : 550.837 3435
Electric Field of an Oscillating Dipole on the Surface of a Two Layer Earth.—A. Wolf. (*Geophys.*, Oct. 1946, Vol. 11, No. 4, pp. 518–534.) "The electric field of a low frequency oscillator placed on the surface of a two layer earth is determined in two special cases, namely, the case in which the conductivities of the two layers are nearly equal, and the case in which the lower layer is a perfect insulator ; in the latter case, only terms of zero and first order in frequency are considered. It is shown that, when the upper layer is sufficiently thin or is very thick, the mutual inductance of two wire elements on the surface of a two layer earth has the same value as for a homogeneous earth. In the case of an insulated layer, it is shown that the maximum departure of the value of mutual inductance of two colinear wire elements from the corresponding value on a homogeneous earth is 35%."

621.396.675 : 550.837 3436
Electric Field of an Oscillating Dipole at the Surface of a Two Layer Earth.—W. B. Lewis. (*Geophys.*, Oct. 1946, Vol. 11, No. 4, pp. 535–537.) Discussion of 3435 above. Field measurements of the transverse component E_y of the dipole field show that its value is dependent on frequency, whereas according to Wolf's rigorous solution (above) E_y should be independent of frequency. The experimental results are in agreement with the solution of the problem of a dipole oscillator in a homogeneous medium. The disagreement of the measurements with the more rigorous theory and the agreement with theory that neglects the air-earth boundary is paradoxical.

621.396.679.4 3437
Choosing a Transmission Line.—R. M. Purinton. (*QST*, June 1947, Vol. 31, No. 6, pp. 39–44, 118.) A comparison of various types of feeders and considerations governing the choice for particular installations.

621.396.677 : 621.396.97 3438
Directional Antennas [Book Review]—C. E. Smith. Cleveland Institute of Radio Electronics, Cleveland, 1946, 298 pp., $15.00. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, p. 706.) " . . . Of particular interest to those concerned with the design of vertical-tower directional antennas for broadcast stations. A thorough, systematic engineering treatment. . . ."

CIRCUITS AND CIRCUIT ELEMENTS

621.314.23 : 621.396.69 3439
Toroidal Transformers.—A. L. Morris. (*Electronic Engng*, July 1947, Vol. 19, No. 233, pp. 218–219.) These can effect a considerable saving in space and weight. Special winding machines are required and insulation and winding difficulties may be encountered in high-voltage windings, but toroids are very suitable for multi-winding filament transformers, especially in aircraft equipment where supply frequencies of 400 or 1600 c/s are used and the number of turns in each winding can be correspondingly reduced. Developments in silicon-iron core material may make toroids advantageous for 50 c/s working. For an account of a winding machine, see 3672 below.

621.316.722.1.076.7 3440
Diode-Controlled Voltage Regulators.—L. Helterline. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 96–97.) Circuit details of a bridge-type regulator, in which the filament of a temperature-limited diode acts as control element. A.c. output voltage is constant within 0.2% over a 10 : 1 load variation. The stability of a d.c. version equals that of batteries.

621.316.89 + 621.315.59 3441
Properties and Uses of Thermistors—Thermally Sensitive Resistors.—J. A. Becker, C. B. Green & G. L. Pearson. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, pp. 170–212.) Reprint of 765 of March.

621.318.323.2.042.15 3442
Permeability of Dust Cores.—Legg. (*See* 3555.)

621.318.572 3443
Self-Switching R.F. Amplifier.—H. M. Wagner & . F. Herrick. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 128–131.) A twin pentode multivibrator ircuit amplifies and automatically switches two ircuits into a common indicator for direction nding purposes. Design considerations, switching atios and input resistance variations are discussed.

21.318.572 3444
Vane-Actuated Controller.—W. H. Wannamaker, r. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 17–119.) Movement of a vane between the coils a double triode r.f. oscillator causes a sudden hange of anode current, which actuates an output elay. Full circuit details are given, with several ndustrial applications.

21.318.572 : 621.317.755 3445
A Laboratory Four-Channel Electronic Switch.— . S. Replogle, Jr, & V. M. Albers. (*Rev. sci. nstrum.*, Feb. 1947, Vol. 18, No. 2, pp. 114–117.) ermits the simultaneous presentation of four gnals of frequency up to 100 kc/s on a c.r.o. screen. ee also 1780 of 1946 (Moerman).

.1.319.53 3446
A Simple Pulse Converter for Gas Tube Applica- ons.—L. Reiffel & K. Rothschild. (*Rev. sci. strum.*, March 1947, Vol. 18, No. 3, pp. 181–183.) ulses of either polarity are fed through a resist- ce network to the screen grid of a thyratron, hose electrodes are biased to give monopolar tput pulses. The anode circuit is used to provide lse shaping.

1.392.2 3447
Use of [transmission] **Lines as Resonant Circuits.**— urnier. (*See* 3424.)

1.392.21 3448
On the Short-Circuiting of a Charged Transmission ie.—V. L. Ginzburg. (*Bull. Acad. Sci. U.R.S.S., . phys.*, 1946, Vol. 10, No. 1, pp. 57–64. In ssian.) A transmission line with uniformly tributed circuit parameters is considered. tially it is open-circuited and charged. A general ation is derived for the self-oscillations in the when short-circuited through a loading induc- ice, and solutions are found for two particular ues of this inductance.

.392.43 : 621.396.615.141.2 3449
Microwave Generator.—W. C. Brown. (*Tele- h*, May 1947, Vol. 6, No. 5, p. 59.) Summary of .E. paper. The effect of a mismatched trans- ssion line on the frequency stability and power put of a magnetron is studied by means of an ivalent circuit.

.392.5 : 621.396.622.6 3450
rystal Networks.—L. Apker, E. Taft & J. Dickey. *le-Tech*, May 1947, Vol. 6, No. 5, p. 54.) Sum- y of I.R.E. paper. Discusses the case where the rtion loss of a nonlinear quadripole is different power transmitted in opposite directions. ults of tests on 20 Si and Ge crystals are given.

.392.5.015.3 3451
etwork Distortion.—M. J. DiToro. (*Tele-Tech* 1947, Vol. 6, No. 5, pp. 55–56.) Summary of .E. paper. The transient response of a network step signal may be used as a measure of the distortion to be expected. Curves to facilitate the study of transient response are shown together with design data for correcting networks.

621.392.52 3452
A Simplified Analysis of the Parallel-T Null Network.—M. P. Givens & J. S. Saby. (*Rev. sci. Instrum.*, May 1947, Vol. 18, No. 5, pp. 342–346.) "The parallel-T resistance-capacitance null net- work is analyzed algebraically. General conditions for null, and expressions for network impedance and sharpness of null, are obtained in a convenient form for application to practical design problems. Vector diagrams are used to illustrate the variations of phase and amplitude of output voltage with frequency."

621.392.52 3453
Analysis of a Resistance-Capacitance Parallel-T Network and Applications.—A. E. Hastings. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, p. 694.) Correction to 1464 of 1946.

621.394/.397].645 3454
Cathode-Follower Circuit.—H. L. Krauss. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, p. 694.) Comment on 1025 of April (McIlroy). See also 1373 of May.

621.394/.397].645 : 518.3 3455
Cathode Follower Nomograph for Pentodes.—M. B. Kline. (*Electronics*, June 1947, Vol. 20, No. 6, p. 136.) Gives relation between gain, transcon- ductance and cathode load resistance.

621.394/.397].645.34 3456
A Variation on the Gain Formula for Feedback Amplifiers for a Certain Driving-Impedance Con- figuration.—T. W. Winternitz. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 216.) Summary of 50 of January.

621.395.645 : 621.395.614] : 621.395.623.8 3457
Microphone Pre-Amplifier.—R. Selby. (*Wireless World*, July 1947, Vol. 53, No. 7, pp. 239–240.) Cathode-follower circuit suitable for public address work.

621.395.661 3458
Mica Capacitors for Carrier Telephone Systems.— A. J. Christopher & J. A. Kater. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, p. 213.) Summary of 374 of February.

621.396.611.3.029.56 3459
Coupled-Circuit Oscillators.—D. K. Cheng. (*Tele- Tech*, May 1947, Vol. 6, No. 5, pp. 58–59.) Summary of I.R.E. paper. Measurements of wavelength and loading characteristics of a 2-Mc/s coupled-circuit oscillator show good correlation with theoretical predictions. Conclusions concerning the optimum degree of coupling and magnitude of the external load resistance are stated.

621.396.611.4 3460
The Simplest Design Calculations of Certain Cavity Resonators.—V. M. Lopukhin. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 111–116. In Russian.) Approximate formulae are derived for calculating the Q and impedance of the following resonators : simple toroidal (Fig. 1), quasi-toroidal (Fig. 2), π type (Fig. 3) and cylindrical (Fig. 4).

621.396.611.4 **3461**

On the Self-Excitation of a Cavity Resonator traversed by an Electron Beam.—S. Gvozdover & V. Lopukhin. (*Bull. Acad. Sci, U.R.S.S., sér.* phys., 1946, Vol. 10, No. 1, pp. 29–36. In Russian.)

621.396.611.4 **3462**

Coupling between Cavity Resonators through Small Apertures.—V. B. Brodski. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 17–22. In Russian.) A mathematical investigation of the effect on the fields inside two resonators of a small aperture in the common wall.

621.396.611.4 **3463**

Flat Cavities as Electrical Resonators.—C. G. A. von Lindern & G. de Vries. (*Philips tech. Rev*, May 1946, Vol. 8, No. 5, pp. 149–160.) The characteristic vibrations of Lecher systems short-circuited at one end are first considered. It is then shown that in the case of conical flat cavity resonators, short-circuited round their outer edge, the rotation-symmetrical vibrations correspond exactly to those of the short-circuited Lecher systems. The rotation-symmetrical vibrations of flat resonators of more general forms are discussed and curves are given for the variation of current and voltage with the radius. Resonance resistance and quality factor are calculated; these can be improved by making the cavity resonators thicker than those for which the theory given applies unconditionally. Examples are given of practical, resonators and of their use for h.f. stabilization or as output and input electrodes for short-wave transmitting valves.

621.396.611.4 **3464**

End Plate and Side Wall Currents in Circular Cylinder Cavity Resonator.—J. P. Kinzer & I. G. Wilson. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, pp. 31–79.) Formulae are given for the calculation of the current streamlines and intensity in the walls of a circular cylindrical cavity resonator. Tables are given which permit calculation for many of the lower order modes.

The integration of $\int_0^x [J_l(x)/J_l'(x)]dx$ is discussed and the integral is tabulated for $l = 1$, 2 and 3.

The current distribution for a number of modes is shown by plates and figures.

621.396.611.4 : 621.396.662.3.029.64 **3465**

Cavity Resonators.—M. W. Wheeler. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 60.) Summary of I.R.E. paper. Discussion of their characteristics and use as u.h.f. band-pass filters.

621.396.611.4.029.64 : 621.396.662 **3466**

3 cm Resonant Cavity.—R. R. Reed. (*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 54–55.) Summary of I.R.E. paper. A transmission-type cavity for use in an automatic frequency-control circuit. The resonant frequency is nearly independent of temperature and humidity effects and may be accurately pretuned. Source and load are coupled to the cavity by 'Kovarglass' windows; temperature compensation is effected by altering the length of the cavity by a flexible diaphragm moved by the differential expansion of copper and invar.

621.396.615 : 621.316.726.078.3 **3467**

Synchronization of Oscillators.—R. D. Huntoon & A. Weiss. (*Bur. Stand. J. Res.*, April 1947, Vol. 38, No 4, pp. 397–410.) An analysis of the behaviour of any self-limiting oscillator when a sinusoidal current or voltage of small but constant magnitude is injected into it. The synchronization band is proportional to the injected voltage. The theory was checked by measurements on a small Hartley oscillator at 11.5 Mc/s. The analysis includes the mutual synchronization of two oscillators. For synchronization measurements the driving oscillator must be more powerful than the test oscillator. Applications of the synchronized oscillator include (*a*) linear voltmeter for small voltages, (*b*) field-intensity meter, (*c*) linear a.m. demodulator for small signals, (*d*) f.m. demodulator, (*e*) f.m. synchronous amplifier limiter.

In these applications microwave generators can be used as well as the more conventional triode oscillators.

621.396.615.14 **3468**

The Excitation of Resonant Circuits by Electron Currents in the Transit-Time Domain.—F. W. Gundlach. (*Rev. sci., Paris*, 1st Jan. 1947, Vol. 85, No. 3264, pp. 19–28.) Translation into French of paper to appear in *Hochfrequenztechnik*. A method is described which gives the magnitude of both the in-phase and quadrature components of the circuit current induced by an electron current through a valve grid. The intensity and velocity of the electron current may vary in any periodic manner with time. The method is applicable to all possible cases and a series of abacs is provided. Application is made to the Barkhausen-Kurz oscillator.

621.396.615.14 **3469**

Band-Switched Exciter.—P. W. J. Gammon. (*Short Wave Mag.*, March 1947, Vol. 5, No. 1, pp. 16–20.) A switched-coil oscillator and frequency-doubler circuit for driving high-powered output stages on frequencies between 1.7 and 28 Mc/s.

621.396.615.142 **3470**

The Principles of a General Theory of the Generation of Electron Oscillations at Ultra High Frequencies.—V. I. Kalinin. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 93–102. In Russian.) 'Electron oscillations' are defined as oscillations the excitation of which depends ultimately on the inertia of electrons. A general scheme of the different phases in the excitation of such oscillations is presented in a graphical form (Fig. 1) and using Brüche and Recknagel's conception of 'phase focusing' (2325 of 1938) the foundations are laid of a theory which would not only explain the oscillation mechanism but also answer questions relating to the energy balance in an electron oscillator.

The first two fundamental equations (I and II) cover the kinetic side of the problem and determine respectively the current in the oscillator and the condition necessary for the formation of a focus. Two energy equations (III and IV) determining respectively the power output and efficiency of the oscillator are also derived.

The main factor determining the character of any particular modification of the oscillating system is the distribution and behaviour of potentials in the transformation zone where the velocity-modulated beam is subjected to the action of an electric field with a potential varying in space and time in a known manner. If the electric field is absent and the velocity-modulated beam is moving by inertia, the simplest case corresponding to a two-circuit klystron is obtained. Conclusions reached in udying this case are briefly enumerated and as a rther illustration of the proposed theory the eration of an oscillator with a retarding field in transformation zone is discussed in detail.

