

Wireless World

RADIO • ELECTRONICS • ELECTRO-ACOUSTICS



JAN. 1943

1/3

Vol. XLIX No. 1

FREQUENCY MODULATION : NEW SERIES

GECALLOY

N.F. ALLOY POWDER.

GECALLOY NF ALLOY POWDER

is now used for practically all radio cores being manufactured in this country. It is an all-British Product, the result of extensive research and development work carried out during the last 15 years.

The use of a finely divided alloy of high magnetic quality represents a further advance in the science of Magnetic Powder metallurgy in comparison with all the various grades of iron powder, most of which previously have been imported.

PROGRESS

IN MAGNETIC POWDER

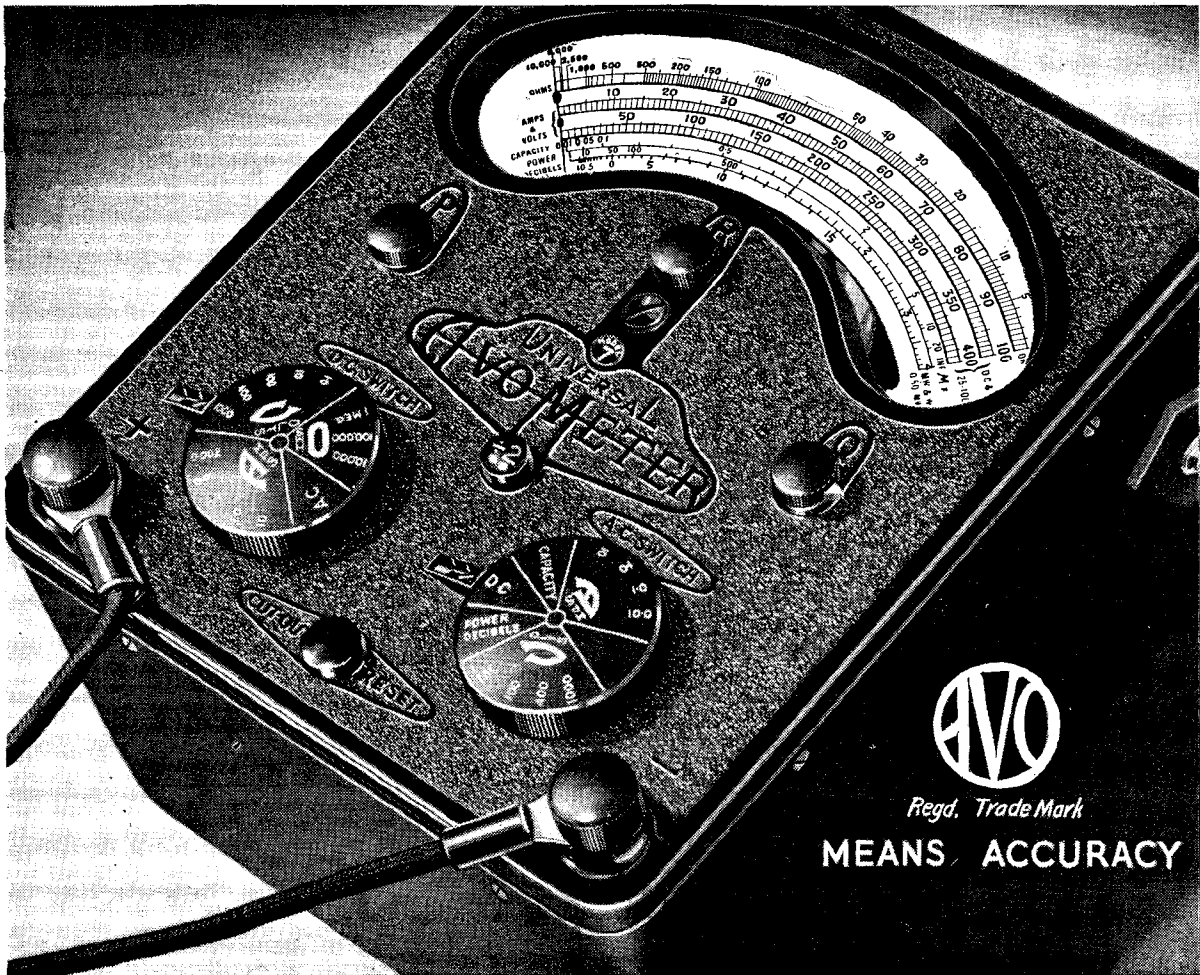
METALLURGY

MAIN ADVANTAGES of GECALLOY NF ALLOY POWDER and RADIO CORES.

1. Higher permeability.
2. Higher particle specific resistance.
3. Lower Eddy Current Loss.
4. Non-rusting.

Please send your enquiries to:—

SALFORD ELECTRICAL INSTRUMENTS LTD.
PEEL WORKS, SALFORD, 3. Telephones : BLAckfriars 6688 (6 lines). Telegrams and Cables : "Sparkless, Manchester"
PROPRIETORS: THE GENERAL ELECTRIC Co. Ltd., OF ENGLAND



46-range Model 7 Universal AvoMeter

The Model 7 Universal AvoMeter (illustrated) is a compact combination electrical measuring instrument of B.S. 1st Grade accuracy. Its 46 ranges cover A.C. and D.C. amperes and volts, resistance, capacity, audio-frequency power output and decibels. No external shunts or series resistances. Protected by automatic cut-out against damage through overload.

Some delay in delivery of Trade Orders is inevitable, but we shall continue to do our best to fulfil your requirements as promptly as possible.

Sole Proprietors and Manufacturers:
AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT Co., Ltd., Winder House, Douglas St., London, S.W.1
 Telephone: VICTORIA 3404/7

The world-wide use of "AVO" Instruments is striking testimony to their outstanding versatility, precision and reliability. In every sphere of electrical test work—laboratory, shop or out on a job—they are appreciated for their dependable accuracy, which is often used as a standard by which other instruments are judged. There is an "AVO" Instrument for every essential electrical test.

**WHAT
BIT TEMPERATURE
SHOULD BE USED
FOR 40/60 ALLOY?**

This and numerous other queries are answered in reference sheet 2 of "Technical Notes on Soldering," published by the manufacturers of Ersin Multicore—the A.I.D. approved solder wire with three cores of non-corrosive Ersin activated flux.

Firms engaged on Government contracts are invited to write for a copy of this reference sheet and samples of Ersin Multicore Solder Wire.



ERSIN MULTICORE

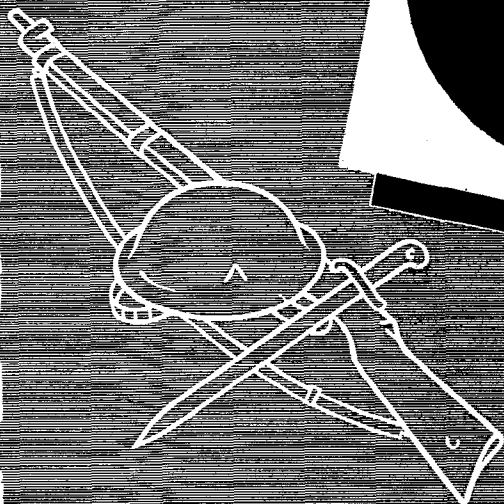
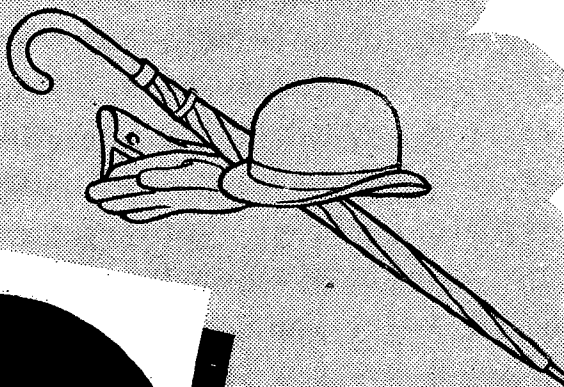
The Solder Wire with 3 Cores of Non-Corrosive Ersin Flux
MULTICORE SOLDERS LIMITED, BUSH HOUSE, W.C.2. 'Phone Temp.Bar5583/4.

PRE-EMINENT IN PEACE

T

C

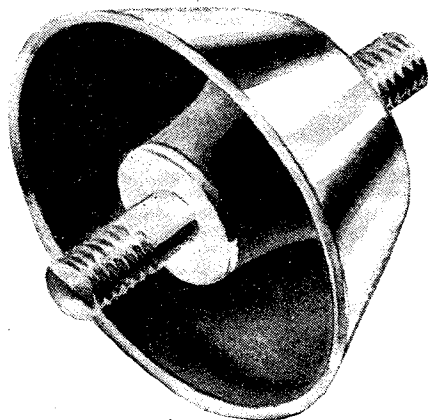
C



INDISPENSABLE IN WAR

ADVERTISEMENT OF THE TELEGRAPH CONDENSER CO. LTD.

