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WIRELESS ENGINEER

The Journal of Radio Research & Progress

Vol. XIX DECEMBER 1942 No. 231

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CONTENTS

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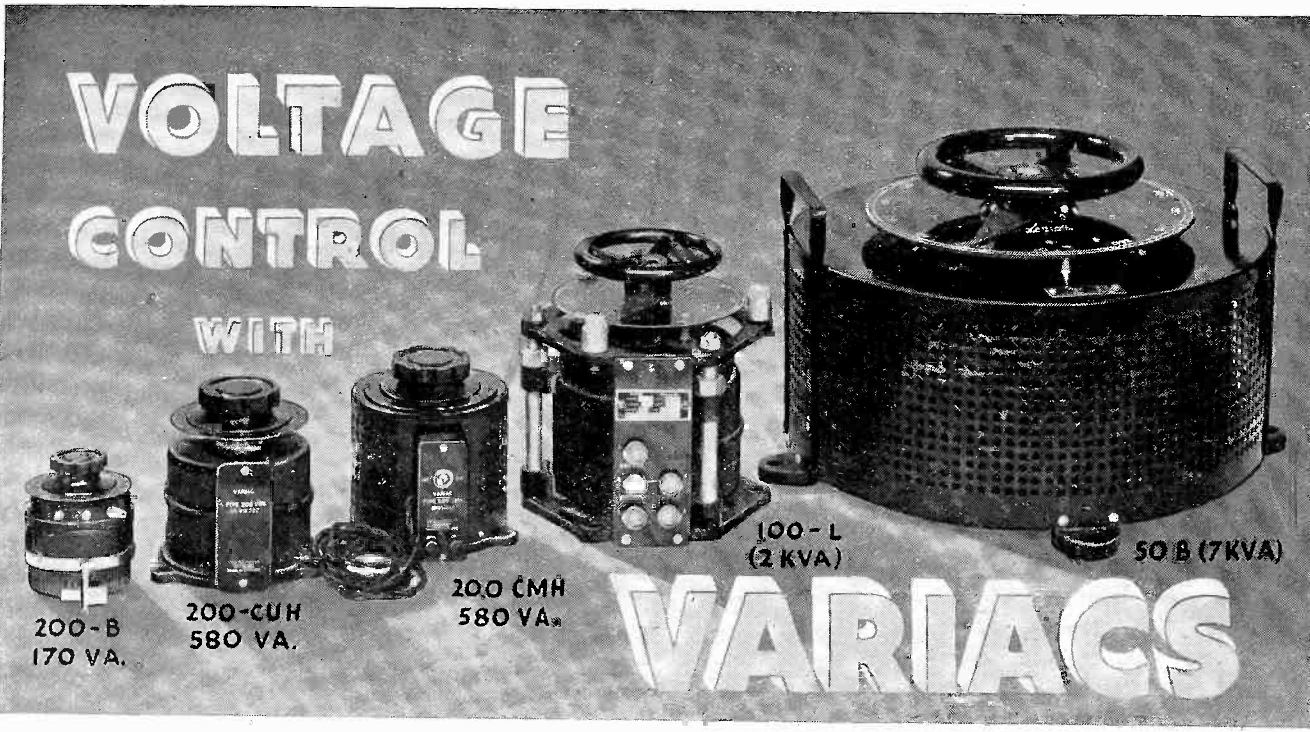

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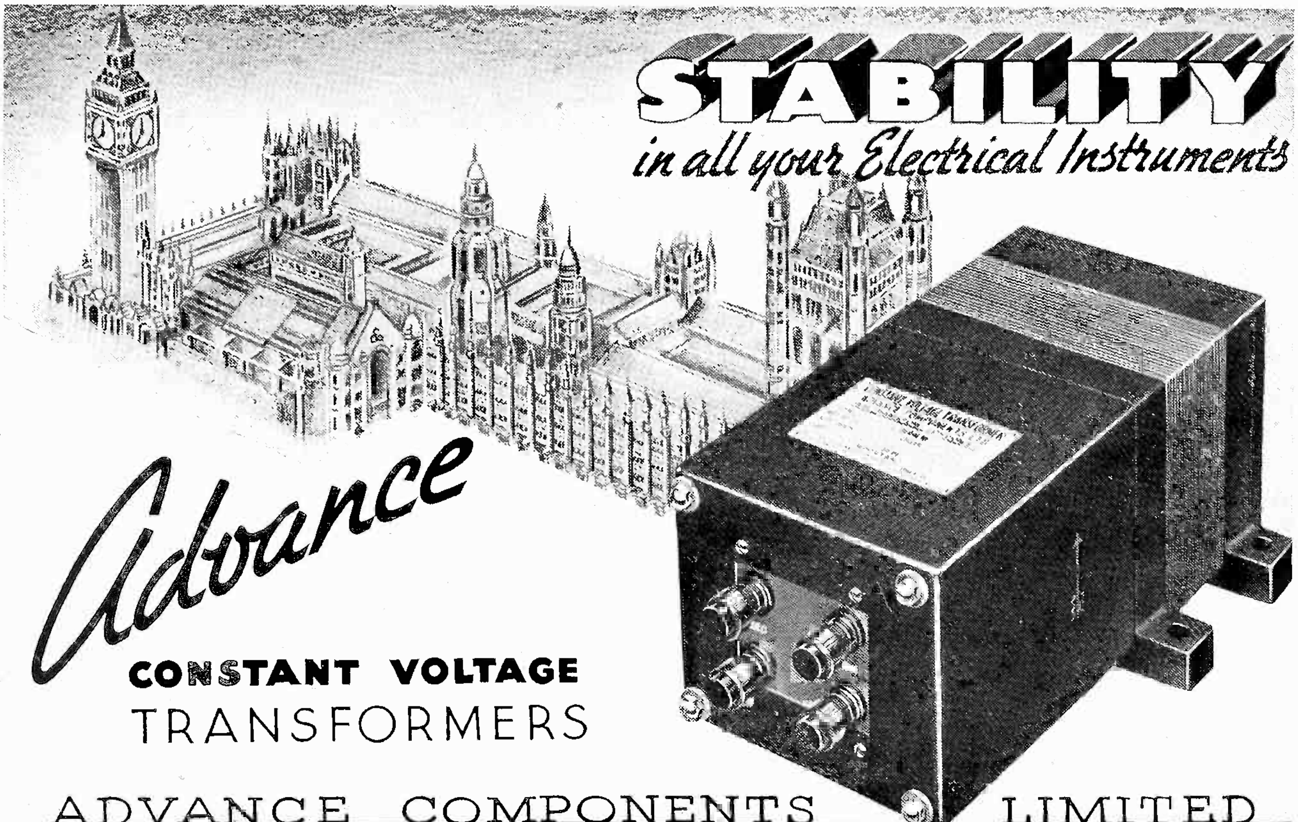

CONSTANT VOLTAGE
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It sounds like "coals to Newcastle"—but U.S.A., the home of cored solder, found it worth while to import British made Ersin Multicore—the A.I.D. approved solder wire with three cores of non-corrosive Ersin flux, although Ersin Multicore, after paying freight and duty, costs American manufacturers fifty per cent. more than American made solders. Why? With the correct, rapid soldering technique, H.R. or "dry" joints are impossible with Ersin Multicore, and production is speeded up. Present conditions do not permit the export of Multicore to U.S.A., but after Victory, U.S.A. manufacturers will, once again, be able to use "the finest cored solder in the world."

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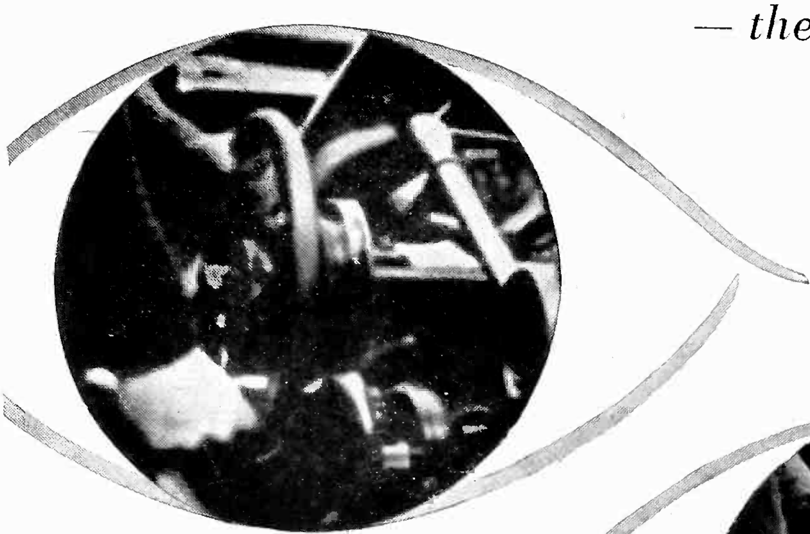
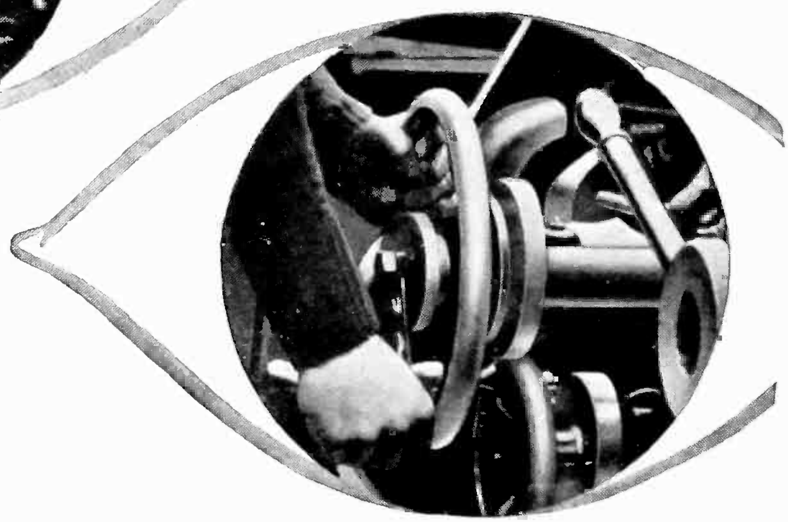
— the thief of output . . .



Eye fatigue blurs and slows the vision, seriously affecting output and accuracy.



Daylight is the best light to combat eye fatigue and maintain the quantity and quality of output.

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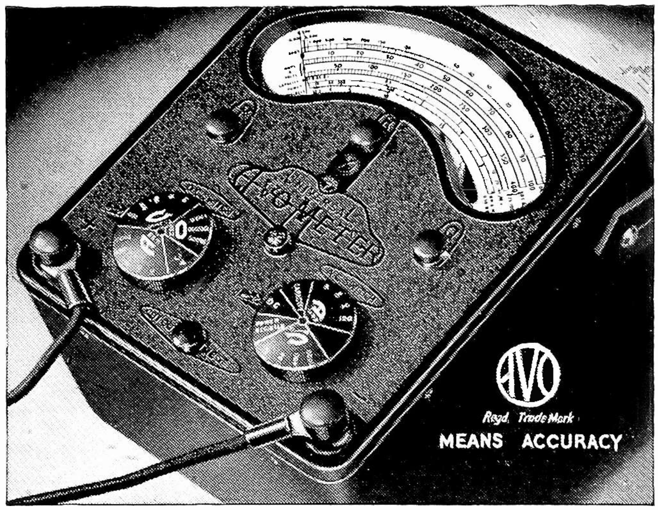

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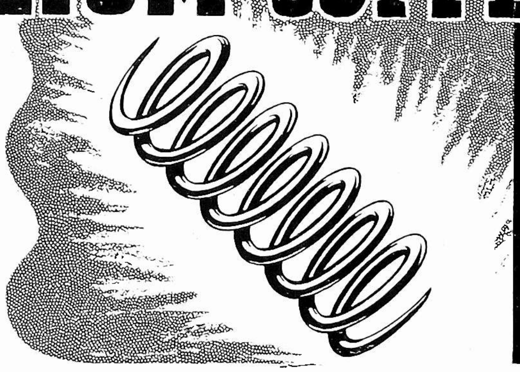

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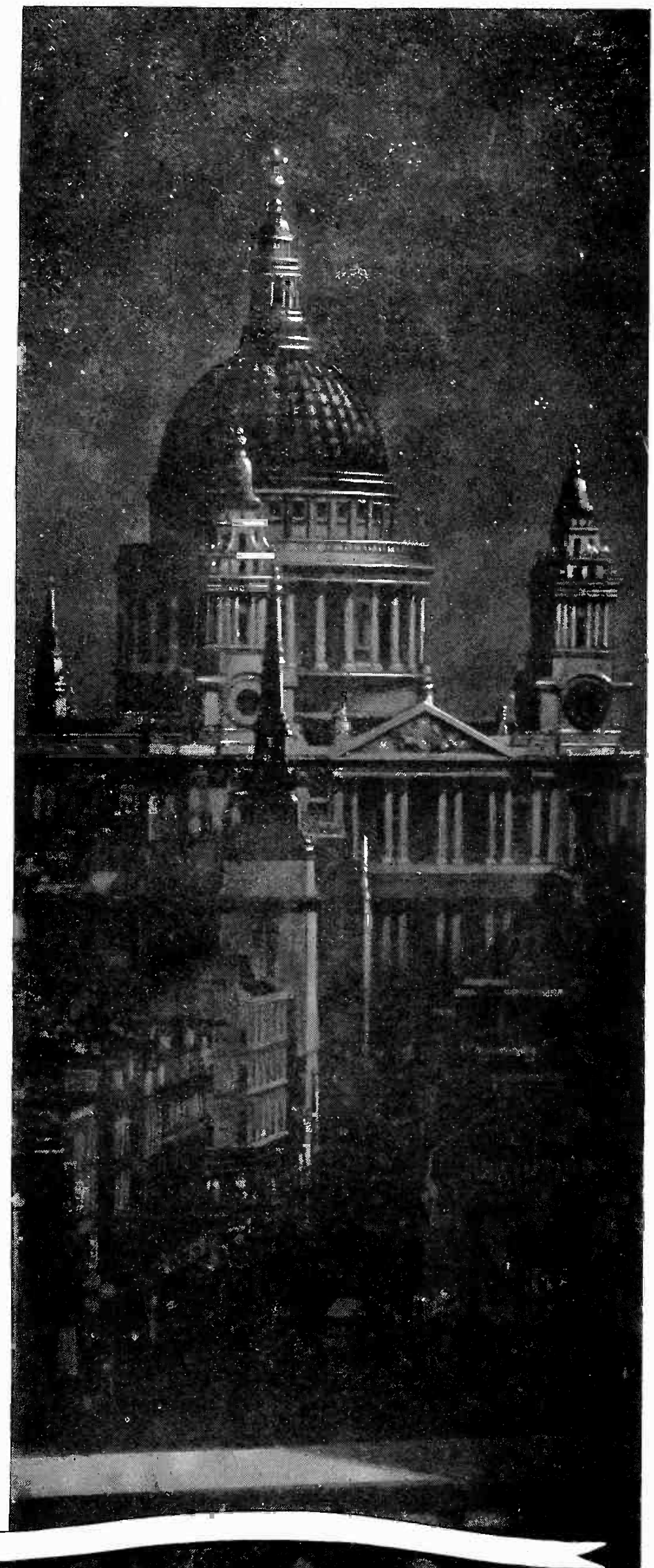

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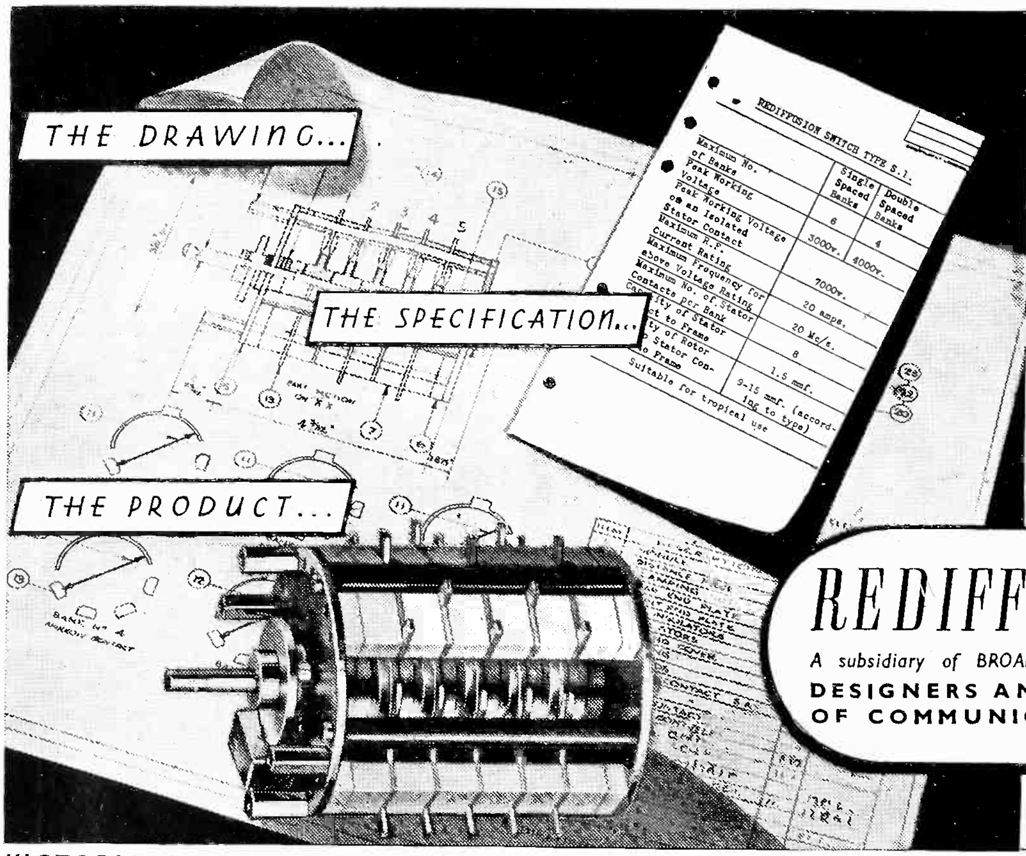

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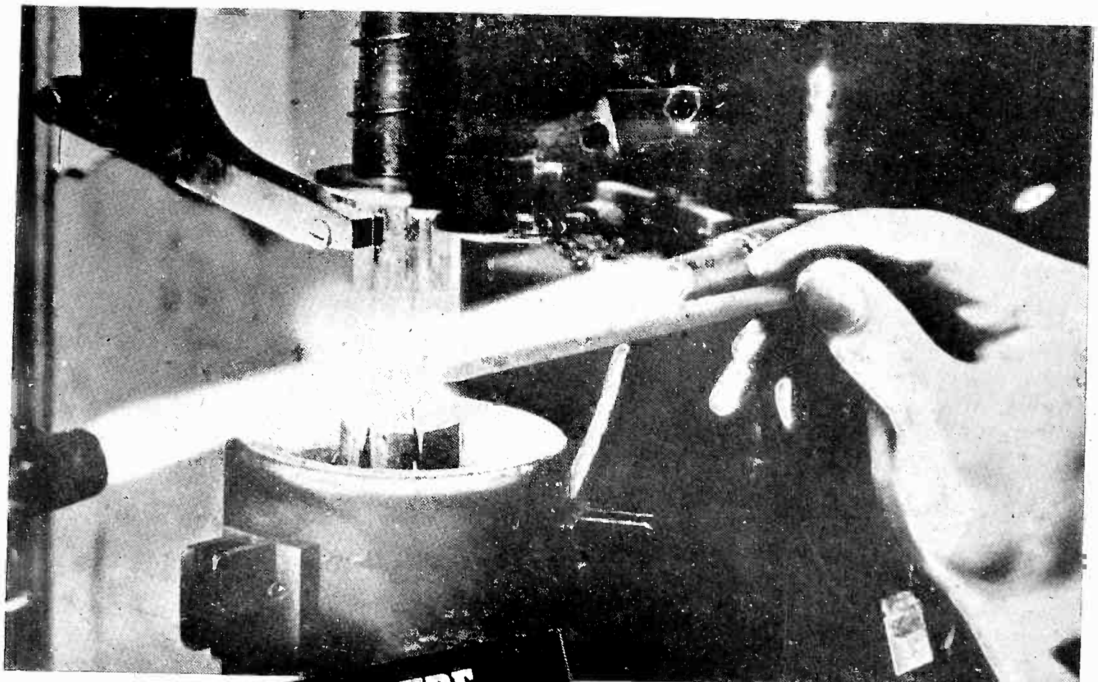

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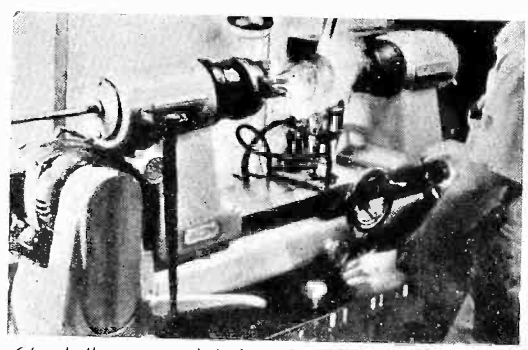
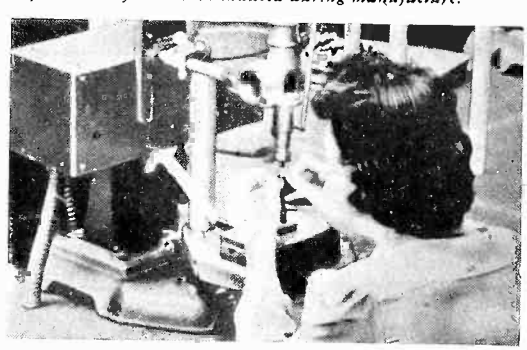


Glass bulbs are annealed after valve is fully assembled. This operation relieves stress and strain in the glass itself which may have been induced during manufacture.



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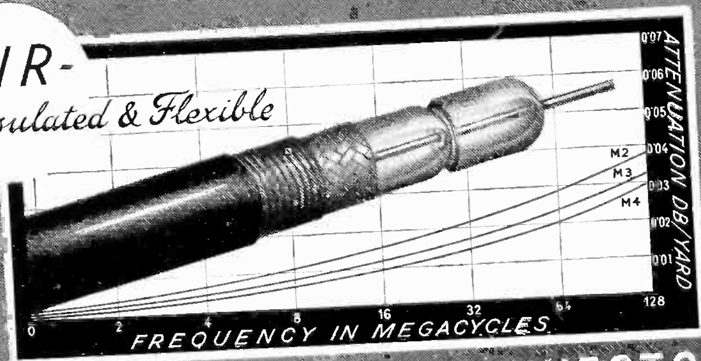

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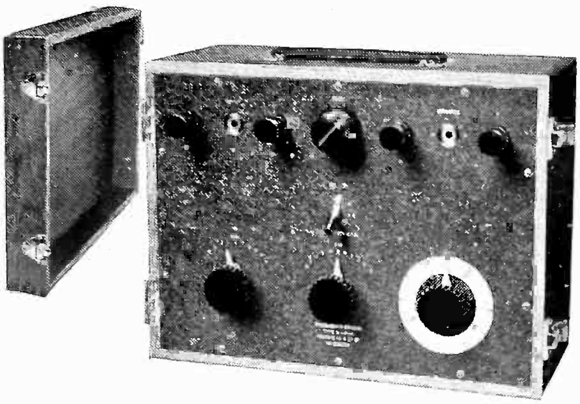

A complete description of this Bridge is given in Bulletin B-526-A, which will be sent on request

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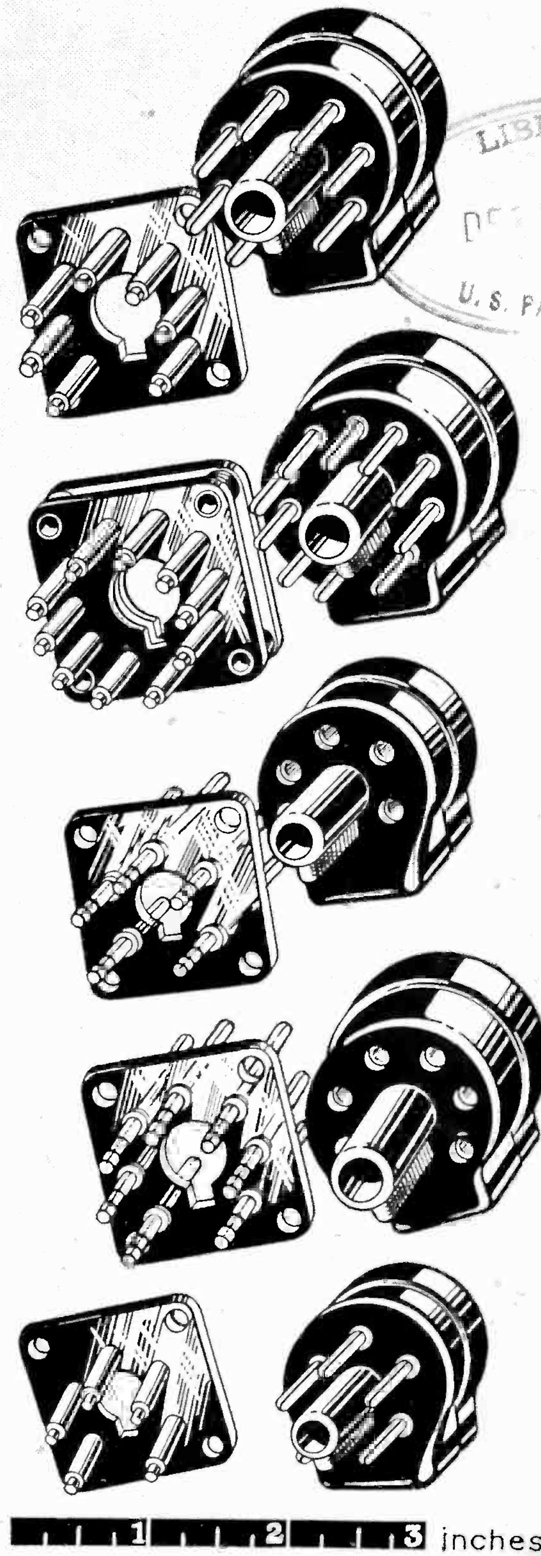

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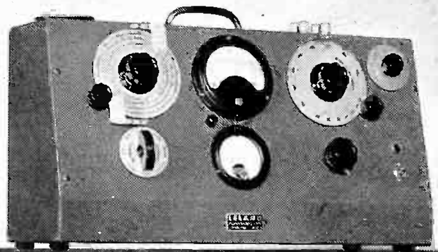

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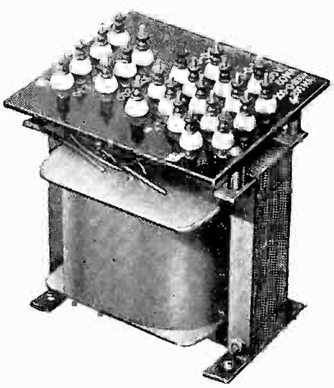

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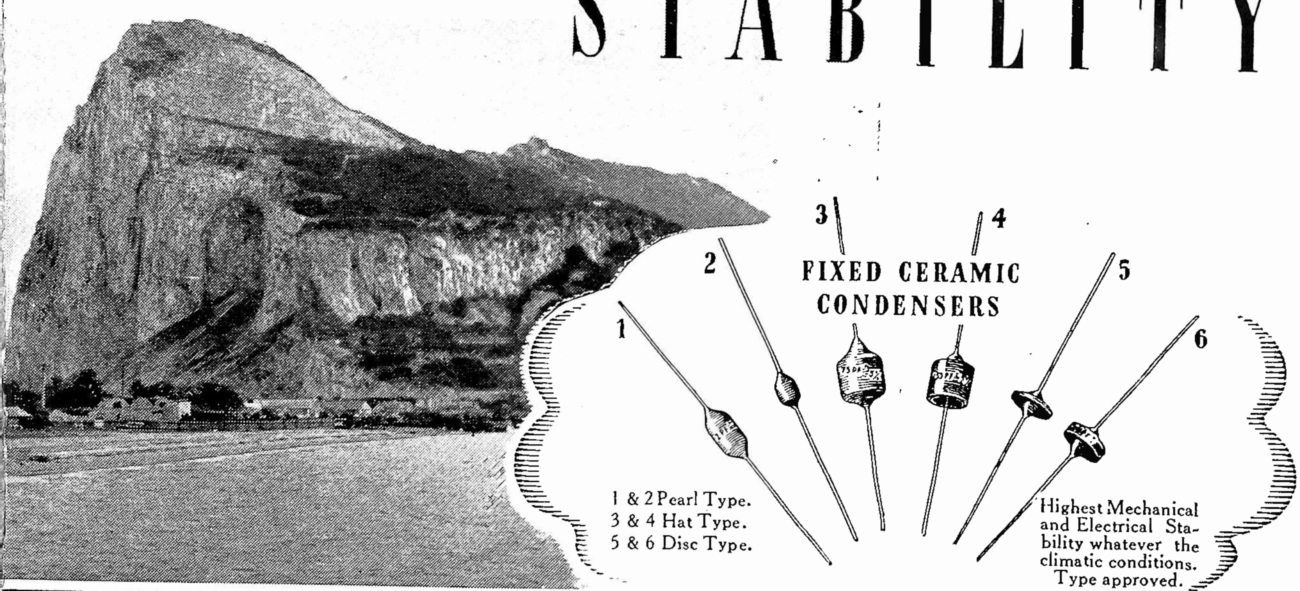

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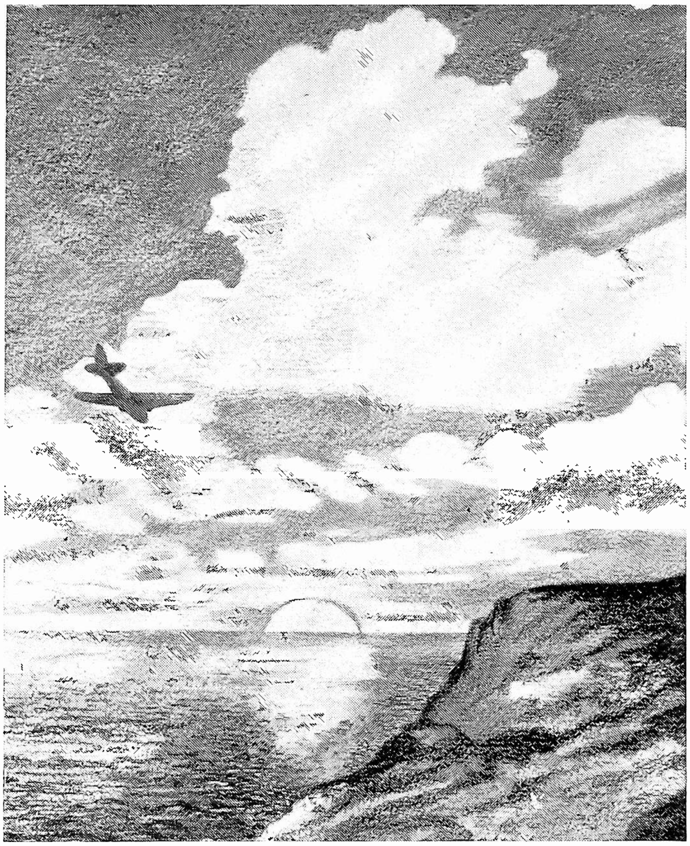

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The need for vast and increasing quantities of these metals must be met by a national search for everything made from them which is broken or serving no useful purpose.

WHAT TO SEARCH FOR

Here is a list of some of the important non-ferrous metal articles, parts and equipment likely to be found on your premises. Use it as a guide to your search for everything you can spare.