1.396.615.17 : 621.396.663 **3471**

On a Standardized Aperiodic Pulse Generator and Application to the Statistical Recording and diogoniometry of Atmospherics.—F. Carbenay. (*R. Acad. Sci., Paris*, 9th June 1947, Vol. 224, . 23, pp. 1624–1626.) Apparatus similar in nciple to that used by R. Bureau for atmospheric ording, but including a standardized variable uctive coupling between the capacitor discharge uit and either the aerial or the input circuit of receiver-recorder. Some circuit details are en and the methods of use and standardization briefly described.

.396.621.54 **3472**

he Inversion of the Autodyne Principle.— . Saic. (*Elektrotech. u. Maschinenb.*, Jan./Feb. , Vol. 64, Nos. 1/2, pp. 16–24.) A new type eterodyne arrangement is described in which oscillator frequency is fixed and the i.f. variable. nerous advantages are claimed. A scheme is n for an all-wave receiver incorporating the principle and giving an appreciable increase utput power.

96.622.71 **3473**

e Ratio Detector.—Seeley & Avins. (*See*)

96.645 **3474**

eory of Grounded Grid Amplifiers.—A. van der (*Philips Res. Rep.*, Nov. 1946, Vol. 1, No. 5, 81–399.) In part 1 a survey of the existing theory at u.h.f. is given. Neglecting lead s, the four characteristic impedances of a ded-grid triode at u.h.f. can be described by cold ' valve capacitances, the amplification μ and the transconductances S_1 and S_2 in cathode-grid lead and grid-anode lead tively (the moduli and the phase angles of transconductances can be measured). Shot in triode valves can be completely described suming two mutually dependent fluctuating nts i_1 and i_2 to be flowing in the cathode- ead and in the grid-anode lead respectively; .f. i_2 is delayed in phase with respect to introduction of these mutually dependent ting currents is a direct consequence of the r analysis of the shot effect). It is shown the introduction of the 'equivalent noise nce' of the valve may cause serious errors calculation of the signal/noise ratio.

art 2 this theory is applied to grounded- mplifiers. The input resistance R_1 of the when the output is short-circuited and the resistance R_2 of the valve when the input t-circuited, are of special importance in this Denoting the transformed aerial resistance and the transformed input resistance of the tage by R'_2, the power gain g is calculated function of R'_1/R_1 and R'_2/R_2. It is that the internal feedback of the valve it impossible to match at the same time the o the input of the amplifier and its output input of the next stage. The best results ained by using a high value of R'_1/R_1 (loose oupling) and matching the output of the amplifier to the next stage. The theoretical gain limit is $(\mu + 1)$; values between $0.5 (\mu + 1)$ and $0.8 (\mu + 1)$ may easily be obtained. For wide-band amplifiers $R'_1/R_1 = 1$ for maximum gain, whereas it is shown that a wide anode-grid spacing will give a higher gain. It is shown that electronic transit times cannot account for the drop in power gain at u.h.f.; this drop must be due to the impedance of the electrode leads. At u.h.f. instability may occur; a stability condition is given, from which it can be seen that careful shielding and narrow electrode spacings result in a better stability of the amplifier. Finally the signal/noise ratio of the grounded-grid amplifier is calculated and it is shown that the grounded-grid amplifier contributes only slightly to the noise, especially for large values of R'_1/R_1. This result is verified experimentally.

621.395.645 **3475**

Non-Stationary Processes in Tuned and Band-Pass Amplifiers.—A. N. Shchukin. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 37–48. In Russian.) A mathematical investigation of the processes taking place in amplifiers when a constant or an alternating e.m.f. is suddenly applied.

621.396.645 **3476**

A Note on a Paper by Faust and Beck.—W. M. Stone. (*J. appl. Phys.*, April 1947, Vol. 18, No. 4, pp. 414–416.) "An infinite sum transformation is defined and applied to a system of linear difference equations discussed by Faust & Beck in their paper on single tuned amplifiers [677 of March]. Some transforms of the more common functions are given and points of superiority of the transform method over the classical methods of solution of difference equations are emphasized."

621.396.645 : 534.78 **3477**

The Theory and Design of Speech Clipping Circuits.—M. H. Dean. (*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 62–65..119.) The action of a compressor in preventing overmodulation of a.m. transmitters is described, and is shown to be less effective than might be expected. Clipping speech peaks squarely at a pre-determined level, and inserting a low-pass filter to eliminate any harmonics caused thereby, is considered better, and the design of a clipper suitable for good commercial speech transmission is given.

621.396.645.029.3 **3478**

A Portable Two Channel Amplifier and Ink Recorder.—W. Grey Walter & A. A. Brooks. (*Electronic Engng*, July 1947, Vol. 19, No. 233, pp. 221–226.)

621.396.645.029.62 **3479**

Broad Band Amplifiers.—A. M. Levine & M. G. Hollabaugh. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 58.) Summary of I.R.E. paper. Calculations for input damping and instability due to feedback are outlined. Calculated and measured values are given for various valve types throughout the 30–300-Mc/s range. Measurements taken on actual amplifiers are displayed graphically.

621.396.645.029.63 **3480**

550 Megacycle Amplifier.—R. O. Petrich. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 59.) Summary of I.R.E. paper. A gain of 10 db for each of five stages has been obtained for a 20-Mc/s bandwidth, using a lighthouse triode in a grounded-grid amplifier circuit.

621.396.645.029.64 : 621.396.615.142.2 **3481**
On U.H.F. Amplification and on the Resonance Method for suppressing Noise in a Klystron.—Yu. A. Katsman. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 23–28. In Russian.) The use of klystrons at the input stage of a radio receiver at frequencies greatly exceeding 600 Mc/s is limited by the high level of valve noise. To overcome this difficulty it is suggested that a resonant oscillatory circuit absorbing the noise energy should be connected between the cathode and the input electrodes of the valve.

621.396.645.35 : 621.317.71⁺.72 **3482**
Stabilized D.C. Amplifier with High Sensitivity.—H. S. Anker. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 138, 140.) Designed to measure very small currents or voltages from a high-impedance source.

621.396.645.37 **3483**
Feed-Back Amplifiers.—J. A. Rado, A. M. Levine & M. G. Hollabaugh. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 55.) Summary of I.R.E. paper. Analysis of the generalized feedback amplifier shows that it can be regarded as a ladder network with negative conductance shunt arms. Mathematical analysis shows that these amplifiers have a gain-bandwidth capacity equal to that of an ideal amplifier. In actual amplifiers the ideal has been approached very closely.

621.396.645.37.029.3 **3484**
A Stable Selective Audio Amplifier.—J. M. Sturtevant. (*Rev. sci. Instrum.*, Feb. 1947, Vol. 18, No. 2, pp. 124–127.) A narrow-band amplifier using both frequency-dependent and independent degeneration to secure stability and linearity.

621.396.662 **3485**
Electronic Attenuators.—F. W. Smith, Jr, & M. C. Thienpont. (*Communications*, May 1947, Vol. 27, No. 5, pp. 20–22.) Continuously variable attenuation over a wide frequency range is achieved by varying the cathode load of a cathode follower. The influence of various factors on design is discussed and a typical attenuator described.

621.396.662.3.029.3 **3486**
Tuned A.F. Filters : Part 1.—H. E. Styles. (*Wireless World*, July 1947, Vol. 53, No. 7, pp. 242–244.) General considerations and design formulae.

621.396.69+621.317.7+621.38 **3487**
The Physical Society's Exhibition.—(*See* 3581.)

621.396.69 : 621.315.3 **3488**
Stamped Wiring.—W. MacD. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 82–85.) Basically, a series of vertical and horizontal conducting strips, separated by a thin sheet of insulator, with interconnection by eyelets or pins.

621.397.335 **3489**
New Techniques in Synchronizing-Signal Generators.—E. Schoenfeld, W. Brown & W. Milwitt. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 237–250.) The pulse edges are established by means of a terminated artificial transmission line carrying 31.5-kc/s trigger impulses and their number during each framing interval is determined by an electronic counter. The locked-in relationship between line and field scanning frequencies makes use of the cascade-binary type of frequency divider.

621.38/.39].01 **3490**
Fundamentals of Industrial Electronic Circuits. [Book Review]—W. Richter. McGraw-Hill Book Publishing Co., London and New York, 1947, 569 pp., 22s. 6d and $4.50. (*Elect. Rev., Lond.*, 6th June 1947, Vol. 140, No. 3628, p. 930 : *Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, p. 707.) The interest of the book is not confined to industrial electronics. The explanations of fundamentals and valves are so good that those mainly interested in radio would do well to study it. Intended as a text of intermediate standard for use in evening classes.

GENERAL PHYSICS

535.13 : 512.831 **3491**
On the Matrix Form of Maxwell's Equations.—J. Baudot. (*C. R. Acad. Sci., Paris*, 9th June 1947, Vol. 224, No. 23, pp. 1622–1624.) See also 2475 of August.

535.215 : 621.383.4 **3492**
Lead Sulphide Photoconductive Cells.—Sosnowski, Starkiewicz & Simpson. (*See* 3709.)

536.21 : 517.942.9 **3493**
Heat Conduction in Elliptical Cylinder and an Analogous Electromagnetic Problem.—N. McLachlan. (*Phil. Mag.*, March 1946, Vol. 37, No. 266, p. 216.) Correction to 3570 of 1946.

536.422 **3494**
The Escape of Molecules from a Plane Surface into a Still Atmosphere.—K. J. Brookfield, H. D. N. Fitzpatrick, J. F. Jackson, J. B. Matthews & E. A. Moelwyn-Hughes. (*Proc. roy. Soc. A*, 17th June 1947, Vol. 190, No. 1020, pp. 59–67.)

536.483 **3495**
A Helium Cryostat.—S. C. Collins. (*Rev. sci. Instrum.*, March 1947, Vol. 18, No. 3, pp. 157–167.) For temperatures down to 2 K. Three types of expansion device are described.

537.122 : 538.3 **3496**
The Electron and Electromagnetic Theory.—G. Darrieus. (*Bull. Soc. franç. Élect.*, May 1947, Vol. 7, No. 69, pp. 249–264.) Certain difficulties of the classical theory are discussed and an outline is given of a modified Born-Infeld nonlinear theory.

537.228.1 : 512.9 **3497**
First and Second Order Equations for Piezoelectric Crystals expressed in Tensor Form.—W. P. Mason. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, pp. 80–138.) The phenomena occurring on application of electric fields, stresses and temperature changes are examined. The nine first order effects are considered for the 32 types of crystal and measurement methods are discussed. Second order effects dealt with are :—elastic constants dependent on the applied stress and electric displacement, the electrostrictive effect, piezoelectric constants dependent on the applied

ress, and the piezo-optical and electro-optical ects. These second order equations may be used examine the phenomena occurring in ferro-ctric type crystals, and are applied to the case Rochelle salt.

7.32 3498

Thermoelectric Properties of Conductors: Part 1.—L. Gurevich. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, . 6, pp. 477–488.) A new possible mechanism thermoelectric e.m.f. is the carrying of electrons the phonon current created by the temperature dient. In a certain temperature range this e.m.f. y greatly exceed that to be expected from the al theory, and observed anomalies may be due to transition from one mechanism to another.

525.5 + 621.314.65 3499

n the Mechanism of Dielectric Ignition and istance Ignition in Mercury Arc Rectifiers. esis]—Warmoltz. (*See* 3670.)

527 3500

milarity of High-Pressure Discharges of the vection-Stabilized Type.—W. Elenbaas. (*Philips Rep.*, Nov. 1946, Vol. 1, No. 5, pp. 339–359.) larity conditions are deduced for discharges in air, or in tubes so wide that the walls have no t. Pressures considered are so high that energy by radiation, dissociation and diffusion is gible. Similarity conditions for discharges in us gases, discharges stabilized by forced ction and discharges in closed tubes filled with us gases are also considered.

3501

gnetism.—R. M. Bozorth. (*Rev. mod. Phys.*, 1947, Vol. 19, No. 1, pp. 29–86.) A general ptive account of the whole subject, taken from American edition of the Encyclopaedia nica. Magnetic theory is treated historically to the modern 'electron-spin' theory. A n is devoted to the measurement of magnetic ities and references are given to modern on this subject. A bibliography of textbooks ended.

2 : 621.316.974 : 621.318.4 3502

Field of a Coil between Two Parallel Metal —E. B. Moullin. (*J. Instn elect. Engrs*, , March 1947, Vol. 94, No. 75, p. 158.) ary of 2077 of July.

3503

ive Directions of the Electric and Magnetic in Electromagnetic Waves *in Vacuo*.— Japolsky. (*Nature, Lond.*, 26th April & une 1947, Vol. 159, Nos. 4043 & 4050, & 817.) In general the electric vector E magnetic vector B will not be perpendicular ctromagnetic waves in vacuo. They are icular in the special cases of (*a*) non- vectors, (*b*) circularly polarized plane and (*c*) spherical or cylindrical waves.

535.13 3504

eflection of an Electromagnetic Plane Wave finite Set of Plates: Part 2.—A. E. Heins & arlson. (*Quart. appl. Math.*, April 1947, No. 1, pp. 82–88.) In part 1 (2756 of per) the case was treated in which only one nt of the electric field was excited, the electric field being parallel to the edges of the plates. Fourier transform technique is again used when the excitation is by a plane wave which has only a single component of the magnetic field parallel to the edges of the plates. In this case it is found that the reflection and transmission coefficients are independent of the wavelength and depend only on the angle of stagger of the plates and the angle of incidence of the waves.

538.566 3505

[One-Dimensional] **Propagation of a Perturbation, of Narrow Frequency Range, in a Non-Absorbing Dispersive Medium.**—A. Blanc-Lapierre & P. Lapostolle. (*Rev. sci., Paris*, 1st/15th Dec. 1946, Vol. 84, Nos. 3262/3263, pp. 579–595.) The type of perturbation considered is that of filtered background noise or quasi-monochromatic light. The harmonic analysis of such perturbations leads to a representation analogous to a Fourier integral. The notions of phase velocity and group velocity are analysed and their limits of validity are given as functions of the width of spectrum considered and of the dispersive properties of the medium in the neighbourhood of the mean frequency. The results of the analysis are summarized and discussed.

538.567.2 3506

The Biased Ideal Rectifier.—W. R. Bennett. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, pp. 139–169.) Methods of solution and results are given for the frequency response of devices with sharply defined transitions between the conducting and non-conducting portions of their characteristics.