RUBBER-TO-METAL BONDING

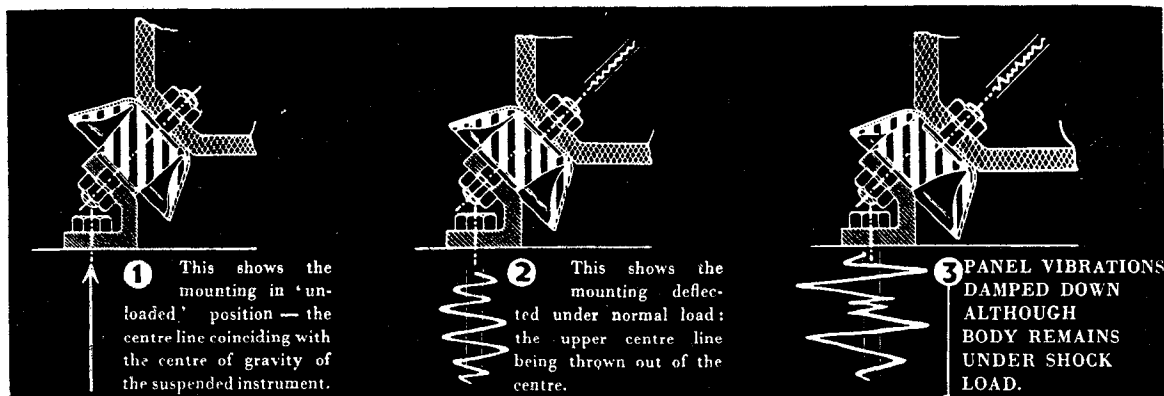


Another very interesting problem in **VIBRATION**—and its solution.

PROBLEM: An instrument panel requires immunisation from shock arising in any or all of three dimensions.

SOLUTION:

The R.B. Mushroom Mounting Type D.T.



Here is a problem in Vibration solved by the Rubber-to-Metal Bonding Technology of Rubber Bonders Ltd.

Vibrations are represented diagrammatically and the isolating effect of the Type D.T. Mushroom Mounting is clearly seen. This mounting is proving valuable in eliminating persistent vibration or shock.

Rubber Bonders Ltd., are successful because their scientific staff deal with every problem *individually*. Why not send a typical "vibration headache" to Flexilant Works, Dunstable for cure?

A semi-technical booklet entitled "A Short Review of 'FLEXILANT' Products" is available upon enquiry.

This shows the mounting, deflected under shock load. The upper centre line being still further thrown out of centre. You will notice the progressive 'abutment' of the rubber profile which gives a stiffening effect that increases as the deflection increases.



RUBBER BONDERS LIMITED

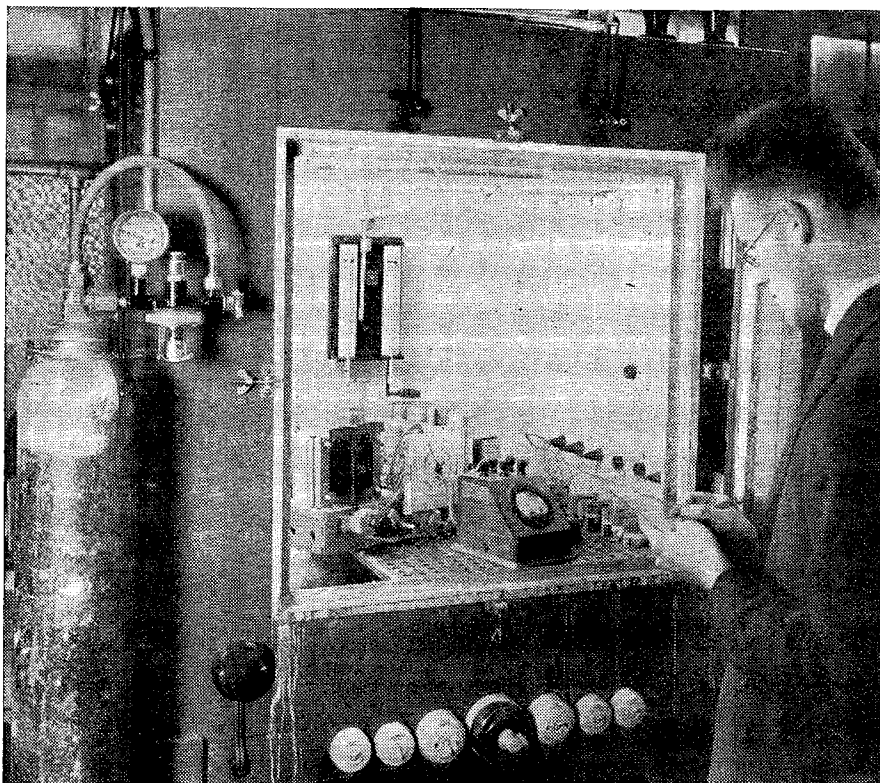
Engineers in Rubber bonded to metal

FLEXILANT WORKS · WATLING ST · DUNSTABLE · BEDS

TELEGRAMS: FLEXILANT DUNSTABLE

TELEPHONE: DUNSTABLE 715

Value proved by long service



Osram Valves

MADE IN
ENGLAND

Ever since the advent of radio Osram Valves have been closely connected with all the progressive stages of development in radio science. Intensive research still goes on by improvements in design and technique to keep pace with the advancing times, and which will ultimately be of benefit to all.

◆ LINAGLOW LIMITED ◆

WATCH OUR ADVERTISEMENTS EVERY MONTH—IT WILL PAY YOU

We have secured the entire stocks of a famous manufacturer and offer these at from 33-45% below normal prices.

TUBULAR PAPER CONDENSERS, 500 v., D.C. working. .5 mfd., 16/- doz.; .01, .02, .03, .001, .002, .003, .005 mfd., 6/- doz.; .0001, .0002, .0003, .0005 mfd., 4/- doz., etc., etc., or Assorted Parcel of 50 for £17/6. Minimum orders, 1 doz., any type.

FIXED CARBON RESISTORS. Wire Ends—Assorted and Useful Values. ¼-watt, 24/-; ½-watt, 30/-; 1-watt, 36/-; 2-watt, 55/-; 3-watt, 84/- per 100. Minimum orders 50 assorted. Assorted parcel for £3. Contains 25 ¼-watt, 50 ½-watt, 50 1-watt, 25 2-watt, 10 3-watt.

FIXED WIRE WOUND RESISTORS. Wire Ends—Assorted and Useful Values. 4-watt, 110/-; 6-watt, 118/-; 8-watt, 135/-; 10-watt (800 ohm only), 150/- per 100. Minimum orders 50 Assorted.

HEAVY DUTY WIRE WOUND RESISTORS. Copper Ends. 8-watt, 100/25,000 ohm, 2/6 each; 12-watt, 900/40,000 ohm, 3/- each; 15-watt, 200/175,000 ohm, 3/6 each; 20-watt, 6,000, 7,000 and 8,000 only, 4/- each; 25-watt, 250/75,000 ohm, 5/6 each; 50-watt, 435/100,000 ohm, 7/- each.

TAPPED WIRE WOUND RESISTANCES. Special Offer. 25-watt, 375 ohm, tapped 125 and 250, 6/6 each; 50-watt, 840 ohm, tapped 600, 680 and 760, 8/- each.

MANSBRIDGE CONDENSERS. .01, 500 v. D.C., 18/- doz.

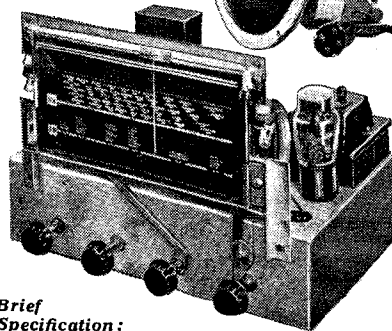
PHILIPS I.F. TRANSFORMERS, 3-hole chassis mounting, in circular copper cans, 1/- each.

ASSTD. S/WAVE COILS, Paxolin Formers, chassis mounting, 5/- doz.

3, HAMPSTEAD LANE, LONDON, N.6 'Phone: Mountview 9432

Special Offer!