COPPER — cable, electrical parts and fittings, sheathing, tube, turnings, wire.
ZINC — sheet, cuttings.
LEAD — covered cable, pipe, sheet, solder.
WHITE METAL — anti-friction metal, plumber's jointings, solder waste.
BRASS — pipe, sheet, tube, turnings.
BRONZE — bearings, bushes, cocks, couplings, crown wheels, junction boxes, unions, valves.
ALUMINIUM SCRAP (and its alloys) — pipe, sheet, castings, tube, turnings.

HOW TO DISPOSE OF IT

1. Sell your non-ferrous scrap to a Merchant.
2. Or hand it to a Local Authority Depot.
3. SPECIAL COLLECTIONS of amounts over ONE TON may be obtained by getting in touch with the nearest Demolition and Recovery Officer. If you don't know his name, write to The Ministry of Works & Planning, Lambeth Bridge House, London, S.E.1.

NOTE: Under the provisions of the Scrap Metal (No. 2) Order, 1942, if you are in possession of more than 3 tons of Scrap Metal, it is now an offence not to disclose the fact to The Ministry of Works & Planning, Lambeth Bridge House, London, S.E.1.

WANTED! INDUSTRIAL SALVAGE STEWARDS

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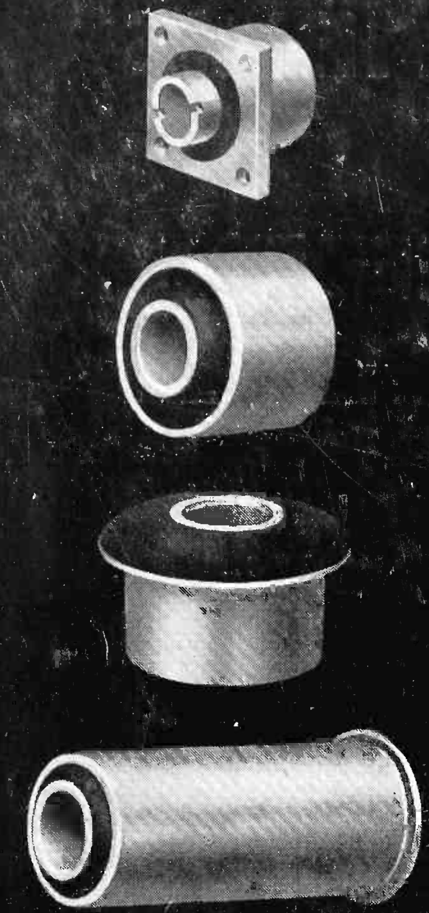

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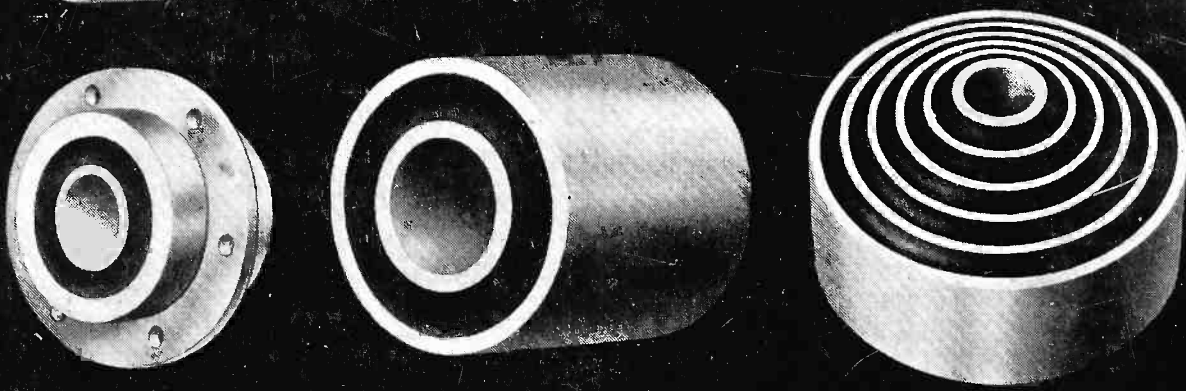

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Editor HUGH S. POCOCK, M.I.E.E. Technical Editor Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

VOL. XIX DECEMBER 1942 No. 231

Editorial

Joseph Henry

IN a recent number of the Proceedings of the American Institute of Radio Engineers, the Dean of Princeton University, contributed a biographical article on Joseph Henry with the somewhat surprising subtitle of "Pioneer in Space Communication." We feel sure that very few people have ever associated the name of Henry with early work in the field of space communication. As a matter of fact, very few of the thousands of people who talk daily of henries, millihenries and microhenries, have the faintest idea of what Joseph Henry really did, that his name should thus be perpetuated. That his name was given to the unit of inductance was due to the fact that the fourth international Congress was held in Chicago in 1893. The third Congress had met in Paris in 1889 and had decided to call the unit a "quadrant," but four years later in Chicago, the home team succeeded in getting this rescinded and replaced by the name of an American scientist, Joseph Henry, just as in 1881 the Paris Congress had replaced "Weber" by "Ampere" as the name of the unit of current.

In 1832 Henry, at the age of 35, was appointed professor of natural philosophy at Princeton. At the age of 13 he had been apprenticed to a watchmaker, but had given this up and taken the study of chemistry, anatomy and physiology with the idea of adopting a medical career; this in turn he had given up for engineering which he followed for some time. In 1826 he was appointed a teacher of mathematics and physics at Albany Academy, where he experimented with electromagnets, using a wrapping of silk to insulate the wire and making two types of winding, one with few turns of thick wire, the other with many turns of finer wire, which were known as "quantity" and "intensity" windings. respectively. Like Faraday, he had the idea that, as an electric current produces magnetic effects, so a magnetic field, if powerful enough, would surely produce electric effects. This problem haunted Faraday foi years; in 1822, he wrote in his note-book "Convert magnetism into electricity," and although he was engaged on many researches, mostly of a chemical or metallurgical character, he repeatedly returned to the attack. In 1825 he made many experiments to see if a powerful electromagnet held near a wire carrying a current had any effect on the current, but although he used a delicate galvanometer and tried thick and thin wires of different metals, the results were all negative. Six years later in August, 1831, Faraday returned to the attack and in a series of experiments of marvellous ingenuity and thoroughness he laid bare the secret of the evolution of electricity from magnetism, he described the experiments to the Royal Society on 24th November, 1831, in a paper of 41 pages.

Henry was still at Albany making experibut also of giving the scientific outlook to the historian and the classic . . ." (ii) " It leaves one breathless " [R. A. Butler's observation at Harrow]. For correspondence *see* issues for 21st & 28th August, pp. 155 & 174.

3429. RESEARCH AS USUAL [in Total War ?].—Blackwelder. (*Science*, 14th Aug. 1942, Vol. 96, pp. 158–159.)

3430. UTILIZATION OF SCIENTIFIC AND TECHNICAL RESOURCES [and the Need for a Whole-Time Central Scientific & Technical Board : Leading Article].—(*Nature*, 15th Aug. 1942, Vol. 150, pp. 189–191.) *See* also 3157 of October.

3431. ORGANISATION OF SCIENCE FOR WAR [Leading Article].—(*Nature*, 12th Sept. 1942, Vol. 150, pp. 301–305.) *See* also p. 316, and issue for 10th October, p. 434.

3432. SECOND REPORT OF THE WAR POLICY COMMITTEE OF THE AMERICAN INSTITUTE OF PHYSICS.—(*Science*, 24th July 1942, Vol. 96, pp. 89–90.) For the first report *see* 3158 of October.

3433. WARTIME DESIGN PRACTICE [with Examples of Unprecedented Requirements].—Marshall. —(*Communications*, March 1942, Vol. 22, No. 3, pp. 5–6.)

3434. WAR-TIME RELAXATIONS OF I.E.E. REGULATIONS.—I. E. E. (*BEAMA Journal*, Aug. 1942, Vol. 49, No. 62, pp. 228–229.)

3435. PUBLICATION OF SCIENTIFIC RESEARCH CARRIED OUT IN INDUSTRY.—Denbigh. (*Nature*, 12th Sept. 1942, Vol. 150, p. 322.)

" There is thus a closer liaison between university and industry [in U.S.A., where the non-publication by private enterprise is far less pronounced] than has yet been achieved in Great Britain . . . ." For a reply by N. R. Campbell *see* issue for 3rd October, p. 408.

3436. ENCOURAGEMENT OF RESEARCH IN INDUSTRY [Some Suggestions to Industrialists & Research Workers]. — Benham. (*Nature*, 22nd Aug. 1942, Vol. 150, pp. 235–236.) Prompted by Bragg's remark " Lip service is paid to research because it is respectable and fashionable to do so, but responsible industrialists in private express their disappointment."

3437. SCIENTIFIC TERMINOLOGY FOR INDIA [Comments on Committee Report to Central Advisory Board of Education].—Kothari. (*Sci. & Culture* [Calcutta], Feb. 1942, Vol. 7, No. 8, pp. 376–378.)

3438. ARTICLES AND ADDRESSES ON THE WESTINGHOUSE GRAND SCIENCE AWARDS, SCIENCE TALENT SEARCH.—(*Sci. News Letter*, 25th July 1942, Vol. 42, No. 4, pp. 51–55 & 60–62.) *See* 2570 of August.

3439. TYPESCRIPT DOES NOT MAKE GOOD LANTERN SLIDES : A SIMPLE METHOD OF OVERCOMING THIS DISABILITY.—(*Journ. Roy. Soc. Arts*, 21st Aug. 1942, Vol. 90, p. 630.) Reference to the article in *Engineering*, 3rd July, referred to in 2857 of September.

3440. SQUARE RULED PAPER PROJECTION [Correspondence].—Boys. (*Journ. of Scient. Instr.*, July 1942, Vol. 19, No. 7, pp. 111–112.) *See* 2197 of July.

3441. A REPORT ON THE 1942 I.R.E. CONVENTION. —Winner. (*Communications*, Jan. 1942, Vol. 22, No. 1, pp. 14–16 and 21, 29..32.)

3442. A REPORT ON THE 5TH ANNUAL CONFERENCE OF BROADCAST ENGINEERS [Ohio, Feb. 1942] *and* ON THE 20TH ANNUAL N.A.B. CONVENTION [Cleveland].—Winner. (*Communications*, March 1942, Vol. 22, No. 3, pp. 7–11 and 26, 27 : May 1942, No. 5, pp. 14, 16, and 34, 35.) The discussions referred to in the second report include shortages, pooling, and precautions against sabotage.

3443. ACTIVITIES OF THE I.E.N.G.F : REUNIONS OF THE FIRST QUARTER 1941/42.—(*Alta Frequenza*, June 1942, Vol. 11, No. 6, pp. 303–304.)

3444. " RADIO AMATEUR'S HANDBOOK : DEFENSE EDITION " [Book Review].—American Radio Relay League. (*Communications*, April 1942, Vol. 22, No. 4, pp. 35 and 36.)

3445. " ELECTRONICS " [Book Review].—Millman & Seely. (*Communications*, April 1942, Vol. 22, No. 4, p. 15.)

3446. ELECTRONICALLY CONTROLLED VARIABLE CAPACITY [Application to Air-Raid Warnings].—Hector & others. (*See* 3220.)

3447. COLOUR AND MUSIC.—Harrison. (*See* 3297.)

3448. A PRECISION DIRECT-READING DENSITOMETER [Agfa Ansco Model 11, based on Modification of Hardy's Logarithmic-Circuit Amplifier (1929 Abstracts, p. 346)].—Sweet. (*Journ. Opt. Soc. Am.*, July 1942, Vol. 32, No. 7, p. 400.)

3449. AN EXTENDED-RANGE GALVANOMETER-DEFLECTION RECORDING SYSTEM [Use of Three-Metre Focal-Length Mirrors and Multiple Light Source to expand Range of Deflections by more than Three (for Photoelectric Spectrophotometers, etc.) and for Simultaneous Recording of Two Galvanometers].—Pfister & Rank. (*Journ. Opt. Soc. Am.*, July 1942, Vol. 32, No. 7, pp. 397–399.)

3450. IS THE BARRIER-LAYER PHOTOELEMENT [Lange Selenium Photocell] SUITABLE FOR PRECISION PHOTOMETRIC MEASUREMENTS ? — Björnståhl. (*Zeitschr. f. Instr:kunde*, June 1942, Vol. 62, No. 6, pp. 181–186.)

The writer's measurements lead to the conclusion that " the characteristic of the selenium photoelement is not linear for small light intensities. The short-circuit current is not proportional to the intensity of illumination, even when this is less than 100 lux : in other words, the sensitivity is variable. With certain elements, however, the sensitivity can be made practically constant over a limited range of light intensity, by the introduction of a series resistance. For intensities above or below this region the photoelement cannot be employed unless special arrangements are made."

3451. A Turbidity Comparator [primarily for Assay of Physiologically Active Substances: A.C.-Operated Photoelectric Apparatus with Electronic Stabilisation of Supply to Amplifier & Light Source].—Krebs & others. (*Review Scient. Instr.*, May 1942, Vol. 13, No. 5, pp. 229–232.)

3452. An Ultra-Violet Measuring Apparatus with Modified Ulbricht Sphere, for Large Angles of Incidence [Development from Krefft & Rössler's Selenium Cell Instrument].—Larché & Schulze. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 23, 1942, pp. 114–117.) Successfully used for sky-radiation measurements and for tropical-climate tests with artificial illumination.

3453. An Automatic Recording Absorption-Spectrophotometer. — Himmelreich. (*Zeitschr. f. Instr:kunde*, June 1942, Vol. 62, No. 6, pp. 202–203: summary, from *Zeitschr. f. tech. Phys.*, Vol. 22, 1941, p. 148 onwards.)

3454. Photoelectric Detection and Intensity Measurement in Raman Spectra [using the RCA-931 Photomultiplier Tube].—Rank & others. (*Journ. Opt. Soc. Am.*, July 1942, Vol. 32, No. 7, pp. 390–396.)

" . . . the initial 230000 amplification obtainable with this tube is in practice as simple as turning on a light switch. When the ultimate in sensitivity is to be achieved, the initial 230 000 amplification furnished by the cascade-type tube is almost too good to be true . . . It was found that the total dark current for the tube in question was 7.5×10^{-9}A . . . Fluctuations of the dark current set the limit to the smallest observable quantity of luminous flux which can be detected . . . the lower limit appears to be 1.5×10^{-10} lumen. It should be possible to reduce these fluctuations due to thermionic emission to a fraction of their value at room temperatures by refrigerating the photomultiplier tube."

3455. Photoelectric Width Gauge [for Flat Strips or Webbing during Production, with Possibility of Control].—Alexander. (*Electronics*, Jan. 1942, Vol. 15, No. 1, pp. 66..72.)

3456. High-Speed Photoelectric Recorder [Self-Contained, Portable, with Special Advantages].—Clark. (*Gen. Elec. Review*, July 1942, Vol. 45, No. 7, pp. 384–386.) For the original recorder and its uses *see* 1932 Abstracts, p. 422, & 1933 Abstracts, p. 581 (La Pierre), and 3264 of 1936.

3457. Study of the Degree of Polarisation of Light by Polaroids.—Melankholin. (*Journ. of Tech. Phys.* [in Russian], No. 18, Vol. 10, 1940, pp. 1481–1485.)

3458. Monochromatic Light Filters.—Ronis. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 10, 1940, pp. 1383–1385.)

A table has been compiled giving the composition of 14 monochromatic light filters covering the range of 370–700 mμ and made up of combinations of coloured selenium-cadmium, copper-cobalt, and nickel glasses with solutions of copper chloride of various concentrations: curves showing the optical density of these filters are given.

3459. Eyes are Most Sensitive Light Recorders [Minimum Energy required for Vision 2.2–5.7 Ten-Billionths of an Erg, representing 58–148 Quanta falling on Eye, or 5–14 Quanta reaching Retina].—Hecht. (*Scient. American*, May 1942, Vol. 166, No. 5, p. 226.) *Cf.* 1576 of 1941.

3460. Simple Construction of a Parabolic Mirror.—Bubb. (*See* 3255.)

3461. On a Comparative Study of the Reflectivities of Aluminium and Silver Films [and Methods of Preparation]. — Ramakrishnan. (*Indian Journ. of Phys.*, Feb. 1942, Vol. 16, Part 1, pp. 12–22.)

3462. On the Theory of Non-Stationary Discharges: II—The Light Emission from a Modulated High-Pressure Arc [and the Effect of Frequency & of Depth of Current-Modulation on the Depth of Light-Modulation & on Phase Conditions, etc.].—Weizel & others. (*Zeitschr. f. Phys.*, 9th July 1942, Vol. 119, No. 3/4, pp. 237–244.) For I *see* 597 of February.

3463. Thermal Effects in the Double Refraction in Flowing Liquids [hitherto Neglected, the Phenomenon being considered purely a Turbulence Effect]: on the Upper Limit of the Maximum Double Refraction.—Björnståhl. (*Zeitschr. f. Phys.*, 9th July 1942, Vol. 119, No. 3/4, pp. 245–264.) For previous work by this writer *see* 4496 of 1938 and 3257 of 1939. *Cf.* 2873 of September.

3464. Determination of Absolute from Relative X-Ray Intensity Data.—Yü: Wilson. (*Nature*, 1st Aug. 1942, Vol. 150, pp. 151–152: p. 152.) Following on 2910 of September.

3465. The Measurement of Radiation for Medical Purposes [Survey leading to Attempt to estimate Total Energy flowing into the Body or absorbed by It from Beams of X and Gamma Rays, & to link These Values to Measurements of Ultra-Violet & Infra-Red Radiations].—Mayneord. (*Proc. Phys. Soc.*, 1st Sept. 1942, Vol. 54, Part 5, No. 305, pp. 405–421.)

3466. Remarks on Physical Model Representations of Energy-Propagation Mechanisms in the "Hit" Region in Radiation-Biological Processes.—Möglich, Rompe, & Timoféeff-Ressovsky. (*Naturwiss.*, 3rd July 1942, Vol. 30, No. 27, pp. 409–419.)

3467. "Wetter und Gesundheit" [Weather & Health, Part I: Reaction-Time Measurement as a Test Method for determining the Influence of the Weather & Solar Activity on Healthy Subjects: Book Review].—Düll. (*Naturwiss.*, 19th June 1942, Vol. 30, No. 25/26, p. 408.) For earlier work *see* 3277 of 1940.

3468. Research on the Practical Problem of Power and Heat from the Sun: a Progress Report from M.I.T.—Sibley. (*Scient. American*, June 1942, Vol. 166, No. 6, pp. 284–286.)

3469. Actinometry and Applications of the Sun's Heat: the Warming of Houses by Water heated by the Sun [Survey, including the Writer's Opposed-Bimetallic-Spiral Actinometer]. — D'Halluin. (*Génie Civil*, 17th/24th Jan. 1942, Vol. 119, No. 3/4, pp. 25–29.)

3470. An Electrometer for Measurement of Voltage on Small Ionisation Chambers.—Farmer. (*See* 3337.)

3471. The Origin of Statistical Fluctuations in Proportional Geiger Counters, *and* Pulse Size as a Function of Pressure in Geiger-Mueller Counters.—Swann: Miller & Montgomery. (*Phys. Review*, 1st/15th June 1942, Vol. 61, No. 11/12, p. 734: p. 734: summaries only.)

3472. "Radioaktivität: I [Fundamentals & Measuring Methods: Book Review]. — Israël. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 23, 1942, p. 165.) Vol. 2 of "Geophysik, Meteorologie, Astronomie."

3473. The Electrical Prospecting of the Subsoil: the Tracing and Study of Petroliferous Fields and Coal Beds.—Calfas. (*Génie Civil*, 1st Aug. 1942, Vol. 119, No. 18, pp. 217–220.)

3474. A 100-Cycle Frequency Standard [for Calibration of Seismic-Prospecting Timing Oscillators].—Honnell & Dickerson. (*See* 3334.)

3475. Auxiliary Apparatus for Precision Seconds-Counters. — La Barbera. (*See* 3336.)

3476. Resonance [Mathematical & Physical Conditions for Occurrence of Harmonic, Multiple-Harmonic, & Sub-Harmonic Resonance: with Photographs of Models].—Ludeke. (*Journ. Applied Phys.*, July 1942, Vol. 13, No. 7, pp. 418–423.)

3477. Quartz-Crystal Accelerometer [for Vibrations 10–10 000 c/s, Accelerations 10–5000 times Gravity (reducible to 1–500 times, for Upper Frequency Limit of 1000 c/s)].—Fehr. (*Gen. Elec. Review*, May 1942, Vol. 45, No. 5, pp. 269–272.) *See* also *Electrician*, 14th Aug. 1942, Vol. 129, pp. 172–174.

3478. "Practical Solution of Torsional Vibration Problems: Vol. II [including Detailed Description & Method of Use of Various Types of Measuring Instrument: Book Review].—Ker Wilson. (*Current Science* [Bangalore], May 1942, Vol. 11, No. 5, pp. 200–201.)

3479. The Measurement of Torsional Vibrations [General Principles of Operation of Electro-Magnetic Torsiographs: Application of Filter for Separation of Frequencies].—Stansfield. (*Engineer*, 24th & 31st July 1942, Vol. 174, pp. 77–79 & 101–102.)

3480. Applications of the Cathode-Ray Oscillograph in Industry: VI—The Recording of Mechanical Pressure Fluctuations.—Wilson. (*BEAMA Journal*, Aug. 1942, Vol. 49, No. 62, pp. 222—225: to be contd.) For a letter contesting the writer's remarks on the Einthoven string galvanometer see *ibid.*, p. 226: Wilson replies on pp. 226–227.

3481. The Properties of Carbon Resistor Elements [for Mechanical Stress Measurements] with Particular Reference to Their Behaviour under Steady Loads.—Rigden & Starks. (*Journ. of Scient. Instr.*, Aug. 1942, Vol. 19, No. 8, pp. 120–122.)

3482. Measurement of the Gas-Temperature Characteristics in Internal-Combustion Engines [Survey, including Ionisation Method & the Writer's Photocell Method (607 of February)].—Graff. (*Zeitschr. V.D.I.*, 25th July 1942, Vol. 86, No. 29/30, pp. 461–466.)

3483. Liquid-Level Controls ["Series 260" Remote Controllers, including the "Gauge Pick-Up Unit" (with Level-Sensitive H.F. Condenser connected by Coaxial Cable to Control Cabinet)].—Wheelco Instrument. (*Review Scient. Instr.*, June 1942, Vol. 13, No. 6, pp. 269–270.)

The single valve of the controller generates the h.f. oscillations, detects the resonance (or deviation from it) of the pick-up, and actuates a relay controlling valves or pumps.

3484. An Adaptation of the Anderson Bridge for the Detection of Minute Changes in Temperature.—Kennon & Cullen. (*See* 3327.)

3485. Electronic Moisture Monitor for Furnace Gases in Steel Hardening.—(*Sci. News Letter*, 25th July 1942, Vol. 42, No. 4, p. 62.)

3486. Mechanical Detection of Wheel-Seat Flaws in Railway Axles [and a Defence of the Electrical Conductance Method].—Thornton: Johansen. (*Engineering*, 14th Aug. 1942, Vol. 154, p. 133.) *Cf.* issue for 28th August, p. 174.

3487. Eddy-Current-Type Flaw Detectors for Non-Magnetic Metals [with Five Types of Pick-Up, including Spot-Weld Tester: Eddy-Current-Pattern Changes detected by Bridge Circuits sensitive to Amplitude & Phase Changes: Possibilities of Automatic Scanning & Recording].—Vigness, Dinger, & Gunn. (*Journ. Applied Phys.*, June 1942, Vol. 13, No. 6, pp. 377–383.)

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Editorial

Joseph Henry

IN a recent number of the Proceedings of the American Institute of Radio Engineers, the Dean of Princeton University, contributed a biographical article on Joseph Henry with the somewhat surprising subtitle of "Pioneer in Space Communication." We feel sure that very few people have ever associated the name of Henry with early work in the field of space communication. As a matter of fact, very few of the thousands of people who talk daily of henries, millihenries and microhenries, have the faintest idea of what Joseph Henry really did, that his name should thus be perpetuated. That his name was given to the unit of inductance was due to the fact that the fourth international Congress was held in Chicago in 1893. The third Congress had met in Paris in 1889 and had decided to call the unit a "quadrant," but four years later in Chicago, the home team succeeded in getting this rescinded and replaced by the name of an American scientist, Joseph Henry, just as in 1881 the Paris Congress had replaced "Weber" by "Ampere" as the name of the unit of current.

In 1832 Henry, at the age of 35, was appointed professor of natural philosophy at Princeton. At the age of 13 he had been apprenticed to a watchmaker, but had given this up and taken the study of chemistry, anatomy and physiology with the idea of adopting a medical career; this in turn he had given up for engineering which he followed for some time. In 1826 he was appointed a teacher of mathematics and physics at Albany Academy, where he experimented with electromagnets, using a wrapping of silk to insulate the wire and making two types of winding, one with few turns of thick wire, the other with many turns of finer wire, which were known as "quantity" and "intensity" windings. respectively. Like Faraday, he had the idea that, as an electric current produces magnetic effects, so a magnetic field, if powerful enough, would surely produce electric effects. This problem haunted Faraday foi years; in 1822, he wrote in his note-book "Convert magnetism into electricity," and although he was engaged on many researches, mostly of a chemical or metallurgical character, he repeatedly returned to the attack. In 1825 he made many experiments to see if a powerful electromagnet held near a wire carrying a current had any effect on the current, but although he used a delicate galvanometer and tried thick and thin wires of different metals, the results were all negative. Six years later in August, 1831, Faraday returned to the attack and in a series of experiments of marvellous ingenuity and thoroughness he laid bare the secret of the evolution of electricity from magnetism, he described the experiments to the Royal Society on 24th November, 1831, in a paper of 41 pages.

Henry was still at Albany making experiments with electromagnetics when his other duties permitted. It is claimed that he had already, in 1830, observed the induced current but had postponed making any announcement until he had repeated the experiments on a larger scale. It is stated, on the authority of his daughter, that he used to express his regret that he did not follow up his observations and publish them. Before he had resumed his experiments he read of Faraday's discovery. When thinking over his experiments after reading of Faraday's discovery, new light would be thrown on points that at the time may have appeared of little importance, and it would be very difficult indeed to decide whether he had actually anticipated any of Faraday's discoveries. The statement in the biographical article that "it seems probable that Henry really was ahead of Faraday in the observation of the induced current" is open to question, for if he had really made an observation of such enormous moment, it is almost incredible that he would have said nothing about it, but put the apparatus away with the idea of repeating the experiment on a larger scale when opportunity offered. Henry himself never made any claims to priority. It is dreadfully easy to be wise—and sorry—after the event.

Electromagnetic Telegraph and Electric Motor

In Sulliman's Journal of 1831, he described what was probably the first electromagnetic telegraph, in which a primary battery operated a bell through a mile of copper wire and he stated that the way was now clear for the development of a commercial telegraph. He also described an oscillating electric motor in which the oscillating beam actuated a kind of commutator which reversed the polarity and thus maintained the oscillations.

On going to Princeton in 1832, Henry was at first kept busy with the duties of his professorship, but he constructed a large electromagnet capable of sustaining a weight of 1.5 tons and ran a telegraph line from his house to the laboratory so that he could call for his lunch to be sent to the laboratory when he was too busy to go home. He experimented on the large voltage produced when the current in an inductive circuit is suddenly broken and, in a paper read before the American Philosophical Society in 1835, he rightly ascribed the effects observed to "that species of dynamical induction discovered by Mr. Faraday." Faraday had also been working at the same subject and had sent in a long paper to the Royal Society in December, 1834, on "the influence by induction of an electric current on itself."

Telegraph Relay, Earth Return, and Oscillatory Discharge

It was also in 1835 that Henry added a relay to his telegraph receiver and used the earth as a return.

Henry spent 1837 in a trip to Europe, visiting the leading scientists. On his return to Princeton he seems to have settled down to a definite line of investigation, viz. the inductive effects in the primary and in neighbouring circuits without the use of electromagnets. He made many coils which he used as primaries and secondaries and even as tertiaries and he studied the effects produced in these when the primary current was suddenly interrupted and also when a Leyden jar was discharged through the primary winding. He repeated and confirmed Savary's observation of 1826 that needles placed at different distances from the wire in the latter case were not all magnetised in the same direction, and he gave the correct explanation in a paper read in June, 1842, in which he said that he must admit "the existence of a principal discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained." This was certainly a very important discovery. In this same paper in 1842 he described experiments with a distinctly Hertzian flavour. To see how far the inductive effect would be transmitted, he placed a wire circuit in an upper room, and excited it by a spark about an inch long from the prime conductor of an electrical machine. His secondary or receiving circuit was in a cellar thirty feet below with two intervening floors and ceilings each fourteen inches thick. The induced current was sufficiently strong to magnetise needles placed in a spiral coil in the circuit. He also inserted such a spiral in a wire led from the roof down to his study, and found that the needles were magnetised by the current induced by distant lightning. He also tried the inductive effect between two parallel wires 220 feet apart, again impulsing the primary wire by a spark from an electrical machine, and having a gap in the secondary circuit so that current could not circulate through the earth. It was some years later in 1851 that he said with reference to these experiments that "as these are the results of currents in alternate directions, they must produce in surrounding space a series of plus and minus motions analogous to if not identical with undulations." In 1846 he had resigned from Princeton to become secretary of the newly-founded Smithsonian Institution; he was also a member and later chairman of the National Lighthouse Board. Presumably on leaving Princeton he gave up his experimental work, for he said that he was thereby probably exchanging permanent fame for transient reputation.

It was in 1842, just a hundred years ago, that he published, or rather presented orally to the American Philosophical Society, the account of the above experiments which are the justification for describing him as a pioneer in space communication. The Dean of Princeton admits that his failure to obtain general recognition was partly his own fault. He was always dilatory about publication, some of his most important communications being made orally to a local society of little importance which published them in its Proceedings.

He was undoubtedly kept pretty busy with his teaching work at Princeton for we are told that he lectured on mathematics, physics, chemistry, mineralogy, geology, astronomy and architecture! It was probably this rather than any dilatoriness of disposition that prevented him from publishing fully and promptly the results of his experimental researches, for on leaving Princeton he gained a great reputation as a highly efficient organiser in connection with various activities associated with the Smithsonian Institution. In particular he created and organised the U.S. weather service and had much to do with the creation of the American Association for the Advancement of Science. When he died in 1878 he had become the leading figure in the scientific world of America.

G. W. O. H.

Shunt Condenser Aerial Coupling*

An Analysis of the Circuit

By S. W. Amos, B.Sc. (Hons.)

IN an article on aerial coupling circuits, in the April and May, 1941, issues of *Wireless Engineer*, K. R. Sturley gave an account of the shunt condenser method. This article is devoted to further notes on this circuit, attention being concentrated on the particular case when the aerial circuit is resonant within the frequency range of the tuned circuit.

The circuit is shown in Fig. 1 (a). In this L_2C_2 is the tuning circuit, C' the coupling condenser and L' an aerial loading inductance, which is not coupled inductively to L_2. We shall be concerned only with the medium waverange of 550-1500 kc/s, L_2 and C_2 having the standard values of 157 μH and 500 $\mu\mu$F (maximum) respectively.