538.569.4.029.64 : 546.171.1 3507

The Inversion Spectrum of Ammonia at Centimetre Wavelengths.—B. Bleaney & R. P. Penrose. (*Proc. roy. Soc. A*, 1st May 1947, Vol. 189, No. 1018, pp. 358–371.) Measurement technique and results for wavelengths between 1.1 and 1.6 cm. 29 lines have been identified, each corresponding to a different rotational quantum state. An accurate formula is given for the wave numbers of these lines. See also 2622 of 1946 and 3096 of October (Strandberg et al.).

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

523.72 : 621.396.822.029.62 3508

Solar Radio Noise: Part 1.—E. V. Appleton & J. S. Hey. (*Phil. Mag.*, Feb. 1946, Vol. 37, No. 265, pp. 73–84.) An account of experiments carried out during a period of sunspot activity. Ground-level measurements of the noise spectrum at metre wavelengths are described; the shape of the spectral curve at the longer wavelengths is deformed by ionospheric influences. Enhancement of the noise has been observed to occur simultaneously with solar flares and short-wave radio fade-outs. See also 402 of February (Appleton) and back references.

523.746 : 538.12 3509

The Growth and Decay of the Sunspot Magnetic Field.—T. G. Cowling. (*Mon. Not. R. astr. Soc.*, 1946, Vol. 106, No. 3, pp. 218–224.) The rapid growth and decay, a matter of days, is thought to be due to convection and an initial magnetic field, otherwise the time taken would be about 300 years.

523.746 "1947.03/.04" 3510

Recent Solar Activity.—(*Nature, Lond.*, 19th April 1947, Vol. 159, No. 4042, p. 549.) Report on the return of the sunspot group mentioned in

2760 of September. In April it had a peak area of 5 400 millionths of the sun's hemisphere, and there were no associated magnetic storms. See also 3107 of October.

523.854 : [621.396.822.029.58/.6 **3511**

Interpretation of Radio Radiation from the Milky Way.—C. H. Townes. (*Astrophys. J.*, March 1947, Vol. 105, No. 2, pp. 235–240.) A discussion of the emission of radiation by ionized interstellar gas. Measurements between 30 000 and 9.5 Mc/s are analysed and compared with theory. The radiation is explicable on the basis of an electron gas density of about 1 electron per cm^3 and a temperature of 100 000°–200 000° K, which is much higher than that indicated previously. See also 402 of February and 3598 and 3599 of 1946.

537.591 **3512**

Further Cosmic-Ray Experiments above the Atmosphere.—S. E. Golian & E. H. Krause. (*Phys. Rev.*, 15th June 1947, Vol. 71, No. 12, pp. 918–919.)

537.591 **3513**

Slow Cosmic Ray Mesons at Sea-Level.—G. R. Evans & T. C. Griffiths. (*Nature, Lond.*, 28th June 1947, Vol. 159, No. 4052, pp. 879–880.)

537.591 **3514**

Recent Research in Meson Theory.—G. Wentzel. (*Rev. mod. Phys.*, Jan. 1947, Vol. 19, No. 1, pp. 1–18.)

537.591 **3515**

The Production of Nucleons by the Cosmic Radiation.—S. A. Korff & B. Hamermesh. (*Phys. Rev.*, 15th June 1947, Vol. 71, No. 12, pp. 842–845.)

551.510.53 **3516**

The Temperature of the Upper Atmosphere.—R. Penndorf. (*Bull. Amer. met. Soc.*, June 1946, Vol. 27, No. 6, pp. 331–342.) Translation of paper in *Met. Z.*, Jan. 1941, Vol. 58, No. 1, pp. 1–10. Summary noted in 3492 of 1942. A critical review of work published up to 1940. It is concluded that the probable thermal structure for latitudes 45°–55° may be represented approximately by the following points: 10 km, 220° K; 35 km, 230° K; 50 km, 320° K; 80 km, 200° K; 100 km, 330°–370° K; 230 km, 430°–830° K. Data for high latitudes are also discussed briefly.

551.510.53 **3517**

The Constitution of the Stratosphere.—R. Penndorf. (*Bull. Amer. met. Soc.*, June 1946, Vol. 27, No. 6, pp. 343–345.) Translation of paper in *Met. Z.*, 1941, Vol. 58, No. 3, pp. 103–105. Summary noted in 3492 of 1942. The pressure/height relation used is $\log_e(p_2/p_1) = -A(h_2 - h_1)/T$. Assuming the values of T as a function of height given in 3516 above, pressure is calculated in 1-km steps up to 100 km where the value agrees with that given by Martyn & Pulley (2073 of 1936) based on ionospheric data. The values of p are used to derive other parameters as a function of height and the results are tabulated for 10 km intervals up to 100 km.

551.510.535 **3518**

Ionospheric Clouds.—H. G. Wells. (*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 53–54.) Summary of I.R.E. paper. A description of a motion-picture pulse recording equipment.

551.510.535 : 621.396.11 **3519**

Radio Investigation of the Ionosphere.—C. J. Bakker. (*Philips tech. Rev.*, April 1946, Vol. 8, No. 4, pp. 111–120.) A general survey of the physical constitution and properties of the ionosphere and their bearing on radio communication.

551.510.535 : 621.396.11 **3520**

The Role of the Ionosphere in the Propagation of Radio Waves.—R. Jouaust. (*Bull. Soc. franç. Élect.*, May 1947, Vol. 7, No. 69, pp. 265–270.) Discussion on 1447 of May.

551.510.535 : 621.396.11 **3521**

Radiation Angle Variations from Ionosphere Measurements.—Hallborg & Goldman. (*See* 3625.)

551.547 + 551.524.7 **3522**

Pressure and Temperature of the Atmosphere to 120 km.—N. Best, R. Havens & H. LaGow. (*Phys. Rev.*, 15th June 1947, Vol. 71, No. 12, pp. 915–916.) Results of measurements made using a V-2 rocket and discussion of their accuracy.

LOCATION AND AIDS TO NAVIGATION

621.396.663 : 621.396.615.17 **3523**

On a Standardized Aperiodic Pulse Generator and Its Application to the Statistical Recording and Radiogoniometry of Atmospherics.—Carbenay. (*See* 3471.)

621.396.93 : 519.2 **3524**

A Problem on the Summation of Simple Harmonic Functions of the Same Amplitude and Frequency but of Random Phase.—Horner. (*See* 3566.)

621.396.93 : 551.594.6 **3525**

The Location of Thunderstorms by Radio Direction-Finding.—F. Adcock & C. Clarke. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 237.) Summary of 2779 of September.

621.396.93 : 621.396.677 **3526**

The Development and Study of a Practical Spaced-Loop Radio Direction-Finder for High Frequencies.—W. Ross. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 235.) Summary of 2780 of September.

621.396.93 : 621.396.677 **3527**

The Use of Earth Mats to reduce the Polarization Error of U-Type Adcock Direction-Finders.—R. L. Smith-Rose & W. Ross. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 234.) Summary of 2781 of September.

621.396.93 : 621.396.677.029.58 **3528**

Site and Path Errors in Short-Wave Direction-Finding.—W. Ross. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 235.) Summary of 2782 of September.

621.396.93 : 621.396.677.029.62 **3529**

An Experimental Spaced-Loop Direction-Finder for Very High Frequencies.—F. Horner. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 233.) Summary of 2783 of September.

621.396.93 : 621.396.677.029.63 **3530**

Some Experiments on Conducting Screens for a U-Type Spaced-Aerial Radio Direction-Finder in the Frequency Range 600–1 200 Mc/s.—R. R. Pearce. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 236.) Summary of 2784 of September.

21.396.932 3531
Radar for Merchant Marine Service.—F. E. paulding, Jr. (*RCA Rev.*, June 1947, Vol. 8, o. 2, pp. 312–330.) "Discusses the technical atures of a new 3-centimeter merchant marine dar equipment. Factors relating to the basic sign are treated and operation of the various cuits is explained by reference to functional ock diagrams. The physical form of the apparatus shown and plan-position-indicator (PPI) photo- aphs are included to illustrate the navigational ta furnished by this instrument. Specifications fining the performance characteristics are also cluded." See also 2194 of 1946 (Byrnes).

1.396.933 3532
P.I.C.A.O. Report on Navigational Aids. [Book tice]—Obtainable from E. M. Lewis, North lantic Regional Office, 7 Fitzwilliam Place, ublin, 3s. 9d. (*Engineer, Lond.*, 2nd May 1947, l. 183, No. 4762, p. 369.) Final report covering first session in Montreal.

.396.933.2 3533
The Theory and Application of the Radar Beacon. . D. Hultgren & L. B. Hallman, Jr. (*Proc. Inst. dio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, 716–730.) The functions of the various com- ents of a typical beacon and its applications.

396.933.2 : 621.396.615.141.2 3534
abilized Magnetron for Beacon Service : Part 1 evelopment of Unstabilized Tube.—Donal, ia & Brown. (*See* 3736.)

396.933.2 : 621.396.615.141.2 3535
abilized Magnetron for Beacon Service : Part 2 ngineering of Tube and Stabilizer.—Vogel & ds. (*See* 3737.)

396.96 : 621.317.79 3536
ho Boxes for Radar Testing.—Marshall. (*See*)

96.96 : 623.827 3537
ctronics in Submarine Warfare.—C. A. Lock- . (*Proc. Inst. Radio Engrs, W. & E.*, July Vol. 35, No. 7, pp. 712–715.)

96.96(52) 3538
rt Survey of Japanese Radar : Part 1.— Wilkinson. (*Bell Syst. tech. J.*, Jan. 1947, 6, No. 1, p. 215.) Summary of part 1 of 424 bruary.

ERIALS AND SUBSIDIARY TECHNIQUES

3539
rmal and X-Ray Analyses of Some Common hors.—R. Nagy & Chung Kwai Lui. (*J. opt. Soc.* Jan. 1947, Vol. 37, No. 1, pp. 37–41.) The ural changes which occur in the formation of hors are explained and the correct firing ratures for maximum fluorescence determined.

-15 : 666.112.3 : 535.34 3540
ared Absorption Spectra of Some Experi- Glasses containing Rare Earth and Other .—R. Stair & C. A. Faick. (*Bur. Stand. J.* an. 1947, Vol. 38, No. 1, pp. 95–101.) Trans- data for soda lime glasses from 0.7 to 4.5 μ.

535.61-15/-2 : 679.5 3541
Plastic Filters for the Visible and Near Infra-Red Regions.—J. H. Shenk, E. S. Hodge, R. J. Morris, E. E. Pickett & W. R. Brode. (*J. opt. Soc. Amer.*, Oct. 1946, Vol. 36, No. 10, pp. 569–575.) Discussion of the combination of dyes and plastics to give filters capable of resisting heat, intense light, and weather effects, and possessing specified transmis- sion characteristics.

538.21 : 669.14-41 3542
Medium-Frequency Magnetization of Sheet Steel.—R. Pohl. (*J. Instn elect. Engrs*, Part II, April 1947, Vol. 94, No. 38, pp. 118–123.) Discusses the inter- dependence of hysteresis, eddy currents and magnetic utilization and gives simple expressions and curves for eddy-current loss, apparent flux and utilization factor. Summary *ibid.*, Part I, June 1947, Vol. 94, No. 78, p. 278. For earlier work see 2047 of 1945.

620.197 3543
Protective Finishing of Electrical Equipment.—(*Engineering, Lond.*, 25th April 1947, Vol. 163, No. 4239, p. 330.) Summary of I.E.E. paper by F. Widnall & R. Newbound. A general survey covering self-protective materials, electrolytic and chemical finishing, paint spraying, vitreous enamel- ling, metal spraying and test methods. For another account see *Elect. Times*, 6th March 1947, Vol. 111, No. 2887, p. 246.

621.314.63 3544
Remarks on the Operation and Construction of Barrier Layer Rectifiers.—M. Leblanc. (*Bull. Soc. franç. Élect.*, April 1947, Vol. 7, No. 68, pp. 202–208.) Discussion on 1468 of May.

621.314.63 3545
Applications of Dry Rectifiers.—J. M. Girard. (*Bull. Soc. franç. Élect.*, April 1947, Vol. 7, No. 68, pp. 202–208.) Discussion on 1469 of May.

621.315.59 + 537.311.33 3546
Semiconductors and Their Applications.—A. F. Ioffe. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 3–14. In Russian.) The work in progress at the Physico-Technical Institute of the Academy is surveyed under the following headings: (*a*) The determination of the number of the conductivity electrons and of their mobility; experimental curves for various types of semi- conductors are shown. (*b*) Electrical conductivity in strong electric fields: deviations from Ohm's law are discussed. (*c*) The mechanism of con- ductivity: factors determining the direction of the current passed by a semiconductor are examined. (*d*) Boundary layers: the penetration into semi- conductors of the field set up by the contact potential difference is considered. (*e*) Photoelectric phenomena: spectral sensitivity characteristics are plotted for various semiconductors. (*f*) Appli- cations of semiconductors: particulars of the Ag_2S and Tl_2S photocells of Soviet manufacture are given in Table 2.

621.315.61.011.5 : 546.431.823 : 537.228.1 3547
Dielectric and Piezoelectric Properties of Barium Titanate.—S. Roberts. (*Phys. Rev.*, 15th June 1947, Vol. 71, No. 12, pp. 890–895.) Description and discussion of measurements of dielectric constant and loss at biasing field strengths from

0 to 5 MV/m, at temperatures from −50°C to +135°C and at frequencies from 0.1 to 25 Mc/s. The transverse and longitudinal piezoelectric effects have been measured directly.

621.315.611.011.5 + 537.226.3 **3548**

The Relation between the Power Factor and the Temperature Coefficient of the Dielectric Constant of Solid Dielectrics : Part 3.—M. Gevers. (*Philips Res. Rep.*, Aug. 1946, Vol. 1, No. 4, pp. 298–313.) A new theory is presented which explains why, for most of the commercial dielectrics, the ratio between the temperature coefficient (T.C.) of the dielectric constant and the power factor tan δ has a value of about 0.6. Hence the value of the T.C. can be predicted from measurements of tan δ at two different frequencies and two temperatures. For a mixture of dielectrics a simple linear relation is found to exist betwe-n its T.C. and those of the components. Thus a mixture of 90% CeO_2 (T.C. + 100 × 10^{-6}) and 10% TiO_2 (T.C. —880 × 10^{-6}) has a T.C. approximately zero. The linear relation does not apply to the power factors of the components of a composite dielectric and no general law relating T.C. and tan δ can be given for mixtures, particularly if some of the components have a positive and others a negative T.C. For part 4 see 3572 below.