5-V. ALL-WAVE SUPERHET CHASSIS. Complete with VALVES and M.C. SPEAKER. **DE LUXE**
LATEST MODEL.



Brief Specification:
Wave Band Coverage 18m. to 2,000 metres, 5 watts output. Large tin. Glass Dial. Separate tone and volume controls. Extremely good selectivity and sensitivity. Really "Hot" on Short Waves. Heavy Gauge Steel Chassis. Provision for extension Loud-speaker and Pick-up.

£14.15.0

ALSO SIMILAR TO ABOVE BUT WITH
**PARAPHASE PUSH/PULL OUTPUT
7-VALVE CIRCUIT**
£19.10.0

Above prices include Purchase Tax

POCKET VOLTMETERS in case, good quality, 0-120 v., 0-12 v. nickel, with lead, 10/6 each.

.0003 VARIABLE CONDENSERS, 2-gang, ceramic insulation, complete in brass screening can. Ideal for short wave work. Worth 21/-, 7/6 each.

SHORT-WAVE VARIABLE CONDENSERS, mounted on porcelain base. Solid brass, split vane, long spindle. Normally 30/-, 15/- each.

.0005 TWIN-GANG VARIABLE CONDENSERS. Aluminium screened, with trimmers. Long spindle. 5/- each.

AMERICAN 3-GANG VARIABLE CONDENSERS. Aluminium screened with trimmers, two sections .0003, one section .0002, 10/6 each.

DUAL H.F. CHOKES, a bargain, 3/- each.
SINGLE H.F. CHOKES, a bargain, 1/6 each.

Don't miss this opportunity. These prices cannot be repeated. All goods are brand new. Guaranteed best quality. Close Tolerance.

VALVES—AT CONTROLLED PRICES 6K8, 12SA7, 1N5, 1D8, 12K7, 6V6G, 6D6, 42, 6X5, 6U5, 1A5, 75, 6U7, QP22A, 50L6, 12S7, 1H5, 6Q7, 25Z6, 25Z6GT, 35Z4, 35Z5, 45Z5, 70L7, 83, 12SK7.

VOLUME AND TONE CONTROLS, with and without switch—suitable for all well-known makes of radio. 6 assorted and useful values for £17/6.

L.F. CHOKES
20 hys. 100 m.a. brand new 16/9
40 hys. 100 m.a. " 21/-

ELECTROLYTIC CONDENSERS. Tubular Paper, 25×12, 2/- each; 25×25, 2/6 each; 8 mfd. Tubular, 150 v., 3/6 each; 8 mfd. Can, 350 v., 6/- each; 8×8 Can, 450 v., 12/6 each; 10 mfd. Tubular, 50 v., 1/6 each; 32×32 Block, 175 v., 6/6 each; 32 mfd. Can, 350 v., 12/6 each; .50×50×2 Block, 15/550 v., 5/6 each; 5×5 Block, 35 v., 3/6 each.

SILVER MICA CONDENSERS. Flat Wire End—Assorted and Useful Values, 17/6 per 100 (not more than 5 alike).

I.F. AND AERIAL TRIMMERS. 12 Assorted and Useful Values for 2/6.

CLEAR BULBS. 2.5, 15/9 per 100, inc. tax.

Valve Holders. 7-pin low loss ceramic porce., 3/6 doz.

Lissen R.C. intervalve coupling unit, 1/6 each.

Colvern 5- and 6-pin coil bases, 6d. each.

Benjamin 4-pin anti-phonic valve holders, 5/6 doz.

Glass Radio Fuses. Spring clip, bakelite base, 1-5 amp., 1/- each.

L.F. Intervalve Transformers. Heavy laminations. Exceptionally well made. Ratios 4:1 and 6:1, 3/6 each.

Philips Wire Wound Potentiometers, with switch, 1/6 each.

NOTE.—All Orders C.O.D. or Cash with Order, carriage paid. We cannot hold ourselves responsible for goods damaged or lost in transit.

The Voice of the Service

SIGNALLING EQUIPMENT

LTD.

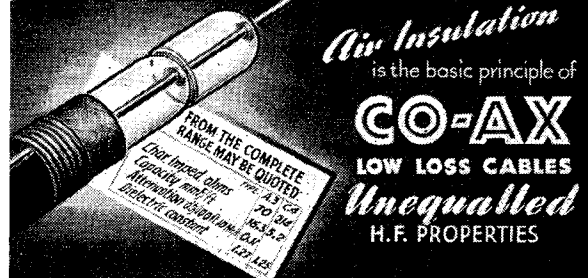
Specialists in Morse Equipment

also makers of Small Transformers, Coil Windings, Small Bakelite Mouldings, Turned Parts, Light Pressings, and other components and accessories for the Wireless and Electrical Trades.

Merit House, Southgate Road, Potters Bar

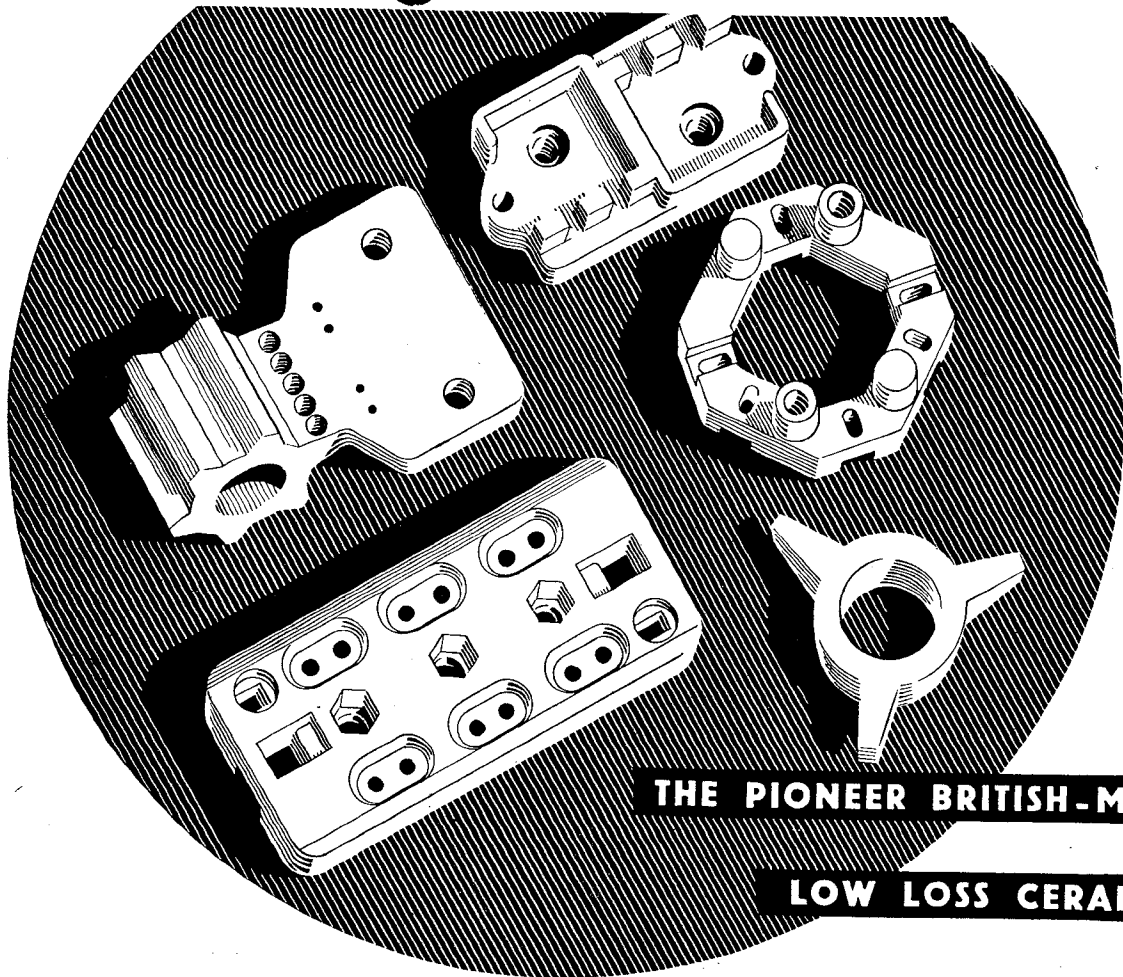
Phone: Potters Bar 3133

BASICALLY BETTER...



TRANSRADIO LTD. Inc. TELEQUIPMENT CO. 16 HIGHWAY, BEACONSFIELD.