The three factors with respect to which any aerial circuit must be analysed in any estimate of its utility are (a) the voltage step-up obtained; (b) the selectivity; and (c) the effect of the coupling on the frequency of the tuned circuit. In this article the voltage gain is taken as the value of $\frac{V_2}{V_1}$ in Fig. 1 (b), which is the theoretical equivalent of Fig. 1 (a). L_1 and C_1 are the aerial inductance and capacitance respectively, R_1 includes the H.F. resistance of the aerial and L', and R_2 is the H.F. resistance of the tuned circuit L_2C_2. V_1 is a generator of alternating potential and represents the voltage injected into the aerial, i.e., it is equal to the product of the field strength and the effective height of the aerial.

* MS accepted by the Editor, July, 1942.

Voltage Step-Up

In order to calculate the value of $\frac{V_2}{V_1}$ we can use Kirchhoff's laws. Representing the primary current by i_1 and secondary current by i_2 we have from Fig. 1(b) :—

$$V_1 = j\omega(L_1 + L')i_1 + i_1R_1 + \frac{i_1}{j\omega C_1} + \frac{i_1}{j\omega C'} - \frac{i_2}{j\omega C'} \quad .. \quad (1)$$

$$i_2R_2 + j\omega L_2 i_2 + \frac{i_2}{j\omega C_2} + \frac{i_2}{j\omega C'} - \frac{i_1}{j\omega C'} = 0 \quad .. \quad .. \quad .. \quad (2)$$

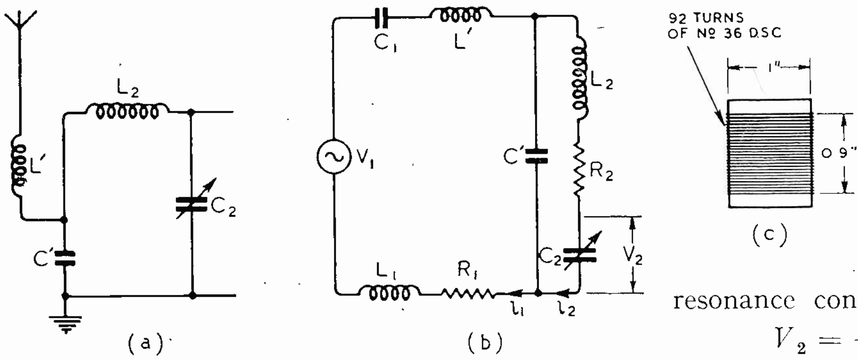


Fig. 1. *(a) The circuit considered ; (b) its electrical equivalent. (c) Details of the coil used in the experimental work.*

Now in practical circuits, as we shall see later, C' is large compared with either C_1 or C_2.

We may thus neglect $\frac{i_1}{j\omega C'}$ in comparison with $\frac{i_1}{j\omega C_1}$ in (1) and similarly $\frac{i_2}{j\omega C'}$ in comparison with $\frac{i_2}{j\omega C_2}$ in (2). This is the mathematical expression of the assumption that C' is large enough compared with C_1 and C_2 to have no appreciable effect on the frequency either of the primary or secondary circuits. (1) and (2) now become :—

$$V_1 = j\omega(L_1 + L')i_1 + i_1R_1 + \frac{i_1}{j\omega C_1} - \frac{i_2}{j\omega C'} \quad .. \quad .. \quad (3)$$

$$i_2R_2 + j\omega L_2 i_2 + \frac{i_2}{j\omega C_2} - \frac{i_1}{j\omega C'} = 0 \quad (4)$$

Now at the resonant frequency of the secondary circuit $L_2\omega = \frac{1}{C_2\omega}$. If this is taken into account equation (4) becomes :—

$$i_2R_2 - \frac{i_1}{j\omega C'} = 0 \quad .. \quad .. \quad .. \quad (5)$$

giving

$$i_2 = \frac{i_1}{j\omega C'R_2} \quad .. \quad .. \quad .. \quad (6)$$

Substituting for i_2 in (3) :—

$$V_1 = j\omega(L_1 + L')i_1 + i_1R_1 + \frac{i_1}{j\omega C_1} + \frac{i_1}{\omega^2 C'^2 R_2}$$

$$\therefore i_1 = \frac{V_1}{j\omega(L_1 + L') + R_1 + \frac{1}{j\omega C_1} + \frac{1}{\omega^2 C'^2 R_2}} \quad .. \quad .. \quad (7)$$

From Fig. 1 (b) $V_2 = \frac{i_2}{j\omega C_2}$ and from the resonance condition :—

$$V_2 = -jL_2\omega i_2$$

Substituting for i_2 from (6) we have :—

$$V_2 = -\frac{L_2}{C'R_2} \cdot i_1$$

Combining this result with (7) we have :—

$$V_2 = \frac{-\frac{L_2}{C'R_2} \cdot V_1}{j\omega(L_1 + L') + R_1 + \frac{1}{j\omega C_1} + \frac{1}{\omega^2 C'^2 R_2}}$$

$$\therefore \frac{V_2}{V_1} = \frac{-\frac{L_2}{C'R_2}}{j\omega(L_1 + L') + R_1 + \frac{1}{j\omega C_1} + \frac{1}{\omega^2 C'^2 R_2}}$$

The numerical value of $\frac{V_2}{V_1}$ is thus given by :

$$\left|\frac{V_2}{V_1}\right| = \frac{\frac{L_2}{C'R_2}}{\sqrt{\left([L_1 + L']\omega - \frac{1}{\omega C_1}\right)^2 + \left(R_1 + \frac{1}{\omega^2 C'^2 R_2}\right)^2}} \quad .. \quad .. \quad (8)$$

In this expression, if we are considering a particular aerial and tuned circuit, then at a particular frequency all quantities are fixed except L' and C'. Now for maximum value of voltage step-up C' should be zero. In this case the circuit reduces to a simple series aerial tuner, which has the great disadvantage that with normal aerials the whole of the medium waverange can never be covered. The smallest practical value of C' is about 0.002 μF. L' should, for greatest gain, be so chosen that the aerial circuit resonates in the middle of the band it is desired to receive. A suitable value for L' is 100 μH. The losses in L_2C_2, represented by R_2, belong mostly to the inductance L_2 and they increase with frequency. As a first approximation R_2 was assumed directly proportional to frequency, which is tantamount to stating that the Q function of the coil (i.e., $\frac{L_2\omega}{R_2}$) is independent of frequency. The medium wave coil used in the experimental verification of this analysis had the dimensions given in Fig. 1 (c). Its inductance is 157 μH and its Q value at 600 kc/s is 100. Assuming Q to remain constant at this value over the medium waverange, R_2 has the values given in Table I. Using these values of R_2 and formula (8), the curve (a) of Fig. 3 was obtained. The disagreement with the experimentally determined curve (c) at high frequencies is due to R_2 increasing more rapidly than the linear relationship predicts. To allow for this Q was determined at various medium wave frequencies and it was found to decrease from 105 at 550 kc/s to 50 at 1500 kc/s, the relationship being substantially linear. Making due allowance for this in formula (8) gives curve (b) of Fig. 3, which agrees well with the experimental curve. Such disagreements as still remain are due to omission in the analysis of the variation with frequency of the H.F. resistance of L' and to the effects of C' on the effective capacity of C_1 and C_2. For both calculated and experimental points, $L_1 = 20$ μH, $L' = 105$ μH, $C_1 = 160$ $\mu\mu$F, $C' = .002$ μF. Curve 2 (a) shows the amplification obtained by omitting the loading inductance L'. Though low the amplification is remarkably constant. This curve is taken from Sturley's article.

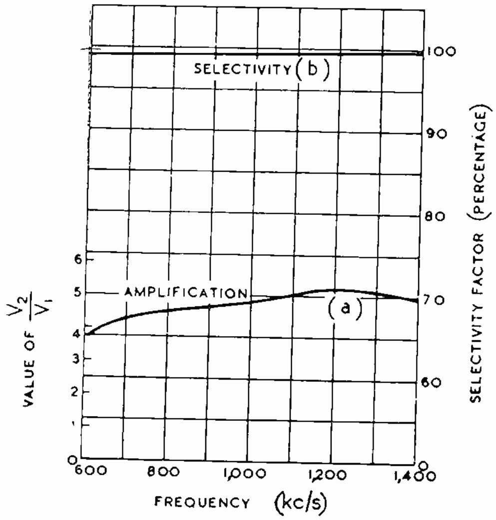


Fig. 2. *Curves illustrating the amplification and selectivity of the shunt condenser aerial circuit without loading coil.*

TABLE I.—VALUES OF EFFECTIVE H.F. RESISTANCE R_2 OF AN INDUCTANCE OF 157 μH WHICH HAS A CONSTANT Q VALUE OF 100 OVER THE MEDIUM WAVEBAND

ω ($\times 10^6$ rads/sec)	3	4	5	6	7	8	9
f(kc/s)	477	636	796	955	1114	1273	1432
$R_2(\Omega)$	4.71	6.28	7.85	9.42	10.99	12.56	14.13

Selectivity

The selectivity of a tuned circuit may be measured by its effective Q value or by the quotient L/R. No matter which is taken as

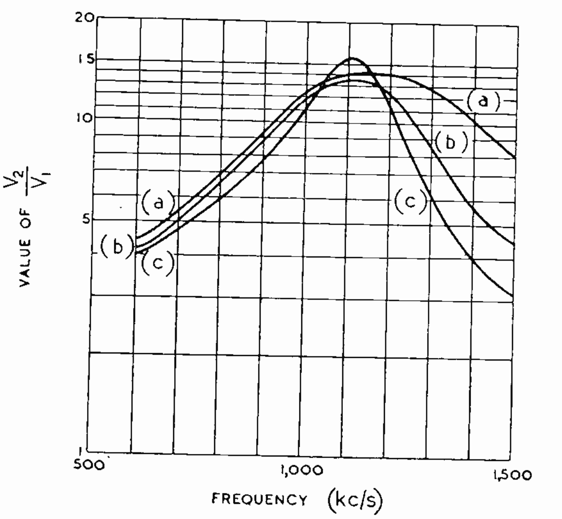


Fig. 3. *Variation of* $\frac{V_2}{V_1}$ *with frequency for a medium-wave shunt condenser inductance-loaded aerial coupling circuit :—(a) calculated assuming Q constant, (b) calculated, allowing for frequency variation of Q, and (c) experimental.*

the criterion by which performance is judged, it is clear that if R_2 represents the losses occurring in L_2 and C_2 alone at a particular frequency and if the additional H.F. loss

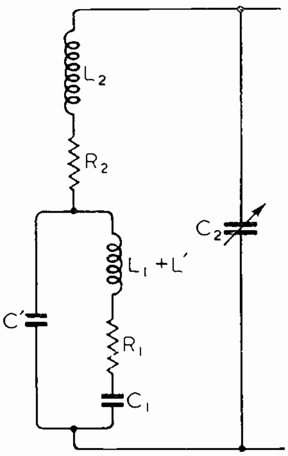


Fig. 4. *In order to facilitate calculations of selectivity factor the circuit of Fig.* 1 (*b*) *may be redrawn as shown above.*

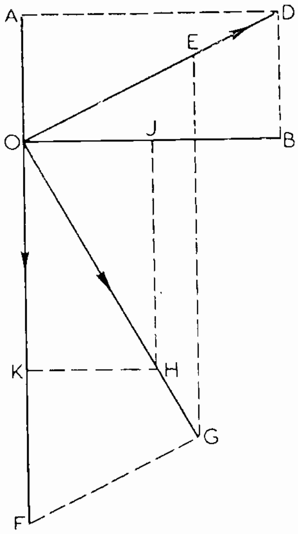


Fig. 5. *Vector diagram for Fig.* 4, *illustrating phase relationships.*

due to the aerial coupling circuit is R'' then :

$$\frac{\text{Effective selectivity}}{\text{Maximum selectivity}} = \frac{R_2}{R_2 + R''}$$

This we shall term the selectivity factor. In order to calculate this for the circuit under review the diagram of Fig. 1 (b) can be redrawn as in Fig. 4. It is evident that we need to know the effective impedance of the series-parallel network which includes C_1, L_1, R_1 and C' at a particularly frequency in order to calculate the selectivity factor. Fig. 5 has been drawn for a frequency higher than the resonant frequency of the series circuit $L_1R_1C_1$, i.e., when its reactance is inductive. OA represents the combined reactance of $L_1 + L'$ and C_1, equalling $(L_1 + L')\omega - \frac{1}{\omega C_1}$ and OB represents R_1 giving OD as the series impedance Z_1. Along OD, OE is drawn representing $1/Z_1$, the admittance of $L_1R_1C_1$. OF similarly represents the admittance of C' ($\omega C'$) so that OG gives the resultant admittance of the parallel circuit. Along this OH is marked to equal the combined impedance of the parallel network. This is then resolved horizontally and vertically giving OJ as the resistive component and OK as the reactive one, the latter being clearly capacitive. This can be done for a number of frequencies. It is a simple matter to calculate the magnitude of the condenser which has the resultant reactance at the frequency in question.* For any particular frequency therefore this network can be replaced by a simple circuit comprising a resistance R'' and a condenser C'' in series. The way in which R'' and C'' vary with frequency is illustrated graphically in Fig. 6. At the resonant frequency of L_1C_1 there is a great and sudden increase in R'', giving a poor selec-

* Another—and perhaps easier method of calculating these results was described by T. F. Wall in *Electronic Engineering*, April, 1942, p. 704.

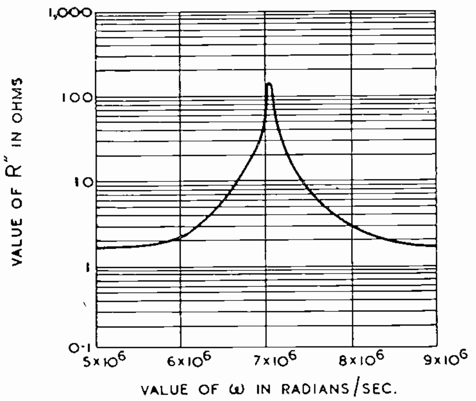


Fig. 6*a*. *Curve showing the variation with frequency of effective ohmic resistance R″ of a medium-wave tuning system with aerial circuit resonant within the band received.*

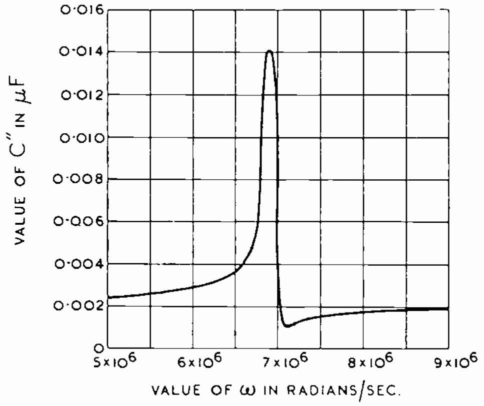


Fig. 6*b*. *Curve illustrating the variation with frequency of the effective series capacitance C″ in shunt condenser medium-wave aerial circuit. The value of the shunt capacitance is* $0.002\mu F$.

tivity factor, whereas for frequencies more than 50 kc/s away the selectivity factor is greater than 50 per cent. of the maximum possible. It is clear that the best possible performance as regards selectivity is secured by making the aerial circuit resonant outside the waveband it is desired to receive. In confirmation of this, curve (b) of Fig. 2 has been reproduced from the article by Sturley. Curves (a) and (b) of Fig. 7 are respectively the calculated and experimental values of the selectivity factor for the aerial circuit already mentioned.

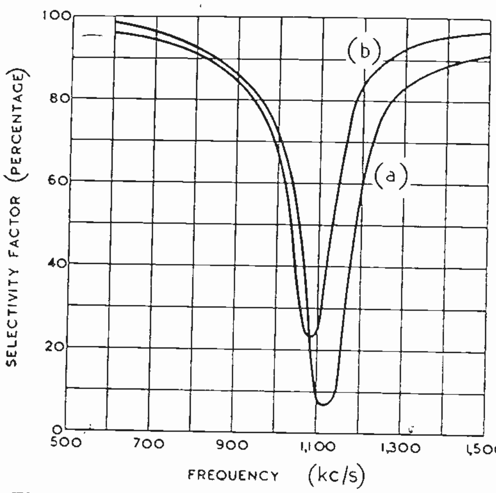


Fig. 7. *Variation of selectivity with frequency of the shunt condenser aerial coupling circuit with inductive loading. (a) Is the calculated curve and (b) the experimental one.*

Waveband Coverage

From the determination as described in the previous section of the effective capacitance C'' of the series network of the aerial coupling circuit we can calculate the effective tuning capacitance in the circuit for any particular capacitance C_2 of the tuning condenser. It is clearly given by $\dfrac{C_2C''}{C_2 + C''}$

It is then a simple matter to evaluate the frequency correction Δf which must be added to the observed resonant frequency of the circuit to give the natural frequency of the undamped circuit. It is clearly given by :—

$$\Delta f = \frac{10^6}{2\pi}\left\{\frac{1}{\sqrt{\dfrac{L_2C_2C''}{C_2+C''}}} - \frac{1}{\sqrt{LC_2}}\right\}$$

$$= f_0\left\{\sqrt{\frac{C''+C_2}{C''}} - 1\right\}$$

where f_0 = natural frequency of L_2C_2

$$= \frac{10^6}{2\pi\sqrt{L_2C_2}}$$

The values of Δf given by this expression and the corresponding experimental points have been plotted in Fig. 8. The full curves apply with the aerial circuit resonant at 1100 kc/s approximately; the dotted one when the aerial resonant frequency does not fall within the received band. It is noteworthy that the frequency coverage is restricted by a curtailment of the low frequency end. This can be corrected to some extent by the addition of a fixed condenser in parallel with L_2. The frequency range of a parallel tuned circuit is given by :—

$$\frac{f_{max}}{f_{min}} = \sqrt{\frac{C_{max}}{C_{min}}}$$

and for the medium waves $\dfrac{f_{max}}{f_{min}} = 2.73$ so that $\dfrac{C_{max}}{C_{min}} = 7.45$. If therefore, the maximum tuning capacitance is 500 $\mu\mu$F, then $C_{min} = 67$ $\mu\mu$F. Towards this the minimum capacitance of the tuning condenser, the self-capacitance of L_2 and other stray capacitances will probably contribute half,

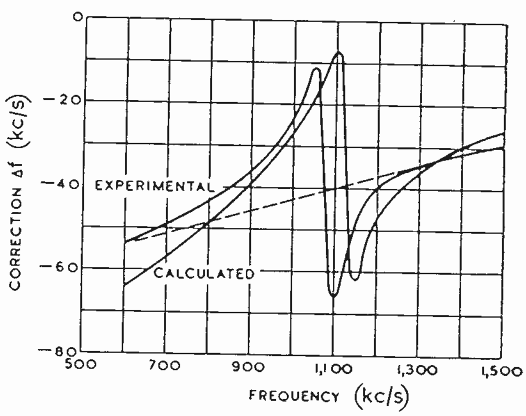


Fig. 8. *Curves illustrating the frequency error introduced by the inductance-loaded shunt capacitance aerial coupling circuit discussed in the text.*

so that it will rarely be possible to add more than 40 $\mu\mu$F in parallel with L_2 without restricting the high frequency end of the band. In the circuit used by the author a range of 570-1500 kc/s was obtained with a trimmer of 40 $\mu\mu$F.

Conclusion

The shunt condenser aerial circuit is a particularly useful one. If the aerial is connected directly to the coupling condenser and not via a loading inductance then the primary circuit will not, in general, resonate within the frequency range of the secondary circuit, and the following properties are observed :—

(a) A very constant, though low, voltage amplification (see curve (a) of Fig. 2)

(b) Excellent selectivity factor, the value of which depends almost entirely on the construction of the tuning inductance itself (see curve (b) of Fig. 2),

(c) The calibration of the tuning condenser is virtually independent of the constants of the aerial-earth system.

With careful choice of coupling and trimming condensers the circuit can be made to cover the whole of the medium waverange, and because of the properties enumerated above, it has been used in the first stages of communication type receivers for reception of medium and long waves.

If the aerial circuit is made resonant at about 1000 kc/s considerable improvement in voltage amplification is achieved though necessarily at the expense of selectivity. Moreover, anomalies are produced in the calibration of the tuning condenser at the resonant frequency of the aerial-earth system. The circuit in this form is useful in simple receivers using reacting detectors. By use of regeneration the " crevasse " in the curve of the selectivity factor can be eliminated and it is interesting to note that, as the greatest H.F. losses occur at the resonant frequency of the aerial system, the reaction control will have to be advanced more at this frequency than elsewhere. The calibration of the receiver will be almost independent of the characteristics of the aerial-earth system, anomalies being present, as before, at the resonant frequency.

Non-Ferrous Metals

TO speed-up the supply of non-ferrous metals and to save as much shipping as possible, the Ministry of Supply has issued an urgent appeal to the wireless industry for all unwanted copper, zinc, lead, pewter, whitemetal, brass, bronze and aluminium. Salvaged scrap should be disposed of through the normal channels.

Index to Abstracts

Must be Ordered in Advance

THE inclusion of the Index to the Abstracts and References section for the current volume as part of the December issue was discontinued last year and instead it was issued separately. The Index to the abstracts and references published in *Wireless Engineer* from January to December, 1942, will, therefore, be published separately early in the new year.

A charge of 2s. 8d. (including postage), will be made for the Index and it will be necessary for those requiring copies to make early application to our Publishers as supplies will be limited.

As in former years the Index to Articles and Authors for the current volume, XIX, January to December, 1942, is included in this issue.

Books Received

Wireless Terms Explained.—By " Decibel." This is the second edition of a reprint in book form of a series of articles which appeared in *World Radio*. It gives simple explanations of wireless terms in common use. Many of the explanations are amplified by the addition of practical information and diagrams. A number of additional terms have been added to bring this edition up to date. Pp. 74+vi (illustrated). Sir Isaac Pitman & Sons, Ltd., 39, Parker Street, Kingsway, London, W.C.2. Price 2s. 6d.

Modern Radio Operator's Guide.—By H. E. Chamberlain. This book is not intended as a training manual but as an introduction to the scope of an operator's duties at sea and to provide the " apprentice " with information regarding his status " that would otherwise take him many voyages to acquire." Of the sixteen chapters eight deal briefly with the technical aspects of his job. Pp. 72 (illustrated). Hutchinson's Scientific and Technical Publications, 47, Princes Gate, London, S.W.7. Price 5s.

Teach Yourself Radio Communication.—By E. M. Reid. Written for those who have no previous knowledge of the subject, the aim of this book, which is one of the " E.U.P. Teach Yourself " series, is to explain the principles underlying radio communication. Pp. 175. Diagrams 96. The English Universities Press, Ltd., St. Hugh's School, Bickley, Kent.

Universal Decimal Classification

READERS concerned with the abstracting of scientific and technical literature, the compilation of bibliographies or the classification of scientific documents of all kinds, will be interested to learn that the following parts of the English Edition of the Universal Decimal Classification, all stocks of which were destroyed by enemy action, are being reprinted by the British Standards Institution. Advantage has been taken of the opportunity to make several minor amendments, e.g. correction of printer's errors and errors of translation.

Vol. 1, Part I. General Introduction, Auxiliary Tables and Class O, Generalities. Price 7s. 6d.
Vol. 2, Part I. Classes 51, Mathematics; 52, Astronomy; 53, Physics. Price 10s.
Vol. 2, Part 2. Class 54, Chemistry. Price 10s.
Vol. 2, Part 3. Classes 55, Geology and Geophysics; 56 Palaeontology; 57, Biology; 58, Botany; 59, Zoology. Price 10s.
Class 621.3 Electrical Engineering is in preparation and will be available early in the New Year.

Owing to the restrictions imposed by the Paper Controller, the edition will be strictly limited, and the B.S.I. is desirous of ascertaining as soon as possible the probable extent of the demand for the various parts. All orders will be dealt with in rotation, and should be addressed to the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1.

Foyles' Technical Books Catalogue. A 104-page list of new and secondhand books on more than 450 subjects, including acoustics; radio and electrical engineering, and mathematics for engineers. Copies are obtainable from W. and G. Foyle, Ltd., 119-125, Charing Cross Road, London, W.C.1.

Waste Paper is a vital munition of our war effort. Every scrap should be salvaged and stringent economy exercised in the use of paper.

War Office Communications

Communication with British Troops in all parts of the world is maintained through the War Office Signals Office, which is installed deep underground, not far from Whitehall. This nerve centre of the British Armies is operated by the Royal Corps of Signals. Communication with the various Home Commands is normally maintained by land-line, but in case of emergency, or in event of line breakdown, a network of hand-keyed wireless transmitters, which are dispersed at a distance, is remotely controlled from the Home Wireless Room of the Signals Office. This "Wireless World" photograph shows a corner of the room.

Tracing Valve Characteristics*

Using the Cathode-Ray Oscillograph

By Geoffrey Bocking

(*Pasta Developments Ltd.*)

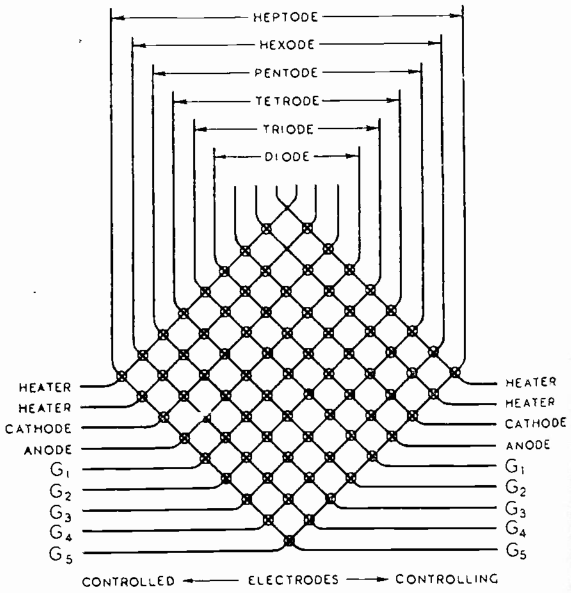
IT is conventional to express the characteristics of thermionic valves by means of curves. These are normally plotted by point-to-point methods and with valves of small anode dissipation this technique is practically simple and may be carried out with a high degree of accuracy. Nevertheless it has the disadvantage that it is lengthy and rather tedious. The advent of the cathode-ray oscillograph did little to affect this procedure as on first sight the increase in convenience due to its use did not appear to justify the loss of accuracy and developmental difficulties involved. In the case of valves of large dissipation, however, operating under positive grid conditions the conventional method encountered a stumbling block in that the time necessary to take readings when the grid potential was highly positive had considerable deleterious effects on the valve. In this case it was natural that recourse should be made to oscillographic methods and details of measuring techniques soon appeared in the technical press. Experience of this technique led to a consideration of its suitability for smaller dissipation valves but, by reason of the point from which this consideration derived, considerable prejudice and inertia were encountered and the technique did not achieve universal popularity. It is the author's contention, however, that the tracing of the characteristics of valves of all classes by means of the C-R-O now offers such an increase in convenience and so little difficulty of construction and loss of accuracy that suitable apparatus should be a standard piece of equipment in every laboratory.

The problem of valve characteristic tracing may be very simply stated. The first order curves are two in kind :

1. Current flowing from an electrode as a function of the potential at that electrode.

2. Current flowing from an electrode as a function of the potential at some other electrode.

For the sake of convenience the first will be named the " anode volts-anode current " (E_a/I_a) curve and the second the " grid volts-anode current " (E_g/I_a) curve although such nomenclature involves a certain ellipsis. The electrode from which the current flows will be described as the controlled electrode and the electrode at a potential controlling that current will be described as the controlling electrode. In order to present more information than is available from one curve it is conventional to present a family of curves having as parameter the potential at another controlling electrode. Despite this artifice the number of sets of curves that can be drawn for a multi-electrode valve are numerous and the table shown below sets these out :



The second order curves generally presented are the transconductance between two electrodes, the A.C. resistance between

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* MS accepted by the Editor, June, 1942.

cathode and an electrode, and the amplification factor or potential relationship for constant current, as functions of the potential at a controlling electrode. All the above curves are normally presented on a Cartesian

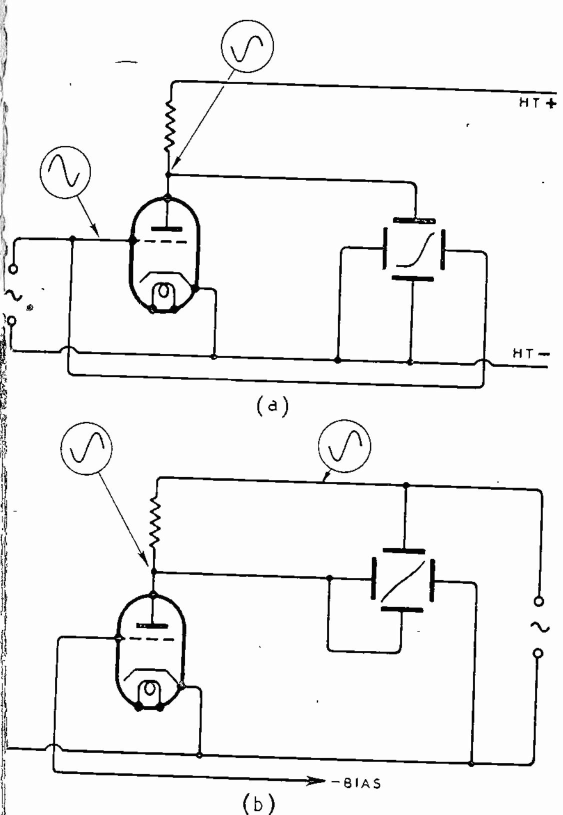

Fig. 1. *Generic forms of set-up for delineating (a) E_g/I_a curves; (b) E_a/I_a curves.*

co-ordinate system so that for tracing with the C-R-O it is only necessary that the X and Y deflection plates have at any instant voltages which are directly proportional to the values of the variables. The tracing of several different curves on the screen is achieved sequentially by the usual stroboscopic effect.

In designing an equipment for the above purpose therefore the problem may be divided into three parts:

1. The provision of a system of power supplies so that the test valve may be set up at any point at which curves are required.
2. The provision of varying voltages to the controlling electrodes.
3. The derivation from these voltages and from the resultant currents of deflection voltages of correct amplitude, phase, duration and sequence to provide undistorted the characteristic curves required.

The solution of the first part of the problem does not present any unusual difficulty. Owing to the wide range of voltage values to be provided and the wide variations of current to be expected, an unusual degree of stabilisation is required. For this electronically stabilised power supplies may be necessary but as the means adopted depends upon the solution of the last two parts of the problem it will be again referred to below. Although for the purpose of analysis the problem is divided into three parts it is convenient to consider the last two concurrently. Two methods of solution have been generally used, which it is convenient to name the "continuous-trace" and the "scan" methods. In the first in its simplest form the control voltage is applied to the controlling electrode and to one pair of deflection plates as shown in Fig. 1 (a), and a voltage derived from the current at the controlled electrode is applied to the other pair of deflection plates. The oscillograph spot then traces out a continuous path which is a graph of the required relationship. The second, the "scan" method, will be considered in detail later.