621.315.611.011.5 + 537.226.3 **3549**

The Relation between the Power Factor and the Temperature Coefficient of the Dielectric Constant of Solid Dielectrics : Part 4.—Gevers. (*See* 3572.)

621.315.612.2 **3550**

Alkaline Earth Porcelains possessing Low Dielectric Loss.—M. D. Rigterink & R. O. Grisdale. (*J. Amer. ceram. Soc.*, 1st March 1947, Vol. 30, No. 3, pp. 78–81.) Porcelain bases for deposited carbon resistors, prepared from mixtures of clay, flint and synthetic fluxes consisting of clay calcined with at least three alkaline earth oxides. These white porcelains have excellent dielectric properties and low coefficients of thermal expansion.

621.315.612.4.011.5 **3551**

Properties of Barium-Strontium Titanate Dielectrics.—E. N. Bunting, G. R. Shelton & A. S. Creamer. (*Bur. Stand. J. Res.*, March 1947, Vol. 38, No. 3, pp. 337–349 ; *J. Amer. ceram. Soc.*, 1st April 1947, Vol. 30, No. 4, pp. 114–125.) Results are given for various properties, including dielectric constant and power factor reciprocal for frequencies of 50–20 000 kc/s, together with some measurements at 3 000 Mc/s.

621.316.89 + 621.315.59 **3552**

Properties and Uses of Thermistors — Thermally Sensitive Resistors.—J. A. Becker, C. B. Green & G. L. Pearson. (*Bell Syst. tech. J.*, Jan. 1947, Vol. 26, No. 1, pp. 170–212.) Reprint of 765 of March.

621.318.2 : 621.775.7 **3553**

Sintered Permanent Magnets.—S. J. Garvin. (*Engineering, Lond.*, 30th May & 6th June 1947, Vol. 163, Nos. 4244 & 4245, pp. 445–446 & 465–467.) A review of the development of sintering and a detailed account of recent methods for producing accurately shaped magnets of alnico or alcomax. Such methods involve the use of a 'master alloy' of 48% Fe, 52% Al, which has a wetting point about 100°C below the sintering temperature. This alloy is brittle and can be crushed readily to a fine powder. It is also much less prone to oxidation than pure Al, so that commercial hydrogen can be used as the atmosphere during the sintering process.

621.318.22 : 669.144.25 **3554**

Vicalloy — A Workable Alloy for Permanent Magnets.—G.W.O.H. (*Wireless Engr*, July 1947, Vol. 24, No. 286, p. 192.) Editorial comment on a Bell Telephone System monograph by E. A. Nesbitt. Vicalloy is a new alloy of Fe, Co and Va, which can be rolled and drawn and has been used as a tape 0.05 inch × 0.002 inch for speech recording in the Western Electric mirrorphone.

621.318.323.2.042.15 **3555**

Permeability of Dust Cores.—V. E. Legg. (*Wireless Engr*, July 1947, Vol. 24, No. 286, pp. 218–219.) Comment on 35 of January. The value of an empirical formula for the permeability of molybdenum permalloy cores given in 4424 of 1940 (Legg & Given) is discussed. An empirical treatment is stated to be more profitable than a mathematical analysis of the magnetic behaviour of such cores, as the shape and size of the magnetic particles and their relative dispositions in the insulating material are not simple and depend on the grain structure of the permalloy as originally cast and on its subsequent treatment. See also 1692 and 1693 of June and 2816 of September.

666.2 : 621.327.3 **3556**

Ultraviolet-Transmitting Glasses for Mercury-Vapor Lamps.—M. E. Nordberg. (*J. Amer. ceram. Soc.*, 1st June 1947, Vol. 30, No. 6, pp. 174–179.) The ultraviolet transmitting properties of Vycor glasses No. 791 and No. 7911 are compared with those of certain other glasses and fused silica. Transmission loss with age is much less than with other glasses.

678 + 546.26] : 621.317.331 **3557**

Electrical Conductivity of GR-S and Natural Rubber Stocks loaded with Shawinigan and R-40 Blacks.—P. E. Wack, R. L. Anthony & E. Guth. (*J. appl. Phys.*, May 1947, Vol. 18, No. 5, pp. 456–469.)

679.5 **3558**

A Plastics Primer for Engineers.—K. Rose. (*Materials & Methods*, April 1947, Vol. 25, No. 4, pp. 119–138.) Description and characteristics are given for thermosetting resins of the phenolic, amino-formaldehyde, aniline-formaldehyde and allyl ester groups and the effects of various fillers upon their properties are discussed. Thermoplastic groups include cellulosics, vinyls, acrylics, polyamides, polystyrenes, polyethylene, polytetrafluorethylene, caseins and silicones. The trade names by which the principal plastics are known in the U.S.A. are tabulated.

679.5 : 621.315.616 **3559**

Teflon — An Improved Plastic for R.F. Use.—W. S. Penn. (*Electronic Engng*, July 1947, Vol. 19, No. 233, p. 220.) Electrical, mechanical and dielectric properties of polytetrafluorethylene (Teflon) and polythene are compared. See also 1121 of April and 3169 of October (Johnson).

MATHEMATICS

3.732.6 : 621.396.615.141.2 **3560**

A Flux Plotting Method for obtaining Fields tisfying Maxwell's Equations, with Applications the Magnetron.—P. D. Crout. (*J. appl. Phys.*, pril 1947, Vol. 18, No. 4, pp. 348–355.) Flux otting methods previously applied to fields tisfying Laplace's and Poisson's equations are re extended to fields satisfying Maxwell's equans. The method is applied to the hole-and-slot pe of magnetron operating in its main mode, and the vane type of magnetron. For previous work Radiation Laboratory Report 1047.

7.512.2 : 621.396.67 **3561**

Fourier Transforms in Aerial Theory: Part 2.— F. Ramsay. (*Marconi Rev.*, Jan./March 1947, . 10, No. 84, pp. 17–22.) Graphs of the Fourier e transforms of a square wave, a saw-tooth wave, ine wave and a sine squared wave are given. part 1 see 2680 of September.

.5 **3562**

n Electrical Network for the Solution of Secular ations.—R. H. Hughes & E. B. Wilson, Jr. . *sci. Instrum.*, Feb. 1947, Vol. 18, No. 2, pp. -108.) A network of suitable coils and capacitors ssembled whose resonance equation is identical the secular determinant. For determining latent roots of a real symmetric matrix of n and columns, the network has n junctions h are interconnected by reactive admittances grounded by equal variable admittances which sent the unknown in the equation. The values he variable admittances corresponding to ma of the voltages of the junctions with respect ound give the desired roots. Usually an accuracy r than 1% is obtained, for $n \leq 6$.

3563

ctrical Analogue Computing: Parts 1 & 2.— . Mynall. (*Electronic Engng*, June & July Vol. 19, Nos. 232 & 233, pp. 178–180 & 16.) The fundamental circuits used for o-mechanical addition, multiplication, division, entiation and integration are described. To ntinued.

: 621.385 **3564**

ctrostatic Storage.—Rajachman. (*See* 3712.)

3565

e Improvements in the Use of Relaxation ds for the Solution of Ordinary and Partial ential Equations.—L. Fox. (*Proc. roy. Soc.* h June 1947, Vol. 190, No. 1020, pp. 31–59.) andard use of relaxation methods is extended e inclusion of terms usually neglected in the lifference equations involved. Eight examples method are given, illustrating the high cy obtainable with reduced labour.

621.396.93 **3566**

oblem on the Summation of Simple Harmonic ons of the Same Amplitude and Frequency Random Phase.—F. Horner. (*Phil. Mag.*, 1946, Vol. 37, No. 266, pp. 145–162.) The n treated is the determination of the proba- $P_n(s)$ that the amplitude of an arbitrarily component of the resultant shall lie between its s and $s + ds$. Curves of $P_n(s)$ are given tions of s for $n = 1, 2, 3$ and 7 where n is mber of harmonic functions involved in the ion. For large values of n, the distribution is of Gaussian form, and it seems likely that the lowest value of n for which the Gaussian curve gives a reasonably good fit is 5. The root mean square values of s are the same for the true and normal distributions for all values of n.

MEASUREMENTS AND TEST GEAR

531.76 : 621.317.755 **3567**

Precision Device for Measurement of Pulse Width and Pulse Slope.—H. L. Morrison. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 276–288.) Direct measurement in microseconds for pulses having the same repetition rate.

531.761 : 621.317.39 **3568**

An Electronic Millisecond Timer.—S. S. West & L. C. Bentley. (*Electronic Engng*, July 1947, Vol. 19, No. 233, pp. 207–210.) The circuit comprises an electronic trigger arrangement, which can be operated by a photocell or from an external source. It will measure short time intervals in the range 0.5–100 ms with an accuracy of ± 2%. The accuracy depends almost entirely on the stability of a standard capacitor and on the calibrating resistance.

531.765 : 621.317.755 **3569**

Spiral Chronograph for Measurement of Single Millisecond Time Intervals with Microsecond Accuracy.—R. J. Emrich. (*Rev. sci. Instrum.*, March 1947, Vol. 18, No. 3, pp. 150–157.) The spiral timebase is controlled by a crystal; the c.r.t. beam is held off in the steady state and is switched on by the pulse marking the beginning of the time interval to be measured. The beam brilliance is modulated to provide 5-μs markers and is turned off by the pulse marking the end of the required time interval, an Eccles-Jordan trigger circuit being used. The screen is of long persistence, the trace being measured directly, or photographed as a 'still' record. A pulse sharpening circuit is used to eliminate uncertainty as to the exact time of operation of the on-off trigger.

538.569.4.029.64 : 546.171.1 **3570**

The Inversion Spectrum of Ammonia at Centimetre Wavelengths.—Bleaney & Penrose. (*See* 3507.)

621.3.012.3 **3571**

Microwave Impedance-Plotting Device.—W. Altar & J. W. Coltman. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 734–737.) The device is used in conjunction with a Smith Impedance Chart (1372 of 1939) and computes the angular position of the load point directly from the observed data.

621.315.611.011.5+537.226.3 **3572**

The Relation between the Power Factor and the Temperature Coefficient of the Dielectric Constant of Solid Dielectrics: Part 4.—M. Gevers. (*Philips Res. Rep.*, Nov. 1946, Vol. 1, No. 5, pp. 361–379.) The power factor is measured by determining the increase in damping of a tuned circuit when a capacitor formed from the dielectric is connected in parallel. The details of this method and the apparatus used for determining the temperature coefficient of the dielectric constant are discussed. Sources of error and the necessary corrections are indicated. For previous parts see 125 of January, 1476 of May and 3548 above.

621.317.1.011.5 3573

A Method for Measuring Certain Electric Constants at Centimetre Wavelengths.—K. G. Knorre. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 117–123. In Russian.) A rectangular cavity resonator is considered with ideally conducting walls and divided into three zones each representing a different dielectric medium (Fig. 1). The discussion is limited to H-waves and systems of equations (3) and (7) are derived determining the field in each zone. On the basis of the results obtained a method is proposed for measuring the dielectric constant of a medium. The method is based on obtaining resonance by moving one of the end walls of the resonator. The damping of a resonator containing a dielectric is discussed and also the possibility of measuring losses in the dielectric.

621.317.3 : 621.396.611.21 3574

Electrical Characteristics of Quartz-Crystal Units and Their Measurement.—W. D. George, M. C. Selby & R. Scolnik. (*Bur. Stand. J. Res.*, March 1947, Vol. 38, No. 3, pp. 309–328.) *Q*-meters and r.f. bridges were used. Measurement methods and their relative merits and limitations are discussed. Antiresonance impedance up to 5 MΩ was measured to within ±5%. Constancy of electrical characteristics, secondary responses, and changes with amplitude of vibration and temperature were investigated for many 8.7-Mc/s BT-cut crystal units and a few 50-kc/s and 100-kc/s units. A graphical method of representing the electrical characteristics of normal crystal units is suggested.

621.317.333.82 : 621.319.4 3575

Overvoltage Testing of Capacitors.—R. J. Hopkins. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 105–107.)

621.317.336.1 : [621.385.3/.5 3576

The Measurement of Dynamic Mutual Conductance of Valves using the Grounded-Grid Triode Mode of Operation.—F. Gutmann. (*J. sci. Instrum.*, April 1947, Vol. 24, No. 4, pp. 94–95.) The valve under test is connected as a cathode-loaded grounded-grid triode and a known alternating voltage in series with a current indicator is applied across the load. The measured current is approximately proportional to the dynamic mutual conductance.

621.317.361 3577

F.C.C. Frequency Measurement Techniques.—A. K. Robinson. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 114–116.) The system depends on a primary 50-kc/s standard, of accuracy greater than 1 in 10^7, with frequency subdivision to 50 c/s for comparison check with standard time signals. 10-kc/s markers, derived from the standard, extend up to 500 Mc/s by use of a high-gain harmonic amplifier having individual harmonic output constant with frequency. The external signal to be checked is made to beat with the nearest marker. The beat note is measured by an audio interpolation oscillator, range 0–5 kc/s, accuracy ±2 c/s, used with an oscilloscope. Provision is made for sense determination. Signals of short duration are checked by means of a heterodyne frequency meter.

621.317.382 : 621.385.831 3578

Power Measurement of Class B Audio Amplifier Tubes.—D. P. Heacock. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 147–157.) An accurate method, particularly suitable for production tests, of determining the performance by a simple measurement of the anode current of one of the two valves.

621.317.44.025 3579

An Alternating Current Probe for Measurement of Magnetic Fields.—E. C. Gregg, Jr. (*Rev. sci. Instrum.*, Feb. 1947, Vol. 18, No. 2, pp. 77–80.) A summarized account of this probe was noted in 3184 of October. Advantage is taken of the fact that the a.c. permeability of most magnetic alloys changes with superposed steady-state d.c. magnetic fields.

621.317.49 : 534.321.9 3580

Comparison of Supersonic Intensities by means of a Magnetostriction Gauge.—A. W. Smith & D. K. Weimer. (*Rev. sci. Instrum.*, March 1947, Vol. 18, No. 3, pp. 188–190.) The gauge consists essentially of a small rod of Ni wound with a few turns of wire. The acoustic pressures present in the liquid produce changes in length of the rod which in turn, because of the inverse magnetostrictive effect, induce voltages in the coil.