F R E Q U E N T I T E



THE PIONEER BRITISH-MADE

LOW LOSS CERAMIC

THE DEMAND for Frequentite, which possesses outstanding properties of Low Loss and High Mechanical Strength, continues to increase rapidly—*and to be met.* Production capacity has been stepped up over a period of years by extensions to plant, the

employment of specialised new equipment, and progressive improvements in manufacturing technique. Bulk supplies of the most intricate designs can be delivered promptly, and all manufacturers are invited to write for Catalogue No. SP.10.

STEATITE & PORCELAIN PRODUCTS LTD.

Head Office :

Telephone : Stourport 111.

STOURPORT - ON - SEVERN, WORCS.

Telegrams : Steatoin, Stourport.

SP.2

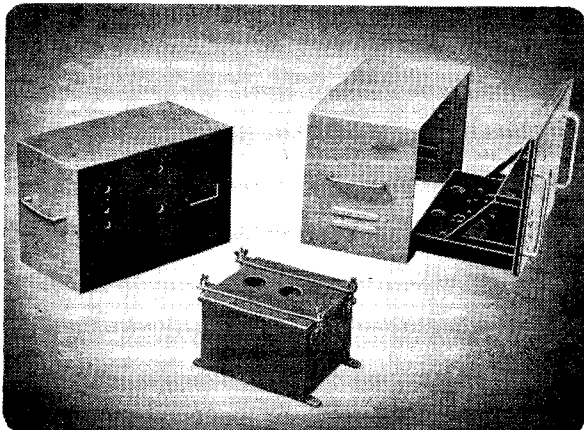


Keeping **FAITH**

In the wider interests of the country we are compelled to disappoint many users of our products. It is impossible for us to supply or repair any apparatus except on Government contract. But, to all those radio workers who have supported and encouraged our efforts in the past, let us say at once that we will neither forget them nor the aims which we set ourselves. One day, apparatus created by the research and experience we have gained in war years will bring you loudspeakers that set new standards of perfection in sound reproduction.

GOODMANS
INDUSTRIES LIMITED

Lancelot Road, Wembley, Middx.



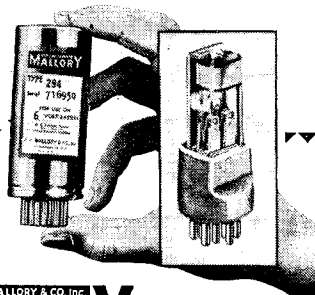
A skilled team of workers in an efficiently equipped modern factory produces to an unusually high standard all types of metal instrument cases, radio chassis, panels, brackets, boxes and other metal components. We are also able to undertake the design and manufacture of complete amplifying equipment for special requirements.

PRIORITY ORDERS ONLY

Engineering and Electrical Contractors to the Admiralty, Air Ministry and Ministry of Supply.

IMHOF'S

ALFRED IMHOF LTD. 112-116, New Oxford Street, London, W.C.1.



P. R. MALLORY & CO. INC.
MALLORY
VIBRATORS

are always dependable

(BRITISH PATENTS)

ALONG every front Mallory has pioneered in vibrator design to ensure safety, dependability and long service. Mallory offers synchronous and non-synchronous vibrators for 6, 12 and 32 volt input also a new range of accepted "STRATOSPHERE" vibrators for high altitude aircraft service.

Mallory engineers are at your disposal.

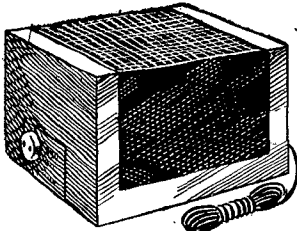
P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA, U.S.A.

Represented exclusively in Gt. Britain by

FRANK HEAVER LTD., Kingsley Road, Bideford, N. Devon, Eng.

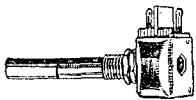
CLARKE'S ATLAS A.C. to D.C. CONVERTERS

Type R.M. 80/150



Input : 230v. A.C. 50~
Output : 80, 100, 120, 150, 230v. D.C.
 Incorporating Westinghouse Metal Rectifier.
 In strong steel case, well venti-
 lated ... Price **5 Gns.**
 Post and packing 3/6 extra.

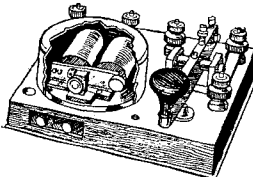
ON-OFF TOGGLE SWITCHES



Finest quality.
 Turn movement.
 1 1/2 in. spindle.

2/6

G.P.O. MORSE KEY AND BUZZER UNIT



Made for professional use. All parts of heavy brass mounted on mahogany base.

Platinum contacts. A robust unit which will give years of service ... **40/-**

CELESTION AMPHENOL VALVE HOLDERS



The best quality obtainable
 8-pin International
 Octal ... each **1/3**

T.C.C. CONDENSERS

0.1 mfd. 5,000 v. D.C. wkg. Each **9/6**

ELECTRIC SOLDERING IRONS

200/250 v. 75 watts ... **12/6**

PIEZO-CRYSTAL Hand—Table MICROPHONES

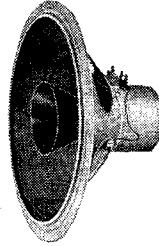
See December issue for details. **82/6**

Good Quality Components by PHILIPS

PHILIPS High Quality SUPER SENSITIVE P.M. SPEAKERS

These brand new speakers are fitted with concentrically mounted Hi-note Difusers. 8 1/2 in. cone. Complete with Pentode Transformer.

Price **32/6**

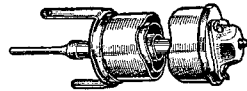


PHILIPS DOUBLE-WET ELECTROLYTIC CONDENSERS

15 mfd. at 275v., and 50 mfd. at 320v. each **12/6**

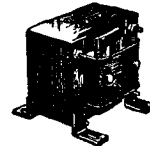
PHILIPS TRIMMER CONDENSERS

Non-drift air dielectric, 60 mmfds., suitable for S.W. work. Price **1/3**



PHILIPS SMOOTHING CHOKES

Brand new, well-built chokes, 60 ohms D.C. resistance 400/120 m.a. Core size : 2in. x 1 1/2 in. x 1in. each **5/6**
 Also 400 ohms D.C. resistance 60 m.a. Core size : 1 1/2 in. x 1in. x 3/8 in. ... each **3/6**



PHILIPS CARBON POTENTIOMETERS

700,000 ohms, with 2-pole M and B Switch **4/6**
 100,000 ohms, less switch ... **3/6**

PHILIPS CONCENTRIC SPIRAL VANE VARIABLE CONDENSERS

3-Gang 0.0005 mfd. without trimmers. As used in Philips well-known Push-Button receivers. Price **4/6**

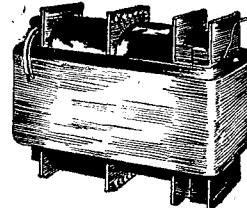


PHILIPS WIRE WOUND POTENTIOMETERS

450 ohms and 10,000 ohms ... each **6/6**

PHILIPS HIGH VOLTAGE TRANSFORMERS

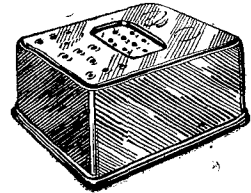
Robust in construction; weight approx. 13 lb. Dimensions : 5 1/2 x 5 1/2 x 4 1/2 in. Specification : 350-0-350v., 70 m.a. Four tapings giving 4v. 3 amps., 6.3v. 4 amps., 4v. 0.65 amp. and 4,000 v. at 3 m.a. Input 100/250. Free wiring diagram. Carriage forward. Price **32/6**



SUPREMUS H.T. BATTERY ELIMINATORS

Model E25A

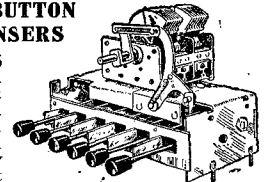
for 200-250v. A.C. 40-100~



Tappings, 40, 60, 80, SGH, 100, SGL, 125v. These well-known H.T. Mains Supply Units are fitted in handsome bakelite cases. Here is an opportunity for battery set owners, who have A.C. mains current available, to be independent of the battery situation. Owing to post and rail conditions these are available TO CALLERS ONLY. Price **70/-**

PUSH-BUTTON CONDENSERS

The .0005 6-button Front Manual Control Model recently offered at 10/6 are all sold. We can now offer a .0003 mfd. 2-gang 6-button Condenser as illustrated, but with SIDE manual control. Price **15/6**. Also .0005, 3-gang 8-button at 17/6.