The control voltage may be applied in several ways but that given below is an example. With valves of large dissipation

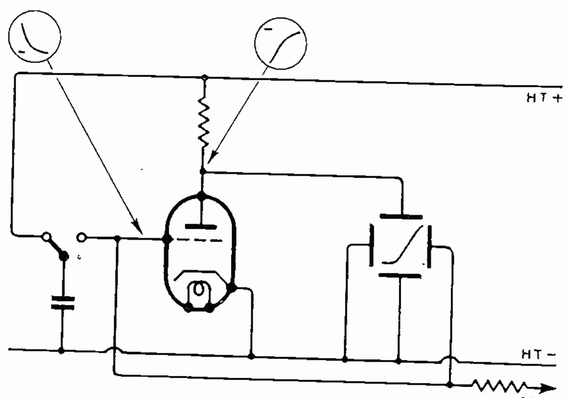

Fig. 2. *Circuit for delineating E_g/I_a curves by the "condenser-discharge" method.*

the characteristic most difficult to obtain by point-to-point methods is the E_g/I_a relationship as the power supplied to the electrodes during the minimum possible measuring period is sufficient to raise their temperature beyond the safe limit. By the "condenser-discharge method"[1] the duration of the measuring period is insufficient to endanger the valve. This method may be briefly outlined as follows: before the measuring period begins the valve has a high standing anode potential and a negative grid potential beyond the cut-off point. The measuring period is started by switching into the grid circuit a high-capacitance condenser, (Fig. 2), charged to any positive potential and allowing it to be discharged by the grid current of the valve. The measuring period is thus a function only of the capacitance of the condenser and the grid current of the valve. The cycle may be made repetitive and hence readily visible by arranging that the condenser is switched alternately to the charging system and to the valve by means of a commutator or vibrator,[2] or by thyratrons [3, 4, 5, 6]. This method is simple, inexpensive and for the purpose for which it was developed entirely suitable. It is not flexible, however, and suffers from the disadvantage that the scales are non-linear.

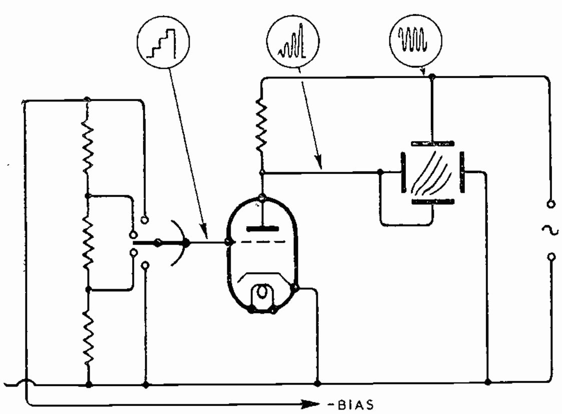

Fig. 3. *Use of a commutator for delineating E_a/I_a curves with E_g parameter.*

When the duration of the measuring period is not of paramount importance, as is the case with valves of small dissipation operated in a restricted negative-grid régime, the applied control voltage may be made cyclic and the trace thereby made self-repeating [7, 8]. The information provided by such a measuring set-up, namely, one single E_a/I_a or E_g/I_a curve, is so meagre, however, that its use offers no advantage over the conventional point-to-point method. To be of service such an apparatus should provide a complete family of curves of both types. For curves of the E_a/I_a type with E_g as parameter this may be done by arranging that after each curve has been traced the grid voltage is rapidly altered to a new value, the whole display being repeated sufficiently frequently to appear stationary without flicker. An obvious but inelegant way of doing this is by means of a rotating commutator which is synchronised with the control voltage [9, 10]. Apart from the clumsy nature of such a device it suffers from the disadvantage of inflexibility and erratic performance, and even under the best conditions it is difficult to avoid switching transients. An obvious solution to this difficulty is to use electronic switching and means have been suggested of achieving the desired control of the E_g parameter in the case of E_a/I_a curves [7, 8, 11, 13]. Reference to Fig. 3 will show that for this case the grid voltage should be scalariform in nature, the time occupied by each step and riser being equal to that for tracing one curve. This voltage may be provided by the circuit shown in Fig. 4. The control voltage is applied to the grid of the pentode charging valve of a linear time base generator. If the magnitude of this voltage is considerably in excess of the input handling capacity of the valve it will be cut-off for one half of the

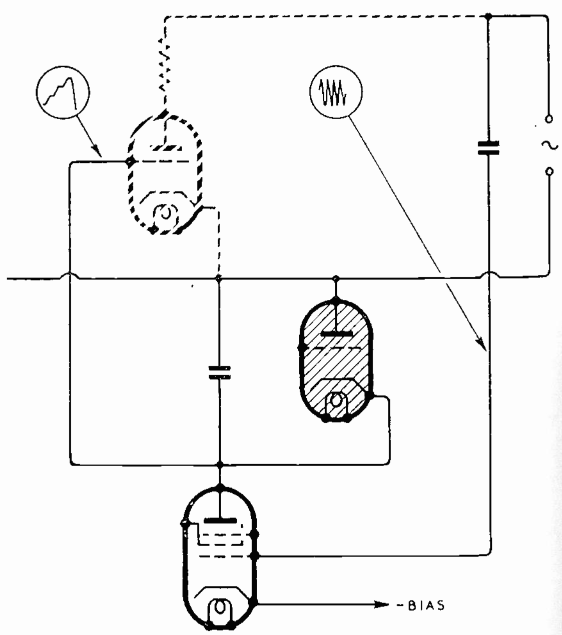

Fig. 4. *Scalariform generator for delineating E_a/I_a curves with E_g parameter.*

cycle, during which the condenser will remain at a constant potential, and will be fully conducting during the other half-cycle,

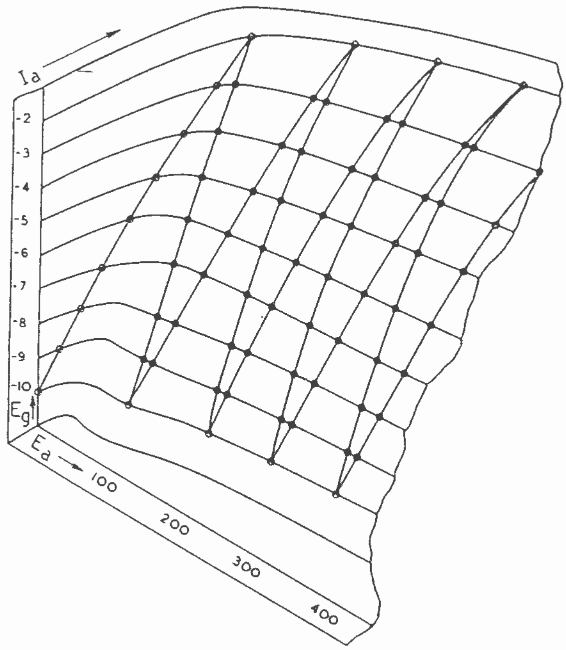

Fig. 5. $E_a/E_g/I_a$ *characteristic showing potential traverse for the "scan" method.*

thus producing the required waveform. It will be observed that in contrast to the mechanically operated case the time required to change from one voltage step to another is some considerable part of one half-cycle. During this time it is necessary that no trace should appear and this may be arranged either by "blacking-out" the C-R tube or by adjusting the test valve operating conditions so that there is no standing anode voltage, the trace on negative half-cycles then appearing as a line along the control voltage axis.

An alternative and more fundamental method of delineating valve characteristics is that referred to above as the "scan" method. This derives from a suggestion originally due to Watson-Watt[12], of using the C-R-O stroboscopically whereby a complete coverage of a characteristic is made but only that part of it which is of interest is allowed to be visible. For the present purpose the test valve is supplied with cyclically varying voltages of differing frequency, one on the parameter controlling electrode and the other on the controlling electrode so that in a given interval of time the entire characteristic is completely traversed. During this interval the beam current is suppressed except when those parts necessary to make up the normal display are being traversed. Fig. 5 shows a space-diagram of the $E_a/E_g/I_a$ characteristic of a typical pentode on which are traced the paths of the varying voltages. In this case the frequencies are shown as exact multiples although in order that the entire characteristic may be traversed it is necessary that this condition should not obtain. A difficulty arises in deriving the "brightening" impulses at the correct points as, owing to grid current, the control voltage may be distorted and unless this voltage ***directly*** controls the instant at which the impulses occur considerable inaccuracies will arise. In the equipment developed at the Philips

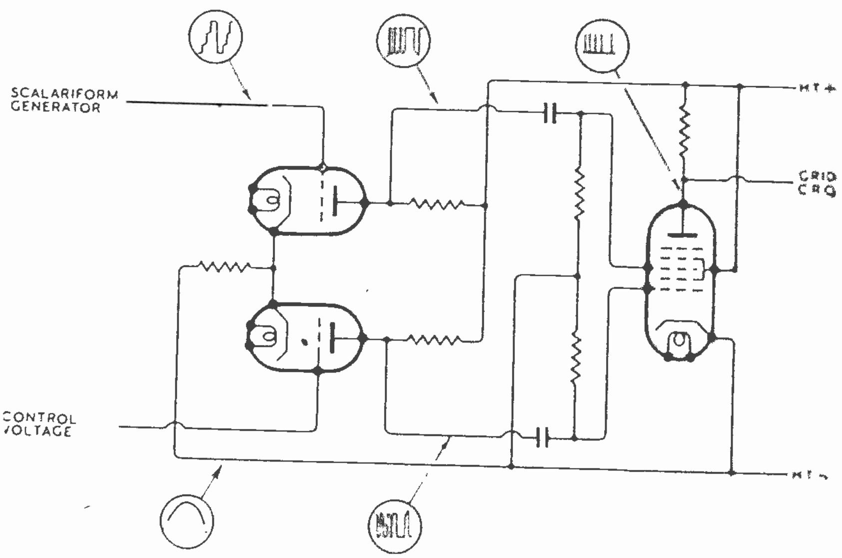

Fig. 6. *Electronic method of deriving beam-release impulses for the "scan" method.*

laboratories[13] an auxiliary C-R tube, due to Posthumus, having a metallic screen with several slots displaced at equal intervals along the direction of scan is used. The control voltage applied to the test valve is also the scanning voltage driving the beam across the slotted plate; impulses are consequently derived from this plate at exact voltage intervals whatever the voltage/time relationship of the control voltage may be and, after amplification may be used to "brighten" the recording C-R-O. Whilst undoubtedly this is a very satisfactory way of ensuring the requisite accuracy it necessitates a separate C-R tube, facilities for making which are not generally available. A method which obviates this difficulty at the expense of some accuracy is shown in circuit form in Fig. 6. The control voltage is applied to one grid of a "long-tailed pair,"* the other grid having applied to it a scalariform voltage similar to that already described. When exact coincidence between the potentials applied to both grids occurs the potential difference between the anodes is also zero; if the anodes are coupled to the control grids of a hexode amplifier a voltage pulse will then occur at its anode. The duration of the pulse, which controls the width of the line traced on the recorder tube may be adjusted by varying the gain of the "long-tailed pair" and the input acceptance of the hexode.

Both the electronic methods of delineating curves described above give only the E_a/I_a characteristic where the current taken by the parameter controlling electrode is negligible; neither as at present described is practically capable of delineating curves of the E_g/I_a type where the current taken by the parameter controlling electrode is appreciable. The provision of this facility will be discussed in detail later, after consideration of other problems.

The next problem is the derivation from the varying current at the controlled electrode of a deflection field of suitable magnitude in the C-R tube. This may be done either magnetically or electrostatically, but owing to the inductance of any practical deflection coil affecting the operation of the test valve and the difficulty of designing such a coil to have zero phase/frequency variation, the former is seldom used. Deflection by electrostatic means may be readily achieved by passing the current through a resistance and applying the resultant potential difference to the deflection plates. Unfortunately it is a condition of measurement when tracing curves of the E_g/I_a type that the potential at the controlled electrode remain constant. For practical purposes the maximum permissible deviation may be limited to one volt, and the interposition

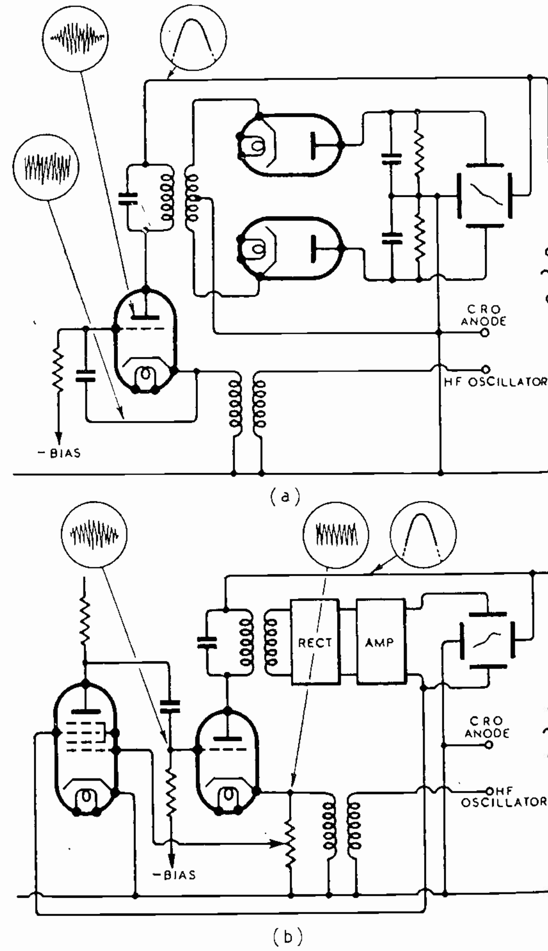

Fig. 7. *Generic forms of set-up for delineating (a) A.C. resistance; (b) amplification factor curves.*

* A "long-tailed pair" refers to two valves having a high value of common cathode resistance so that the application of a potential to either grid produces substantially equal and opposite variations of current in both valves. The term is significant because this operating characteristic is maintained even though the common mean grid potentials be varied over a range several times the "grid-base" of either valve operated separately.

of an amplifier between this resistance and the C-R-O is, therefore, essential. This amplifier must be very carefully designed [10, 14] to have zero phase shift over a wide band of frequencies, otherwise the trace will be quasi-elliptical in form, a very slight deviation being sufficient to make the "go" and "return" paths not coincident. One design[14] published in 1937 utilises acorn valves and has no reactive decoupling or smoothing elements, but with the knowledge now available of degenerative feedback a rather more simple design may be achieved. Nevertheless considerable care should be exercised in its design and no amplifier which does not have a uniform gain and zero phase shift over the range of 25–25,000 c/s is of any value.

With the equipment so far outlined curves of the E_a/I_a type may be delineated; it now remains to provide means of delineating curves of the E_g/I_a with E_a parameter type and the second order curves given above. It is profitable at this stage to consider which of the two methods outlined, namely "continuous-trace" or "scan" offers the greater possibility of successful modification to provide these facilities. Considering first the second order curves a little reflection will reveal that as far as the "scan" method is concerned the parameter controlling electrode must always have the higher frequency applied to it; if the lower frequency is 50 c/s then this higher cannot be less than 500 c/s. Moreover, it must supply considerable power without serious waveform distortion and the apparatus, namely, oscillator and power supply, entailed will necessarily be large. The delineation of the a.c. resistance and amplification factor curves also necessitates the provision of an oscillator of high power as shown in Fig. 7. With the "continuous-trace" method delineation of the E_g/I_a type curves with E_a parameter requires only that E_a vary in steps, although considerable power has also to be provided. As far as the author is aware no method whereby this may be achieved has yet been published. If however an electronically stabilised power supply of the form shown in Fig. 8 is used it can be shown [15, 16] that the magnitude of the output from the stabiliser may be continuously varied over a wide range by adjustment of the grid potential of the pentode control valve V without materially affecting its stabilisation properties. By suitable design[16] it is possible to achieve a linear relationship between the

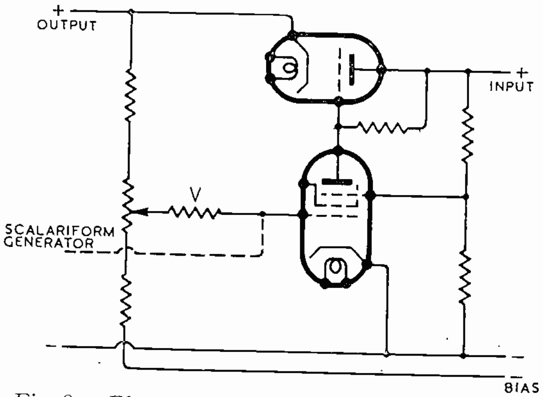

Fig. 8. *Electronic method of securing scalariform variation of a stabilised H.T. supply.*

grid potential and the stabiliser output voltage; if then to this grid is applied the scalariform voltage derived as above the output voltage will in like manner be scalariform and will at the same time be stabilised against variation due to a fluctuating load. It will be seen that this offers almost no increase in complexity over the apparatus necessary for delineating the E_a/I_a curves as this too necessarily incorporated a stabilised power supply. If provision of means of recording the last two of the second order curves is omitted, an additional oscillator of only negligible power is required to delineate the first and most commonly required second order curve. By this means it is possible to make an apparatus which has the merit of compactness and transportability. On the other hand, the "scan" method is the most economical when an unrestricted field of measurement is essential, although the apparatus will be more bulky than that for the restricted function.

The circuit arrangement of a test set working on the "continuous-trace" principle, designed to be adscititious to a portable C-R-O is shown in Fig. 9. It will measure all types of valves up to an anode dissipation of 15 watts and operates from the 50 c/s mains. This also supplies the trace voltages so that the maximum number of curves presented in each display is limited to five in order that undue flicker should not be troublesome. One half cycle, the recording stroke, is used to trace out the curve and the other, the resetting stroke, is used to reset the grid or anode voltage parameter. The power supply provides a wide range of heater voltages and an electronically stabilised output variable either manually or by the scalariform generator between 50 and 350 volts and capable of a peak current drain of 200 mA ; this is normally fed to the controlled electrode. For multi-electrode valves two further sources of power are available, adjustable in steps, and fed from neon stabilisers across the power supply preceding the electronic stabiliser. This supply is also fed to the deflection amplifiers. The scalariform condenser discharge valve operates on the damped oscillation principle and is arranged so that it may be used as an oscillator when delineating transconductance curves. Five transparent scales calibrated in different values of voltage, current and transconductance are provided to be slipped over the face of the C-R tube and by means of a switch the electrical operating conditions are altered so that with predetermined values of E_g/I_a and E_a/I_a exact correspondence is obtained.

Such an apparatus as described is, however, a test set and not a measuring instrument ; its compactness and ease of adjustment are obtained at the expense of some accuracy and limitation of function. The design of a measuring instrument using the "scan" method demands further consideration of possible inaccuracies ; in particular inaccuracies inherent in the C-R tube must be considered. Much attention has been given to this point and it is impossible to refer to all the literature on the subject [17, 18, 20]. The C-R tube is being continually developed, but at the present stage

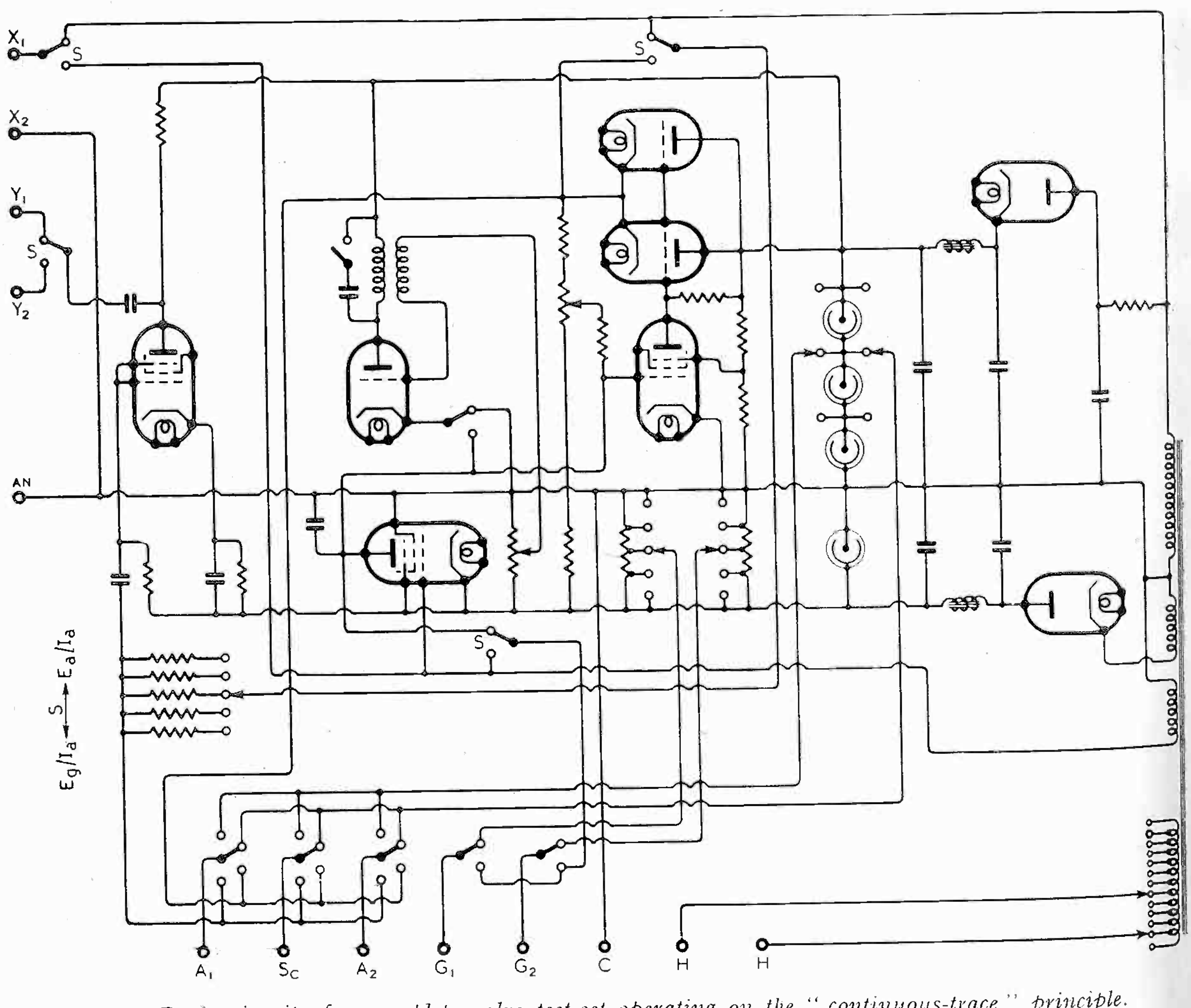

Fig. 9. *Basic circuit of a complete valve test-set operating on the "continuous-trace" principle.*

of improvement cannot be regarded as being possessed of a high order of accuracy. However, the advent of the double-beam tube has offered a means whereby continuous calibration is possible. If certain precautions are taken[19] the spot positions at any point on the screen may be made congruent when the deflection potentials applied in the X and Y directions bear definite relationships. These relationships are constant, irrespective of beam deflection, and are dependent only upon the ratio of the beam currents; they may, therefore, be predetermined and the application of known voltage to one deflection plate used to check the voltage on the other. The amplifier used in the test set described above although having a phase/frequency characteristic of the required nature introduces some distortion due to the non-linearity of its input/output and output/frequency characteristic. An improved form of amplifier is required in Fig. 10 which sets out in block

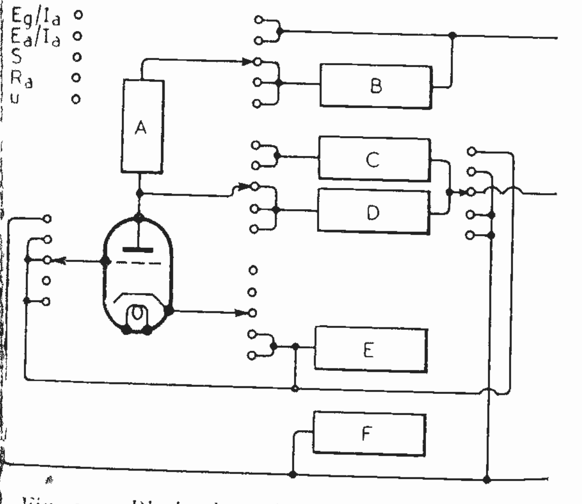

Fig. 10.—*Block schematic of complete measuring equipment. A, amplifier; B, rectifier; C, resistance load; D, tuned H.F. load; E, H.F. oscillator; F, L.F. oscillator.*

schematic form the components of a complete measuring equipment. It is impracticable to do more than describe this equipment by means of such a schematic as the possibilities of additions are without limit and depend mainly upon the user. With the information given above, however, the basis of an instrument of considerable utility may be constructed.

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"RCA Review"

THE suspension of publication, until further notice, of the American quarterly journal *RCA Review* is announced by the publishers, RCA Institutes Technical Press. The reason given is that a large proportion of the current research and development work going on in radio and electronic laboratories is associated with the war effort, and the number of topics which may be openly discussed or published is greatly restricted. The last issue to appear was No. 4 of Vol. VI, dated April 1942.

I.E.E. Meetings

DR. G. E. DONOVAN, M.Sc., B.Ch., M.B., will deliver a paper on "The Electrical Amplifying Stethoscope and Phono-Electro Cardioscope" and will also demonstrate the apparatus at the meeting of the Wireless Section of the I.E.E. on Wednesday, December 2nd, at 5.30.

At the Ordinary Meeting of the Institution on Thursday, December 3rd, at 5.30, Lt.-Col. K. Edgcumbe, T.D., will deliver a paper on "Standardisation as applied to Industrial Electrical Instruments."

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

547 357.—Electric wave filter with piezo-electric elements and variable impedances to produce a desired attenuation characteristic.

Standard Telephones and Cables (assignees of R. A. Sykes). Convention date (U.S.A.) 14th September, 1940.

547 468.—Limiting and filtering circuits, particularly for controlling the operation of voice-frequency relays.

Standard Telephones and Cables (assignees of A. W. Horton, Junr.; O. J. Murphy; and H. E. Vaughan). Convention date (U.S.A.), 5th April, 1940.

547 505.—Circuit arrangement for analysing and synthesising the frequency components of human speech.

Standard Telephones and Cables (assignees of H. W. Dudley). Convention date (U.S.A.) 16th March, 1940.

547 782.—Transducer circuit for increasing the frequency range of a piezo-electric driving unit, say for a loudspeaker.

The Brush Development Co. (assignees of A. L. W. Williams). Convention date (U.S.A.) 3rd August, 1940.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

547 231.—Removing unwanted amplitude modulation from a frequency-modulated signal by a process of heterodyning prior to de-modulation.

A. C. Cossor and D. A. Bell. Application date 18th February, 1941.

547 367.—Tuning circuit in which a movable powdered-iron core is combined with a variable feed-back to produce an output voltage which is independent of frequency.

Johnson Laboratories Inc. (assignees of W. A. Schaper). Convention date (U.S.A.) 19th February, 1940.

547 492.—High-frequency tuning inductance with a sliding core and with coils which are deformable in order to facilitate ganging or tracking.

Marconi's W.T. Co. (assignees of W. E. Newman). Convention date (U.S.A.) 29th February, 1930.

547 623.—Automatic gain-control system including a cathode-ray tube having an electron stream of variable cross-section.

Hazeltine Corporation (assignees of J. C. Wilson). Convention date (U.S.A.) 9th September, 1940.

547 677.—Input circuit for coupling a receiving set either to a frame aerial or to a grounded aerial at will.

Hazeltine Corporation (assignees of N. P. Case). Convention date (U.S.A.) 23rd March, 1940.

547 698.—Filter and rectifier coupling for reducing the inter-signal "hiss" in a super-regenerative receiver.

Philips Lamps (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 23rd April, 1940.

547 737.—Automatic gain control for a set adapted to receive either continuous-wave or speech-modulated signals.

Standard Telephones and Cables and J. D. Holland. Application date 7th February, 1941.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION

547 259.—Television signal-generator of the so-called image-dissector type.

Farnsworth Television and Radio Corporation. Convention date (U.S.A.) 11th March, 1940.

547 285.—Scanning system comprising a mirror-wheel for televising from a continuously moving film.

Gesell. zur Forderung &c. Technischen Hochschule. Convention date (Switzerland) 16th September, 1938.

547 441.—Safeguarding a cathode-ray tube against voltage breakdown by immersing it in an oil container which is provided with a window for viewing the screen.

J. L. Baird. Application date 27th February, 1941.

547 529.—Cathode-ray tube for reproducing television pictures upon an incandescent screen for large-scale projection.

Farnsworth Television and Radio Corporation. Convention date (U.S.A.) 9th October, 1940.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

547 473.—Concentric-line circuit, particularly for monitoring the output from a frequency modulator.

Marconi's W.T. Co. (assignees of H. E. Goldstine). Convention date (U.S.A.) 18th June, 1940.

547 498.—Means for balancing, with respect to earth or cathode, the grid and plate transmission-lines of a single-valve short-wave oscillator.

Standard Telephones and Cables and E. O. Willoughby. Application date 28th February, 1941.

547 605.—Increasing the efficiency by means of regulating the power transfer in a modulating system which includes a transmission-line as a variable impedance.

Intercontinental Service Corporation. Convention date (U.S.A.) 8th March, 1940.

547 837.—Frequency-modulating circuit giving a ten-to-one frequency range without the use of doublers.

Marconi's W.T. Co. (assignees of C. L. Townsend). Convention date (U.S.A.) 19th July, 1940.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

547 193.—Thermionic valve the design of which combines the characteristics of a "hard" or high-vacuum tube and of a "soft" or gas-filled trigger relay.

Electrical Research Products Inc. Convention date (U.S.A.) 2nd March, 1940.

547 645.—Method of using Zirconium as a "getter" in a short-wave oscillation-generator.

Philips Lamps (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 19th September, 1941.

547 646.—Method of screening the electrodes of a multi-stage gas-filled amplifier or generator.

Philips Lamps (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 19th September, 1941.

547 801.—Construction and arrangement of the perforated electrodes of a secondary-emission amplifier to facilitate the passage both of the stream and of the electric field.

F. J. G. van den Bosch and Vacuum-Science Products. Application date 6th March, 1941.

SUBSIDIARY APPARATUS AND MATERIALS

547 154.—Combined portable transmitter and receiver for facsimile telegraphy.

W. G. H. Finch. Convention date (U.S.A.) 10th February, 1940.

547 269.—Automatic gain-control system, particularly as applied to unattended repeater stations in a carrier-wave transmission line.

Standard Telephones and Cables (assignees of V. M. Bishop). Convention date (U.S.A.) 11th May, 1940.

547 281.—Harmonic generator of ultra-high frequencies comprising a diode operating on the upper end of its characteristic.

Standard Telephones and Cables (assignees of . S. Ohl). Convention date (U.S.A.) 18th June, 1940.

547 460.—Construction and arrangement of an anti-interference screen, particularly for sparking-plugs.

Bendix Aviation Corporation. Convention date (U.S.A.) 22nd March, 1940.

547 499.—Feed-back network, of the lattice or Wheatstone Bridge type, for a valve generating a plurality of different, stabilised frequencies.

Standard Telephones and Cables and B. B. Jacobsen. Application date 28th February, 1941.

547 510.—Relay systems, particularly for handling and monitoring frequency-modulated signals.

Marconi's W.T. Co. (assignees of H. E. Goldstine). Convention date (U.S.A.) 5th June, 1940.

547 548.—Circuit arrangement for coupling two electric networks, one of which is balanced, and the other unbalanced, with respect to ground.

Standard Telephones and Cables (assignees of G. N. Slezskinsky). Convention date (U.S.A.) 20th July, 1940.

547 588.—Valve limiting device for regulating the D.C. voltage applied to a load circuit.

The British Thomson-Houston Co.; J. Moir; and W. J. R. Farmer. Application date 3rd July, 1941.

547 601.—Circuit for obtaining relative phase-shifts which remain substantially constant over a wide range of frequencies.

Standard Telephones and Cables and K. G. Hodgson. Application date 31st January, 1941.

547 638.—Means for lighting-up the lamps of an aerodrome, or the like, by a system of remote radio control.

Westinghouse Electric International Co. Convention date (U.S.A.) 8th June, 1940.

547 748.—Photo-electric device for automatically stopping a loom when a warp yarn breaks or becomes entangled with other yarns.