621.317.7+621.38+621.396.69 3581

The Physical Society's Exhibition.—(*Engineer, Lond.*, 18th & 25th April & 2nd May 1947, Vol. 183, Nos. 4760–4762, pp. 328–331, 352–353 & 383–385; *Engineering, Lond.*, 2nd May 1947, Vol. 163, No. 4240, pp. 364–366.) Descriptions of further selections of the exhibits in the trade and research sections. See also 3185 of October and 2494 of August.

621.317.7.029.62/.63 : [621.396.81+621.396.822 3582

A V.H.F./U.H.F. Noise and Field Intensity Meter.—L. W. Martin. (*Communications*, June 1947, Vol. 27, No. 6, pp. 32–35, 44). Description, with complete circuit diagram, of equipment for noise measurement in μV or db and field-intensity measurement in μV/m, in the frequency range 88–400 Mc/s.

621.317.725 3583

A Very High Impedance R.M.S. Voltmeter for Iron Testing.—K. A. Macfadyen : D. C. Gall & F. C. Widdis. (*J. sci. Instrum.*, April 1947, Vol. 24, No. 4, p. 109.) Discussion of 1514 of May. Input impedance up to 80 MΩ is achieved by returning the grid leak to a positive voltage. The relative merits of current and voltage feedback are considered.

621.317.725.027.7 3584

The Design of an Ellipsoid Voltmeter for the Precision Measurement of High Alternating Voltages.—F. M. Bruce. (*J. Instn elect. Engrs*, Part II, April 1947, Vol. 94, No. 38, pp. 129–137. Discussion, pp. 149–154.) High alternating voltages are measured by timing the oscillations of a small ellipsoid suspended by a thread in the uniform electric field between two parallel vertical disks. By accurate mechanical construction, and correction of the results for known sources of error, the voltage between the disks is deduced with an estimated error of less than ±0.3%. See also 3585 below. Summary *ibid.*, Part I, June 1947, Vol. 94, No. 78, p. 279.

:1.317.728.089.6 3585
Calibration of Uniform-Field Spark-Gaps for igh-Voltage Measurement at Power Frequencies.— M. Bruce. (*J. Instn elect. Engrs*, Part II, April 47, Vol. 94, No. 38, pp. 138–149. Discussion, . 149–154.) Description of spark gaps using ctrodes shaped to give a uniform field in the gap. calibration beween 9 and 315 kV is given, reeing with a simple empirical formula to within p.2%. See also 3584 above. Summary *ibid.*, rt I, June 1947, Vol. 94, No. 78, pp. 279–280.

.317.75 3586
A Rotary Periodograph.—G. B. Moncrieff-Yeates. *sci. Instrum.*, Feb. 1947, Vol. 24, No. 2, pp. -40.) An instrument for the rapid analysis of turbed periodic functions. The variance, obned photoelectrically, of the sum of two ordinates plotted against their separation to produce a aracteristic curve' containing many of the nstants required.

.317.755 : 621.3.015.3 : 621.311.1 3587
scillographs for Rapid Transient Phenomena. ir Application to the Study of Overvoltages in l Systems.—P. Grassot. (*Bull. Soc. franç. t.*, Feb. 1947, Vol. 7, No. 66, pp. 95–101.) rt descriptions of various modern instruments, applications to surge investigations.

317.761 + [621.396.615.12 : 621.317.79 3588
V.H.F. Signal Generator or Frequency Meter.— . Ratcliff. (*R.S.G.B. Bull.*, Feb. 1947, Vol. No. 8, pp. 118–122.) Describes a compact rodyne frequency meter, covering the range o Mc/s, which can also be used as a toneulated source of r.f. voltage. Six plug-in are used and crystal check points are provided - and 10-Mc/s intervals. Transitron multitors give division down to 500 or 100 kc/s.

17.763.029.64 3589
ect Reading Wavemeters.—G. E. Feiker & . Meahl. (*Tele-Tech*, May 1947, Vol. 6, No. 5, .) Summary of I.R.E. paper. An account of coupled quarter-wave coaxial wavemeters e in the 8–12 and 12–17 m wavelength ranges. nance is indicated by a crystal-valve voltmeter. racy is within 0.1%.

17.772.029.64 : 621.396.67 3590
ase-Front Plotter for Centimeter Waves.— ms. (*RCA Rev.*, June 1947, Vol. 8, No. 2, 70–275.) The area to be plotted is scanned motor-actuated probe. The energy picked the probe at any point is combined with a nce signal and applied to a detector. The or output, which varies with the phase nce between the probe and reference signals, plified and applied to a stylus directly below robe; a sheet of current-sensitive paper is arkened in proportion to the detector output record is obtained showing which parts of ea have the same phase. The plotter was o test centimetre wave aerials.

7.79 : 621.396.822 3591
ortion-Noise Meter.—C. W. Clapp. (*Tele-* May 1947, Vol. 6, No. 5, p. 61.) Summary of paper. A bridged-T type filter covering 00 c/s rejects the fundamental whilst passing nics. The circuit can be adapted for use as meter.

621.317.79 : 621.396.96 3592
Echo Boxes for Radar Testing.—R. W. Marshall. (*Bell. Lab. Rec.*, March 1947, Vol. 25, No. 3, pp. 111–113.) A short account of typical constructions and their use to indicate overall performance of radar installations.

621.396.619.083 : 621.397.5 3593
A Method of Measuring the Degree of Modulation of a Television Signal.—T. J. Buzalski. (*RCA Rev.*, June 1946, Vol. 7, No. 2, pp. 265–271.) The double sideband output of the transmitter energizes a linear diode monitor, the output of which contains a d.c. component in addition to the visual signal. This composite signal is short-circuited periodically by a 'Vibroswitch' thus establishing a zero level. The amplitudes of the components of the resultant trace may be read directly on an oscilloscope and the modulation percentage calculated.

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

534.321.9 : 531.717 : 621.436-222 3594
Ultrasonic Measurement of Wall Thickness in Diesel Cylinder Liners.—F. W. Struthers & H. M. Trent. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 368–371.)

535.61-15 : 621.389 3595
Infra-Red Equipment for Military Purposes.— (*Engineering, Lond.*, 4th April 1947, Vol. 163, No. 4236, p. 258.) For another account see 2862 of September.

535.61-15 : 621.391.64 : 621.327.032.196 3596
Cesium Vapor Lamps.—N. C. Beese. (*J. opt. Soc. Amer.*, Oct. 1946, Vol. 36, No. 10, pp. 555–560.) Structural details and characteristics of lamps giving infra-red radiation and capable of 100% current modulation throughout the a.f. range.

537.533.73 : 539.2 3597
Electron Diffraction. Apparatus used in France and Abroad. Possibilities of the Method for Crystal Analysis of Thin Plates and for Surface Structure.—J. Devaux. (*Bull. Soc. franç. Élect.*, Feb. 1947, Vol. 7, No. 66, pp. 111–115.)

538.71.001.8 + 538.71 : [623.26 + 623.95 3598
Bomb and Mine Location: Peace-Time Applications.—(*Beama J.*, April 1947, Vol. 54, No. 118, pp. 139–140.) A short account of the E.R.A. mumetal magnetometer and balanced-coil locator, with applications to the location of sunken anchor buoys and other equipment in the Seine estuary.

550.837 : 621.396.675 3599
Electric Field of an Oscillating Dipole on the Surface of a Two Layer Earth.—Wolf : Lewis. (*See* 3435 and 3436.)

550.837.7 3600
On the Use of Electromagnetic Waves in Geophysical Prospecting.—C. W. Horton. (*Geophys.*, Oct. 1946, Vol. 11, No. 4, pp. 505–517.) The response of the earth to a d.c. step function is analysed for the case in which displacement currents are negligible. It is shown that under typical conditions the depth of an electrical interface 6 000 ft below ground can be measured by means of e.m. waves, even thin layers of salt water or oil-bearing sand giving measurable effects.

550.837.7 : 621.396.9 3601
Use of the Broadcast Band in Geologic Mapping.—L. Kerwin. (*J. appl. Phys.*, April 1947, Vol. 18, No. 4, pp. 407–413.) A description of field equipment to study the effect of geologic anomalies on e.m. field intensity, with experimental results.

551.46.018.3 : 621.317.39 3602
The Measurement of Sea-Water Velocities by Electromagnetic Induction.—R. W. Guelke & C. A. Schoute-Vanneck. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 232.)

621.191.33 : 534.321.9 3603
The Detection of Internal Leaks in Aircraft Hydraulic Systems.—R. G. Nuckolls & H. M. Trent. (*J. acoust. Soc. Amer.*, March 1947, Vol. 19, No. 2, pp. 364–367.) A crystal pickup and amplifier which monitor " the ultrasonic vibrations produced in the system by the leaking valve, which vibrations are most intense at the defective element".

621.318.572 3604
Vane-Actuated Controller.—Wannamaker. (*See* 3444.)

621.365.5 3605
Temperature Charts for Induction and Constant-Temperature Heating.—M. P. Heisler. (*Trans. Amer. Soc. mech. Engrs*, April 1947, Vol. 69, No. 3, pp. 227–236.) " Charts are presented for determining complete temperature histories in spheres, cylinders and plates."

621.38/.39].001.8 3606
Radar Techniques in an Industrial Control.—W. D. Cockrell. (*Elect. Engng, N.Y.*, April 1947, Vol. 66, No. 4, pp. 365–368.) A description of u.h.f. methods for register control in the printing and paper industries.

621.38 : 6(048) 3607
Industrial Electronic Equipment Uses : Part 2.—W. C. White. (*Electronic Industr.*, April 1947, Vol. 1, No. 4, p. 6.) Continuation of 2520 of August. A further list of 123 references.

621.384.6 3608
Atomic Artillery.—J. Stokley. (*Gen. elect. Rev.*, June 1947, Vol. 50, No. 6, pp. 9–19.) An outline of the various types of electron and ion accelerators which have been used to produce streams of atomic particles of high energy. The principles of operation of the cyclotron, synchrocyclotron, betatron and synchrotron are described and mention is made of a new type of linear accelerator expected to produce particles with an energy of 40 MeV, in which radar pulse transmitters will provide the energy source.

621.384.6 : 621.316.7 3609
The Synchronization of Auxiliary Apparatus with a Betatron.—G. C. Baldwin, G. S. Klaiber & A. J. Hartzler. (*Rev. sci. Instrum.*, Feb. 1947, Vol. 18, No. 2, pp. 121–124.) Automatic control by external apparatus, such as a cloud chamber, of the production of X-rays by a betatron is described. Upon receiving an initiating signal from the cloud chamber a relay and thyratron circuit permits injection of electrons into the betatron vacuum tube only during a single cycle. Three thyratrons furnish a series of synchronizing signals.

621.385.833 3610
Present Status and Future Possibilities of the Electron Microscope.—J. Hillier. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 29–42.)

621.385.833 3611
The Electron Microscope.—P. Grivet. (*Bull. Soc. franç. Élect.*, Feb. 1947, Vol. 7, No. 66, pp. 102–110.) A description of some of the special features of the C.S.F. electrostatic instrument, with microphotographs of widely differing objects. See also 3706 of 1946.

621.385.833 3612
The Electron Optical System of the Electron Microscope.—M. E. Haine. (*J. sci. Instrum.*, March 1947, Vol. 24, No. 3, pp. 61–66.) Theoretical and practical considerations in the design and use of the microscope.

621.385.833 3613
On the Limit of Resolution of the Electron Microscope. Unsymmetrical Lens.—H. Bruck. (*C. R. Acad. Sci., Paris*, 9th June 1947, Vol. 224, No. 23, pp. 1628–1629.) Formulae for the limit are derived which depend on the lack of symmetry in the objective lens. Similar formulae are given for the optical case. The formulae hold in all cases where lack of symmetry is a more serious defect than spherical aberration. See also 3238 of October.

621.385.833 3614
Conditions for extending the Resolution Limit of the Electron Microscope.—V. E. Cosslett. (*J. sci. Instrum.*, Feb. 1947, Vol. 24, No. 2, pp. 40–43.) The limiting resolution obtainable with magnetic lenses of existing type may be reduced from 10 Å to perhaps 6 Å by the use of a sufficiently high accelerating voltage, provided that the lens power is maintained at the value which gives minimum aberration. Further improvement can only be obtained by correction of lens aberrations.

621.385.833 3615
Preparation and Uses of Silica Replicas in Electron Microscopy.—C. H. Gerould. (*J. appl. Phys.*, April 1947, Vol. 18, No. 4, pp. 333–343.) A method is described for preparing silica replicas of specimens which cannot be subjected to the temperatures and pressures of the ordinary technique.

621.386.1 3616
X-Ray Generators for 1 000 and 2 000 kV.—J. Saget. (*Bull. Soc. franç. Élect.*, May 1947, Vol. 7, No. 69, pp. 273–274.) Discussion on 1547 of May.

621.386.1 : 615.849 3617
A 400 Kilovolt Installation for X-Ray Therapy.—W. H. Boldingh & W. J. Oosterkamp. (*Philips tech. Rev.*, April 1946, Vol. 8, No. 4, pp. 105–110.) A novel construction, with the anode earthed and the focus at the end of a long earthed metal tube projecting through a partition into the irradiation chamber.

621.791.736.31 3618
Precision Energy-Storage Spot Welder.—R. Briggs & H. Klemperer. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 102–104.)

23.454.25 : 621.396.9 3619
Radio Proximity Fuze.—(*Tech. Bull. nat. Bur. Stand.*, Jan. 1947, Vol. 31, No. 1, pp. 3–8.) An account of the development of the fuse at the National Bureau of Standards, Washington. See also 623, 624 and 1627 of 1946.

PROPAGATION OF WAVES

8.566+621.396.11 3620
On the Propagation of Electromagnetic Waves through the Atmosphere.—B. K. Banerjea. (*Proc. R. Soc. A*, 17th June 1947, Vol. 190, No. 1020, pp. 67–81.) "A general method of tackling the problem of the propagation of electromagnetic waves in the ionosphere has been developed and the current methods of Appleton, Hartree, Saha, Rai and Mathur, etc., have been deduced as special cases from the general results. The different assumptions by Appleton, Hartree, Bose, Booker and Rai, as regards the condition of reflexion of the waves from the ionosphere, have been shown to be identical. A symbol-correspondence chart for the different symbols used by the different workers has been given to facilitate the understanding of the parallelism between the different methods. Polarization of the radio waves has been discussed fully."