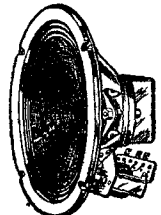


6 PUSH-BUTTON MECHANISM only UNIT Complete with buttons 4/6

SPEAKERS

ROLA 8in. P.M. without transformer ... **25/-**

CELESTION 8in. P.M. Pentode Output. New **25/6**

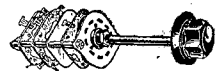


MULLARD EA50 DIODES

60 mm. x 12 mm. overall. 6.3v. heater at 15 amp. ... Each **10/6**

OAK SWITCHES

2 1/2 in. spindle. Complete with knob :
 4-way, 2-bank with connecting block ... **4/6**
 4-way, 2-bank ... **3/9**



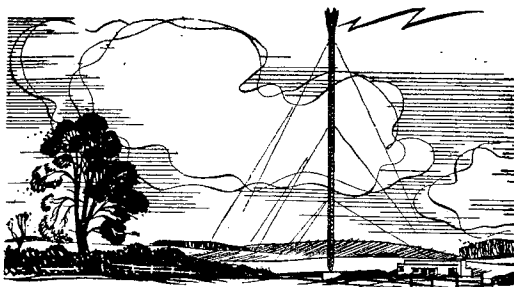
● ALL PUSH-PULL TRANSFORMERS HAVE BEEN SOLD.

— YES —
 When sending your orders you must **ADD POSTAGE**

LONDON CENTRAL RADIO STORES

23, LISLE ST. GERrard 2969 LONDON, W.C.2

— NO —
 We cannot send Proforma Invoices nor can we accept **G. O. D. ORDERS**



Things to come



IN 1939 we were able to claim to be the largest U.K. suppliers of fixed condenser replacements, with unequalled range and variety of products.

In nineteen when radio and other electrical services return to their right use for the benefit of mankind and when the pace of technical improvement will be greatly accelerated, we shall be immediately ready to resume our cordial co-operation with the distributing trade in meeting the great public demand.

TRADE **HUNTS** MARK

The Home of Condensers

Established 1901

Advt. of A. H. HUNT, Ltd., London, S.W.18

WHARFEDALE

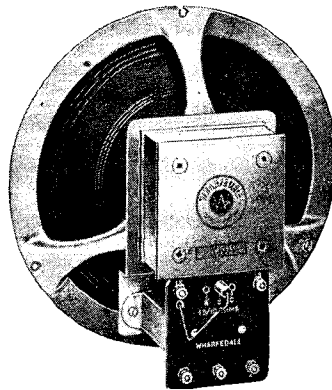
GOLDEN CHASSIS

As supplied to the B.B.C.

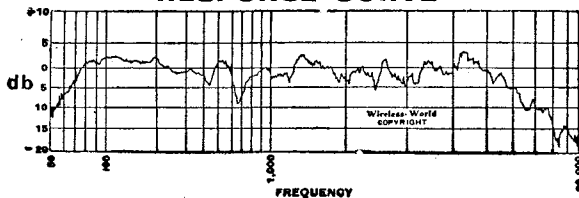
Speech Coil 2-3 ohms :
Flux Density 10,000 lines,
7-8 watts • 10" Chassis

Although we are making more than ever of this excellent Loud Speaker the output is absorbed by the B.B.C. and other Priority users.

PRICE 70/-
(Less Transformer)



RESPONSE CURVE



WHARFEDALE WIRELESS WORKS

SOLE PROPRIETOR : D. E. BRIGGS

HUTCHINSON LANE, BRIGHOUSE, YORKS.
'PHONE : BRIGHOUSE 50. 'GRAMS "WHARFEDALE."

Aeme Electric

TRANSFORMER SPECIALISTS

NEW YORK.

WHERE PRIORITIES ARE AVAILABLE ACME CAN MAKE GOOD DELIVERIES OF THE FOLLOWING TYPES OF TRANSFORMERS :

- | | |
|---------------------|------------------------|
| AUDIO | FILAMENT |
| INTERSTAGE | MODULATION |
| OUTPUT | COMMUNICATIONS |
| PUSH-PULL | RECTIFIER |
| DRIVER | 3-PHASE POWER |
| MICROPHONE | 400 CYCLE POWER |
| SIGNALLING | AIR-COOLED |
| PLATE SUPPLY | LIGHTING |

USERS OF TRANSFORMERS OF SPECIAL SPECIFICATIONS IN QUANTITIES NEEDING MASS PRODUCTION FACILITIES ARE INVITED TO SEND US THEIR ENQUIRIES.

SOLE BRITISH DISTRIBUTORS

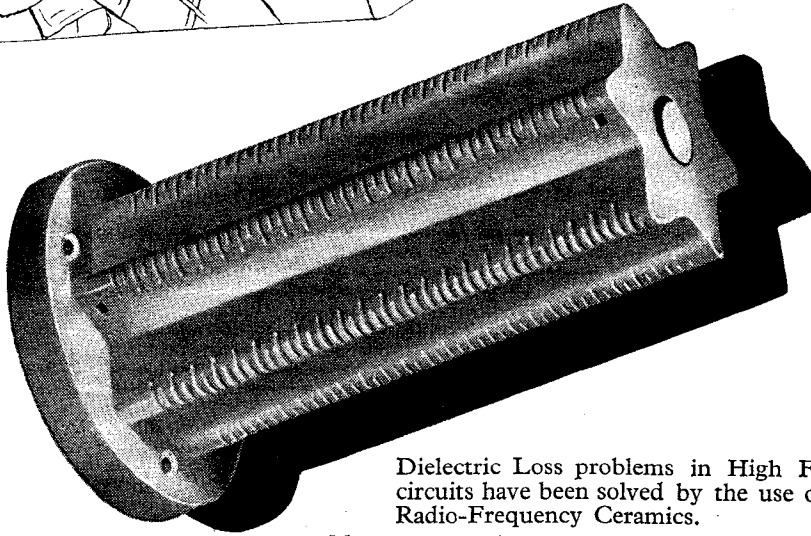
ELECTRONIC ENGINEERING SERVICES LTD.

24, STANLEY ROAD, HEATON MOOR
STOCKPORT

TELEPHONE : HEATONMOOR 3107



**"Everything
O.K. Sir !"**



Dielectric Loss problems in High Frequency circuits have been solved by the use of Bullers Radio-Frequency Ceramics.

Many years of research and development in our Laboratories have brought these materials to a high degree of efficiency.

They are in constant use for transmission and reception and play an important part in maintaining communication under all conditions.

**Made in Three
Principal Materials**

FREQUELEX

An insulating material of Low Dielectric loss. For Coil formers, Aerial Insulators, Valve Holders, etc.

PERMALEX

A High Permittivity Material. For the construction of Condensers of the smallest possible dimensions.

TEMPLEX

A Condenser material of medium permittivity. For the construction of Condensers having a constant capacity at all temperatures.

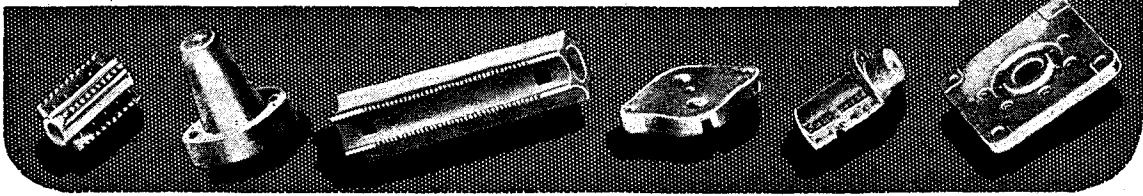
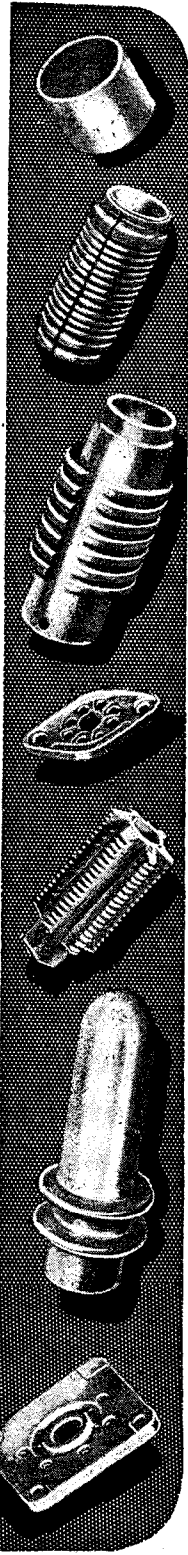


BULLERS LTD.,
THE HALL, OATLANDS DRIVE,
WEYBRIDGE, SURREY.