A. S. Guthman. Convention date (U.S.A.) 30th March, 1940.

547 749.—Electric timing circuit, including a diode rectifier for operating a relay, particularly for a welding machine.

The British Thomson-Houston Co. Convention date (U.S.A.) 10th April, 1940.

547 767.—Photo-electric device for controlling the movement of a pantograph device over the contour of a surface to be cut or welded.

The British Thomson-Houston Co. Convention date (U.S.A.) 3rd April, 1940.

547 818.—Arrangement and design of the filter choke element in a rectifying circuit.

Philips Lamps (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 10th December, 1941.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

PROPAGATION OF WAVES

3488. ON THE SKIN EFFECT IN COAXIAL CABLES.—W. Wiechowski. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 174–179.)

Author's summary:—" In order to determine in what frequency region it is permissible, in calculating the complex propagation coefficient $[\gamma = \sqrt{(R+j\omega L)(G+j\omega C)}]$ for coaxial cables, to apply line theory which assumes constant cable properties (resistance, self-inductance, capacitance, and leak-conductance), a generally valid transcendental equation for the complex propagation coefficient is derived, starting from the equations of the rotationally symmetrical field concerned and taking into account the boundary conditions appropriate to the particular cable, namely the continuity of transition of the tangential components of the electric and magnetic field strengths, and of the normal component of the total current density, at the boundary between conductor and insulator, and also the vanishing of the magnetic field in the cable axis and outside the cable.

" From this equation, under certain assumptions which are fulfilled, for cables with non-magnetic metallic conductors and highly insulating low-loss dielectrics, right down to the region of millimetric waves, the propagation coefficient itself can be calculated explicitly [eqn. 27]. It proves to be in agreement with the propagation coefficient of line theory [eqns. 1a or 28], if in reckoning the resistance and self-induction the skin-effect phenomena are, as is usual, calculated as if the electromagnetic field (and thus the current and voltage) were constant in the direction of propagation."

Section iv uses the results to derive an expression (eqn. 52), valid for the highest frequencies, for the attenuation equivalent β: this shows how the frequency and the cable data affect this, the quantity on which, ultimately, the serviceability of a cable depends.

3489. SOME PROBLEMS RELATING TO ULTRA-HIGH-FREQUENCY PROPAGATION AND METEOROLOGY.—E. P. Tilton. (*QST*, June 1942, Vol. 26, No. 6, p. 47: August, p. 49.)

" Why is Southern California the scene of the country's most frequent and pronounced inversions? Can u.h.f. propagation be gauged by watching cloud formations? Why do some sections of the country show their most favourable u.h.f. conditions in the winter, others in spring or fall? . ."

3490. A NEW HYDRODYNAMIC CONSERVATION LAW [of Importance in Meteorology].—H. Ertel. (*Naturwiss.*, 4th Sept. 1942, Vol. 30, No. 36, pp. 543–544.)

3491. APPROXIMATE FORMULAE FOR ATMOSPHERIC PRESSURE AND DENSITY AT GREAT HEIGHTS [Troposphere & Stratosphere].—F. Haber. (*Zeitschr. V.D.I.*, 5th Sept. 1942, Vol. 86, No. 35/36, p. 555.)

3492. THE TEMPERATURE OF THE UPPER ATMOSPHERE, *and* THE CONSTITUTION OF THE STRATOSPHERE.—R. Penndorf. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 180–181: pp. 181–182.) Summaries, by Zenneck, of papers in *Meteorolog. Zeitschr.*, Vol. 58, 1941, pp. 1 and 103 onwards. For a reference to the first paper see 2969 of 1941, and for a *Naturwissenschaften* article on the ionospheric temperatures see 1582 of 1941.

3493. ENERGY OF DISSOCIATION OF CARBON MONOXIDE [and of Nitrogen: with Suggested Values].—A. G. Gaydon & W. G. Penney. (*Nature*, 3rd Oct. 1942, Vol. 150, pp. 406–407.)

3494. Radio Locators may Find Meteors and Measure Their Velocities [Doppler-Effect Whistles in 10-Mile Reception of Delhi Short-Wave Station attributed to Meteors].—(*Sci. News Letter*, 15th Aug. 1942, Vol. 42, No. 7, p. 104.) *See* 1607 of June.

3495. Research Work on the Speed of Wireless Waves.—R. L. Smith-Rose. (*Electrician*, 16th Oct. 1942, Vol. 129, pp. 415–418.) Summary of one section of the Chairman's address to the Wireless Section, I.E.E. (*see* also Editorial on pp. 405–406, and 3803, below). For another summary of this section see *Nature*, 24th October, pp. 477–479, and of the other sections, pp. 493–494.

3496. On the Applicability of the Maupertuis Principle to the Theory of the Propagation of Electromagnetic Waves.—D. N. Nasilov. (*Journ. of Tech. Phys.*, in Russian, No. 21, Vol. 10, 1940, pp. 1783–1784.)

It is suggested that the application of the principle of least action to the propagation of electromagnetic waves enables new explanations to be given of various abnormal phenomena, and the following examples are put forward :—

(1) The discrepancies in the measurements of the velocity of propagation of radio waves made by Colwell & Friend (3241 of 1937 : the greatest discrepancies were observed between the days when the meteorological conditions were different : *see* also Nasilov & Pogosyan, 3111 of 1938 and 23 of 1939). (2) The deviation of radio waves from the great circle, observed by Barfield & Ross (3070 of 1938 : the waves appear to travel along the path of the lowest resistance). (3) The variations in the direction of the minimum, and even its total absence, in direction finding. (4) Cases of abnormally long distance communication. (5) Large increases in the field intensity (usually coinciding with the appearance of the lower ionised layers).

It appears that the problem of determining the field intensity of radio waves is analogous to that of determining the current strength for parallel circuits.

3497. On the Interference Fading of Radio Waves.—D. A. Ladygin. (*Journ. of Tech. Phys.*, in Russian, No. 21, Vol. 10, 1940, pp. 1785–1792.)

It is usually considered that interference fading, as distinct from polarisation fading, is caused by rays undergoing a different number of reflections at the same height above the surface of the earth (Fig. 1). Under certain conditions, however, namely with a certain concentration of free electrons in the reflecting layer and at a certain operating frequency, two rays may penetrate the same layer to different heights and therefore arrive at the receiving point with a certain difference in path length (Fig. 2). Various authors do not accept the second interpretation (the writer cites Farmer, Childs, & Cowie, 219 of 1938) but in this paper a mathematical discussion with numerical examples is presented proving the existence of this path-difference and showing that it may be equal to several thousands of wavelengths. The speed of the variation in the path-difference as determined by the speed of the variation in the electron concentration is also discussed, and it is shown that the fading period is of the order of 1 sec. An experimental curve (Fig. 6b) showing the variation in interference fading and confirming the theoretical values is reproduced (experimental curve in Fig. 6a shows polarisation fading).

3498. On Non-Linear Effects during the Propagation of Radio Waves in the Ionosphere.—V. P. Tselishchev. (*Journ. of Tech. Phys.*, in Russian), No. 19, Vol. 10, 1940, pp. 1630–1633.)

The paper by Bailey & Martyn (1934 Abstracts, pp. 199 & 606) on the influence of electromagnetic waves on the ionosphere is considered, and the physical meaning of the method used by the authors discussed. Approximate formulae (7), (12) and (13) are derived for determining respectively the collision frequency of electrons, ν; the absorption coefficient of the ionosphere, κ; and the average field intensity, Z_1, of a wave after it has travelled over a distance d in the ionosphere (the original field intensity being Z). Using these formulae, it is possible to determine the relationship between κ and Z. A numerical example is given, and curves 1–4 are plotted showing respectively $\nu/\nu_s = f(Z)$, $\kappa = f(Z)$, $Z_1 = f(Z)$, and $Z_1/Z = f(Z)$. Suggestions are also made regarding the derivation of more exact formulae and the calculation of the "klirr" factor of the ionosphere (for a modulated wave).

3499. Experiments on Pulse Exploration of Heaviside Layer on Medium Wavelengths [200 m] at Night, E Layer (screened in Day by D Layer) disperses, leaving Free Ionic Clouds which act like Homogeneous Layer to Glancing Rays but are often Penetrated at Steeper Incidence, giving Many F-Layer Reflections: Effect in limiting Effectiveness of Anti-Fading Aerials].—H. L. Kirke. (In Discussion referred to in 3585, below.)

3500. Holes in the Ionosphere and Magnetic Storms [Another Effect of Neutral Streams from Sun: Electrons brought to Standstill in Higher Ionospheric Regions, while Positive Ions penetrate to E Layer: Resulting Large Electric Force between E & F Layers, with Horizontal Component of Earth's Magnetic Field, produces Violent Drift of All Electrified Particles in F Layer: Corresponding Opposite Movement in Lower Layer hindered by Large Molecular Density: "Sweeping" Action produces Holes: Theory explains Several Effects observed during Magnetic Storms: Computations required to determine Comparative Part played by Such Mass Movements in producing These Storms].—T. L. Eckersley. (*Nature*, 8th Aug. 1942, Vol. 150, p. 177.)

3501. Existence of Electromagnetic-Hydrodynamic Waves [in Conducting Liquid in Constant Magnetic Field: Conditions for Existence satisfied in Sun: on Certain Assumptions, Calculated Velocity there is about 60 cm/s, approximately the Velocity with which Sunspot Zone moves towards Equator during Sunspot Cycle].—H. Alfvén. (*Nature*, 3rd Oct. 1942, Vol. 150, pp. 405–406.)

3502. THE SOLAR ERUPTION OF 28TH FEBRUARY AND THE MAGNETIC STORM OF 1ST/2ND MARCH 1942 [and the Abnormal Duration of Eruption (Multiple Eruptions?) & of Fade-Out: the Time of Travel of the Corpuscular Stream]. — H. W. Newton. (*Nature*, 8th Aug. 1942, Vol. 150, p. 183: summary only.)

3503. ZODIACAL LIGHT—A COSMIC MYSTERY [Survey of Present Ideas: Intensity Variations & Their Connection with Magnetic Storms & Solar Eruptions: Seasonal Variations: Spectrum, & Relations to Light of Night Sky: Apparent Absence of Parallax need Not mean Remote Origin].—S. K. Mitra & S. D. Sarma. (*Sci. & Culture* [Calcutta], July 1942, Vol. 8, No. 1, pp. 8–12: to be contd.)

3504. A NEW THEORY OF THE SOLAR CORONA [Discussion of Alfvén's "On the Solar Corona"].—H. Alfvén. (*Naturwiss.*, 4th Sept. 1942, Vol. 30, No. 36, pp. 547–549.) For other recent work on the corona, by other writers, *see* for example 683, 1597, 2348, & 3232 of 1941 and 2285/6 of August & 2948 of October.

3505. WARBLE OR SWEEPING FREQUENCIES IN OSCILLATORY CIRCUITS [and the Effects of the Departure of the Dynamic Curves from the Stationary].—Feldtkeller & Wilde. (*See* 3530.)

3506. TRANSMITTER FOR SHORT PULSES.—Muth. (*See* 3555.)

3507. SURGE CHARACTERISTICS OF TWO-WINDING TRANSFORMERS.—R. Rüdenberg. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1136–1144.) For previous work *see* 1837 of 1941: for Discussion *see* pp. 1333–1334.

3508. ILLUMINATION AND VISUAL RANGE UNDER WATER.—H. H. Poole: R. Ruedy. (*Nature*, 19th Sept. 1942, Vol. 150, pp. 337–339.) An article prompted by Ruedy's report No. 1061 to the National Research Council of Canada.

3509. A NEW CALCULUS FOR THE TREATMENT OF OPTICAL SYSTEMS: IV.—R. Clark Jones. (*Journ. Opt. Soc. Am.*, Aug. 1942, Vol. 32, No. 8, pp. 486–493.) *See* 2992 of 1941.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3510. AIRCRAFT PRECIPITATION-STATIC RADIO INTERFERENCE [Its Mechanism & Reduction]. —E. C. Starr. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 363–370.) A summary was referred to in 1662 of June.

3511. MEASUREMENT OF THE SENSITIVITY OF RECEIVERS FOR SHORT [Metric & Decimetric] WAVES [including Some Observations on "Jansky Noise"].—Fränz. (*See* 3564.)

3512. SHIELDING OF TRANSMISSION LINES [including Survey of Ideas on Lightning Mechanism (Cloud Heights, etc.): Model Tests & Conclusions].—C. F. Wagner & others. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 313–328.)

3513. FIELD INVESTIGATIONS OF LIGHTNING [and the Differences between Nature of Direct Strokes and of the Currents produced in Arresters].—C. F. Wagner & others. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1222–1230.) For previous work *see* 382 of February: for Discussion, pp. 1381–1382.

3514. DISCUSSION ON "LIGHTNING TO THE EMPIRE STATE BUILDING."—K. B. McEachron. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1377–1380.) *See* 971 of April.

3515. LIGHTNING STROKES IN FIELD AND LABORATORY: III [Effects of Long-Duration Low-Current Components: Characteristics of Lightning-Stroke Discharge].—P. L. Bellaschi. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1248–1256: Discussion pp. 1392–1393, particularly on the mechanism of arcs.)

3516. DISCUSSION ON "IMPULSE AND 60-CYCLE CHARACTERISTICS OF DRIVEN GROUNDS."—P. L. Bellaschi. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 717–719.) *See* 25 of January.

3517. MEASUREMENTS ON LIGHTNING-CONDUCTOR EARTHS: II.—V. Fritsch. (*Arch. f. Tech. Messen*, Aug. 1942, Part 134, V35192-6, Sheet T79.) For I *see* 2966 of October.

3518. PROTECTION OF POWER TRANSFORMERS AGAINST LIGHTNING SURGES.—A.I.E.E. Committee. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 568–577: Discussion pp. 749–752.)

PROPERTIES OF CIRCUITS

3519. ON THE SKIN EFFECT IN COAXIAL CABLES [at Ultra-High Frequencies].—Wiechowski. (*See* 3488.)

3520. PRACTICAL MICRO-WAVE OSCILLATORS: SHIELDED PARALLEL-ROD ACORN-TUBE CIRCUITS FOR 400 AND 750 Mc/s.—Reed. (*See* 3551.)

3521. 100 CENTIMETRES AND DOWN: A REVIEW OF MICRO-WAVE TECHNIQUE: PART I—SPECIAL VALVES, INCLUDING KLYSTRONS: PART II—CAVITY RESONATORS.—R. F. Shaw. (*QST*, July 1942, Vol. 26, No. 7, pp. 25–27 and 96..100: Aug. 1942, No. 8, pp. 33–37 and 110.) With bibliographies.

3522. Correction to "The Laws of Similitude of the Electromagnetic Field, and Their Application to Cavity Resonators."—H. König. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, p. 151.) *See* 1304 of May.

3523. Anomalous Working Regions in the Heterodyning Process.—W. Rogowski, H. Thielen, & O. Martin. (*Arch. f. Elektrot.*, 31st May 1942, Vol. 36, No. 5, pp. 293–303.)

"In the heterodyning process there is, of course, a normal region for which the originating frequencies f_1 and f_2 are nearly equal. With multi-grid valves, however, it is possible—even for ideally sinusoidal originating oscillations—to obtain anomalous regions as well. These regions lie in the neighbourhood of the relation $pf_1=qf_2$, where p and q are whole numbers. The anomalous beat regions owe their existence to the bent-surface characteristic of the multi-grid valve [second and higher terms of the Taylor's series, pp. 296–298]. They present advantages for the suppression of interfering effects [*see* below]. It is shown also that the generation of the heterodyning oscillations, their superposition, and the production of the anomalous heterodyne current, can all be carried out with a single valve" [octode].

The example taken of the advantage for interference-elimination is the case of a device where the variation of the inductance of a coil is to be measured by a beat-note method [*e.g.*, presumably, for some ultra-micrometer purpose] and the leads to this coil pick-up introduce an interfering variation of inductance owing to mechanical vibration (Fig. 9). Equations 17–20 show that the sensitivity of such an inductance-variation device is increased by a factor m, when the normal heterodyne zone is used, by raising the frequency m times, but that at the same time the disturbing variation increases still more rapidly (as m^2) so that if m is made large the use of the higher frequency may actually be detrimental. It is here assumed that the inductance of the leads, and its variation, remain unaltered by the change to the higher frequency, whereas in both the heterodyning circuits the inductance of the coil, as well as the tuning condenser, is reduced m times. Using the abnormal beat-note region, on the other hand, the complete pick-up circuit can remain unchanged for the lower frequency, while the second circuit is altered so that (say) $p=10q$. In this case both the useful frequency shift and the disturbing frequency shift are proportional to p, so that the increased sensitivity given by the use of the high frequency can be utilised to the full without the fear of an increased proportion of interference effect, since the latter is kept dependent on the lower frequency.

The final section deals with the history of the phenomenon: the connection between Wilhelm's explanation (152 of 1936) of certain disturbances in heterodyne reception as being due to combination frequencies produced in the anode circuit by two sinusoidal frequencies on a single grid, and the present case of two signals each on a separate grid, here examined (eqns. 24 & 26). It is also seen that the same qualitative results are obtainable if the second heterodyning signal is applied not to a second grid but to the anode circuit. Finally the close connection between the anomalous heterodyne regions and the question of the note-gaps in the normal region (Figs. 5 & 6) is mentioned, and the occurrence of abnormal "pull-in" zones discussed: *see* also Gilson, 3524, below.

3524. Intensity and Pull-In in Anomalous Heterodyning Regions.—W. Gilson. (*Arch. f. Elektrot.*, 31st May 1942, Vol. 36, No. 5, pp. 304–309.)

Experimental confirmation of the theoretical results of Rogowski and others (3523, above): the first series of tests were on the multiplicative heterodyning of two h.f. oscillations in an octode: both frequencies were first adjusted accurately to 80 kc/s, and they kept in step with one another until a detuning of from 4 to 7% was reached in either circuit: thus for $p = q = 1$ the pull-in zone was up to 7%. Fig. 2 shows that the normal regions $p = q = 1..12$ all gave "very loud" signals (black squares), and this intensity was practically constant also for the abnormal regions $p = 1$, $q = 2$ or 3: the silent region of synchronism became a little narrower. From this point on, instead of varying f_1 by altering the oscillatory circuit, a sinusoidal oscillation from a h.f. signal-generator was applied to grid G_1: for $p = 1$, $q = 4..6$ the intensities were "loud," becoming "medium" for $q = 7$ or 8, "weak" for $q = 9..11$ and "very weak" for $q = 12$. The pull-in zone decreased steadily as q was increased. Results for $q = 1$, $p = 1..12$ were the same, so that both grid characteristics must have been of the same character. The increase of p was carried on to 120, keeping $q = 1$, and abnormal regions could still be detected: amplification would have made many of them usable. Fig. 3 shows that the intermediate anomalous regions ($p/q = 2/3$, $4/5$, $5/6$, etc.) were also obtained, but the intensities decreased more rapidly than for the whole-number relations. The effect of the working-point on the characteristic on the production of the regions was investigated (top of p. 307), and the prediction in the Rogowski paper that strong regions would have wide pull-in zones and weak regions narrow was completely confirmed.

Although the octode is pre-eminent as a heterodyne generator, a similar series of tests was carried out with a two-pentode circuit (Figs. 4 and 5): the intensities in the anomalous regions ($q = 1$) decreased at first rather more slowly than with the octode, but more rapidly from $p = 13$ onwards, and from $p = 17$ no further regions could be found. Nor could the intermediate regions ($p/q = 5/3$, $7/4$ . . .) be obtained, as they were with the octode: this is because of a smaller curvature of the characteristic, and also because the amplification is lower. Finally (Figs. 6 and 7) the additive heterodyning of two oscillations was investigated: here again the existence of anomalous regions was established, but the intensity fell off rapidly and beyond the 8th order nothing was detectable.

3525. A Flexible Equalising Amplifier [based on Use of Frequency-Discriminating Networks in Feedback Loop.]—Cook. (*See* 3621.)

3526. Correction to Equation in "An Equivalent Diagram for the Voltage Transmission of a R–C Amplifier Stage."—R. Wunderlich. (*T.F.T.*, Nov. 1941, Vol. 30, No. 11, p. 336.) *See* 1927 of July.

3527. Feedback Amplifiers [Short Survey of the Calculation of Negative-Feedback Amplifiers, particularly the Effects of Phase-Shift].—C. A. A. Wass. (*Nature*, 26th Sept. 1942, Vol. 150, pp. 381–382.) For the papers quoted *see* Black, 1934 Abstracts, p. 272; Peterson and others, 393 of 1935; and Bode, 4231 of 1940.

3528. Note on an Additional Control for the D.C. Negative-Feedback Amplifier for measuring Stellar Photoelectric Currents: Very Satisfactory Stability & Sensitivity.—R. G. Wilson: Heidelberg & Rense. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, p. 300.) *See* 1328 of 1941.

3529. Graphical Analysis of Saw-Tooth Waves [with Graph for calculating Amplitudes of Higher Harmonics: for Design of Amplifiers & Filters, and Selection of Wave-Form for Frequency Multiplication in Multivibrators, etc.].—U. R. Furst. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 49 and 50.)

3530. Warble or Sweeping Frequencies [" Gleitfrequenzen "] in Oscillatory Circuits [in Exploring-Note Sound Analysis, Resonance-Curve Recording with Cathode-Ray Oscillograph, etc.].—R. Feldtkeller & H. Wilde. (*T.F.T.*, Dec. 1941, Vol. 30, No. 12, pp. 347–352.)

In such technique a current whose frequency alters with time is sent through the oscillatory circuit: short measuring times are desired and the testing frequency is therefore made to sweep as quickly as possible. For this the rule is that the time of stay of the testing frequency in the pass-band of the circuit must not be shorter than the building-up time of the circuit (Walter, 3943 of 1935). The present work investigates this rule theoretically and determines the error produced when the speed of the frequency-change approaches this limit. In order that the results may be applicable to any oscillatory circuit with a comparatively narrow resonance curve, all magnitudes throughout the treatment are referred to the oscillatory circuit: thus the "normalised" detuning Ω along the horizontal axis of Fig. 1 represents $(\omega - \omega_o)/\Delta\omega$, where $\Delta\omega$ is the 45° detuning which is characteristic of the oscillatory circuit and therefore used as a measure of the detuning: $|\omega_{45} - \omega_o| = \Delta\omega = G/2C$, where G $(= 1/R_p)$ is the conductance of the parallel LCG circuit considered, in the anode circuit of a pentode. Similarly the ordinates of Fig. 1 represent the ratio of the voltage $|\mathfrak{U}_a|$ in the oscillatory circuit to the voltage U_o at resonance, or the equal ratio of the impedance $|\mathfrak{R}_a|$ to its value R_p at resonance; while for the "normalised" time (abscissae in Fig. 2, the curve for the building-up process at resonance) the ratio t/τ is taken, where $\tau = 2C/G = 1/\Delta\omega$ and is the characteristic time for the circuit. Thus the "normalised" speed of frequency-change γ, obtained by differentiating Ω with respect to t/τ, is $(1/\Delta\omega^2)(d\omega/dt)$, and if the frequency-change occurs at a constant speed, integration gives the instantaneous value ω_t of the frequency as $\omega_o + \gamma\Delta\omega^2 t$. Using these "normalised" magnitudes the writers derive the time of stay $(t_V = 2\tau/\gamma)$ and the building-up time $(t_E = 2\tau)$: when these two times are equal (limiting condition of the "rule" mentioned), $\gamma = 1$, while in general $\gamma = t_E/t_V$.

The ordinary type of resonance curve is plotted with an infinitely slow frequency-change, represented by a "normalised" frequency-speed of $\gamma = 0$: the corresponding locus of voltage $|\mathfrak{U}_a|/U_o$ or impedance $|\mathfrak{R}_a|/R_p$ is given by the reactance circle of Fig. 3. By an approximate graphical method (3417 of 1941) the locus for a finite γ can be obtained: as γ increases, this departs more and more from the reactance circle. Thus Fig. 3 also shows the dynamic locus for the specially interesting case of $\gamma = 1$, the limiting condition in the above-mentioned "rule." It is particularly to be noticed that it cuts the real axis where Ω is not zero but 0·65; that its greatest distance from the null point of the complex plane is reached when Ω is not zero but 1·25; and that the locus forms a loop at high frequencies. The significance of these loops (which become still more marked for larger values of γ) is found on p. 352, in the section dealing with frequency displacement; "with a varying frequency the current and voltage in a parallel oscillatory circuit have different frequencies. If the frequency of the current is increasing, the frequency of the voltage is below that of the current; if the current frequency is decreasing, the voltage frequency is higher than that of the current; thus in both cases the frequency of the voltage lags behind that of the current." This frequency displacement is calculated, first from the stationary locus and then from the dynamic locus of Fig. 3, for $\gamma = 1·0$ and 0·5 [probably a misprint for 2·0]: the first results are shown in the broken curves of Fig. 8, the second by the full curves: the discrepancy between these curves shows that the frequency displacement must *not* be calculated from the static resonance curve but from the dynamic. Fig. 9 gives the correct curves for $\gamma = 1$, 2, and 10: "the curves for large values of γ, particularly, show that the voltage frequency, after the current frequency has passed through the resonance frequency ω_o, strives to remain at $\Omega_u = 0$, that is, at the resonance frequency: the oscillatory circuit oscillates as long as possible at its natural frequency. Here, also, is the explanation of the loop in the dynamic locus of Fig. 3". In the dynamic locus for $\gamma = 10$ (Fig. 10) the loop at high frequencies has become a spiral about the null point: the loop in Fig. 3 is merely the transition between the loop-less stationary curve and this spiral.

Returning to the discussion of the differences between the static and dynamic locus curves, the writers have derived from the latter (obtained by the graphical process previously mentioned) the values for $|\mathfrak{U}_a|/U_o$ and have plotted these in Fig. 4 as a function of the "normalised" detuning Ω, for positive values of γ (*i.e.* for increasing frequency) from 0 to 10. As γ increases, these "dynamic resonance curves" rise more and more slowly to their peaks, which are displaced further and further beyond the ordinary ($\gamma=0$) peak and also become lower and more rounded. A sharper descent follows the maximum, ending in rapidly decaying up-and-down swings and a final merging into the static curve. Fig. 5 shows how the displacement of the resonance-curve peak varies with the "normalised" frequency-change speed γ: the displacement increases most rapidly at small values of γ and in that region (up to about $\gamma = \pm 0{\cdot}5$) is approximately equal to $1{\cdot}5\gamma$: *see* the broken-line tangent to the curve.

"The rôle played by the deviation of the dynamic resonance curve from the stationary curve is best seen from a few examples": the writers therefore examine, in section 3, the method of acoustic analysis by a warble note. Taking the values of a typical arrangement with $\gamma=1$, involving a measuring time of 6 seconds per kilocycle of band width, it is found that if the apparatus is calibrated for frequency and amplitude in the stationary state, in the dynamic régime the spectral lines will be displaced by 6 c/s and their amplitude will be recorded 10% too low. Doubling the measuring time to 12 seconds per kilocycle, γ becomes $0{\cdot}5$ and the dynamic displacement will be only 4 c/s, the amplitude error only 4%: these systematic frequency-errors are tolerable: they can, moreover, be allowed for in the calibrating process if the speed of frequency-change is kept constant. But if the apparatus is to be used sometimes for stationary measurements, two different calibration scales will be needed for precision results. By the above refinement the objection to the use of a slightly higher analysing speed is removed, and shorter test times arrived at.

Section 4 deals with the cathode-ray-tube recording of resonance curves; it is assumed that with a time-base provided by the 50 c/s mains the signal-generator frequency is swept sinusoidally over a range of $\pm$ 20 kc/s in synchronism with this. For the highest frequency-change speed, at the middle of the resonance curve, γ works out at only $0{\cdot}11$, and the "normalised" displacement of the dynamic-resonance-curve maximum ($=1{\cdot}5\gamma$, as above) becomes $0{\cdot}165$. This means that with a 45° detuning of 3 kc/s the dynamic-curve maximum is recorded with a displacement of 500 c/s towards the higher frequencies when the sweep is rising, and towards the lower frequencies when it is falling (Fig. 7). If, instead of a sinusoidal time-base, a saw-tooth base is used, the maximum is displaced only 150 c/s, and towards the higher frequencies only. If, finally, the time-base frequency is reduced to the flicker-limit of about 25 c/s, the displacement will be reduced to only 75 c/s.

3531. A Circuit for Two Loads on a Single Current Source without Mutual Interaction.—Eggers. (*See* 3681.)

3532. Diode Rectifying Circuits with Capacitance Filters [for Anode Supply in Small Radio Receivers, for Television Tubes, etc: Solution of Equivalent-Circuit Equations, and Experimental Confirmation: Curves suitable for Design Calculations: etc.].—D. L. Waidelich. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1161–1167.) For other work *see* 998 of April, and for Discussion, pp. 1388–1389.

3533. Resistance in Parallel—Capacitances in Series: Abac for Calculating the Effective Value of Two or More Elements.—(*Wireless World*, Sept. 1942, Vol. 48, No. 9, p. 205.)

3534. Distribution of D.C. Potential in the Series Connection of Ceramic Condensers.—F. Lieblang. (*E.T.Z.*, 27th Aug. 1942, Vol. 63, No. 33/34, p. 387.)

"If several condensers are connected in series across a d.c. source, there occurs, independently of the values of the component capacitances, a potential distribution which is proportional to the insulation resistances of the condensers. With ceramic condensers the measured results often seem to contradict this: the relations between capacitance, insulation resistance, and potential distribution are therefore considered more closely," theoretically and experimentally. The conclusion is that the insulation resistance of ceramic condensers is so high that the final state of the potential distribution is only reached a long time after switching on, and that consequently the individual condensers must be designed to take the full d.c. potential, unless a definite distribution can be enforced by the use of high resistances in parallel.

3535. Methods of determining Natural Frequencies in Coils and Windings.—Bewley & others. (*See* 3658.)

3536. Solenoid Inductance Calculations [Nagaoka Formula's Only Disadvantage, Its Inadaptability to Determination of Number of Turns required for Given Inductance on Given Former, etc., overcome.]—T. C. Blow. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 63–64.)

3537. The Optimum Damping of Coils with Compressed-Powder Coils.—G. Lohrmann: Labus. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, pp. 150–151.)

Lohrmann compares the formulae obtained by Labus (2097 of 1941) with those of his own paper (1929 Abstracts, p. 643), and finds that the important ones are identical, except that in Labus's formula "4" the printers have dropped a "μ." "The only important novelty in Labus's paper seems to me to be the statement in the summary, that the maximum attainable quality factor is independent of the shape and size of the coil and of the core"; and this statement Lohrmann condemns as incorrect, since the expression for Q_{opt} involves, in addition to the iron properties, the *optimum* frequency (not merely the frequency), which is dependent on the coil dimensions.

3538. Considerations on the Coupling Relations of n Transformers in Series, particularly when $n = 2$.—M. Päsler. (*Arch. f. Elektrot.*, 30th April 1942, Vol. 36, No. 4, pp. 256–264.)