.566 3621
[One-Dimensional] **Propagation of a Perturbation, Narrow Frequency Range, in a Non-Absorbing Dispersive Medium.**—Blanc-Lapierre & Lapostolle. 3505.)

510.535 : 621.396.24 3622
Application of the Theories of Indirect Propagation to the Calculation of Links using Decametre Waves.—Gibert. (*See* 3654.)

396.11 3623
On the Problem of Efficient Long-Distance Wireless Power Transmission.—S. Tetelbaum. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 6, pp. 505–514.)

396.11 : 534.231 3624
A Device for Plotting Rays in a Stratified Medium.—Dawson, Miller & Schiff. (*See* 3389.)

396.11 : 551.510.535 3625
Radiation Angle Variations from Ionosphere Measurements.—H. E. Hallborg & S. Goldman. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 342–351.) "... heights of the F and F_2 layers at Washington, ... and San Francisco, California, and their ... bility ranges are studied for the year 1945. ... data are applied to determine the optimum ... tion angle ranges for various hop modes on ... New York - San Francisco Circuit. Wide ... l and seasonal variations are indicated. ... cal applications to effective antenna design ... scussed."

6.11 : 551.510.535 3626
The Role of the Ionosphere in the Propagation of Radio Waves.—Jouaust. (*See* 3520.)

6.11 : 551.510.535 3627
Radio Investigation of the Ionosphere.—Bakker. 3519.)

.11.029.62/.63 3628
Propagation Studies on 45.1, 474, and 2 800 Mc/s within and beyond the Horizon.—Wickizer & A. M. Braaten. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 670–680.) Recordings of field strength on 2 800, 474 and 45.1 Mc/s over a period of 13 months were made at distances of 42 miles (within the horizon) and 70 miles (beyond the horizon) from the transmitter. Maximum values 3 or 4 times the free-space values were obtained at the two higher frequencies. Variations at 474 and 2 800 Mc/s were greater than those at 45.1 Mc/s; variations at 70 miles were greater than those at 42 miles. Refraction was found to be greater in summer; superrefraction only occurred when the wind velocity was less than about 13 m.p.h. Simultaneous meteorological observations were made.

621.396.41.029.64 3629
Calculation of Multiplex U.H.F. Radio-Telephone Links.—H. Chireix. (*Bull. Soc. franç. Élect.*, May 1947, Vol. 7, No. 69, pp. 271–272.) Discussion on 1559 of May.

621.396.81 3630
V.H.F. Propagation Surveys for Mobile Services.—R. G. Peters. (*Communications*, June 1947, Vol. 27, No. 6, pp. 20 . . 45.)

621.396.812.029.62 3631
Propagation on Five.—E. J. Williams & D. W. Heightman. (*Short Wave Mag.*, Feb. 1947, Vol. 4, No. 12, pp. 749–751.) Criticism of 1561 of May; for Russell's reply see 3632 below.

621.396.812.029.62 3632
More about V.H.F. Propagation.—O. J. Russell. (*Short Wave Mag.*, March 1947, Vol. 5, No. 1, pp. 46–48.) A reply to criticism in 3631 above of 1561 of May.

621.396.812.029.64 3633
Research in England on the Propagation of Ultra-Short Waves.—Bras. (*Bull. Soc. franç. Élect.*, May 1947, Vol. 7, No. 69, pp. 270–271.) Discussion on 1563 of May.

621.396.812.4.029.62 3634
Tropospheric Reception.—G. W. Pickard & H. T. Stetson. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 54.) Summary of I.R.E. paper. Daily records of field strength of W2XMN f.m. transmissions on 42.8 Mc/s show variations dependent upon the passage of warm and cold fronts across the transmission path. Reception at 167 miles range was, on the average, three to four times stronger in summer than in winter.

RECEPTION

621.396.621 3635
Modernizing the Old Receiver.—W. L. North. (*QST*, April 1947, Vol. 31, No. 4, pp. 54–55, 130.) Details of alterations to an RME-69 receiver resulting in considerable improvement in both gain and image rejection.

621.396.621 3636
Criteria for Diversity Receiver Design.—W. Lyons. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 373–378.) Discussion limited to receivers incorporating diode switching of the common diode load variety.

621.396.621 : 621.395.623.66 3637
The Pocket Ear.—J. L. Hathaway & W. Hotine. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 139–146.) The development of a three-valve pocket radio receiver, with a flexible tube for conducting sound to

the ear, for maintaining contact between a programme producer and a roving announcer.

621.396.621 : 621.396.619.11 **3638**

The Synchrodyne.—F. G. Apthorpe : D. G. Tucker. (*Electronic Engng*, July 1947, Vol. 19, No. 233, p. 238.) Comment on 2364 of August. Comparison is made with the 'Homodyne' (F. M. Colebrook, *Wireless World and Radio Review*, 1924, Vol. 13, pp. 645–648.) Apthorpe considers distortion of a signal subject to selective fading by reference to vector diagrams and discusses the advantages of harmonic synchronization, and methods for avoiding the howl when off tune. Tucker stresses the essential difference between the homodyne and the synchrodyne, pointing out that whereas the homodyne gives selectivity in preference to quality, in the synchrodyne selectivity and quality are quite independent and both may be excellent.

621.396.621.001.4 : 621.396.82 **3639**

Static for Radio Receiver Tests.—J. C. R. Licklider & E. B. Newman. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 98–101.) Apparatus for artificial production of 'atmospherics'.

621.396/.397].621.004.67 **3640**

The Servicing of Radio and Television Receivers.—R. C. G. Williams. (*J. Instn elect. Engrs*, Part I, March 1947, Vol. 94, No. 75, pp. 156–158.) Summary of 2224 of July.

621.396.621.5.029.62 **3641**

R.F./Mixer Design for V.H.F.—W. J. Crawley. (*Short Wave Mag.*, March 1947, Vol. 5, No. 1, pp. 44–46.) Describes the development of a circuit for 58 Mc/s with two high-gain r.f. stages; it uses a low-noise h.f. pentode and split-stator tuning capacitors.

621.396.621.54 **3642**

The Inversion of the Autodyne Principle.—Saic. (*See* 3472.)

621.396.622.71 **3643**

The Ratio Detector.—S. W. Seeley & J. Avins. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 201–236.) "In this circuit two frequency-sensitive voltages are applied to diodes and the sum of the rectified voltages held constant. The difference voltage then constitutes the desired a.f. signal. This means of operation makes the output insensitive to amplitude variations.

". . . The ratio between the primary and secondary components of the frequency-sensitive voltages in a phase-shift type of ratio detector is a function of the instantaneous signal amplitude. The a.m. rejection properties, however, are shown to depend upon the mean ratio between these voltages. An expression which is developed for this ratio in terms of the circuit parameters provides the basis for arriving at an optimum design. The measurements necessary in the design of a ratio detector and in checking its performance are described."

621.396.812.4.029.62 **3644**

Tropospheric Reception.—Pickard & Stetson. (*See* 3634.)

621.396.822 : 621.396.621 **3645**

On the Theory of Noise in Radio Receivers with Square Law Detectors.—M. Kac & A. J. F. Siegert. (*J. appl. Phys.*, April 1947, Vol. 18, No. 4, pp. 383–397.) "For the video output V of a receiver, consisting of an i.f. stage, a quadratic detector, and a video amplifier, the probability density $P(V)$ has been obtained for noise alone and for noise and signal. The results are expressed in terms of eigenvalues and eigenfunctions of the integral equation

$$\int_0^\infty K(t)\rho(s-t)f(t)dt = \lambda f(s),$$

where $\rho(\tau)$ is the i.f. correlation function (i.e., the Fourier transform of the i.f. power spectrum) and $K(t)$ is the response function of the video amplifier (i.e., the Fourier transform of the video amplitude spectrum). Two special cases are discussed in which the integral equation can be solved explicitly. Approximations for general amplifiers are given in the limiting cases of wide and narrow videos." Summary abstracted in 1199 of April.

621.396.822.029.6 : 621.385.2 **3646**

A Coaxial-Line Diode Noise Source for U.H.F.—Johnson. (*See* 3722.)

621.396.828 **3647**

A New Noise-Reducing System for C.W. Reception.—D. L. Hings. (*QST*, June 1947, Vol. 31, No. 6, pp. 21–23, 134.) Full details of a practical circuit for application to the second detector and a.f. end of a communications receiver. See also 1576 of May and 3649 below.

621.396.828 **3648**

A Method for preventing Impulse Interference with Radio Reception.—A. N. Shchukin. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 49–56. In Russian.) The receiver is assumed to consist of a wide-band unit, followed by an amplitude limiter which in turn is followed by a narrow-band unit. The operation of the system is considered when one or more impulses are received in the presence or absence of the desired signal. Formulae are derived determining the ratio of the interference voltage at the output of the receiver to the corresponding useful signal voltage if there were no interference. The interference from another radio station operating at a frequency lying within the wide but outside the narrow band is also considered.

621.396.828 : 621.394.141 **3649**

Noise-Free Code Reception.—D. L. Hings. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 125–127.) A method for discriminating between the time constants of signal and noise, allowing c.w. signals to trigger an a.f. generator feeding a loudspeaker. See also 1576 of May and 3647 above.

STATIONS AND COMMUNICATION SYSTEMS

621.391.64 **3650**

Infrared Communications.—M. C. Beese. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 53.) Summary of I.R.E. paper.

621.394/.395].7(68.01) **3651**

Communications Network of the Union of South Africa.—D. P. J. Retief. (*Trans. S. Afr. Inst. elect. Engrs*, March 1947, Vol. 38, Part 3, pp. 84–112.) The development since the introduction of voice-frequency amplifiers in 1922 is described, with particular reference to recent expansions.

21.395.5 : 621.396.5 3652
Wire or Wireless?—T. Roddam. (*Wireless World*, July 1947, Vol. 53, No. 7, pp. 236–238.) Outlines the future possibilities of wide-band n. v.h.f. links for the trunk communications at esent handled by telephone lines.

1.396.1 3653
F.C.C. makes Allocations for Short-Distance mmunication.—(*Electronics*, June 1947, Vol. 20, o. 6, p. 152.) Brief survey of the allocation of quencies in the 152–162-Mc/s band.

..396.24 : 551.510.535 3654
Application of the Theories of Indirect Propagation to the Calculation of Links using Decametre aves.—R. Aubert. (*Bull. Soc. franç. Élect.*, y 1947, Vol. 7, No. 69, pp. 265–270.) Discussion 1210 of April.

.1.396.3 : 621.396.933 3655
International Commercial Aviation Radioteletype tems.—F. V. Long. (*Communications*, June 7, Vol. 27, No. 6, pp. 24–26 . . 43.)

.396.41 : 621.396.619.16 3656
Multiplex Broadcasting.—A. M. Levine. (*Tele-h*, May 1947, Vol. 6, No. 5, p. 55.) Summary I.R.E. paper. A system using time division tiplexing and pulse-time modulation for eight grammes each of bandwidth 9.5 kc/s, on a single Mc/s carrier. See also 1213 of April (Grieg & ine) and 3657 below.

396.41 : 621.396.619.16 : 621.396.97 3657
Multiplex Broadcasting.—F. Altman & J. H. r. (*Elect. Engng, N.Y.*, April 1947, Vol. 66, 4, pp. 372–380.) Multiplex operation and hods of modulation are briefly discussed with ial reference to pulse-time modulation. An t-channel system working on 930 Mc/s and rporating the cyclophon is described. The ophon, a special c.r. tube with rotating electron n which acts as a cyclic switch and modulator modulator, is discussed in detail. The advan- of multiplex operation are summarized. See 239 of January, 1213 of April (Grieg & Levine) 3656 above.

96.41.029.64 3658
lculation of Multiplex U.H.F. Radio-Telephone s.—Chireix. (*See* 3629.)

96.5 3659
perimental Rural Radiotelephony.—J. H. c, P. K. Seyler & S. B. Wright. (*Elect. g, N.Y.*, April 1947, Vol. 66, No. 4, pp. 346– A description of an experimental radio llation on 44–50 Mc/s, worked on the party ystem, for isolated rural communities having ephone facilities.

96.619.11/.13 3660
nparison of Amplitude and Frequency Modula- -M. G. Nicholson. (*Wireless Engr*, July 1947, 24, No. 286, pp. 197–208.) Comparisons of mance have previously been made between n 40–50 Mc/s with a channel width of about /s and a.m. at a signal frequency of 1 Mc/s s with a channel width of about 10 kc/s. The t comparison is made under conditions of ncy stability, channel width and receiver idth normally realized in the v.h.f. band. concluded that f.m. is superior to a.m. only where fluctuation noise is the limiting factor. As regards interference, a.m. is superior to f.m. even if the selectivity of the a.m. receiver is identical with that of the f.m. receiver. A.m. has better discrimination against impulse noise, is less adversely affected by imperfect tuning and is superior to f.m. in 'satellite' station operation. See also 3661 below (G.W.O.H.).

621.396.619.11/.13 3661
Amplitude and Frequency Modulation.—G.W.O.H. (*Wireless Engr*, July 1947, Vol. 24, No. 286, p. 191.) Refers to Nicholson's paper (3660 above) and stresses that the merits of the two modulation systems must be compared under similar conditions.

621.396.619.13 : 518.3 3662
Radiation Chart for F.M. Stations.—C. F. Guthrie. (*Communications*, May 1947, Vol. 27, No. 5, pp. 34–36.) For determining the effective radiated power, a parameter required in Everett's range prediction chart (736 of 1946).

621.396.931 3663
V.H.F. Railroad Communications in Tunnels.—J. P. Shanklin. (*Communications*, June 1947, Vol. 27, No. 6, pp. 16–19.) Preliminary field strength measurements made in a disused water tunnel were followed by the erection of a train communication system in a railway tunnel 2 760 ft long. 152–162-Mc/s signals were fed into transmission lines in the crown of the tunnel from an external rhombic aerial. Reflecting wires were placed above the transmission lines to reduce signal loss.

621.396.931 3664
V.H.F. Radio Equipment speeds up Railroad Operation.—L. G. Sands. (*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 38–41 . . 111.) A description of modern two-way f.m. equipment used on U.S. railways.

621.396.931.029.62 3665
Mobile F.M. Communications Equipment for 30 to 44 Mc/s.—R. B. Hoffman & E. W. Markow. (*Communications*, June & Aug. 1947, Vol. 27, Nos. 6 & 8, pp. 28–29 . . 41 & 34–35.) The transmitter uses a crystal-controlled master oscillator, phase-shift variable transconductance modulation and four frequency-multiplying and amplifying stages. The receiving selective-calling system uses a two-valve Wien-bridge oscillator circuit.