Telephone : Walton-on-Thames 2451.
Manchester Office : 196, Deansgate, Manchester.

LOW LOSS CERAMICS

Bullers



COSMOCORD CRYSTAL PICK-UP SERIES III

It is regretted that production is severely curtailed and only very limited supplies are available through existing channels.

Sole Selling Agents :

SALE, TILNEY & Co. LTD.
3, LLOYD'S AVENUE, LONDON, E.C.3

Phone : ROYal 4811

SERVICE ON COSMOCORD CRYSTAL PICK-UPS IS MAINTAINED AS HITHERTO

Owing to lack of replacement parts and shortage of labour it is regretted that service on all other products and apparatus must be discontinued.

THINGS TO COME— HIGH FIDELITY REPRODUCTION

Are you interested? If so, will you kindly forward your name and address to

COSMOCORD LTD.

SERVICE DEPT.

700, GREAT CAMBRIDGE ROAD,
ENFIELD, MIDDLESEX

**KEYSTONE
OF POWER**

Wherever Portable Power—sturdy, reliable, efficient—is required for Transmitters, Receivers, Amplifiers, etc., this Supply Unit is the most obvious choice.

Masteradio LTD GRAMS: MASTIOLA
PHONE: WATFORD 3885/3660
VIBRANT WORKS, WATFORD, HERTS.

ROLA

LOUD
SPEAKERS
THE WORLD'S FINEST REPRODUCERS

TRANSFORMER
LAMINATIONS
Core Widths $\frac{3}{8}$ " to $1\frac{1}{2}$ " (E's and I's.)
EIGHT STOCK SIZES

A Comprehensive Bulletin together with details of Associated Covers and Clamps with design data will be sent to manufacturers on request.

BRITISH ROLA LIMITED
MINERVA ROAD · PARK ROYAL · N.W.10 · WILlesden 4322

NEVILLE'S

COIL WINDING MACHINES

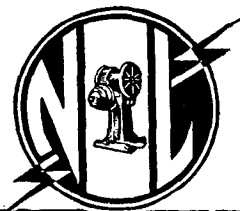
TAPING MACHINES

WIRE COVERING MACHINES

ARMATURE AND STATOR

COIL WINDERS

Contractors to the
Admiralty and
other Government
Departments



Please address all enquiries to

NEVILLE'S (LIVERPOOL) LIMITED

SIMMONDS TOWER · GREAT WEST ROAD · LONDON

A DIVISION OF THE SIMMONDS GROUP

Lassolastic Identification

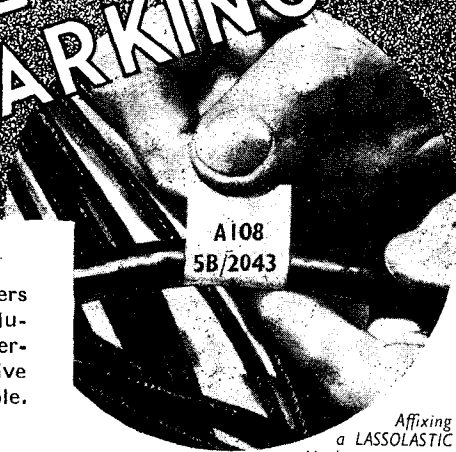
Tape provides thin filmic markers which adhere instantly by firm pressure, offer no undesirable thickening or interference with flexibility at their point of contact and can be affixed anywhere on a cable without necessitating any disconnection.

The identifications, which take form of any desired style of printing and colouring, cannot be erased till the filmic base, completely protecting them, is first destroyed.

Lassolastic
SELF-ADHESIVE
IDENTIFICATION
Tape

SPEEDIER SIMPLER**CABLE MARKING**

Lassolastic Markers are impervious to fluids and remain permanent, distinctive and always legible.



Affixing
a LASSOLASTIC
Marker to a Cable

HERTS. PHARMACEUTICALS Ltd. INDUSTRIAL TAPE SECTION WELWYN GARDEN CITY, HERTS.**DAGENITE**

AND

PERTRIX*—the dependable***BATTERIES**

**FOR
RADIO, CARS
MOTOR CYCLES
COMMERCIAL
VEHICLES
ETC.**

Sales Concessionaires:

HOLSUN BATTERIES LIMITED

137 Victoria Street, London, S.W.1

D 9c 42

M.R. SUPPLIES

offer from stock the following brand new **INDUSTRIAL and ELECTRO-TECHNICAL EQUIPMENT**, for which early application is essential. All prices nett cash.

HEAVY DUTY OUTPUT TRANSFORMERS for two KT66 valves in push-pull (low loaded—opt. Id. 3,500 ohms) with sec. for 7.5 and 15 ohms coils. Handling 35 watts, weight 13½ lb. Final opportunity, 72/6 (pkg. and pass. train 2/6 extra).

STEP-DOWN MAINS TRANSFORMERS. Prim. 200/250v. tapped. Sec. 12 and 17v. at full 5 amps., weight 9½ lb. For chargers, l.v. lighting, etc., 42/6 (pkg. and post 1/6).

SUPERIOR BELL TRANSFORMERS. Prim. 200/250v. Sec. tapped 3, 5 and 8v. at 1 amp. Porcelain base with bakelite cover, fully fused on prim. and sec., complying with recommendations, 13/6.

MEASURING INSTRUMENTS by Weston, Ferranti, Elliott, etc. (We cannot undertake to select particular maker.) Housing 2½in. square flange, flush panel mtg. requiring 2½in. hole, black bakelite, back terminals. **M(COIL MILLIAMMETERS,** 0/150 m.a. only left, 32/6. **THERMO-COUPLE AMMETERS** for any frequency and D.C., same style as above, 0/2.5 amp. and 0/3.5 amp. (two models), either 38/6. These meters are second-hand ex Govt., in good condition and lab. tested, and guaranteed accurate.

RELAYS. Lendex with 200/250v. A.C. coil (2va) and 2-pole change over 6-amp. switch, size approx. 2½in. by 2½in., silver contacts, 42/6. Also U.S.A. model, 4/12v., D.C. coil, with single pole make switch, 8/6.

VARIABLE RESISTANCES, 100 watts, fully enclosed, approx. 3in. by 3in. by 6½in. in following range, 4 ohms 5 amps., 10 ohms 3 amps., 50 ohms 1.5 amp., 100 ohms 1 amp., 200 ohms 0.7 amp., and 400 ohms 0.5 amp., any one 21/-. Whole range in stock at time of going to press.

TOGGLE PRESSES (by S.T.C.). Quick acting and accurate bench model exerting 1½ tons pressure. Height 22in., weight 130 lb. Many advantages over fly press—space saving, rapidity and ease of operation. A further small supply for immediate delivery from stock. Many already supplied to most important users. Price £30 nett, carriage forward.

INDUSTRIAL ELECTRIC SOLDERING IRONS. Best makes from stock. S.T.C., all voltages, 100/110, 200/220 and 230/250, 75 watt with 4in. pointed bit, 21/- (spare elements, any voltage, 6/-). Same make, 150 watt with massive flat bit, 32/6 (elements 7/6). Also Acru, popular bent model with interchangeable bit, good general purpose bit supplied, 28/6 (100 watt). Spare bits, 4/- each. Leave choice to us.

PIEZO-CRYSTAL MICROPHONES (Rothermel-Brush). Just arrived, 400 only. Special miniature model only 1½in. dia. lightweight. Made for deaf-aid but suitable for all purposes, having a fine frequency response. In aluminium housing with short screened lead but no front grille, 27/6. Also continuation of our well-known offer of well-housed, knuckle jointed, high fidelity mikes of same make, response level to 3,000 c/s., ½in. (26) mounting boss, as supplied to most important users, 72/6. **FLOOR STANDS,** to suit latter model, collapsible, 2ft. to 5ft. 6in., chromium plated, 37/6.

G.E.C. PUBLIC ADDRESS SPEAKERS. Industrial model in 9in. drum, handling 5 watts, with transformer, 45/-. 10 watt **PROJECTOR SPEAKERS** with P.M. Unit with built-in line trans. and 42in. metal horn, £10.5.0. (Carr. 7/6 extra.)

Please estimate postage where not stated; any excess refunded.