Author's summary:—"An arrangement of n transformers in series can always be reduced to a single transformer whose primary and secondary inductances, and their mutual inductance, can be expressed in terms of the original circuit components. The application of the usual definition of coupling to the equivalent transformers leads to a calculation of the resultant coupling κ^* of n linked transformers. For an arbitrary value of n a quantitative expression for κ^* cannot be given explicitly, only symbolically [eqn. 18 and adjacent text]. But in the case $n = 2$ [three coupled circuits] the relations are comparatively simple, and are derived here [eqns. 49 & 51]. It is found in particular that the resultant coupling is independent of the input and output circuits, being determined by the ratio of the two inductances of the intermediate circuit and by the partial couplings κ_1 and κ_2 [between these inductances and those of the other two circuits: the expression for κ^* in eqn. 51 involves only these couplings and λ, the above-mentioned ratio of inductances]. A maximum resultant coupling is given when the intermediate-circuit inductances bear a certain relation to the total leakage factor [$\lambda^2 = \sigma_2/\sigma_1$ . . . eqn. 63]. If the intermediate-circuit inductances are equal, the optimum resultant coupling is obtained when the partial couplings are equal also." For the writer's matrix methods *see* 3225 of November.

3539. A Simple Narrow-Band Crystal Filter [Analysis yielding Properties of Lattice-Type Filter with Two Crystal Resonators, or Unbalanced Equivalents with One Resonator only (subject to Greater Limitations): Lattice Type can give Nominal Pass-Band Width of 5 c/s (in about 60 kc/s)].—H. Stanesby. (*P.O. Elec. Eng. Journ.*, April 1942, Vol. 35, Part 1, pp. 4–7.) Simpler version of the 4-quartz filter of 1033 of 1941.

3540. Investigations on Crystal Band-Pass Filters [particularly for Carrier-Current Telephony].—W. Pöhlmann. (*T.F.T.*, Oct. & Nov. 1941, Vol. 30, Nos. 10 & 11, pp. 285–295 & 324–329.)

The fundamental construction and principal properties of such filters have been described in many American papers, but the data in these are in general not sufficient for actual design: while in the German literature nothing has appeared so far on the subject. The writer therefore gives a comprehensive survey of all the possible circuits and the necessary design foundations: the advantages and limitations of such filters are brought out. The October instalment, after a short survey of the properties of quartz and Rochelle-salt crystals, is purely theoretical, the classical treatment by wave parameters being employed. In the November instalment it is recalled how Piloty's revolutionary work (46 & 959 of 1940) transferred the responsibility for the behaviour of a filter from its four-pole-network properties to its operative properties, and founded a theory, based on the current and voltage transmission factors, according to which it is no longer necessary that in the pass region "poles" (*see* 46 of 1940) of one reactance should coincide with null-points of the other, and in the cut-off region poles and null-points of both reactances should coincide: it is only necessary that in the pass region one reactance should be large when the other is small, and that in the cut-off region both reactances should be of the same order. Thus the possibilities opened up by the new theory are far wider, but the design is more difficult: hence the use of the older method in the first instalment.

Now, however, the writer investigates the possibilities offered by the greater freedom of the Piloty theory. Thus the investigation of the pure crystal filter without auxiliary coils shows that the slight steepness of the curve flanks is due to the coincidence of the two null-points: clearly, therefore, by moving these null-points apart the slope can be increased at will, though at the cost of the appearance of a hump in the middle of the pass region: to prevent this from becoming too prominent the constant factor C (eqn. 77) must be made suitably small, which reduces the attainable attenuation in the cut-off region. On the other hand, if the desire for a steep slope is renounced the attenuation in the cut-off region can be increased by making C large: this is specially possible in the case where $a = 1$ (for "a" *see* eqn. 75), for then the hump in the pass band disappears. Among other results, it seems probable that a filter could be constructed out of a few sections, each consisting of two comparatively cheap Rochelle-salt crystals and some condensers, which would combine great steepness of flank with a sufficiently high cut-off attenuation: with Rochelle salt the use of additional coils becomes unnecessary, since the necessary width of band is obtained without these. The general conclusion is that the improvement afforded by the Piloty theory becomes less, the higher the class of filter: thus in the "type 5" filter (bridge filter with crystal and series coil in both arms) no increase in steepness is attainable, though the cut-off attenuation may be augmented.

Finally, experimental work on a series of quartz filters of "type 5" is described (final circuit Fig. 42: the additional coils, together with part of the parallel capacitance, are removed from the bridge circuit for convenience in balancing.)

3541. The Operative Equivalents [Attenuation & Angle] of Antimetrical Filters, and Their Application.—H. Wucherer. (*T.F.T.*, Oct. 1941, Vol. 30, No. 10, pp. 277–284.)

For previous work *see* 3916 of 1939 and 1309 of May. Filters for l.f. technique are generally composed of an even number of Zobel half-sections, and contain (according to the requirements as to attenuation or impedance) additional sections with peaks of attenuation and terminating half-sections: their structure, from the operative standpoint, is completely symmetrical. The most common filter circuits can be built up of such networks, but at the cost of a certain malproportion between the required attenuation in the cut-off region and the necessary expenditure in circuit components. It is therefore desirable to economise in the latter, where possible, by using an odd number of basic half-sections in conjunction with the necessary attenuation-peak sections and terminating half-sections; thus saving space, weight, and material. Such mixed filter chains with antimetrical (*see* 1307 of May and back references) and symmetrical links are here dealt with.

3542. Atomic Theory and Four-Terminal-Network Theory [Development of Analogy between Filters & Crystal Lattices].—E. Hameister. (*Zeitschr. f. Fernmeldetech.*, 20th May 1942, Vol. 23, No. 5, pp. 69–73.) For previous work by this writer *see* 3111 of 1941.

3543. A Short Method of evaluating Determinants and solving Systems of Linear Equations with Real or Complex Coefficients.—P. D. Crout. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1235–2141.)

3544. A General Superposition Theorem of the "Thévenin" Type [and Its Usefulness, *e.g.* in calculating Galvanometer Sensitivity in Four-Arm Bridge Network, Six-Arm A.C. Bridge Details, Current-Transformer Performance, etc.].—G. F. Freeman. (*Phil. Mag.*, Sept. 1942, Vol. 33, No. 224, pp. 679–685.)

3545. Analytical Methods of solving Discrete Non-Linear Problems in Electrical Engineering [Solution in Power Series in Parameters (Two Methods): Method of Variation of Parameters: Hyperelliptic Method: Method of Non-Linear Integral Equations: Method of Galerkin: Bibliography].—E. G. Keller. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1194–1200: Discussion pp. 1389–1390.)

3546. An Experimental Investigation of Subharmonic Currents.—J. D. McCrumm. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 533–540.) A summary was dealt with in 1030 of 1941. For Discussion *see* pp. 722–723.

3547. On D.C. Polarised A.C. Choking Coils, and Their Back-Coupling [for increasing the Amplifying Action: Theoretical Investigation based chiefly on Geometrical Technique, to avoid Highly Complex Analytical Treatment: "Natural" & "Forced" Magnetisation: etc.].—Th. Buchhold. (*Arch. f. Elektrot.*, 30th April 1942, Vol. 36, No. 4, pp. 221–238.)

3548. Voltage-Stabilising Circuits with Iron-Cored Chokes [Analysis of Circuits for the Case of a Fluctuating Supply Voltage & the Case of a Fluctuating Load].—W. Taeger. (*Arch. f. Elektrot.*, 31st May 1942, Vol. 36, No. 5, pp. 310–321.)

3549. Relay Circuits with Delayed Armature Release: Part II [Some Perfected Circuits: Investigation of Winter-Rader "Voltage-Independent" Circuit, and Its Improvement].—A. J. Schmideck. (*Arch. f. Elektrot.*, 30th April 1942, Vol. 36, No. 4, pp. 239–255.) For Part I *see* 3223 of November.

3550. Duality of the Mechanisms of Auto-Oscillation.—Y. Rocard. (*Génie Civil*, 1st Sept. 1942, Vol. 119, No. 20, p. 249: from a *Comptes Rendus* note.)

"It is generally believed that to make a resonant circuit self-oscillate it is necessary and sufficient to introduce into it a negative resistance of appropriate magnitude. This is not the case: if a sufficiently large negative resistance does always result in the setting-up of oscillation, it is not necessary. In a system with more than one degree of freedom, another mechanism capable of setting up auto-oscillation consists in the bringing together of the two natural frequencies of the system. If there is no positive or negative resistance in the arrangement, the instability provoking the oscillation is born at the moment the two frequencies coincide. If there are resistances, the instability due to this cause occurs still more readily.

"The so-called passive couplings (by mutual induction, capacitance, inertia, or elasticity, whether mixed, or gyroscopic, or electromagnetic) all have the property of displacing the natural frequencies. To obtain auto-oscillation it is necessary to have dissymetrical couplings, expressing the effect of forces not arising from a potential and capable of transferring to the system an energy derived from an external source. In many technical problems, the tendency to auto-oscillation by a merging of frequencies is due to the existence of parasitic coupling, more or less concealed but showing itself by the fact that the frequency which is established varies more or less with the retroaction mechanism. The stabilisation of frequency in an oscillator, in radioelectricity, consists actually in eliminating this parasitic coupling, so as to leave the oscillatory circuit with a pure negative resistance."

TRANSMISSION

3551. Practical Micro-Wave Oscillators: Shielded Parallel-Rod Acorn-Tube Circuits for 400 and 750 Mc/s [with 2-Inch Copper Pipe (or Rectangular Box) as Shield for Rods and as Mechanical Support for Components: Bent-Copper-Strip Tuning Devices: etc.].—J. C. Reed. (*QST*, June 1942, Vol. 26, No. 6, pp. 14–16.)

3552. The Velocity-Modulation of Linearly Moving Cathode Rays and Its Use in Ultra-Short-Wave Technique [Ideal Velocity Modulation: Velocity Modulation with Sinusoidal Modulating Voltage: the Use of Phase-Focusing in U.S.W. Valve Technique (and the Question of Energy Transfer, Oscillatory Circuits, & Technical Applications of Velocity Modulation): Literature References].—W. Reusse. (*T.F.T.*, Nov. 1941, Vol. 30, No. 11, pp. 314–324.)

3553. Phase and Frequency Modulation: the Two Systems of Transmission compared.—C. Tibbs. (*Wireless World*, Sept. 1942, Vol. 48, No. 9, pp. 210–213.)

3554. Circuit for the Anode Modulation of Ultra-Short Waves.—E. von Collas & L. Pungs. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, p. 184.)

D.R.P. 712 417. A Lecher pair, loosely coupled to the transmitter and terminating in a dipole aerial, is bridged at a potential node by the anode/cathode gap of the modulating valve, whose only bias is the negative voltage between grid and the middle of the coupling loop. This bias is so adjusted that the transit time is greater than a half-period of the h.f. oscillations, and on it is superposed a modulating voltage of such an amplitude that the resultant modulating voltage does not remain negative. Under the influence of the h.f. voltage acting on the anode, the electrons swing about the grid, and a portion of the energy introduced is converted into heat at the anode and taken from the aerial.

3555. Transmitter for Short Pulses [Radiated Wave produced by the Mixing of Two Frequencies in a Mixing Stage, whose Keying interrupts the Mixing Process].—H. Muth. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, p. 152.) Telefunken Patent, D.R.P. 711 867.

3556. Transmitter for High-Frequency Wire Broadcasting [Special Requirements, and Their Fulfilment: Special Testing Instruments: Full Data of the Transmitter: etc.].—A. Dold. (*T.F.T.*, Nov. 1941, Vol. 30, No. 11, pp. 307–314.)

3557. The Controlled Transitron Oscillator [Modification of Delaup's Circuit (1872 of 1941) to give Independent Control of Frequency & Oscillation-Conditions (ensuring Excellent Wave-Form at All Frequencies): applicable also as Very Selective A.F. Amplifier (*e.g.* for Vibration & Balancing Studies].—S. R. Jordan. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 42–43.) For Brunetti's original work *see* 1851 [and 2296] of 1939: and *cf.* Severini, 3233 of November.

3558. R–C Oscillator Analysis [Growing Attention to R–C Sine-Wave Oscillator, especially for Audio-Frequencies: Delaup's Circuit more completely Analysed].—W. B. Nottingham. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 109 and 110.) *Cf.* Jordan, 3557, above.

3559. Duality of the Mechanisms of Auto-Oscillation.—Rocard. (*See* 3550.)

3560. Concentric Transmission Line as Harmonic Filter [for Transmitter on 740 kc/s: Calculation *versus* Makers' Measurements].—R. E. Snoddy. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 68..72.)

3561. Regulations for Lifeboat Transmitters.—F. C. C. (*Electronics*, July 1942, Vol. 15, No. 7, p. 96.)

3562. Power Tuning for the Amateur Transmitter: a Variable-Frequency System with Motor Drive.—H. E. Rice, Jr. (*QST*, June 1942, Vol. 26, No. 6, pp. 39–41 and 76..80.)

RECEPTION

3563. Arrangement for the Separate Reception of Several Waves [of Same Frequency & Type but Different Order] excited in a Metallic Guide Tube.—H. Roosenstein & P. G. Violet. (*Hochf:tech. u. Elek:akus.*, March 1942, Vol. 59, No. 3, p. 94.) Telefunken Patent, D.R.P. 710 089.

3564. Measurement of the Sensitivity of Receivers for Short [Metric & Decimetric] Waves.—K. Fränz. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, pp. 143–144.)

Supplement to 3240 of November. "We have shown in our opening sections that if the theoretical limits of sensitivity are to be discussed, the temperature of the radiation resistance must be known. The great technical interest which this problem possesses presents a contrast to the lack of reliable information on the subject. It is true that Llewellyn recognised that an interesting problem was presented (1931 Abstracts, p. 325) and promised an experimental investigation; but this seems never to have been published. In the older papers [already cited in the previous abstract] which . . . dealt with long waves, room temperature was attributed to the radiation resistance: reasonable grounds can be adduced for this, as already shown." Another standpoint was taken by Bell (3082 of 1939), who encountered the dilemma that an aerial connected with a resistance, and exposed in free space, radiates energy continuously, so that the resistance represents a "cold-machine"; and evaded the dilemma by assuming that the aerial radiated through its radiation resistance only when it was excited by a signal, not by a noise-e.m.f. This assumption is not necessary when it is remembered that the earth and the sun also radiate energy into free space, without, apparently, receiving back any equivalent from world space. There is no contradiction here to thermodynamic laws: these only require that equilibrium should exist when the aerial finds itself in a space filled with equilibrium-radiation of room temperature, which only happens if the space is shut off energetically for the wavelengths considered: the resulting balance between the outward and inward radiation of the resistance leads directly to the Nyquist formula for resistance noise.

"It is quite clear that thermodynamic considerations can only lead to a lower limit for the intensity of the vagabond radiation. Energy may be present, from sources other than the temperature radiation of the confines of a space, which may be far greater than the theoretical minimum: atmospheric disturbances, for example. For all radiations which can pass through the atmosphere or ionosphere of the earth without being absorbed or reflected, the equilibrium-radiation cannot be attained. For instance if we use a vertical dipole as a television receiving aerial, it is exposed only to the temperature radiation of the ground, which corresponds to the radiation from a half-space. In this waveband the ground will certainly have a high reflecting power: if this is r, its emitting power is $1 - r$, and the intensity of the temperature radiation acting on the dipole is smaller, by the factor $1/2 \cdot (1 - r)$, than that corresponding to the equilibrium-radiation shown in Fig. 1 [April issue]. If, for example, a mean reflecting power of 0·8 is assumed, a noise-temperature of $1/10 \cdot T_o$ is arrived at for the radiation resistance, and the minimum field strengths of Fig. 1 must be lowered by one-third. With directive aerials their screening action must be taken into account."

"As to the actual magnitude of the disturbing radiation, only measurements can provide information. For ionosphere-free waves we have Jansky's measurements for $\lambda = 14$ and 16 m (1934 Abstracts, p. 31; 41 of 1936; 948 of 1938). He stated that the theoretical minimum was seldom reached, perhaps never: he tacitly attributes room temperature to the radiation resistance. Also he uses for his measurements a signal generator with ohmic internal resistance, and gives the sensitivities in watts. According to the curves reproduced by him, the minimum of the interfering radiation had about ten times the intensity of the equilibrium radiation at room temperature, while the maximum corresponded to 150 T_o. He found, also, by tests with directional aerials that the maximum of intensity shifted by one day in the course of a year, so that the radiation would seem, in part at least, to come from a constant point in the fixed-star firmament. In some checking experiments we have been able to reproduce his results (Fig. 12). At a 10 m wavelength, using an aerial having an azimuthal beaming of $\pm 15°$ between the first null points and the vertical directivity due to two $\lambda/2$ dipoles, we found a radiation-resistance temperature of 43 T_o over about three-quarters of a day: the maximum intensity was about ten times as great, and the half-value time was only rather less than ± 1 hour. This means that the radiation must come from an extremely well defined part of the heavens, of an extent which in angular measurement can be hardly greater than that corresponding to the beaming angle of the aerial used. The maximum of the radiation shifted, on an average, some four minutes in a day, which agrees with Jansky's observations.

"Measurements on the intensity of the interfering radiation at wavelengths below 10 m seem to have been carried out only by Reber (1769 of 1940). He found that at 160 m Mc/s the external-noise level sank temporarily below the internal-noise level of his receiver. His estimate of the internal-noise level . . . is difficult to accept: for at 160 Mc/s, with the acorn valves used, the internal noise comes chiefly from shot effect, which Reber neglects. He calculates the intensity of the interfering radiation on the assumption of a 3° ray concentration, whereas with the aperture which he gives for his reflector, 5λ, a concentration of $\pm 12°$ is obtained by trial. But since at a wavelength of 2 m and with acorn valves it is possible to reach sensitivities of the order of $10kT_o$, as can be seen from Fig. 3 [April issue], and since Reber found the external-noise level to be, at least temporarily, too small to be measured compared with the internal, he may probably be justified in maintaining that the intensity of the interfering radiation decreases with the wavelength" [*cf.* 2076 of 1937. For Reber's later work see *Proc. I.R.E.*, Aug. 1942, pp. 367–378].

3565. Papers on Anomalous Working Regions in the Heterodyning Process [and Their Value in reducing Interfering Effects, *e.g.* in Ultra-Micrometric Devices].—Rogowski & others: Gilson. (*See* 3523 & 3524.)

3566. The Suppression of Radio Interference from Electro-Medical and Certain Other Types of High-Frequency Apparatus [including Details of Room Screening].—E. F. H. Gould. (*P.O. Elec. Eng. Journ.*, April 1942, Vol. 35, Part 1, pp. 23–27.)

3567. Short-Wave Diathermy Apparatus and Frequency-Control Possibilities [in connection with the Problem of Radio Interference: Analysis & Discussion, leading to Suggested Solution].—C. K. Gieringer. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 459–464.) A summary was dealt with in 656 of 1941.

3568. High-Voltage D.C. Point Discharges [and the Severe Interference on Aircraft: Experimental Investigation].—E. C. Starr. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 356–362.)

3569. Aircraft Precipitation-Static Radio Interference [Its Mechanism & Reduction].—E. C. Starr. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 363–370.) A summary was referred to in 1662 of June.

3570. Eliminating Gas-Driven-Plant Interference [Practical Experience].—H. Wallece. (*QST*, June 1942, Vol. 26, No. 6, p. 48.)

3571. Discussion on "Some Insulator Designs require Special Features to insure Radio Quietness."—C. J. Miller, Jr. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, p. 657.) *See* 1880 of 1941.

3572. Discussion on "High-Voltage Bushings designed to meet Modern Service."—T. F. Brandt & H. L. Rorden. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 696–698.) *See* 85 of January.

3573. On the Specification of the Interference-Producing Property of High-Tension Lines.—F. Conrad. (*E.T.Z.*, 13th Aug. 1942, Vol. 63, No. 31/32, pp. 367–372.)

"Owing to discharge processes at insulators and conductors, high-tension lines frequently cause interference with wireless reception over a certain area. Since the degree of interference produced by such lines depends on the combined action of numerous working conditions, such as the design of the insulators, the height of the conductors, the voltage of the system, the masts, and so on, and is beyond the reach of calculation, it is desirable to devise a method by which, through simple measurements, a coefficient of interference may be allotted to any line." In the U.S.A., a committee (498 of 1937) has recommended that the interference should be measured at a certain distance from the line:

" the influence of metal masts is to be avoided by carrying out a measurement in the middle of the field of the line. When the lie of the land presents difficulties a suitable distance should be chosen. But with such inexact proposals it is impossible to obtain a measuring method which will give comparable values for different lines."

The experimental investigation carried out by the writer on various types of line, fully reported here, leads to the suggestion that the interference coefficient should be taken as the mean interference potential which can be obtained with an aerial (actually 12 m long) stretched parallel to the conductors at a height approximately half-way between the lowest conductor and earth : *see* eqn. 4 and adjacent text. The dependence on frequency of the figures thus obtained varies greatly for different lines, as is natural since many individual sources of disturbance at very different distances along the line are involved, and resonance effects may emphasise certain frequencies : it is therefore necessary to quote several figures, for different parts of the frequency band.

3574. A Compact Panoramic Radio Spectroscope Adapter [for Attachment to Any Superheterodyne Receiver : with Constructional Details].—G. Grammer. (*QST*, July 1942, Vol. 26, No. 7, pp. 16–21 and 100..104.) Following on Miller's paper, 2349 of August.

3575. Designing the Three-Point-Balance Circuit for the Tracking in Superheterodyne Receivers [Simplified Method].—K. Fränz. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, pp. 144–150.) From the Telefunken Company. A full translation will appear in *Wireless Engineer*.

3576. Variable-Selectivity Intermediate-Frequency Amplifiers : preserving Symmetry in the Response Curves of Switched Circuits [Defects of Various Systems : Method giving Band-Width Variation without Shift of Mid-Band Frequency].—J. E. Varrall. (*Wireless World*, Sept. 1942, Vol. 48, No. 9, pp. 202–205.)

3577. Converting the Amateur-Band Single-Signal Superheterodyne Receiver to General Coverage.—W. E. Bradley. (*QST*, July 1942, Vol. 26, No. 7, pp. 52–53 and 86.)

AERIALS AND AERIAL SYSTEMS

3578. Omnidirectional Radiator for Ultra-Short Waves [Series of Tubular Dipoles with Common Internal Two-Wire Feeder whose Spacing continuously Varies so that Matching deteriorates as Distance from Transmitter decreases].—K. Schüssler. (*Hochf:tech. u. Elek:akus.*, March 1942, Vol. 59, No. 3, p. 95.) Telefunken Patent, D.R.P. 709 036.

3579. Periodic Rotation of the Polarisation of a Revolving Beam of Ultra-Short Waves [Horizontal Dipole rotated above Plane Reflector & below Pyramidal Reflector]. — H. Scharlau. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, p. 154.) Telefunken Patent, D.R.P. 711 670.

3580. Low-Capacity Cables : Flexible Types for Laboratory Equipment and U.H.F. Experimental Work [with "Megastyrene"-Bead Separation].—Telequipment Company. (*Wireless World*, Sept. 1942, Vol. 48, No. 9, p. 221.)

3581. High-Gain Antenna [for Mobile Sets : Short Whip surmounting Tuning & Matching Unit].—(*Electronics*, Jan. 1942, Vol. 15, No. 1, p. 102.)

3582. Operating a Half-Wave Doublet at the Second Harmonic [by Additional Feeder which is left Idle for Fundamental Working]. —E. Black. (*QST*, June 1942, Vol. 26, No. 6, p. 49.)

3583. Radiation Energy and Earth Absorption with Dipole Aerials.—A. Sommerfeld & F. Renner. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 168–173.) Extract from the paper dealt with in 1677 of June : for the full translation of the complete paper see *Wireless Engineer*, August, September & October issues, 1942.

3584. On the Optimum Design of Two-Element Radiation-Coupled Directive Aerials.—F. Sammer : Fausten. (*Arch. f. Elektrot.*, 31st May 1942, Vol. 36, No. 5, pp. 331–332.) A scathing denunciation of Fausten's work (2404 of 1941).

3585. Aerial Characteristics [including Sections on Relation between Earth Systems & Radiator Height : Radiation Resistance & the Effect of Retardation (in Mast-Stayed Radiators, etc.) : Vertical Polar Diagrams, & Their Modification by the Feed Current : Radiation Resistance due to Feed Current : Anti-Fading Aerials & Their Optimum Height : etc : with Appendices, including a New High-Capacitance Aerial and a Top-Fed Aerial].—N. Wells. (*Journ. I.E.E.*, Part III, June 1942, Vol. 89, No. 6, pp. 76–95 : Discussion pp. 95–99.) *See* also 3499, above.

3586. On the Determination of the Radiation Diagrams of Radiator Groups [Directive or Anti-Fading Aerial Systems & Acoustic Radiators : an Electro-Mechanical Method]. —H. Kleinwächter. (*T.F.T.*, Dec. 1941, Vol. 30, No. 12, pp. 341–347.)

" Although this electro-mechanical model method cannot replace the analytical treatment of the problems of radiator groups, which yields the general laws and good approximate solutions, nevertheless it may be hoped that it will always be used when time-consuming numerical calculations cannot be tolerated." The complications of the analytical procedure are brought out in a preliminary survey of this : for instance, " the radiation distributions of circular groups lead in general, as eqn. 24 shows, to higher-order Bessel functions whose values are often insufficiently tabulated," so that here in particular the model method is desirable. A description of the actual apparatus is preceded by the explanation (Fig. 1 and adjacent text) of how the phase relations of the waves from *two* elementary radiators can be studied with a simple model: each radiator is represented by a pin stuck into a common turntable, and each is connected by a thread to one end of a transparent paper strip marked with a sinusoidal line. A roller system R presses the two parts of the strip together, so that the sinusoidal lines are superposed and the phase relations at the point of observation P observed (by transmitted light) for different directions as the table is rotated.

The actual apparatus which is the subject of the paper is illustrated in Figs. 7–10. The radiators are represented by "radiating points" S_1, S_2 . . . arranged in their proper positions on an iron disc (Fig. 8) and held down by means of electro-magnets. Each "point" carries the end of a thin steel wire: these wires converge till they pass together through a distant ring or eye at the "point of observation" P (Fig. 7). The iron disc is rotatable about two axes A_1 and A_2 at right angles to each other, so that the point of observation P can be brought into any desired direction with respect to the group of radiators by tilting and rotating the disc which carries these. After passing through the common ring at P the wires go on together to a row of small rotary transformers, each wire ending by being wound on a drum on the axle of one of these. The torque of its armature keeps each wire stretched tightly from the drum to the ring at P (Fig. 9) and through this to the radiator on its iron disc. Then the component wave represented by any particular wire is simulated, as regards phase and magnitude at the point of observation P, by the alternating voltage induced in the single-phase armature of its particular transformer. A change in the length of the wire by the amount of a drum's periphery alters the phase by 360°, so that one such periphery represents the wavelength of the radiator. The superposition at P of all the component waves is given by the sum of all the armature voltages, obtained by a series connection of these armatures. Radiator phase is adjusted for each wire by an epicyclic gear which displaces the wire-drum with respect to the armature. The zero points are obtained by setting the iron disc perpendicular to the direction of P, so that all the radiators are equidistant from P: the process is described on p. 345, after which the direct recording of the indicating current (obtained by rectification) by a moving-coil coordinate-recorder is explained. From such records, by transposition to polar coordinates and multiplication by the elementary characteristic of a short vertical radiator, the plastic radiation structures of Figs. 4 and 6 were obtained for an asymmetrical group of 5 radiators.

By using recorders indicating real and wattless components, in place of the d.c. recorder, the phase conditions of the resultant radiator-system can be determined. It is thus possible to deal with groups of very many radiators, even when these are distributed in layers. A modification of the arrangement, using only one wire, can deal with continuously distributed radiators (*cf.* analytical part, Fig. 5 and adjacent text). The total radiated power can also be measured by a mechanical integration of the square of the field strength over the whole space angle, these squares being obtained by a rectifier with square-law characteristic. Among the various examples of the results given by the equipment, Figs. 13a & b show that a better all-round horizontal diagram can be obtained from an odd number (5) of radiators than from an even number (6), although the latter system might have been chosen because of its symmetry and simpler mathematical representation. Finally the errors of the method are considered, particularly that due to the finite distance of the point of observation: this error is found to be only about 0·5%, while a comparison with calculated results shows an over-all error of less than 1%.

3587. Ice on Conductors: Suggested Amendments of Overhead-Line Regulations.—J. McCombe. (*Elec. Review*, 21st Aug. 1942, Vol. 131, pp. 235–238.) *See* also 708 of March.

3588. On the Sag Calculation for Overhead Lines [Practical Technique].—W. Ebert. (*E.T.Z.*, 30th July 1942, Vol. 63, No. 29/30, pp. 351–354.)

VALVES AND THERMIONICS

3589. The Velocity-Modulation of Linearly Moving Cathode Rays and Its Use in Ultra-Short-Wave Technique.—Reusse. (*See* 3552.)

3590. 100 Centimetres and Down: a Review of Micro-Wave Technique: Part I—Special Valves, including Klystrons: Part II—Cavity Resonators.—R. F. Shaw. (*QST*, July 1942, Vol. 26, No. 7, pp. 25–27 and 96, 98, 100: Aug. 1942, No. 8, pp. 33–37 and 110.) With bibliographies.

3591. Stand-by Filament Saver for Police Transmitters [Excessive (30 Seconds) Starting Delay, and Short Life with Continuous Operation, both avoided by Standing-by at Half Rated Voltage: Automatic Electronic Device for This Procedure].—J. E. Wagenseller. (*Electronics*, May 1942, Vol. 15, No. 5, p. 65.) Giving a delay of four seconds only.

3592. An Improved Electrolytic Trough [of Very Convenient Mechanical Design: requires only Mains Supply (No Note Generator for Null-Point Adjustment with Telephones): High Accuracy].—J. Himpan. (*E.T.Z.*, 30th July 1942, Vol. 63, No. 29/30, pp. 349–351.) For the earlier design *see* 3032 of 1940 and 1362 of May, and for other papers quoted *see* 1027 of 1940 and 2710 of 1941.

3593. The Type 884 or 885 Gas-Filled Grid-Controlled Valve in Circuit allowing It to regain Control of D.C. Discharge.—Eltgroth. (In paper dealt with in 3818, below.)

3594. The Valve Equivalent Circuit and Its Limitations.—Boyland & others. (*Wireless World*, Oct. 1942, Vol. 48, No. 10, p. 244.) Continuing the correspondence (2673 of September) on Boyland's article.

3595. War Production Board eliminates 349 out of 710 Valve Types from Civilian Use.—(*Electronics*, May 1942, Vol. 15, No. 5, pp. 93 and 94.) With list of the discontinued types.

3596. "Amerikanische Röhren" [American & Russian Valve Data, with Nearest German Equivalents, for refitting Broadcast Receivers found in Invaded Territory: Book Review].—F. Kunze. (*Zeitschr. f. Fernmeldetech.*, 15th Sept. 1942, Vol. 23, No. 9, p. 144.)

3597. Non-Metal Shields [for Valves, Photocells, Electronic Musical Instruments, Electrostatic Generators, etc: Use of Colloidal Graphite].—B. H. Porter. (*Electronics*, April 1942, Vol. 15, No. 4, pp. 33 and 126, 127.) *See* also 1927 of 1936, and *cf.* 892 of 1941.

3598. On the Nature of the Secondary Emission from Composite Cathodes.—N. D. Morgulis. (*Journ. of Tech. Phys.* [in Russian], No. 20, Vol. 10, 1940, pp. 1710–1722.)

For previous papers *see* 3096 of 1941 and 171 of 1942. The following aspects of the secondary emission from composite cathodes are now discussed theoretically on the basis of experimental data: energy diagrams of the emitter and their use in the explanation of the large secondary emission from certain semiconductors; the threshold of secondary emission, *i.e.* the minimum energy E_p of a primary electron necessary for releasing a secondary electron; the secondary electron conductivity of the emitter; the distortion of the work-function values at the contact between the metallic base and the semiconductor or dielectric; the effect of introducing colloidal metallic particles into the emitter; the efficiency η of secondary emission; the appearance of a certain potential fall Δv on the active emitting layer; the Malter effect and the thermoelectron emission from barium-oxide cathodes.