621.396.932 3666
Radio for Merchant Ships. [Book Notice]—H.M. Stationery Office, 1s. (*Govt Publ., Lond.*, April 1947, p. 12.) Performance specifications.

621.396.932 : [620.178+620.193 3667
Radio and Radar for Merchant Ships. [Book Notice]—H.M. Stationery Office, 2d. (*Govt Publ., Lond.*, April 1947, p. 12.) A performance specification for the climatic and durability testing of marine radio and radar equipment.

SUBSIDIARY APPARATUS

621.313.2-9 3668
Sub-Miniature D.C. Motors.—(*Electrician*, 2nd May 1947, Vol. 138, No. 3594, pp. 1157–1159.) For another account see 2943 of September.

621.314.632 : 621.315.59 3669
Contact Potential Difference in Silicon Crystal Rectifiers.—W. E. Meyerhof. (*Phys. Rev.*, 15th May 1947, Vol. 71, No. 10, pp. 727–735.) Measurements show no correlation between the work function differences and the contact potential difference, which is practically independent of the metal used and also of the structure of the silicon surface.

621.314.65+537.525.5 3670
On the Mechanism of Dielectric Ignition and Resistance Ignition in Mercury Arc Rectifiers. [Thesis]—N. Warmoltz. (*Philips Res. Rep.*, Nov. 1946, Vol. 1, No. 5, p. 379.) Summary only. A short survey based on the field theory of the low-pressure mercury arc.

621.316.53.029.5/.6 3671
A Design of Heavy-Current Contact, particularly for Radio-Frequency Use.—A. J. Maddock. (*J. Instn elect. Engrs*, Part I, May 1947, Vol. 94, No. 77, p. 233.) Summary of 2249 of July.

621.318.44 3672
Toroidal Coils. Improved Winding Machine.—E. R. Brooke. (*Elect. Rev., Lond.*, 29th Aug. 1947, Vol. 141, No. 3640, pp. 319–320.) Some details of a machine for quantity production of toroidal coils for transformers and chokes. Two rings are threaded on the core, both rings having detachable segments. One ring is channelled to carry enough wire for one winding, while the driving ring carries a wire feed pulley. The method of use for winding an 8-segment coil is described.

621.318.5 3673
Telephone Relays and Their Use in Electronic Circuits : Part 2.—A. A. Chubb. (*Electronic Engng*, July 1947, Vol. 19, No. 233, pp. 211–213.) Various a.c. and d.c. circuits for operating small telephone relays are given, and a complete circuit for remote control of a 1-kW transmitter and its associated receiver is described. For part 1 see 3294 of October.

621.396.68 : 621.397.5 3674
Television High Voltage R.F. Supplies.—R. S. Mautner & O. H. Schade. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 43–81.) A detailed consideration of the design of h.v. supply units using r.f. oscillators and voltage multiplier circuits. Sample calculations for a 75-W 90-kV supply and a 10-W 30-kV supply are included to illustrate the progressive steps in designing and calculating the circuit elements and operating conditions for a specified performance. For earlier work see 2169 of 1943 (Schade).

621.396.682 3675
A Special-Purpose Power Supply.—P. W. Howells. (*Gen. elect. Rev.*, June 1947, Vol. 50, No. 6, pp. 34–39.) A stabilized power pack with output continuously variable between 160 and 1 500 V at 0.125 A. Characteristics include a low-ripple output voltage and a low output impedance to minimize the possibility of undesired coupling between load circuits through the power supply.

TELEVISION AND PHOTOTELEGRAPHY

621.396/.397].62 : 621.396.67.029.62 3676
Aerials for Ultra-Short Waves : Part 1 — A Double Dipole for Television and F.M.—Maurice. (*See* 3433.)

621.396/.397].621.004.67 3677
The Servicing of Radio and Television Receivers.—R. C. G. Williams. (*J. Instn elect. Engrs*, Part I, March 1947, Vol. 94, No. 75, pp. 156–158.) Summary of 2224 of July.

621.397.2 3678
Developments in Picture Transmission.—J. J. E. Aspin. (*J. Instn elect. Engrs*, Part I, March 1947, Vol. 94, No. 75, p. 134.) Abstract of chairman's address to the South Midland Radio Group. A historical survey.

621.397.335 3679
New Techniques in Synchronizing-Signal Generators.—Schoenfeld, Brown & Milwitt. (*See* 3489.)

621.397.5 : 621.396.619.083 3680
A Method of Measuring the Degree of Modulation of a Television Signal.—Buzalski. (*See* 3593.)

621.397.5 : 621.396.68 3681
Television High Voltage R.F. Supplies.—Mautner & Schade. (*See* 3674.)

621.397.6 3682
Portable Camera Chain for Field Use.—L. Mautner. (*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 26–31 . . 109.) Wartime developments have permitted redesign of portable television cameras and associated control equipment for outside broadcast use. An image-orthicon type of pickup tube was chosen because of the wide range of sensitivity required and lack of shading available. A block diagram of a four-camera control system, and some circuit and construction details of camera-blanking methods, cable-delay compensation, and a camera control and monitor system are given.

621.397.6.001.8 3683
Simplified Television for Industry.—R. E. Barrett & M. M. Goodman. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 120–124.) Complete circuit details for a 250-line 60-frame television system, in which a new iconoscope simplifies the circuit and permits reproduction comparable to newspaper half-tones.

621.397.61 3684
The Paris Television Transmitting Centre.—H. Delaby. (*J. Televis. Soc.*, December 1946, Vol. 4, No. 12, pp. 307–313.) Translation of a French article abstracted in 1606 of May.

621.397.61-182.3 3685
Television O.B. [outside broadcast] **Vehicle.**—(*Wireless World*, July 1947, Vol. 53, No. 7, p. 241.) A 660-Mc/s transmitter complete with iconoscope cameras is housed in a car and obtains power from a 3.5-kW generator driven from the vehicle engine. The sound channel is conveyed by width-modulated pulses inserted in the line synchronization pulses and the 50-W output is fed to a beamed horizontal dipole at the top of a 40-ft telescopic mast.

621.397.62 3686
Television Receivers in Mass Production.—D.G.F. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 86–91.) Design features of the R.C.A. Victor postwar seven-inch, ten-inch and projection models. Summary of I.R.E. paper by A. Wright & E. Clark.

21.397.62 3687
Television Receiver Construction: Part 5.—(*Wireless World*, July 1947, Vol. 53, No. 7, pp. 51–257.) Line timebase and high voltage supply r the c.r.t. For earlier parts see 2595 of August nd back references.

1.397.62 3688
Television Receivers.—A. Wright. (*RCA Rev.*, arch 1947, Vol. 8, No. 1, pp. 5–28.) A detailed rvey of R.C.A. direct viewing and projection type ceivers with photographs and circuit diagrams. neral circuit principles are considered. The r.f. her uses push-pull neutralized triode amplifican, a push-pull triode frequency changer and itched coil tuning. The i.f. amplifier has ggered tuned circuits with rejection circuits ned to adjacent channels. An unusual circuit line synchronization, which is immune from erference, uses a stable sinusoidal oscillator whose ase is controlled by the line synchronization ses. The magnetically focused cathode-ray tube an ion trap to prevent ion bombardment of the en from causing discoloration.

.397.62 3689
elevision Receiving Equipment. [Book Review] . T. Cocking. Iliffe & Sons, London, 2nd edn 7, 339 pp., 12s. 6d. (*Proc. Inst. Radio Engrs*, & E., July 1947, Vol. 35, No. 7, p. 706.) For ther review see 2966 of September.

TRANSMISSION

317.76 3690
'WV — World Standard Frequency Generator.—*e-Tech*, May 1947, Vol. 6, No. 5, pp. 42–43.) ographs of some of the equipment used in the dard frequency transmissions.

391.63 : 621.325.53 3691
e Concentrated-Arc Lamp as a Source of ulated Radiation.—W. D. Buckingham & C. R. ert. (*J. Soc. Mot. Pict. Engrs*, April 1947, 48, No. 4, pp. 324–340. Discussion, pp. 340– A lamp using as radiation source a thin layer olten zirconium maintained as an incandescent by intense argon ion bombardment. The tion can be modulated at a.f. by modulating amp current. The use of suitable modulator ts, with optical filters to select the best ral region, enables the output to follow the nt modulation with good fidelity.

96.1 3692
pes of Emission.—(*R.S.G.B. Bull.*, Feb. 1947, 2, No. 8, p. 124.) Recommendations accepted he G.P.O. for the bands allotted to British urs are:
.75, 3.5, 7 and 14 Mc/s; c.w., a.m.
3 and 58.5 Mc/s; c.w., m.c.w., a.m., f.m.
300–2 450 Mc/s; any type of emission, ing television but excluding pulse transon.

6.61 3693
Radio Mike.—J. L. Hathaway & R. dy. (*RCA Rev.*, June 1947, Vol. 8, No. 2, 1–258.) A smaller, lighter and more efficient itter to replace the N.B.C. 'beermug'. The uses and tests applied are described.

621.396.61 : 621.396.712 3694
Placing a 3-kW F.M. Broadcast Transmitter in Operation.—R. G. Soule, Jr. (*Communications*, May 1947, Vol. 27, No. 5, pp. 16–18..46.) Preliminary tests of the area were made with a 50-W unit which is described. The transmitter itself has a four-bay circular aerial and provides 8.5 kW radiated power.

621.396.61.029.62 3695
A Low-Cost 2-Meter Transmitter.—E. P. Tilton. (*QST*, April 1947, Vol. 31, No. 4, pp. 26–29..122.) Circuit and constructional details of a stabilized modulated oscillator with an output of about 3.5 W.

621.396.61.029.62 3696
BC-625 on 144 Mc/s.—L. W. May, Jr. (*Radio Craft*, April 1947, Vol. 18, No. 7, pp. 35–36, 75.) Complete circuit details of the modifications necessary to convert the transmitter of the army SCR-522 set for amateur use.

621.396.611.21 : 621.316.726.078.3 : 621.396.712 3697
Improvements in Synchronisation of B.B.C. Transmitters: 1938–1946.—W. E. C. Varley. (*B.B.C. Quart.*, April 1947, Vol. 2, No. 1, pp. 51–58.) A review of the development of frequency control of broadcasting transmitters from the pre-1938 tuning fork drive to the present crystal drive. The performance of various crystal-controlled oscillators is given and the technique of frequency comparison described with circuit details.

621.396.615.141.2 3698
Modulated Magnetrons.—L. P. Smith, J. Kurshan & J. S. Donal. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 57.) Summary of I.R.E. paper. Picture or audio signals control the electron guns and cause the magnetron to generate a f.m. wave without a.m. Under the influence of a static magnetic field and a r.f. electric field, an electron beam follows a spiral path within the cavity and applies f.m. to the natural resonant frequency of the magnetron. For general discussion of this technique and two specific applications, see 3699, 3730 and 3731 below.

621.396.615.141.2 : 621.316.726 3699
Frequency Modulation and Control by Electron Beams.—L. P. Smith & C. I. Shulman. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 644–657.) General formulae for the effect of electron beams on resonant systems in terms of frequency shift and change in Q are derived both from the point of view of lumped circuits and also from a general electromagnetic field standpoint. Check measurements of the frequency shift produced by such a beam in a multivane magnetron are described. It is shown that this method of frequency control is ideal for frequency modulation or automatic frequency stabilization of magnetrons and that for the former purpose the amplitude and phase distortions are negligible.

621.396.619.11/.13 3700
Generalized Theory of Multitone Amplitude and Frequency Modulation.—L. J. Giacoletto. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 680–693.) The frequency spectra produced by single-tone, two-tone and multitone modulating signals in the case of a.m., f.m. and combined a.m. and f.m. are studied. Computations of the frequency spectra for typical cases are made and compared with actual spectra obtained by means of a spectrum analyser.

621.396.619.11 3701

Overmodulation Splatter Suppression.—O. G. Villard, Jr. (*QST*, June 1947, Vol. 31, No. 6, pp. 13–20.) A method of filling in the overmodulation gaps in the carrier and so preventing the generation of spurious sidebands.

621.396.619.15 : 621.396.3 3702

Relative Amplitude of Side Frequencies in On-Off and Frequency-Shift Telegraph Keying.—G. S. Wickizer. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 158–168.) Measurements and calculations on the frequency spread of the sidebands indicate that frequency-shift keying requires less bandwidth than on-off keying as the characters may be shaped by a low-pass filter.

621.396.619.23 3703

A 40-Watt Modulator with Cathode-Coupled Driver.—W. J. Lattin. (*QST*, April 1947, Vol. 31, No. 4, pp. 42–44.) Circuit details of a unit with built-in power supply and four stages terminating in a 6L6G push-pull class AB2 output stage.

621.396.645 3704

Design of Linear Amplifiers for Single Side Band Transmitters.—E. Green. (*Marconi Rev.*, Jan./March 1947, Vol. 10, No. 84, pp. 11–16.) Distortion of a modulated carrier in a transmitter due to varying input impedance of the power amplifier is avoided by using screen-grid driving valves with an impedance transforming network.

621.396.65.029.63 3705

An Experimental Transmitter for Ultra-Short-Wave Radio-Telephony with Frequency Modulation.—A. van Weel. (*Philips tech. Rev.*, April 1946, Vol. 8, No. 4, pp. 121–128.) For another account see 2606 of August.

VALVES AND THERMIONICS

621.314.6.032.212 3706

A Cold Cathode Rectifier.—W. H. Bennett. (*J. appl. Phys.*, May 1947, Vol. 18, No. 5, pp. 479–482.) Corona discharge is used at atmospheric and higher pressures in H and N free from electron-attaching impurities. Such rectifiers have definite advantages where current requirements are small.

621.314.67 3707

Determination of Current and Dissipation Values for High-Vacuum Rectifier Tubes.—A. P. Kauzmann. (*RCA Rev.*, March 1947, Vol. 8, No. 1, pp. 82–97.) "Rectifier data are shown graphically with generalized parameters from which it is possible to determine the peak steady-state current, the maximum possible hot-switching current, and the dissipations in the diode and in any added series resistors. The paper covers capacitive-input filters with large capacitors and includes half-wave, full-wave, and voltage-doubler circuits. A table of operating conditions and efficiency for a group of typical rectifiers is included."