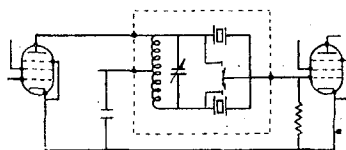
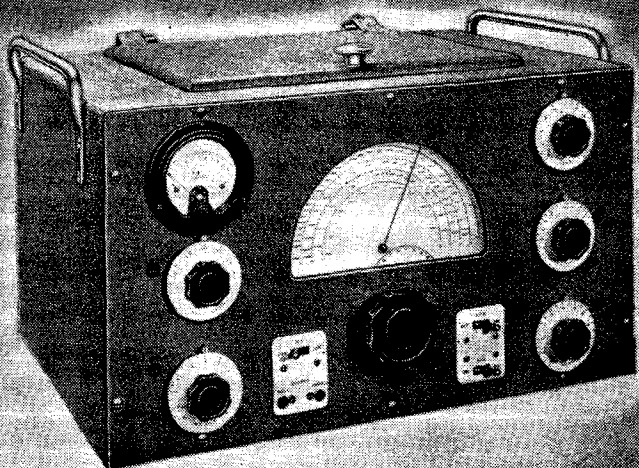
M.R. SUPPLIES, 68, New Oxford Street, London, W.C.1.

('Phone: MUSeum 2958)

EDDYSTONE

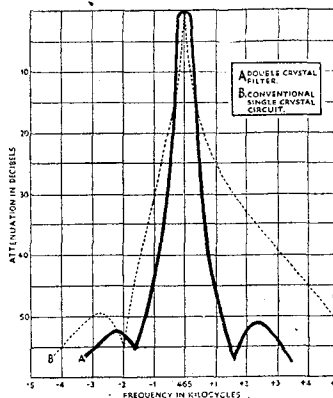
COMMUNICATION RECEIVER

358x



BAND-PASS FILTER CIRCUIT

Above is shown the fundamental circuit similar to that employed in the Eddystone 358X receiver. When in circuit the bandwidth is 300 c/s, front panel control allowing optional use of normal I.F. selectivity, bandwidth 5 Kc/s.



SELECTIVITY CURVE "A"

shows the steep sides and flattened top response curve of the Band-pass Filter. Compare the normal crystal gate (Curve B) with its typical sharp peak necessitating constant tuning adjustment with the slightest signal frequency variation. Note the symmetrical rejection given by Curve "A" as opposed to the uneven tail effect of Curve "B."

In the 358X version of this famous receiver a Band-pass Crystal circuit is employed giving high selectivity and complete rejection of unwanted adjacent signals. Furthermore the double crystal circuit avoids the extreme "peaked" effect of the conventional crystal gate, allowing easier tuning and accommodating some frequency drift of the wanted signal. These advantages are readily appreciated by operators familiar with the hair-breadth tuning of the normal filter.

The "358X" may be inspected at 14, Soho Street, preferably by appointment.

EDDYSTONE COMMUNICATION RECEIVERS ARE AVAILABLE ON PRIORITY ORDER ONLY.

WEBB'S RADIO

Hours of Business 9 a.m.—4 p.m. Saturdays 9 a.m.—12 noon.

14, SOHO ST. OXFORD ST. LONDON, W.1. Telephone. GERRARD 2089

B.I. RADIO MATERIALS

We have had a long experience in the manufacture of all kinds of Cables and Wires, Static Condensers, Insulators and Ironwork, Telephone Cords and Copper Earthing Rods, for Radio use.



U.K. Regd. Trade Mark.

BRITISH INSULATED CABLES LTD.,
Cable Makers and Electrical Engineers
Head Office **PRESCOT, LANCS.** Tel. No.: **PRESCOT 6571**

TAYLOR METER A NEW 38 RANGE UNIVERSAL METER

Sensitivity — 1,000 ohms per volt on all voltage ranges.

D.C. VOLTS. 7 ranges from 0—0.25 to 1,000 v.

A.C. VOLTS. 6 ranges from 0—2.5 to 1,000 v.

OUTPUT. 5 ranges from 0—2.5 to 500 v.

D.C. CURRENT. 5 ranges from 0—1 mA to 2.5 Amps.

A.C. CURRENT. 5 ranges from 0—1 mA to 2.5 Amps.

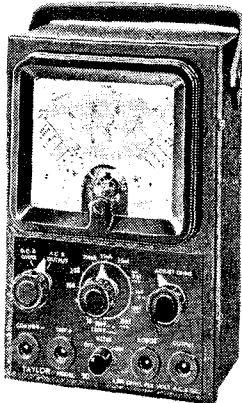
RESISTANCE. 3 ranges from 1 ohm to 1 megohm with internal battery.

RESISTANCE. 1 range from 1,000 ohms to 10 megohms with external 60 volt battery.

DECIBELS. 6 ranges from —22db to plus 60 db.

METER. 5 Scales covering A.C. and D.C. Measurements and also Ohms and Decibels.

SCALE LENGTH. Outer scale is 3½ inches long.



TAYLOR MODEL 90

Supplied complete with leads and test prod. internal battery and instruction book.

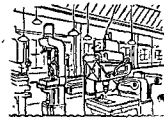
£11-11-0

British made by

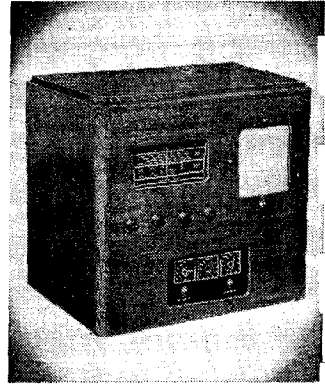
TAYLOR

TAYLOR ELECTRICAL INSTRUMENTS LTD.
Montrose Avenue, Slough, Bucks.
Telephone: Slough 21381

From Footlights to Factory



IN town to-night—at famous theatres and fashionable restaurants you will find Trix Sound Equipment. Like the war workers in the great factories, they all trust the reliability of Trix.



they all trust
TRIX
Quality
SOUND
Equipment

Illustration shows a TRIX 30-watt Amplifier with radio. There are TRIX Amplifiers from 5 to 500 watts.

Send for details.

TRIX ELECTRICAL CO. LTD.
65, Bolsover St., London, W.1.
Phone: EUS 8471/2.
Grams: Trizadio, Westo, London.

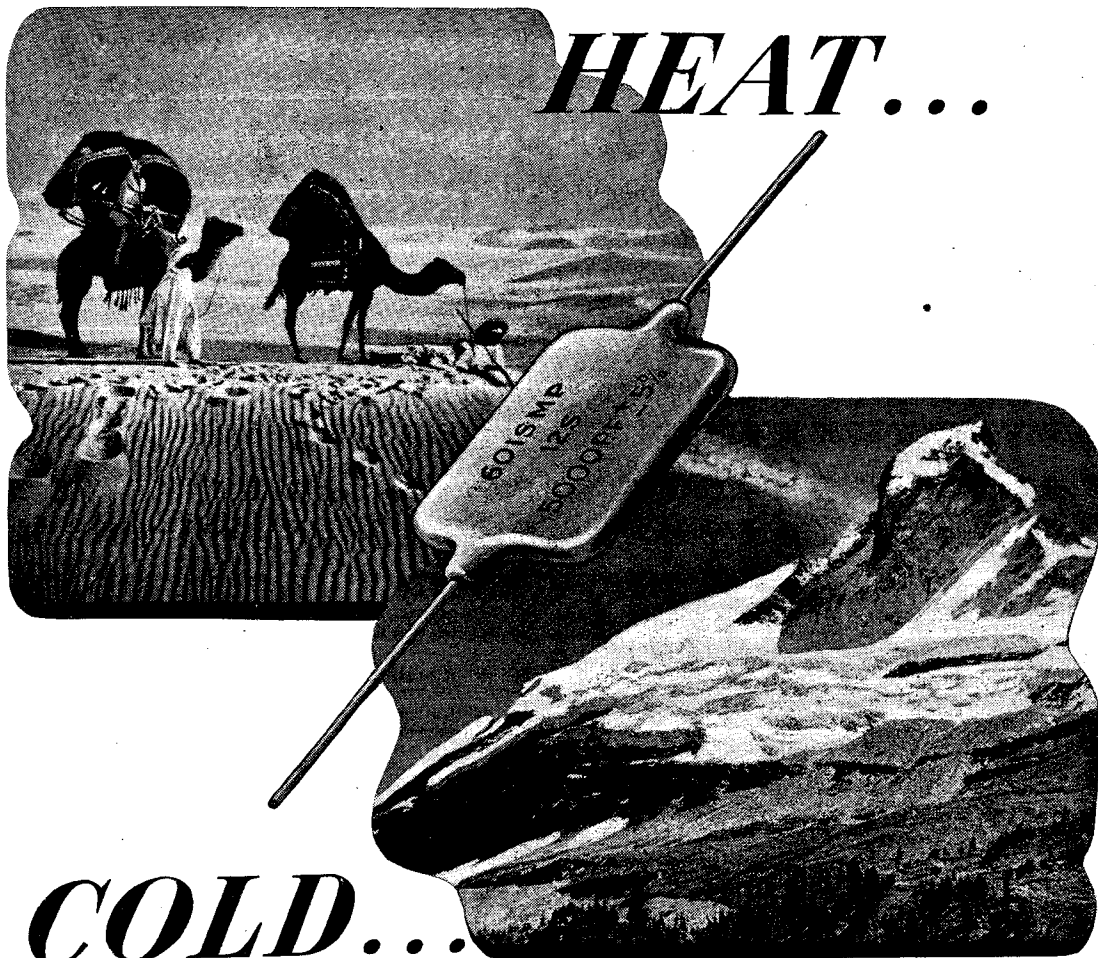
AVAILABLE FOR PRIORITY WORK

HIVAC
THE SCIENTIFIC
VALVE
BRITISH MADE

Specialists in
MIDGET VALVES

HIVAC LIMITED
Greenhill Crescent,
Harrow on the Hill, Middx.
Telephone: Harrow 0895.