3599. On the "Jumps" observed in Emitters of Poor Conductivity, caused by the Blocking Effect.—N. Yasnopol'ski. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 10, 1940, pp. 1813–1818.)

In his report on the existence of abrupt variations in the secondary emission from magnesium oxide (3171 of 1939) Nelson attributed this phenomenon to the appearance of high positive potential gradients in the dielectric-emitter. It is possible, however, that this phenomenon is caused by the ordinary blocking effect due to the existence of an electric resistance in the emitter circuit (the resistance of the emitter itself). Accordingly a theoretical discussion is presented in which the effect of the "ohmic" resistance of the emitter on the relationship between the secondary emission and the primary accelerating voltage is investigated. On the basis of this discussion a simple explanation is offered of Nelson's, Hinterberger's, and other effects, for which it was originally necessary to introduce special hypotheses regarding the processes taking place in the dielectric-emitter.

DIRECTIONAL WIRELESS

3600. Periodic Rotation of the Polarisation of a Revolving Beam of Ultra-Short Waves.—Scharlau. (*See* 3579.)

3601. Radio Locators may find Meteors and Measure their Velocities.—(*See* 3494.)

3602. The Applicability of the Maupertuis Principle to the Theory of the Propagation of Electromagnetic Waves.—Nasilov. (*See* 3496.)

3603. Land Influences in Direction-Finding with Metric Waves [3–9 m, modulated at 1000 c/s].—E. Guyenot. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 162–168.)

A Jena Dissertation for 1939. The receiving aerial took the form (used by Voigt—reference "7") of a $\lambda/2$ wire bent into a circle with a gap of a few centimetres and a coupling-loop at the current antinode: its radiation resistance was about one-fifth of that of a straight dipole. With such an aerial mounted in a vertical plane and rotatable about a vertical axis, the unknown polarisation of a wave front can be determined if the direction of incidence is known, or the unknown direction of incidence if the polarisation is known: in the absence of disturbing reflections it is thus a useful direction-finder for vertically or horizontally polarised waves. A lack of symmetry in the figure-of-eight characteristic, found at first and already mentioned by Michelssen (1928 Abstracts, p. 226) was eliminated by the steps described at the end of section II, and a true figure-of-eight diagram with absolute minima obtained: sense determination, when necessary, was given by the addition of a $\lambda/2$ reflector. The transmitting $\lambda/2$ aerial could be twisted in all directions. As a result of preliminary tests the transmitter was always kept at least $\lambda/2$ above the ground.

Author's summary:—"The plane of polarisation of the waves remains, in general, constant only when the radiation is vertically or horizontally polarised. Direction finding is possible if the receiving position is open and free from disturbing factors, and only the direct ray comes in: in such cases accurate bearings were taken over distances exceeding 30 km, with or without an optical path. An arbitrary polarisation of the transmitted wave between 0° and 90° nearly always suffers a rotation and leads to erroneous bearings, if the receiver employed responds to both polarisations. The magnitude of this rotation is dependent on the form of the land, which determines the angle of arrival of the reflected ray, and on the electrical properties of the ground. This effect can be utilised for a rough determination of ϵ and σ/f [*see* under "Messungen," p. 164].

"Direction finding is strongly affected, or made impossible, if laterally incident rays are added to the direct ray, arising from secondary radiators in the neighbourhood or from distant reflectors such as hill-slopes. This effect is made evident by the fact that field strengths and directions of arrival taken at various neighbouring spots differ among themselves. The principal arrival direction can then be found neither with the circle-dipole here used, nor with other known d.f. receivers, but only with the reflector method described [in section V, with a fixed receiver (which need not be directive) and a simple $\lambda/2$ wire reflector which is moved, at the same height as the receiving aerial, along various radii proceeding from the latter. The signal voltage as a function of the reflector-distance is plotted for the various radial directions: the difference in the reflector-distances for max. signals is $\lambda/2$ when the direction of movement is in the line of arrival of the principal ray, but $\lambda/(1+\cos\tau_B)$ when the radius is at any arbitrary angle τ_B. By taking several series of measurements in various directions and thus finding the various spacings between the "maximum" positions of the reflector, the direction of arrival of the principal wave in an interference field can be determined with satisfactory accuracy].

"The disturbing effects mentioned occur particularly in wooded and hilly locations. In flat land, as also for ships and aircraft, bearing determinations are as a general rule possible." Among other points not included in the author's summary: "the changes in polarisation observed by Peters and by Sohnemann (1931 Abstracts, pp. 30–31; 1932 Abstracts, p. 30) are probably to be explained by this kind of reflection-effect and are not, as those writers assume, dependent on the distance, whose influence could not be traced in the present tests in any single case." Experiments (section IV) with the equipment described, in wide and narrow valleys, showed the effect of lateral reflections to be such as would be expected from Heiligtag's treatment of the problem of two rays from a single transmitter (reference "18"). Other tests in narrow valleys (section VI) led to effects which may explain Beuermann's result (reference "5") that the apparent bearing, taken in a valley, of an aeroplane on a circular course was given as the longitudinal direction of the valley itself. A sudden error of 60° was produced by the 10×15 m² side of a house (laboratory tests on 6 cm waves confirmed that plates measuring $2{\cdot}5\lambda \times 3{\cdot}5\lambda$ could cause a sharply directive reflection). These valley results showed that as a rule the waves preserved their vertical or horizontal polarisations (as mentioned in the summary), but that the latter gave the smaller bearing errors; from this it is concluded that for vertically polarised waves there are considerably more possibilities of reflection (at the edges of woods, rows of trees, etc.) than there are for the horizontal polarised waves (earth surfaces and houses). Finally, section VIII describes a few effects caused by moving objects (aeroplanes, trains, and motor cars). Trains had to pass as close as 1 km to produce their effect, motor cars quite close, while an aeroplane 5 km to the side of the 9 km distant transmitter was noticed in the receiver. Ignition interference from a car reached from 300 m; from small aeroplanes from 2 km, while aeroplanes with interference-suppressed engines could only be heard at 30 to 60 m.

3604. ARRANGEMENT FOR DISTINGUISHING BETWEEN THE FOUR NULL-POINTS OF AN AMBIGUOUS D.F. SYSTEM FREE FROM NIGHT EFFECT.—W. Runge & A. Gothe. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 186–187.) Telefunken Patent, D.R.P. 711 826.

3605. THE CIVIL AERONAUTICS ADMINISTRATION AND INDUSTRY COOPERATE TO DEVELOP INSTRUMENTATION.—C. I. Stanton. (*Electronics*, Jan. 1942, Vol. 15, No. 1, p. 89: summary only.)

ACOUSTICS AND AUDIO-FREQUENCIES

3606. PERTURBATION OF SOUND WAVES IN IRREGULAR ROOMS [Application of New Boundary Perturbation Theory (3168 of 1941)].—R. H. Bolt & others. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 65–73.)

3607. AN ABSOLUTE PRESSURE GENERATOR AND ITS APPLICATION TO THE FREE-FIELD CALIBRATION OF A MICROPHONE [Reconstructed Loudspeaking Telephone (with Four-Inch Voice Coil) as Piston Generator in Essentially Infinite Baffle (Wall of Building)].—W. J. Kennedy & C. P. Boner. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 19–23.)

3608. ACOUSTIC AIRCRAFT-DETECTION [including the "Machine-Gun" Directional Microphone].—A. E. Hayes, Jr. & T. R. Thomas. (*QST*, July 1942, Vol. 26, No. 7, pp. 44–47.) With reports on various work by amateurs.

3609. A SURVEY ON AIR-RAID ALARM SIGNALS [Report on R.C.A. Tests], *and* AIR-RAID SIREN FIELD TESTS [Chrysler Corporation].—J. E. Volkmann & M. L. Graham: L. M. Ball. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 1–9: pp. 10–13.)

3610. RADIO DATA CHARTS: NO. 1 (3RD SERIES)—OUTPUT TRANSFORMER RATIOS [including the Problem of Complex Systems with Loudspeakers & Morse Recorders].—J. McG. Sowerby. (*Wireless World*, Oct. 1942, Vol. 48, No. 10, pp. 226–228.)

3611. A CATHODE-RAY-OSCILLOSCOPE IMPEDANCE COMPARATOR [for Observation & Measurement of Scalar or Vector Electrical Impedance, Location of Resonance as defined by Zero Phase Angle or by Max. or Min. Modulus: primarily for Loudspeaker Investigations].—V. Salmon. (*Electronics*, Feb. 1942, Vol. 15, No. 2, pp. 54..62.)

3612. ON THE DETERMINATION OF THE RADIATION DIAGRAMS OF RADIATOR GROUPS [including Acoustic Systems: Electro-Mechanical Method].—Kleinwächter. (*See* 3586.)

3613. SOUND POWER DENSITY FIELDS [Computation & Graphical Representation of Streaming of Acoustical Energy near Various

Vibrating Radiators & Reflecting Surfaces: in connection with Use of the Acoustic Wattmeter (150 of January)].—J. H. Enns & F. A. Firestone. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 24–31.)

3614. EXPERIMENTS WITH THE NOISE-ANALYSIS METHOD OF LOUDSPEAKER MEASUREMENT [Disagreement with Claims of Virtual Elimination of Standing-Wave Effects (1008 of 1938 & 1016 of 1939): Advantages of Warble-Note Method].—B. Olney. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 79–83.)

3615. WARBLE OR SWEEPING FREQUENCIES IN OSCILLATORY CIRCUITS [and the Effect of the Departure of the Dynamic Curves from the Stationary].—Feldtkeller & Wilde. (*See* 3530.)

3616. THE MEASUREMENT OF THE "VORTEX SOUND" SPECTRA OF ROTATING RODS, PLATES, AND AIRSCREW MODELS.—E. A. Nepomnyashchi. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 10, 1940, pp. 1800–1810.)

A report is presented on an experimental investigation in which the sound generated by vortices behind a rotating body was measured and analysed. Experiments were conducted with wooden cylindrical rods of different dimensions, a metallic plate, and a metallic model of a two-bladed airscrew (Fig. 2). The angle between the blades and the two halves of the plate could be varied. The speed of rotation was varied from 1200 to 2400 r.p.s. The sound generated by the rotating body was picked up by a piezo-quartz microphone M_1 (Fig. 5) and fed through an amplifier Y to a sound analyser A. The detected currents of simple oscillations were then applied *via* a smoothing filter to a mirror galvanometer X. The movements of the mirror were recorded on a film. A number of spectrograms so obtained are shown and certain relationships are established between the frequency of the vortex sound on the one hand and the speed of rotation and general configuration of the rotating body on the other.

3617. DISCUSSION ON "A STUDY OF SOUND LEVELS OF TRANSFORMERS."—H. Fahnoe. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 748–749.) *See* 466 of February.

3618. SENSITIVE FEEDBACK VOLTMETER WITH RUGGED MILLIAMMETER INDICATOR [Response constant from 40 c/s to 20 kc/s or over].—Fleming. (*See* 3674.)

3619. POWER-CIRCUIT INSTRUMENTS FOR THE HIGHER RANGE OF AUDIO-FREQUENCIES [900–12 000 c/s, for Induction Furnaces, etc.].—L. J. Lunas & P. MacGahan. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1230–1234.)

3620. AMERICAN STANDARD ACOUSTICAL TERMINOLOGY, *and* AMERICAN STANDARD FOR NOISE MEASUREMENT.—American Standards Association. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 84–101: pp. 102–110.)

3621. A FLEXIBLE EQUALISING AMPLIFIER [Push-Pull, High-Level Design suitable as Sound-Effects Equaliser, Driver for Cutting-Head, Play-Back Equaliser, Loudspeaker Equaliser-Driver, etc: also for Telephone Cable Circuits for Broadcasting: based on Use of Frequency-Discriminating Networks in Feed-back Loop].—E. G. Cook. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 36–41 and 91.)

3622. TELEPHONE AMPLIFIER FOR POWER COMPANY CIRCUITS [for overcoming Noise when Inter-Office Telephone Line is carried on H.T. Power-Line Structures].—W. H. Blankmeyer. (*Electronics*, April 1942, Vol. 15, No. 4, pp. 78 and 80.)

3623. THE CONTROLLED TRANSITRON OSCILLATOR [applicable also as Very Selective A.F. Amplifier].—Jordan. (*See* 3557.)

3624. HEARING AID DESIGN [and the Types of Deafness which can be Counteracted: Testing for Deafness: etc.].—I. Kamen. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 32–35.)

3625. HEARING AIDS: THE MEDICAL ASPECT: A CASE FOR COOPERATION.—C. M. R. Balbi. (*Wireless World*, Sept. 1942, Vol. 48, No. 9, p. 201.) Editorial on the correspondence dealt with in 3021 of October. *See* also p. 222, and October issue, pp. 244 and 245; and for an article based on Kamen's paper (3624, above) *see* issue for October, No. 10, pp. 229–230.

3626. THE ELEMENTARY QUANTITY OF SOUND PERCEPTION.—S. Lifshitz. (*Journ. of Tech. Phys.* [in Russian], No. 19, Vol. 10, 1940, pp. 1639–1642.) A version in English was dealt with in 2445 of 1941.

3627. ON THE ACOUSTIC PROPERTIES OF SMALL CAVITIES [Apertured Enclosures of Volume 2·0 to 8·45 cc: Marked Resonance Characteristics: Light thrown on Mechanics of Absorption in Perforated Absorbent Materials & on Certain Properties of the Ear].—P. E. Sabine. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 74–78.)

3628. DAMPING AND SELECTIVITY OF THE INNER EAR [How can a Graduated Series of Simple Resonators (probably of Nature of Stretched Strings) have the Effective Selectivity of about Five Cascaded Resonators? Explanation on Supposition of Existence of Mechanism analogous to A.V.C. in Radio Receiver: Evidence].—R. S. Hunt. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 50–57.)

3629. THE LARYNGEAL VENTRICLE CONSIDERED AS AN ACOUSTICAL FILTER, *and* SOME ASPECTS OF MODEL LARYNX FUNCTION.—A. Pepinsky: R. Carhart. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 32–35: pp. 36–40.)

3630. THE TRANSLATIONAL DISPERSION OF SOUND IN GASES [Derivation of Explicit Relation for Variation of Sound Velocity with

Frequency, in Monatomic Gases (where T.D. would Not be masked by Vibrational Dispersion)].—H. Primakoff. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 14–18.)

3631. COCHLEAR POTENTIALS ELICITED FROM BATS BY SUPERSONIC SOUNDS [up to 98 kc/s, the Limit of the Supersonic Voltmeter employed (2421 of 1938)].—R. Galambos. (*Journ. Acous. Soc. Am.*, July 1942, Vol. 14, No. 1, pp. 41–49.) *Cf.* 1418 of 1941.

3632. SIGNAL GENERATORS WITH 1 KILOWATT OUTPUT [100 c/s to 12 kc/s and 8 to 120 kc/s (later to be combined into a Single Apparatus): primarily for Tests on Supersonic Generators, etc.].—H. Nitsche. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, pp. 138–143.)

PHOTOTELEGRAPHY AND TELEVISION

3633. DISCUSSION ON "PICTURE TRANSMISSION BY SUBMARINE CABLE."—J. W. Milnor. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, p. 756.) *See* 167 of January.

3634. DISCUSSION ON "TELEVISION TRANSMISSION OVER WIRE LINES" [and the Importance of Application to the Everyday Paper-Insulated Cable].—M. E. Strieby & J. F. Wentz. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1311–1312.) *See* pp. 1090–1096, and 1124 & 1422 of 1941.

3635. TELEVISION IN NATIONAL DEFENCE [for training Air-Raid Wardens, Nurses, etc: New York City Police Department's Arrangements].—(*Electronics*, July 1942, Vol. 15, No. 7, p. 80.)

3636. THE TRANSMISSION CHARACTERISTICS OF ASYMMETRIC-SIDEBAND COMMUNICATION NETWORKS [Theoretical & Experimental Investigation, with Certain Conclusions common to Modulation by Sine Wave, Repeated Complex Wave, Suddenly Applied Carrier, & General Transient Modulation: Method of obtaining "Equivalent Modulation Characteristics" of Channel, exact for All Types of Envelope at Any Modulation Depth: a Receiver, & the Question of the Detector: etc.].—E. C. Cherry. (*Journ. I.E.E.*, Part III, March 1942, Vol. 89, No. 5, pp. 19–39: Discussion pp. 39–42.) *See* also 3637, below. A summary was referred to in 475 of February.

3637. EFFECTS OF TELEVISION-CHANNEL DISTORTION INVESTIGATED PURELY OPTICALLY BY DIFFRACTION-PATTERN TECHNIQUE.—R. S. Rivlin. (In Discussion, pp. 40 & 42, referred to in 3636, above.)

3638. A WIDE-RANGE BEAT-FREQUENCY OSCILLATOR [4-Range, covering 10 c/s to nearly 4 Mc/s, primarily for Transmission Measurements on Television Circuits: with Automatic Gain Control Unit thrown in by Key in place of Manual G.C: Comparison with Recent Commercial Models].—R. F. J. Jarvis & E. F. S. Clarke. (*P.O. Elec. Eng. Journ.*, April 1942, Vol. 35, Part 1, pp. 28–35.)

3639. A WIDE-BAND SQUARE-WAVE GENERATOR.—Bartelink. (*See* 3650.)

3640. ON THE NATURE OF THE SECONDARY EMISSION FROM COMPOSITE CATHODES.—Morgulis. (*See* 3598.)

3641. ERRATUM TO THE PAPER "THE FORMULA OF THE SELENIUM BARRIER-LAYER PHOTOCELL" [Acknowledgment of Paper by G.E.C. Workers (1088 of 1939)].—R. A. Houstoun. (*Phil. Mag.*, Sept. 1942, Vol. 33, No. 224, p. 699.) *See* 1445 of May.

3642. THE STRUCTURE OF EXPLOSIVE ANTIMONY AND GLASSY SELENIUM [by X-Ray Analysis].—H. Hendus. (*Zeitschr. f. Phys.*, 31st July 1942, Vol. 119, No. 5/6, pp. 265–286.)

MEASUREMENTS AND STANDARDS

3643. ON MEASUREMENTS OF THE DIELECTRIC PROPERTIES OF CERAMIC INSULATING MATERIALS AT CENTIMETRIC WAVELENGTHS.—W. Küsters. (*Hochf:tech. u. Elek:akus.*, May 1942, Vol. 59, No. 5, pp. 129–137.)

At these wavelengths the difficulties with electrical methods are so great "that hitherto only optical methods have been employed (Kebbel, 2444 of 1939). These have the advantage that the material under investigation has not got to be surrounded by metal . . ." with the risk of air films between metal and dielectric: this difficulty, however, is removed if the material is ceramic so that the metallic layers can be sintered on, as is the case in the method here described. Nevertheless the optical method, though more extravagant in apparatus, retains its advantages for wavelengths of a few centimetres only or below one centimetre, especially with materials of high dielectric constant: for in these cases it is difficult to make the cross-section of the concentric line employed in the present method sufficiently small.

Author's summary:—"A method of measuring the dielectric losses of solid insulating materials at centimetric wavelengths is described. It makes use of a resonance method, developed to high precision, of measuring the attenuation of concentric tubular lines. This method is distinguished by the fact that all errors in such measurements, due to the effect of the measuring instruments and to the radiation from the ends of the line, are completely eliminated by experimental methods [" the experimental determination of the necessary corrections is of special importance with centimetric waves, since an estimation of the error-producing effects on a theoretical basis is no longer possible with sufficient accuracy, on account of the size of the measuring apparatus compared with the wavelength"]. . . The practicability of the method is shown by some measurements on ceramic materials [Calit, Tempa, and Condensa, at wavelengths between 8·5 and 9·5 cm: with comparison with optical-method results for the first and last. "For Tempa, compared with the previously known value (tan $\delta = 1$ to 2×10^{-4}), a surprisingly large value, 15×10^{-4}, was found at these wavelengths"[. . . For the experiments described a particularly accurate wavemeter was developed": this is described on p. 135: the tuning circuit is a concentric-tube arrangement with a piston on a micrometer spindle, and the search for a satisfactory design of piston is described. The whole instrument has to be made with the greatest precision, since (as is seen later in the discussion of errors) wavelength changes as small as 2μ have to be measured. A silicon detector is used.

3644. MEASUREMENT OF THE DIELECTRIC CONSTANTS AND LOSS FACTOR OF DIELECTRIC MATERIALS AT A WAVELENGTH OF 14 CM BY MEANS OF CAVITY RESONATORS.—F. Borgnis. (*Physik. Zeitschr.*, 20th Aug. 1942, Vol. 43, No. 15/16, pp. 284–291.)

A full, illustrated account of the work dealt with in 3435 of 1941 and based on the theoretical work dealt with in 2306 of August. The short table of experimental results gives, besides ϵ and tan δ, also the "loss coefficient" ϵ. tan δ, as a measure of the specific loss in the material. All the measurements were made by exciting the resonator to its fundamental ($\lambda_0 = 2{\cdot}61.R$), but it may sometimes be convenient to use resonators excited to a harmonic ($1{\cdot}14.R$, $0{\cdot}725.R$): the oscillation picture is in principle the same, and the formulae for ϵ and tan δ remain unchanged except for different numerical factors. The concentric-line method is discussed at the end of section 3.

3645. ϵ' AND ϵ'' MEASUREMENTS AT FROM 1 TO 50 MEGACYCLES BY SUSCEPTANCE-VARIATION METHOD (specially suitable because Reliably Calibrated Air Condensers form Only Standards: Dielectric-Constant Values accurate to within $\pm 1\%$, tan δ Values of 0·0001 to within $\pm$ 0·00005: Apparatus suitable up to 100 Mc/s).—S. I. Reynolds. (*Elec. Engineering*, Jan. 1942, Vol. 61, No. 1, p. 30: summary only.)

3646. A NEW ABSOLUTE METHOD FOR THE DETERMINATION OF THE Ultra- HIGH-FREQUENCY CONDUCTIVITY OF AQUEOUS ELECTROLYTES (and Some Results on NaCl Solutions).—A. Pracher. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, pp. 157–162.)

A four-slit magnetron generator producing 61 cm waves is coupled to a horizontal parallel-wire system, tuned to $\lambda/2$ by a remotely-driven cross bridge (Fig. 3: avoiding hand-capacity effects) and merging at its far end into the horizontal liquid-filled testing tube: one wire ends in the wall of the brass tube, while the other passes down its centre through the rubber-packed Calit end-discs. a metal screen separates the testing tube from the space containing the parallel-wire system and generator. Along the top of the tube there is a slit edged with two runners on which slides a completely screened valve detector with its screened "antenna" (about $\lambda/4$ in total length) whose end, coated with Pizein, dips into the liquid. The circuit of this detector is seen in Fig. 5: an RE 084 valve is chosen because in this circuit it functions in the lower, square-law part of its characteristic, so that no subsequent correction by a calibration curve is necessary. The valve, choke, and condensers are built into a metal tube provided with slides to run on the tube rails. The valve emission current is compensated by an opposed current taken through the variable resistance W from an accumulator. The measuring instrument is a loop galvanometer, sensitivity 10^{-7} to 10^{-8} A. The valve detector is calibrated with the help of a sensitive thermoelement capacitively coupled at the potential maximum of the parallel-wire system.

The parallel-wire system being tuned to $\lambda/2$, there is a current maximum at the entrance to t[he] tube. If the liquid is sufficiently high in its damping over the whole length of the tube that no reflection can occur at the ends of the tube, no standing waves can be formed: with liquids of low damping the tube must be correspondingly prolonged till this is attained. Thus the wave entering the liquid has a maximum intensity at its entrance and then decreases exponentially along the tube length. The energy values are measured at various points: if α_1 and α_2 are the deflections at two points separated by a distance z, then the absorption coefficient is given by $K = 11{\cdot}10 \times (\log \alpha_1 - \log \alpha_2)/z$, the logarithms being to the base 10. During the measurements the intensity at the entrance to the tube is kept practically constant with the help of thermoelement indications. To remove the effects of any energy fluctuations between various sets of measurements, the values of α entered in the tabulated results are all expressed as percentages of the deflection at 1 cm from the entrance of the tube. The table on p. 160 gives the results for various NaCl solutions whose l.f. conductivities σ_N, measured by Kohlrausch's method, ranged from 0·0039 to 0·0485 mho/cm.

In section v the theoretical values for K are calculated, from dispersion theory, for an air-wavelength of 61 cm, and plotted in the full-line curves of Figs. 11 and 12 as a function of σ_N. The broken curves in these figures are plotted from the tabulated measured values at that wavelength, and it is seen that these curves run parallel to the theoretical curves at a small constant distance from them. This means that the measured high-frequency conductivity σ_H is greater than the low-frequency conductivity σ_N by a constant amount for all strengths of solution ($\sigma_H = \sigma_N + \Delta\sigma$, where $\Delta\sigma$ is 0·0007): it is stated that this constancy is maintained over the range of σ_N = 0·0001 to 0·05.

This constant additional conductivity $\Delta\sigma$ at this frequency corresponds to the anomalous dispersion of the water: its value of $7{\cdot}0 \times 10^{-4}$ mho/cm agrees well with Slevogt's results (754 of 1940). Applied to Wien's formula for the critical ("jump") wavelength (2343 of 1936) it gives 2·0 cm as this wavelength for pure water: this agrees quite well with the results of other workers based on different methods, and such agreement helps to confirm both the Debye theory and the correctness of extrapolation far into the u.s.w. region (Hackel & Wien, 252 of 1938).

3647. MEASUREMENT OF THE SENSITIVITY OF RECEIVERS FOR SHORT [Metric & Decimetric] WAVES.—Franz. (See 3564.)

3648. A Wide-Band [Ultra-] High-Frequency Sweep Generator [39–53 Mc/s Sweep 30 Times per Second, by Motor-Driven Condenser: for Rapid, Accurate Oscilloscopic Alignment of F.M. Receiver Circuits].—E. J. H. Bussard & T. J. Michel. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 58–59.)

3649. A Wide-Range Beat-Frequency Oscillator [10 c/s to nearly 4 Mc/s].—Jarvis & Clarke. (*See* 3638.)

3650. A Wide-Band Square-Wave Generator [2 c/s to 200 kc/s approx: Variable Pulse Width: Multivibrator (with Frequency controlled by Variable Positive Bias applied to Grid Resistors: Advantages of This Circuit) whose Output is clipped in Limiter and delivered by Buffer Valve into Low Impedance: Approx. Analysis of Multivibrator Frequency & Pulse Width: the Self-Contained Instrument].—E. H. B. Bartelink. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 371–376.)

3651. Signal Generators with 1 Kilowatt Output [100 c/s to 12 kc/s and 8 to 120 kc/s].—Nitsche. (*See* 3632.)

3652. Temperature Control for Oscillators of Stable Frequency [Principles, Control Circuits, Monitoring & Alarm Circuits: Approx. Analysis of Thermostat Operation: Effect of Permanent Heat in reducing Working Range of Ambient Temperature].—C. F. Booth & F. J. M. Laver. (*P.O. Elec. Eng. Journ.*, April 1942, Vol. 35, Part 1, pp. 8–14.)

3653. Comparative Piezoelectric Sensitivity of Tourmalin, Sucrose, and Tartaric Acid.—Lawson & Miller. (In paper dealt with in 3816, below.)

3654. Discussion on "An Improved Frequency Meter for Commercial Power Frequencies.—K. J. Knudsen. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1334–1336.) *See* 1127 of April.

3655. Cathode-Ray Oscillograph for Frequency Comparisons [Methods using Lissajous' Figures & Modulated Wave Patterns, including Circular-Sweep Technique].—(*Electronics*, April 1942, Vol. 15, No. 4, pp. 94..100: summary, from *Gen. Rad. Experimenter*.)

3656. Solenoid Inductance Calculations.—Blow. (*See* 3536.)

3657. Formulas for the Inductance of Rectangular Tubular Conductors.—T. J. Higgins. (*Elec. Engineering*, Dec. 1941, Vol. 60, No. 12, Transactions pp. 1046–1050.) A summary was referred to in 1135 of April: for errata, and reference to a paper on the origins and development of the concepts of inductance, skin effect, and proximity effect, *see* the *Transactions Supplement*, Dec. 1941, Vol. 60, pp. 1408–1409.

3658. Methods of determining Natural Frequencies in Coils and Windings [Discrepancies in Results given by Four Usual Methods: Comparison, on Transformer Coil: Superiority of Method using Free Oscillations, with Impulse Generator & C.R. Oscillograph].—L. V. Bewley & others. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1145–1150.) For Discussion (Rüdenberg and Bellaschi) *see* pp. 1361–1363.

3659. The Routine Testing of Coils for Short-Circuits.—F. Brailsford & J. W. Snelson. (*Met.-Vickers Gazette*, Oct. 1942, Vol. 20, No. 338, pp. 119–121.) *See* also 2102 of July.

3660. The Fluxgraph: an Automatic Machine for Plotting the Magnetic Fields of Coils [also for tracing Small Irregularities in Windings or Inaccuracies in Dimensions or Position of Core Materials: Recording by Pencil, Condenser-Discharge, or "Teledeltos"-Paper Methods].—P. G. Weiller. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 52–53.)

3661. Formulas for the Magnetic Field Strength near a Cylindrical Coil.—H. B. Dwight. (*Elec. Engineering*, Dec. 1941, Vol. 60, No. 12, p. 598: summary only.)

3662. A Sensitivity Regulator for the Measurement of Magnetic Flux [with the Grassot Fluxmeter].—H. W. Steinheimer. (*E.T.Z.*, 27th Aug. 1942, Vol. 63, No. 33/34, p. 397.)

3663. Magnetic-Field Measurement in Beta-Ray Spectroscopy [where Absolute Value is required: Method using Spinning Silver Disc].—J. M. Cork & W. G. Wadey. (*Review Scient. Instr.*, Aug. 1942, Vol. 13, No. 8, p. 369.)

3664. The Testing of Magnetic Materials, using a Cathode-Ray Oscillograph with Electrostatic Deflection only [Accuracy within 2%: applicable also to Routine Comparison Method].—K. Kreielsheimer. (*Journ. of Scient. Instr.*, Sept. 1942, Vol. 19, No. 9, pp. 137–139.)

3665. An Instrument for measuring Electrical Field Strengths in Strong High-Frequency Fields [Point-by-Point Measurement by Electrodeless Discharge & Photoelectric Device: for Short-Wave Therapy, Measurements on Insulators, etc.].—K. S. Lion. (*Review Scient. Instr.*, Aug. 1942, Vol. 13, No. 8, pp. 338–341.)

3666. Discussion on "The Detection of Initial Failure in High-Voltage Insulation."—J. B. Whitehead & M. R. Shaw, Jr. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, p. 761.) *See* 195 of January.

3667. Discussions on "The Basis for the Non-Destructive Testing of Insulation" *and* "The A.C. Dielectric-Loss and Power-

FACTOR METHOD FOR FIELD INVESTIGATION OF ELECTRICAL INSULATION."—R. F. Field: F. C. Doble. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1347–1348: pp. 1348–1349.) *See* 1171 of April and 785 of March.

3668. DISCUSSION ON "HIGH-POTENTIAL TESTING EQUIPMENT FOR QUANTITY PRODUCTION."—C. M. Summers. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 756–757.) *See* 195 of January.

3669. DIRECT-READING AIRCRAFT INSULATION TESTER [with Two Test Ranges, for Ignition-System & Aerial Insulation].—W. N. Lambert. (*Electronics*, April 1942, Vol. 15, No. 4, pp. 84..88.)