621.314.671 : 621.386.1 : 616-073.75 3708

High-Voltage Rectifier Valves for X-Ray Diagnostics.—J. H. van der Tuuk. (*Philips tech. Rev.*, July 1946, Vol. 8, No. 7, pp. 199–205.) Relative merits of gas-filled and vacuum valves and construction of new vacuum valves with thoriated tungsten cathodes.

621.383.4 : 535.215 3709

Lead Sulphide Photoconductive Cells.—L. Sosnowski, J. Starkiewicz & O. Simpson. (*Nature, Lond.*, 14th June 1947, Vol. 159, No. 4050, pp. 818–819.) The method of production developed at the Admiralty Research Laboratory is described in detail. Maximum sensitivity is assured when both lead and oxygen impurity centres are present in sufficient quantity and with relative concentration such that minimum conductivity and zero thermoelectric power are obtained. Theory is presented which is in general quantitative agreement with experiment as regards sensitivity, rectifying effect and time of response.

621.383.5 3710

Fatigue in Selenium Barrier Layer Photocells.—R. A. Houstoun. (*Phil. Mag.*, Jan. 1946, Vol. 37, No. 264, pp. 13–17.) See also 3433 of 1941.

621.385+621.396.694 3711

Tube Registry.—(*Electronics*, June 1947, Vol. 20, No. 6, pp. 244, 247.) Characteristics of iconoscope Type 5527, triode power amplifiers and oscillators Types 195 and 196 and c.r. tube Type 3MP1. See also 2976 of September and 2288 of July.

621.385 : 518.5 3712

Electrostatic Storage.—J. Rajachman. (*Tele Tech*, May 1947, Vol. 6, No. 5, p. 61.) Summary of I.R.E. paper. Describes a vacuum-tube 'memory' for electronic computers. A multi-cellular anode stores up to 4 096 impulses separately. Storing time is indefinite and reading follows the reading call by only a few microseconds and can be repeated indefinitely.

621.385 : 537.533.8 3713

Transit-Angle Suppression in Microwave Tubes.—J. H. Owen Harries. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 132–134.) Details of research into the control of the phase of the u.h.f. field near copper target anodes, for the suppression of secondary emission. A transverse modulated electron beam was passed through the aperture in a sub-anode, then traversed a distance d to the surface of the target anode. A resonant cavity in the output circuit was tuned to the modulation frequency f and power transfer was recorded by a diode. The transit angle $\phi = 10^3 d\pi/\lambda V_b^{\frac{1}{2}}$, where V_b is the target and sub-anode voltage and λ is the wavelength corresponding to f, was varied by altering d and/or V_b. Tests were carried out for λ 40 cm. Three types of copper target were used: (*a*) polished, (*b*) roughened and carbonized, (*c*) slotted and carbonized. Plots of ϕ versus power output efficiency show the slotted targets to be the most efficient, with values comparable with theory for $\phi > 0.3\pi$. The theory of suppression is illustrated by graphs in which the target and sub-anode currents are plotted against ωt for values of ϕ from $\pi/6$ to π.

621.385.029.63/.64]+621.396.615.14 3714

On Some Modern Constructions and Some Recent Designs of Ultra-Short-Wave Receiving and Transmitting Valves.—R. Warnecke. (*Bull. Soc. franç. Élect.*, Feb. 1947, Vol. 7, No. 66, pp. 81–94.) Technical details obtained by the author, during visits to Britain and the U.S.A., of the resnatron, klystrons and other high-power velocity-modulation valves, and travelling-wave valves. The prionotron designed by the author is also described.

6[?].385.029.63/.64 3715

Helical-Wave Properties.—C. C. Cutler. (*Tele-*
ch, May 1947, Vol. 6, No. 5, p. 56.) Summary o I.R.E. paper. Probe measurements in a velling-wave valve show that the longitudinal d component along the axis is greater than that dicted by theory.

.385.029.63/.64 : [621.392+537.291 3716

n the Theory of Progressive-Wave Amplifiers.—nc-Lapierre, Lapostolle, Voge & Wallauschek. 3421.)

.385.1+621.396.694 3717

New Range of Glass-Based Valves.—(*Electronic ng*, July 1947, Vol. 19, No. 233, p. 231.) Type nbers and brief descriptions are given of the spigotless miniature valves with B8A base. heater current in the a.c./d.c. range is 0.1 A the bulb size approximately 20 mm. An a.c. ge with the B8A base and 6.3 V heaters is also e introduced, together with a high-gain screened pentode and a triode specially designed for vision reception. Location of these valves in holders is effected by a small boss on the side he base.

385.1+621.396.694] : 389.6 3718

A Valve Base.—(*Electronic Engng*, July 1947, 19, No. 233, p. 235.) For details of the base, 57 and 980 of March. A spigotless version is announced, the ultimate aim being to stand-e a range of valves to fit both bases.

85.1 3719

e Control of the Current Distribution in Electron s.—J. L. H. Jonker. (*Philips Res. Rep.*, Nov. Vol. 1, No. 5, pp. 331–338.) Characteristics ontrol by a negative grid are calculated and n to agree with experiment.

85.1 3720

iature Tubes in War and Peace.—N. H. Green. *Rev.*, June 1947, Vol. 8, No. 2, pp. 331–341.) . describes the design features which account e versatility and lower cost of the miniature and cites several varied applications of minia- in both military and commercial equipment. ble showing typical present-day applications iniature tubes is included."

5.1 : 621.396.694.012.8 3721

ve Equivalent Circuit.—A. W. Keen : B. rg. (*Wireless Engr*, July 1947, Vol. 24, No. p. 217–218.) The use of 'equivalent' circuits a voltage or a current generator is optional matter of convenience for external per-nce, but in general neither gives the correct of internal power dissipation. See also 2622 gust (Salzberg) and back references.

5.2 : 621.396.822.029.6 3722

oaxial-Line Diode Noise Source for U.H.F.—hnson. (*RCA Rev.*, March 1947, Vol. 8, pp. 169–185.) The diode has a single-turn filament coaxial with, and connected to the conductor, the outer conductor being the The valve is connected on one side to a ne to give the correct impedance load and other side to the 50-Ω input line of the r under test. A diode current of 100 mA obtained corresponding to a noise factor of 20 db. The effect of the filament capacitance in producing standing wave errors is considered and the transit-time loss is calculated and is shown to be about 3 db at 3 000 Mc/s. A comparison with signal generator measurement at 750 and 1 500 Mc/s gave a maximum discrepancy of 0.4 db.

621.385.2.032.216 3723

Effect of the Saturation Current on the Space-Charge Current in Valves using Oxide Cathodes.—R. Champeix. (*C. R. Acad. Sci., Paris*, 9th June 1947, Vol. 224, No. 23, pp. 1626–1628.) In a diode with oxide cathode the space-charge current may increase, remain unchanged, or sometimes even decrease when the saturation current increases. These anomalous results are explained.

621.385.3/5 : 621.317.336.1 3724

The Measurement of Dynamic Mutual Conductance of Valves using the Grounded-Grid Triode Mode of Operation.—Gutmann. (*See* 3576.)

621.385.4.029.63 3725

Tetrodes vs Triodes.—W. G. Wagener. (*Tele-Tech*, May 1947, Vol. 6, No. 5, p. 54.) Summary of I.R.E. paper. Neutralized tetrodes offer higher gain and greater circuit stability than neutralized triodes in the region of 500 Mc/s.

621.385.831 : 621.317.382 3726

Power Measurement of Class B Audio Amplifier Tubes.—Heacock. (*See* 3578.)

621.396.615.14 3727

The Excitation of Resonant Circuits by Electron Currents in the Transit-Time Domain.—Gundlach. (*See* 3468.)

621.396.615.141.2.032.21 3728

Coaxial Tantalum Cylinder Cathode for Continuous-Wave Magnetrons.—R. L. Jepsen. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 301–311.) The use of a cathode with a tungsten inner and tantalum outer conductor eliminates many of the drawbacks of normal cathodes.

621.396.615.141.2 3729

On Electron Oscillations in a Magnetron.—V. I. Kalinin & I. I. Wassermann. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 103–110. In Russian.) The electron oscillations in a split-anode magnetron are studied from the standpoint of spatial irregularities in the electron beam. The oscillations of the first order, which appear in all magnetrons under conditions close to the critical régime, are due to a certain radial irregularity. These conditions can be reduced to a system with a retarding field. In considering oscillations in a split-anode magnetron a conception of a tangential irregularity which takes place in the 'ring current,' in close proximity to the anode, is introduced and the frequency of the oscillations determined. Results of experiments with multi-segment magnetrons (from 4 to 20 segments) are in satisfactory agreement with the theoretical conclusions. For 'ring current' see 64 of 1937 (Möller).

621.396.615.141.2 3730

A Frequency-Modulated Magnetron for Super-High Frequencies.—G. R. Kilgore, C. I. Shulman & J. Kurshan. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 657–664.) The development of a 25-W 4 000-Mc/s c.w. magnetron capable of a frequency deviation of 2.5 Mc/s without a.m. is described. F.m. is accomplished by the introduction of electron beams in two of the twelve cavities (3699 above). Design details and performance data are given.

621.396.615.141.2 **3731**

A 1-Kilowatt Frequency-Modulated Magnetron for 900 Megacycles.—J. S. Donal, Jr, R. R. Bush, C. L. Cuccia & H. R. Hegbar. (*Proc. Inst. Radio Engrs, W. & E.*, July 1947, Vol. 35, No. 7, pp. 664–669.) The design and performance of the magnetron are described. F.m. is accomplished by the introduction of electron beams in nine of the twelve cavities (3699 above) and a deviation of 3.5 Mc/s is obtained.

621.396.615.141.2 : 513.732.6 **3732**

A Flux Plotting Method for obtaining Fields satisfying Maxwell's Equations, with Applications to the Magnetron.—Crout. (*See* 3560.)

621.396.615.141.2 : 537.533.8 **3733**

The Secondary Emission in Magnetron Oscillators.—S. Ya. Braude & I. E. Ostrovski. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 65–73. In Russian.) It has been observed that under certain conditions the anode current of a magnetron with grid control can be from 5 to 7 times the normal. A detailed investigation, both theoretical and experimental, shows that this phenomenon is due not to the ionization of the residual gases in the magnetron, as was supposed by some investigators, but to secondary emission from the grid of electrons travelling in the grid-anode space. It is also shown that the grid secondary emission can be greatly increased if oscillating potentials are present in the magnetron.

621.396.615.141.2 : 621.316.726 **3734**

Frequency Modulation and Control by Electron Beams.—Smith & Shulman. (*See* 3699.)

621.396.615.141.2 : 621.365.92 **3735**

A Magnetron Oscillator for Dielectric Heating.—R. B. Nelson. (*J. appl. Phys.*, April 1947, Vol. 18, No. 4, pp. 356–361.) Design and performance of a magnetron having 5 kW continuous output at 1 050 Mc/s.

621.396.615.141.2 : 621.396.933.2 **3736**

Stabilized Magnetron for Beacon Service : Part 1 — Development of Unstabilized Tube.—J. S. Donal, Jr, C. L. Cuccia & B. B. Brown. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 352–361.) The design of the valve is unconventional inasmuch as all the parts are supported on a header to which the envelope is welded. The inserts in the magnetic circuit are at cathode potential. The valve is designed for a pulsed input power of 2.5 kW. The unstabilized peak output is approximately 1 kW at 2 500 V anode potential and a frequency of 9 310 Mc/s.

621.396.615.141.2 : 621.396.933.2 **3737**

Stabilized Magnetron for Beacon Service : Part 2 — Engineering of Tube and Stabilizer.—C. P. Vogel & W. J. Dodds. (*RCA Rev.*, June 1947, Vol. 8, No. 2, pp. 361–372.) The frequency-stabilization device includes an invar tunable cavity using a plunger supported by a spindle of higher-expansion steel and is filled with dry nitrogen. The wave-guide coupling to the load contains adjustable screw tuners. The stabilization process consists in the proper adjustment of these screws. The stability is improved by a factor of 10. For part 1 see 3736 above.

621.396.615.142 **3738**

The Principles of a General Theory of the Generation of Electron Oscillations at Ultra High Frequencies.—Kalinin. (*See* 3470.)

621.396.615.142.2 **3739**

The Theory of a Single-Circuit Klystron.—L. N. Loshakov & S. D. Gvozdover. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 79–86. In Russian.) In a reflex klystron the buncher and collector voltages coincide, with the result that its efficiency is lower than that of a klystron using two coupled resonators. To simplify the construction of the latter type, a klystron using a single resonator but with separate buncher and collector voltages is proposed (Fig. 1). An approximate theory of this klystron is given together with some preliminary experimental results.

621.396.615.142.2 **3740**

The Self-Excitation of a Reflex Klystron.—S. D. Gvozdover. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 1, pp. 75–78. In Russian.) The theory of the reflex klystron is discussed and the condition (5) necessary for self-excitation is established for the case when the potential of the reflecting electrode is equal to that of the cathode. Equation (6) determining the frequency of self-oscillations is also obtained.

621.396.615.142.2 : 621.396.645.029.64 **3741**

On U.H.F. Amplification and on the Resonance Method for suppressing Noise in a Klystron.—Katsman. (*See* 3481).

MISCELLANEOUS

061.6"1947"I.R.E. : 621.396 **3742**

I.R.E. reveals Engineering Advances.—(*Tele-Tech*, May 1947, Vol. 6, No. 5, pp. 52–61.) A report on the 1947 I.R.E. National Convention, with abstracts of 43 of the 125 technical addresses presented. For abstracts of selected individual papers, see other sections.

061.6(73) **3743**

Science Advancing — The Future of Testing.—E. U. Condon. (*ASTM Bull.*, May 1947, No. 146, pp. 53–58.) A review of some of the wartime activities of the National Bureau of Standards and brief discussion of future developments.

621.3 **3744**

British Industries Fair.—(*Elect. Rev., Lond.*, 2nd May 1947, Vol. 140, No. 3623, pp. 697–721.) A guide to the electrical exhibits at Castle Bromwich, Birmingham, and Olympia and Earls Court, London.

621.38/.39 + 539.17 **3745**

Nucleonics and Electronics.—K. Henney. (*Electronics*, June 1947, Vol. 20, No. 6, pp. 80–81.) Nucleonics, a generic name for atomic energy and related subjects and intimately related to electronics.

621.385.1 + 621.396.694] : 389.6 **3746**

B8A Valve Base.—(*See* 3718.)