3670. INSTRUMENTS: TEST AND MEASURING GEAR AND ITS USES: VI—ELECTROLYTIC CONDENSERS: INDUCTANCE AND CAPACITANCE AT RADIO FREQUENCIES.—W. H. Cazaly. (*Wireless World*, Oct. 1942, Vol. 48, No. 10, pp. 232–236.)

3671. A METHOD FOR MEASUREMENT OF THE CONTACT AND VOLUME RESISTANCE OF SEMICONDUCTORS [with Some Results on Metallic-Oxide Semiconductors: Frequently Occurring High-Resistance Surface Layer up to 10^{-3} cm Thick, and Effects of Its Removal: etc.].—P. H. Miller, Jr. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 298–299.)

3672. HIGH-VOLTAGE MEASUREMENT WITH THE ROTATING VOLTMETER: III [including the Pulsating Type (2758 of September) and a Reference to Researches on Periodically Varying Capacitances (3492 of 1938 and 2713 of 1939)].—H. Prinz. (*Arch. f. Tech. Messen*, Aug. 1942, Part 134, J763-5, Sheets T83–84.) For II *see* 3067 of October.

3673. VACUUM-TYPE VOLTMETER [Type 727-A, particularly for Field Use: from Lowest A.F. to beyond 100 Mc/s: Comparison with Type 726-A].—General Radio Company. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, p. 304.)

3674. SENSITIVE FEEDBACK VOLTMETER WITH RUGGED MILLIAMMETER INDICATOR [Modification of Ballantine Circuit (247 of 1939) to replace Sensitive D.C. Instrument: Response constant from 40 c/s to 20 kc/s or over].—L. Fleming. (*Electronics*, April & July 1942, Vol. 15, Nos. 4 & 7, pp. 88 & 90, and 54.)

3675. DISCUSSION ON "A NEW HIGH-SPEED THERMAL WATTMETER."—J. H. Miller. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 633–635.) *See* 1151 of 1941.

3676. DISCUSSION ON "AN AUTOMATIC PRINTING AMMETER."—T. G. LeClair. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 757–758.)

3677. DISCUSSION ON "THE DETERMINATION OF MAGNITUDE AND PHASE ANGLE OF ELECTRICAL QUANTITIES."—E. A. Walker. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, p. 1333.) *See* 1129 of April.

3678. ELECTRONIC PHASE-ANGLE METER [can be calibrated Directly in Degrees: Signals (Not necessarily of Same Amplitude) converted into Equal-Amplitude Square Waves].—E. L. Ginzton. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 60–61.)

3679. SENSITIVE MEASUREMENT OF IMPEDANCE, REACTANCE, FREQUENCY, AND PHASE RELATIONSHIPS WITH AN ELECTRONIC PHASE BRIDGE [Barnhardt's "Unbalanced" Bridge Circuit, using Detector "essentially the same" as Cosen's Phase-Sensitive Detector (511 of 1935): General Theory of Operation of the Detector: Sensitivity of the Circuit, and Special Errors & Their Elimination].—R. H. Brown. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 277–281.)

3680. THE KAPP THREE-PHASE BRIDGE ON UNBALANCED VOLTAGE.—A. J. Good: Kapp. (*BEAMA Journal*, Sept. 1942, Vol. 49, No. 63, pp. 271–272.) Corrections to the paper dealt with in 2438 of August.

3681. A CIRCUIT FOR TWO LOADS ON A SINGLE CURRENT SOURCE WITHOUT MUTUAL INTERACTION [*e.g.* for connecting a Thermoelement with Its Permanent Pointer Instrument so that a Recorder can be switched on Intermittently without vitiating the Readings: Bridge Circuit].—H. R. Eggers. (*Arch. f. Elektrot.*, 30th June 1942, Vol. 36, No. 6, pp. 391–398.)

3682. ATTENUATED SUPERCONDUCTORS: I—FOR MEASURING INFRA-RED RADIATION.—D. H. Andrews, W. F. Brucksch, Jr., & others. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 281–292.)

For previous work *see* 2319 & 3204 of 1941. "No use has ever been made of the striking possibilities which it [superconductivity] presents for the measurement of very small temperature changes and the detection of minute quantities of energy (references "1" & "2"). The advantages in using superconductivity for such purposes may best be seen by reviewing briefly the essential problems in the measurement of radiant energy." This is done here, and the writers' "superconducting bolometer" with its associated equipment is described: it has a tantalum coil operating in a special self-regulating shunt circuit by which its own temperature is maintained constant automatically. The minimum detectable flux is about 10^{-3} erg/s: this should be improved by several orders of magnitude if the variability of background temperature could be overcome. The Formvar [*cf.* 3350 of November] window used seems to be transparent between 50 and 100μ. For other papers on superconductivity *see* 3842/3/4, below.

SUBSIDIARY APPARATUS AND MATERIALS

3683. Tables for the Convenient Calculation of Appropriate Deflecting Plates in Cathode-Ray Tubes [to give the Max. Sensitivity under Given Conditions].—von Borries. (*T.F.T.*, Oct. 1941, Vol. 30, No. 10, pp. 295–299.)

"Fundamentally, the problem has long ago been solved for slanting plates (Matthias, von Borries, & Ruska, 1934 Abstracts, pp. 50–51), bent (Flechsig, 273 of 1940) and curved plates (Hintenberger, 3120 [*see* also 4190] of 1937). The object of the present work is to collect together all the calculation processes for determining the various forms of interest—including the parallel plates—and to carry out a simple comparison of sensitivity for the whole range of deflection angle and plate-length, so that it may easily be decided in any given case whether the trouble of using bent or curved plates instead of the simpler slanting flat plates is justified by a sufficient gain in sensitivity. Further, the tables given, which are partly based on the calculations of other workers [*loc. cit.*] enable a rapid calculation of the plates to be carried out from the external conditions." The small increase in sensitivity given by the curved plate as compared with the bent plate hardly seems to justify the greater expense of the former. The usefulness of adjustable plates (whether slanting, bent, or curved) for tubes permanently connected to the pump, and therefore capable of having their stops changed and their ray diameter thus varied, is mentioned at the end.

3684. Apparatus for the Light/Dark Control of Cathode-Ray Oscillographs for the Photography of Single Processes.—Dätwyler. (*Bull. Assoc. suisse des Élec.*, 29th July 1942, Vol. 33, No. 15, pp. 418–420.)

"It is often (for example where post-acceleration is used) impossible to make the repose position of the spot come outside the edge of the screen . . . In commercial oscillographs provision is often made for a single time-base deflection, but not for a synchronous ray-blocking. The latter must generally be added by the purchaser." The writer describes two such units. The first, more complicated device darkens the spot before and after the process, including also the fly-back time. The second, very much simpler arrangement (applicable when a moderate amount of post-acceleration is used) does not extinguish the fly-back, but the latter produces only a hardly visible trace.

3685. Developments in High-Speed Oscillography [particularly the Redesign of General Electric Cold-Cathode Equipment to increase Recording Speed to One-Fifth of Light Velocity: including Additional Accelerating Potential between Anode & Fluorescent Plate].—Bryant & Newman. (*Electronics*, July 1942, Vol. 15, No. 7, p. 74.)

3686. A Cathode-Ray Method of Wave Analysis [including Suggestion that with Ultra-High-Frequency Oscillographs (Hollmann, 3536 of 1940) the Method could easily be adapted to Such Waves].—Johnson. (*Elec. Engineering*, Dec. 1941, Vol. 60, No. 12, Transactions pp. 1032–1036.) A summary was referred to in 1249 of April (*see* also *Electronics*, Jan. 1942, pp. 84..86): for Discussion *see* the Transactions Supplement, Dec. 1941, Vol. 60, pp. 1398–1399.

3687. Cathode-Ray Oscillograph for Frequency Comparisons, *and* A Cathode-Ray Oscilloscope Impedance Comparator.—General Radio: Salmon. (*See* 3655 & 3611.)

3688. The Testing of Magnetic Materials, using a Cathode-Ray Oscillograph with Electrostatic Deflection.—Kreielsheimer. (*See* 3664.)

3689. The H.T. Voltage-Divider for Cathode-Ray Oscillographs [Argument on Correctness of Conclusions in Höhl's Paper, 2781 of September].—Elsner: Höhl. (*Arch. f. Elektrot.*, 31st May 1942, Vol. 36, No. 5, pp. 329–331.)

3690. Wave-Form Circuits for Cathode-Ray Tubes: Part I [Survey: Fundamental *RC* & *L/R* Generators: *RC* Type Relaxation Generators (including Multivibrator & Blocking-Oscillator Circuits): Synchronisation & Counter Circuits].—Lewis. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 44–48 and 84.)

3691. Time Bases [Survey of Numerous Types: including Jenkins's Method of Linearisation, Godeck's Radial Time Base, Dowling & Bullen's Polar-Coordinate Base, etc.].—Puckle. (*Journ. I.E.E.*, Part III, June 1942, Vol. 89, No. 6, pp. 100–119: Discussion, pp. 119–122.) A summary was referred to in 1145 of April: and *see* 2784 of September.

3692. Graphical Analysis of Saw-Tooth Waves.—Furst. (*See* 3529.)

3693. Fine-Ray Electron Diffraction in the Universal Electron Microscope: Procedure and Results.—von Ardenne & others. (*Zeitschr. f. Phys.*, 31st July 1942, Vol. 119, No. 5/6, pp. 352–365.) For previous work *see* 2208 of 1941 and 1774 of June: and *cf.* 518 of February.

3694. Electron and Optical Microscope Interpretation of the Wall of *Pleurosigma angulatum* [Diatom: an Example of How the Two Instruments supplement Each Other].—Hamly & Watson. (*Journ. Opt. Soc. Am.*, Aug. 1942, Vol. 32, No. 8, pp. 433–442.)

3695. "Elektronenmikroskopie" [and the Work of the AEG Research Institute, 1930–1941: Second Edition: Book Notice.]—Ramsauer. (*E.T.Z.*, 30th July 1942, Vol. 63, No. 29/30, p. 360.) This is presumably the edition referred to by Boersch, 3347 of November.

3696. A New Calculus for the Treatment of Optical Systems: IV.—Clark Jones. (*Journ. Opt. Soc. Am.*, Aug. 1942, Vol. 32, No. 8, pp. 486–493.) *See* 2992 of 1941.

3697. The Polarisation of an Elliptic Cylinder placed in a Uniform Field.—Glushko & Strashkevich. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 10, 1940, pp. 1793–1799.)

For previous work *see* 3476 of 1941. It is pointed out that the problem discussed in this paper is of interest for calculations of both electrostatic and magnetostatic fields, and that the method proposed enables the final results to be expressed in a form suitable for practical purposes. An infinite elliptical cylinder polarised in a field of arbitrary direction is considered, and finite solutions (9), (10), (11) and (12) of Laplace's equation (1) are found. From these solutions the potential distribution inside and outside the cylinder can be determined. Particular cases of a circular cylinder (18 and 19), a long infinitely thin plate (21 and 22), and a field directed along one of the axes of symmetry of the elliptical cylinder (5, 6, and 8) are also considered. The angle formed by the vectors of the primary and inner fields are studied in detail.

3698. An Improved Electrolytic Trough.—Himpan. (*See* 3592.)

3699. A Variable Capillary-Tube Leak [Effective Impedance raised by Heating (Viscosity Effect)].—Bayley. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 299–300.)

3700. A Method for Grinding the Internal Wall of Small-Bore Capillaries [for McLeod Gauges, etc: to prevent Mercury from Sticking & Jumping].—de Turk & Lockenvitz. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 295–296.)

3701. A Hydraulic Relay [for Protection of Water-Cooled Apparatus: Combination of Flexible-Metal Bellows & Microswitch].—Bayley. (*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 300–301.)

3702. Discussion on "Current Rating and Life of Cold-Cathode [Relay, Rectifier, Voltage-Regulating] Tubes."—Rockwood. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1390–1391.) *See* 1153 of April.

3703. Diode Rectifying Circuits with Capacitance Filters [for Anode Supply].—Waidelich. (*See* 3532.)

3704. Discussion on "The Characteristics and Applications of the Selenium Rectifier." —Richards. (*Journ. I.E.E.*, Part III, March 1942, Vol. 89, No. 5, pp. 73–74.) *See* 248 of January. Selenium and copper-oxide rectifiers are briefly compared in the reply to the Discussion at the end of the paper.

3705. Measurement of Resistance of Semiconductors, with Some Results on Metallic-Oxide Semiconductors.—Miller. (*See* 3671.)

3706. Versatile Electro-Kymograph [for Physical & Physiological Recording: using Paper developed for Radio Facsimile Work]. —Moore & Bloomer. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 51 and 54.) The paper used is not specified, but *cf.* 1129 of 1941.

3707. Discussion on "Some Characteristics and Applications of Negative-Glow Lamps" [particularly the Use of a Rotated "Tune-a-Lite"].—Ferree. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, p. 622.) *See* 1186 of 1941.

3708. Voltage-Stabilising Circuits with Iron-Cored Chokes.—Taeger. (*See* 3548.)

3709. On D.C. Polarised A.C. Choking Coils, and their Back-Coupling.—Buchhold. (*See* 3547.)

3710. A Static Voltage Regulator insensitive to Load Power-Factor [Combination of Two Reactors & Two Capacitors].—Summers & Short. (*Elec. Engineering*, Dec. 1941, Vol. 60, No. 12, p. 599: summary only.)

3711. Discussion on "A New Mercury Rheostatic Element for Regulation and Control."—Oplinger. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1386–1387.) *See* 1157 of April.

3712. Relay Circuits with Delayed Armature Release: Part II.—Schmideck. (*See* 3549.)

3713. The Influencing of the Behaviour of D.C. Electro-Magnets by the Introduction of Series and Parallel Resistances, Inductances, and Capacitances.—Schüssler. (*Zeitschr. f. Fernmeldetech.*, 20th May 1942, Vol. 23, No. 5, pp. 73–75.)

3714. Nickel Alloys replaced by Hipersil for Ignitron Reactors.—(*Scient. American*, Sept. 1942, Vol. 167, No. 3, p. 109.)

3715. The Optimum Damping of Coils with Compressed-Powder Coils.—Lohrmann: Labus. (*See* 3537.)

3716. High-Voltage D.C. Point Discharges.—Starr. (*See* 3568.)

3717. Discussion on "Atmospheric Variations and Apparatus Flashover."—McAuley. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1319–1321.) *See* 1229 of April.

3718. Discussion on "High-Voltage D.C. Flashover of Solid Insulators in Compressed Nitrogen."—Trump & Andrias. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1393–1394.) *See* 1164 of April.

3719. Discussions on "D.C. Breakdown Strength of Air and of Freon" and "The Electric Strength of Air at High Pressure: II."—Trump & others: Skilling & Brenner. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 676-677: pp. 677–678.) *See* 233 & 234 of January.

3720. THE ELECTRIC STRENGTH OF NITROGEN AND FREON UNDER PRESSURE [and the Anomalous Rise in Strength of Nitrogen caused by Small Percentage of Freon].—Skilling & Brenner. (*Elec. Engineering*, Jan. 1942, Vol. 61, No. 1, p. 42 : summary only.)

3721. NEW ULTRA-HIGH-FREQUENCY INSULATION [Dilectene 100 & 160 : Synthetic Resin containing No Cellulose Filler, therefore Very Resistant to Moisture : High Electrical Stability].—(*Electronics*, April 1942, Vol. 15, No. 4, p. 130.)

3722. PAPERS ON THE MEASUREMENT OF THE DIELECTRIC PROPERTIES OF INSULATING MATERIALS AT CENTIMETRIC AND DECIMETRIC WAVELENGTHS, WITH RESULTS FOR CALIT, TEMPA, CONDENSA, ETC.—Küsters : Borgnis. (*See* 3643 & 3644.)

3723. DISTRIBUTION OF D.C. POTENTIAL IN THE SERIES CONNECTION OF CERAMIC CONDENSERS.—Lieblang. (*See* 3534.)

3724. AN INVESTIGATION OF THE DISTRIBUTION OF POTENTIAL IN GLASS.—Kosman & Chernyaev. (*Journ. of Exp. & Theoret. Phys.* [in Russian], No. 2/3, Vol. 11, 1941, pp. 303–311.)

Experiments were conducted with a glass tube (Fig. 1) divided by a transverse glass partition into two halves. On each side of the partition are mounted a filament and two electrodes serving as collectors of secondary electrons from the glass partition. A certain potential difference between the two groups of the electrodes was maintained, and the current through the partition when both sides of it were bombarded by electrons was observed on a galvanometer. One of the main conclusions reached is that at temperatures above 60° C the current through the glass decreases with the increase in the potential difference between the two surfaces. This is due to the non-uniform distribution of potential caused by the current (the greatest fall of potential, up to 80% of the total potential difference, takes place at a depth of approximately 10^{-6} cm). It was also found that the strong electric fields so produced greatly reduce (about to unity) the coefficient of secondary-electron emission from the positive surface.

3725. DISCUSSION ON "THE DIELECTRIC STRENGTH OF GLASS—AN ENGINEERING VIEWPOINT."—Shand. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1331–1333.) *See* 1515 of May.

3726. GLASSES CONSIDERED AS COLLOIDAL MATERIALS [Survey : Usefulness of the Hypothesis].—Boutaric. (*Génie Civil*, 3rd/10th Jan. 1942, Vol. 119, No. 1/2, pp. 6–9.)

3727. ANALYSIS OF QUARTZ GLASS [and the Reason for the Nearly Identical Composition of Samples from Different Sources].—von Wartenberg. (*Naturwiss.*, 3rd July 1942, Vol. 30, No. 27, p. 440.)

3728. THE INFLUENCE OF THE ION RADIUS AND THE VALENCY OF THE CATIONS ON THE ELECTRICAL CONDUCTIVITY OF SILICATE MELTS.—Endell & Hellbrügge. (*Naturwiss.*, 3rd July 1942, Vol. 30, No. 27, pp. 421–422.)

3729. TYPE CLASSIFICATION AND SPECIFICATIONS OF [Rubber-Free, Non-Ceramic, Insulating] PLASTICS.—(*E.T.Z.*, 4th June 1942, Vol. 63, No. 21/22, pp. 267–269.)

3730. THE HIGHEST PERMISSIBLE TEMPERATURES FOR NON-CERAMIC RUBBER-FREE INSULATING PLASTICS.—Nitsche & Dober. (*E.T.Z.*, 18th June 1942, Vol. 63, No. 23/24, pp. 279–281.)

3731. PLASTICS IN THE ELECTRONICS FIELD [Survey, with Data (and Suitable Uses) and Directory of Trade Names & Suppliers].—Sasso. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 26–31 and 64, 67.)

3732. SOME RECENT ADVANCES IN INDUSTRIAL PLASTICS [including List with Trade Names and Mechanical, Thermal, Electrical & Other Data].—Wearmouth. (*Journ. of Scient. Instr.*, Sept. 1942, Vol. 19, No. 9, pp. 129–136.) From Halex, Limited.

3733. THE WELDING OF THERMOPLASTIC SYNTHETIC MATERIALS.—Henning. (*Zeitschr. V.D.I.*, 22nd Aug. 1942, Vol. 86, No. 33/34, pp. 523–524.)

3734. "1942 PLASTICS CATALOGUE" [Book Review : including Facts about Melamine ("Melmac 494") and Mention of New Abstract Service on Resins, Rubbers, & Plastics].—(*Review Scient. Instr.*, July 1942, Vol. 13, No. 7, pp. 304–305.) For Melamine *see* also Stäger, 3374 of November.

3735. THE PROTECTION OF SOLID INSULATION BY LIGHTNING ARRESTERS [and the Impulse-Voltage Characteristics of Solid Insulation].—MacCarthy & Carpenter. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, pp. 1349–1350.)

3736. TEMPERATURE AND ELECTRIC STRESS IN IMPREGNATED-PAPER INSULATION.—Whitehead & MacWilliams. (*Elec. Engineering* Jan. 1942, Vol. 61, No. 1, Transactions pp. 10–13.)

3737. DIELECTRIC STRENGTH OF [Distilled & Tap] WATER IN RELATION TO USE IN CIRCUIT INTERRUPTERS [Experimental Investigation, including Effect of Flow].—Slepian & others. (*Elec. Engineering*, Transactions Supplement, June 1941, Vol. 60, pp. 389–395.) For Discussion *see* pp. 631–632.

3738. NATIONAL RESEARCH COUNCIL REVIEWS INSULATION [Summaries of Papers].—(*Elec. Engineering*, Jan. 1942, Vol. 61, No. 1, pp. 30–34.)

3739. CONTRIBUTION TO THE LAW OF LIFE OF ELECTRICAL MACHINES [connecting Working Life with Working Temperature : the Aging of Various Insulating Materials, and the Reliability of Short-Time Tests : etc.].—Büssing. (*Arch. f. Elektrot.*, 30th June 1942, Vol. 36, No. 6, pp. 333–361.)

3740. Discussion on "Measurements of Pre-Breakdown Currents in Dielectrics with a Cathode-Ray Tube."—Race. (*Elec. Engineering*, Transactions Supplement, Dec. 1941, Vol. 60, p. 1388.) *See* 3469 of 1941.

3741. Discussions on "Detection of Initial Failure in a High-Voltage Insulation," "Basis for Non-Destructive Testing of Insulation" *and* "A.C. Dielectric-Loss and Power-Factor Method for Field Investigation of Electrical Insulation."—Whitehead & Shaw: Field: Doble. (*See* 3666 & 3667.)

3742. Instruments: Test and Measuring Gear and Its Uses: VI—Electrolytic Condensers: Inductance and Capacitance at Radio Frequencies.—Cazaly. (*Wireless World*, Oct. 1942, Vol. 48, No. 10, pp. 232–236.)

3743. Effect of Aging Semiconducting Synthetic Rubber [used as Shielding] in Insulating Oil.—Downs & others. (*Elec. Engineering*, Jan. 1942, Vol. 61, No. 1, p. 31: summary only.)

3744. Non-Metal Shields [Use of Colloidal Graphite].—Porter. (*See* 3597.)

3745. The Use of Cupal Sheet and Foil in Communication Technique [Copper-Plated Aluminium & Its Advantages for Screens, in Wound Strips for H.F. Coils, for Condensers, for Decimetric-Wave Radiators, etc.].—Raabe. (*Zeitschr. f. Fernmeldetech.*, 20th May 1942, Vol. 23, No. 5, pp. 75–77.)

STATIONS, DESIGN AND OPERATION

3746. Pennsylvania Turnpike Ultra-High-Frequency Traffic-Control System.—(*Electronics*, May 1942, Vol. 15, No. 5, pp. 34–51.)

Patrol cars and all fixed stations use a.m. transmitters on 37·5 Mc/s. These automatically control the operation of, and modulate, a string of 116–119 Mc/s repeaters on hilltops over the highway's 161 miles. On certain hilltops there are auxiliary f.m. transmitters on 33·94 Mc/s: these are turned on simultaneously with the repeaters, their signals being picked up by patrol cars and some fixed receiving points. Interaction between repeater transmitters and receivers is discouraged by frequency staggering and by alternate vertical and horizontal polarisation.

3747. Automatic Selection in Wireless Multiple Telephony [Impulse System tested in Switzerland for linking a Ten-Channel Ultra-Short-Wave Service with an Inter-Urban Automatic Network.]—Heierle. (*Bull. Assoc. suisse des Élec.*, 29th July 1942, Vol. 33, No. 15, pp. 413–416: in German.)

3748. Two-Way Working with Ultra-Short Waves [using Retarding-Field Valves].—Gerhard. (*Hochf:tech. u. Elek:akus.*, June 1942, Vol. 59, No. 6, p. 184.)

D.R.P. 713 894. An auxiliary alternating voltage is applied to the valves, allowing them to act alternately as transmitters and receivers: the u.s. waves from the other station are used for the auxiliary voltage for reception.

3749. A Talkie-Walkie for Civilian Defence: 112 Mc/s Dry-Battery Transceiver with Unique Features [Both Hands Free, No Headset (Loudspeaker on Shoulder Mounting serves also as Microphone): Send/Receive Relay worked by Button on Belt: etc.].—Kopetzky. (*QST*, June 1942, Vol. 26, No. 6, pp. 9–13 and 86, 88.) Distinct from the "Walkie-Talkie," the military set. *Cf.* also 2525 of August.

3750. Simple Uni-Directional Carrier-Current Communicator [carrying A.F. Output of Remote U.H.F. Receiver over Line controlling & modulating Remote Transmitter].—Smith. (*Electronics*, Feb. 1942, Vol. 15, No. 2, p. 54.)

3751. Frequency-Modulated Carrier-Current Telephony [used on Puerto Rico Water Resources Authority Power System: Advantages of F.M: Apparatus: F.M. receivable also on A.M. Carrier-Current Receivers, & *vice versa*, by Adjustment].—Dueño. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 57 and 119.)

3752. Frequency-Modulated Carrier Telegraph System [and Its Advantages].—Bramhall & Boughtwood. (*Elec. Engineering*, Jan. 1942, Vol. 61, No. 1, Transactions pp. 36–39.)

3753. Public Utility Emergency Radio System [of Montana Power Company: using Forest Service Transmitter–Receiver (2¼ W Output, 2726 kc/s, Weight including Batteries & Aerial 22 lb)].—Blankmeyer. (*Electronics*, May 1942, Vol. 15, No. 5, pp. 65 and 68.)

3754. Regulations for Lifeboat Transmitters.—F.C.C. (*Electronics*, July 1942, Vol. 15, No. 7, p. 96.)

3755. Transmitter for High-Frequency Wire Broadcasting.—Dold. (*See* 3556.)

3756. A Review of Technical Developments in Broadcasting [Chairman's Address].—Bishop. (*Journ. I.E.E.*, Part III, March 1942, Vol. 89, No. 5, pp. 2–18.)

3757. Competitive Broadcasting: Real Alternative Programmes [Editorial Suggestion of Two "Competing" B.B.C. Programme Boards each with Its Network].—(*Wireless World*, Oct. 1942, Vol. 48, No. 10, p. 225.) For a different suggestion *see* 2846 of September.

3758. The Transmission Characteristics of Asymmetric-Sideband Communication Networks.—Cherry. (*See* 3636.)

3759. Airport Control Console [with 7–10 Receivers in Roll-Out Racks for Ease of Maintenance: Squelch Circuits for muting

Receivers until Carrier arrives: etc.].—(*Electronics*, July 1942, Vol. 15, No. 7, p. 54.) In use at Miami.

3760. ERROR-PROOF RADIO-TELEGRAPH PRINTER [rejecting False Signals, printing Asterisk in place of Incorrect Letter].—R.C.A. (*Scient. American*, Sept. 1942, Vol. 167, No. 3, p. 127.)

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3761. EXISTENCE OF ELECTROMAGNETIC-HYDRODYNAMIC WAVES [in Conducting Liquid in Constant Magnetic Field].—Alfvén. (*See* 3501.)

3762. ATOMIC THEORY AND FOUR-TERMINAL-NETWORK THEORY [Development of Analogy between Filters & Crystal Lattices].—Hameister. (*Zeitschr. f. Fernmeldetech.*, 20th May 1942, Vol. 23, No. 5, pp. 69–73.) For previous work by this writer *see* 3111 of 1941.

3763. REFLECTION OF X-RAYS WITH CHANGE OF FREQUENCY.—Raman. (*Nature*, 26th Sept. 1942, Vol. 150, pp. 366–369.) *See* also 606 of 1941.

3764. RELATIVISTIC ASPECT OF THE STRESS TENSOR OF THE ELECTROMAGNETIC FIELD.—Cattermole. (*Phil. Mag.*, Sept. 1942, Vol. 33, No. 224, pp. 674–678.) Further development of the work referred to in 1556 of May.

3765. ON THE DIMENSIONS OF PHYSICAL MAGNITUDES: SECOND PAPER [Reply to Wilson's Comments].—Dingle. (*Phil. Mag.*, Sept. 1942, Vol. 33, No. 224, pp. 692–699.) *See* 2541 of August.

3766. THE DIMENSIONS OF PHYSICAL QUANTITIES [Any Physical Quantity can be regarded as having Dimensions if Components appearing in Formula are measured on Scales which preserve the Same Ratio between Two Measures of a Component, whatever the Scale Units].—Selwyn. (*Proc. Phys. Soc.*, 1st Sept. 1942, Vol. 54, Part 5, No. 305, pp. 428–435.) Arising out of supposition that photographic density can be regarded as having a dimension.

3767. ON THE DEFINITION OF THE MAGNETIC MAGNITUDES [Complete Agreement between Electrostatic & Magnetic Equations obtained by putting $J=\lambda_m B$ instead of $=\kappa H$ and taking Diamagnetism instead of Paramagnetism as the Normal Case (Positive Sign)].—Westphal. (*Zeitschr. f. Phys.*, 9th July 1942, Vol. 119, No. 3/4, pp. 164–166.)

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3770. ANALYTICAL METHODS OF SOLVING DISCRETE NON-LINEAR PROBLEMS IN ELECTRICAL ENGINEERING.—Keller. (*See* 3545.)

3771. A MATRIX THEOREM [New Theorem in Matrix Algebra suggested & proved from Electric-Circuit Theory: resembling De Moivre's Theorem for Complex Numbers].—Pen Tung Sah. (*Elec. Engineering*, Dec. 1941, Vol. 60, No. 12, pp. 615–616.)

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3814. The Controlled Transitron Oscillator as a Highly Selective Amplifier for Vibration Measurements, etc.—Jordan. (In paper dealt with in 3557, above.)

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3819. Electronic Surface Analyser [recording Irregularities of less than 1 Microinch: Piezoelectric Pick-Up (with Thermostatic Temperature Control) & Direct-Inking Oscillograph].—Brush Development. (*Electronics*, July 1942, Vol. 15, No. 7, pp. 54..60.)

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3821. Thickness of Aluminium-Oxide Coatings [Breakdown-Voltage Method of Measuring].—(*Bell Lab. Record*, July 1942, Vol. 20, No. 11, p. 278.)

3822. Nail Detector [for Lumber derived from Motor-Car Crates to South Africa].—(*Electronics*, Jan. 1942, Vol. 15, No. 1, pp. 72 and 74.)

3823. Electronic Gadgeteering [as a War-Time Substitute for Amateur Wireless: Future Big Field for "Quality" Components].—Golenpaul. (*Scient. American*, July 1942, Vol. 167, No. 1, p. 28.)

3824. Electronic Speed Cop [Sign informing Motorist of his Present Speed and warning him of Danger Spot ahead].—(*Gen. Elec. Review*, July 1942, Vol. 45, No. 7, p. 416.)

3825. 1942–1943 Buyer's Guide for the Electronic and Allied Industries.—(*Electronics*, June 1942, Vol. 15, No. 6, pp. D-1–D-37.)

3826. Electronics in Industry: I—Industrial Tube Characteristics: II—Tubes and Their Functions: III—Tubes at Work [with Examples of Applications, classified according to Stimulus—Electrical, Optical, etc.].—(*Electronics*, June 1942, Vol. 15, No. 6, pp. 52–126.)

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3831. Maintaining Control Equipment: A Thorough Study of Power-Unit Maintenance based on Wartime Demands.—Alexander. (*Communications*, May 1942, Vol. 22, No. 5, pp. 10–12 and 27, 31.) From General Electric, Industrial Control Division.

3832. Automatic Precision Control: Its Application in the Chemical Industries.—(*Electrician*, 4th Sept. 1942, Vol. 129, pp. 249–250.)

3833. Electronics at the Chemical Exposition [New York, Dec. 1941: Various Applications shown].—(*Electronics*, Jan. 1942, Vol. 15, No. 1, pp. 56..66.)

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