HEAT...



COLD...

... In the heat of the desert or the jungles, the cold of winter or high altitudes, SILVERED MICA CONDENSERS have to do their job and maintain their stability



TYPE APPROVED

UNITED INSULATOR CO LTD

12-20 LAYSTALL ST., LONDON, E.C.1

Telephone : TERminus 7383

Telegrams : Calanel, Smith, London

The Pioneers of Low-loss Ceramics

Bargains !!!

WIRE-WOUND POTS

A fortunate purchase of
5-WATT AMERICAN C.T.S.
 wire-wound Volume Controls,
OFFERED AT HALF PRICE

- 20,000** ohms **4/-**
- 5,000** ohms **3/-**
- 2,000** ohms **2/6**

In 2-do. lots—less 25%.

HURRY!

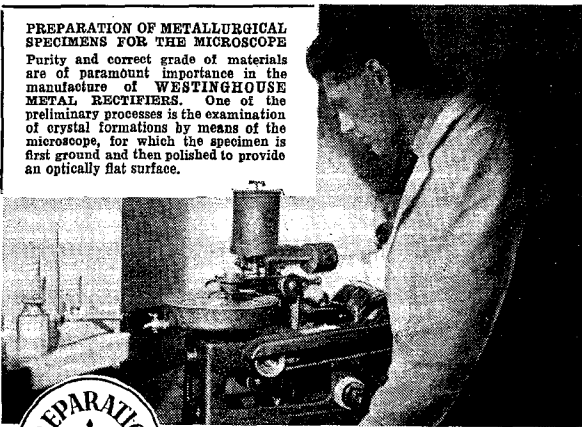
Supplies won't last long.

RADIOMART

G S N I (BHAM) LTD.

48, HOLLOWAY HEAD—BIRMINGHAM, 1
 Telephone: MIDland 3254

PREPARATION OF METALLURGICAL SPECIMENS FOR THE MICROSCOPE
 Purity and correct grade of materials are of paramount importance in the manufacture of WESTINGHOUSE METAL RECTIFIERS. One of the preliminary processes is the examination of crystal formations by means of the microscope, for which the specimen is first ground and then polished to provide an optically flat surface.



Behind the non-stop production of Westinghouse Rectifiers, our technical staff are ceaselessly at work. We sincerely regret that very limited supplies only are available, but we know that our customers will understand. To-day's intensive research, however, will release remarkable features of design when Westinghouse Rectifiers are again freely available to industry.

Westinghouse Rectifiers

Westinghouse Brake & Signal Co. Ltd., Pew Hill House, Chippenham, Wilts.

SPECIAL ANNOUNCEMENT !!!

American Lease-Lend RADIO VALVES

International Majestic Radio Corporation Ltd. have been appointed Official Distributors of these valves, specially released by the Board of Trade.

Owners of Receivers requiring replacements are invited to obtain our list of types available. All prices controlled by Government Order.

Our allocation is very comprehensive, but there will be a large call, so place your order immediately to avoid disappointment.

Any order guaranteed to be for genuine Maintenance-Replacement will be delivered.

PHONE OR WRITE

INTERNATIONAL MAJESTIC RADIO CORPORATION LTD.

6 Angel House, Pentonville Road, London, N.1.
 TERMINUS 2256-7.



We're always doing the improbable

... solving the problems of our Customers with a confidence born of long achievement; producing the most complicated stampings and pressings with the precision of experience.

Have you a small part that's a big problem? We could produce it . . . doubtlessly . . . just try us!

F. Dowler & Sons
 ASTON BIRMINGHAM



Medal of Honor
won in the battle
of production



EITEL-McCULLOUGH, INC.

San Bruno, California, U. S. A.

Export Agents:

FRAZAR & CO., LTD., 301 Clay St., San Francisco, Calif., U. S. A.



But why

THE commandos of industry—those executives whose minds are at once enquiring and courageously receptive to new ideas—are storming the barriers of outworn custom.

Tested and proved in the hard school of industry, the products of the Simmonds Organization are daily presenting the vital short cut to simplicity of manufacture, economy of manpower and acceleration of output.

S I M M O N D S

THE SIMMONDS "1937" NUT
SIMMONDS-CORSEY CONTROLS
SIMMONDS CONTENTS GAUGES
FOR AIRCRAFT.
SIMMONDS POSITION INDICATORS
SIMMONDS ELECTRIC TEMPERATURE
AND PRESSURE GAUGES
SIMMONDS AIRCRAFT FLOORING



SPIRE "1937" NUTS
FRAM OIL & ENGINE CLEANER
SIMMONDS INDUSTRIAL AND
MARINE CONTENTS GAUGES
SIMMONDS JOINTING COMPOUND
SIMMONDS CRYSTAL UNITS
SIMMONDS - GOUDIME
NAVIGATIONAL INSTRUMENTS

SIMMONDS AEROCESSORIES LTD

A COMPANY OF THE SIMMONDS GROUP
LONDON · MELBOURNE · PARIS · NEW YORK.

P.12.

ALL ENQUIRIES TO GREAT WEST ROAD, LONDON.

Wireless World

Radio • Electronics • Electro-Acoustics

32nd YEAR OF PUBLICATION

JANUARY 1943

Proprietors:
ILIFFE & SONS LTD.

Managing Editor:
HUGH S. POCOCK,
M.I.E.E.

Editor:
H. F. SMITH.

Editorial, Advertising
and Publishing Offices:

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

Telephone:
Waterloo 3333 (35 lines).

Telegrams:
"Ethaworld, Sedist, London."

△

PUBLISHED
MONTHLY

Price: 1/3

(Publication date 25th
of preceding month)

Subscription Rate
Home and Abroad
17/- per annum.

EDITORIAL	1
FREQUENCY MODULATION.—i : The Nature of an FM Carrier.	
By Christopher Tibbs, Grad.I.E.E.	2
P.M.G. EXAMINATIONS.	
By William M. Moore	6
HIGH-SENSITIVITY DC AMPLIFIER.	
By George A. Hay, B.Sc.	9
RADIO DATA CHARTS.—No. 3 : The Characteristic Impedance of Transmission Lines.	
By J. McG. Sowerby, B.A., Grad.I.E.E.	10
"WIRELESS WORLD" BRAINS TRUST	12
A DEMONSTRATION MULTIVIBRATOR	
By E. Wilkinson, Ph. D.	13
RANDOM RADIATIONS. By "Diallist"	14
VELOCITY-MODULATION U-H-F GENERATORS.	
By Geoffrey Bocking	16
TOLERANCES.	
By J. T. Terry	19
THE WORLD OF WIRELESS.	23
NEWS IN ENGLISH FROM ABROAD.	24
UNBIASED. By Free Grid	26
LETTERS TO THE EDITOR	27
SHORT-WAVE PHENOMENA	30
RECENT INVENTIONS..	32

Branch Offices :

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

BIRMINGHAM :
Guildhall Buildings,
Navigation Street, 2.
Telephone :
Midland 2971 (5 lines).
Telegrams :
"Autopress, Birmingham."

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

GLASGOW :
26B, Renfield Street, C.2.
Telephone : Central 4857.
Telegrams : "Iliffe, Glasgow."

△

As many of the circuits and apparatus described in these pages are covered by patents, readers are advised before making use of them, to satisfy themselves that they would not be infringing patents.

Announcing The "HYPERLOY" Series

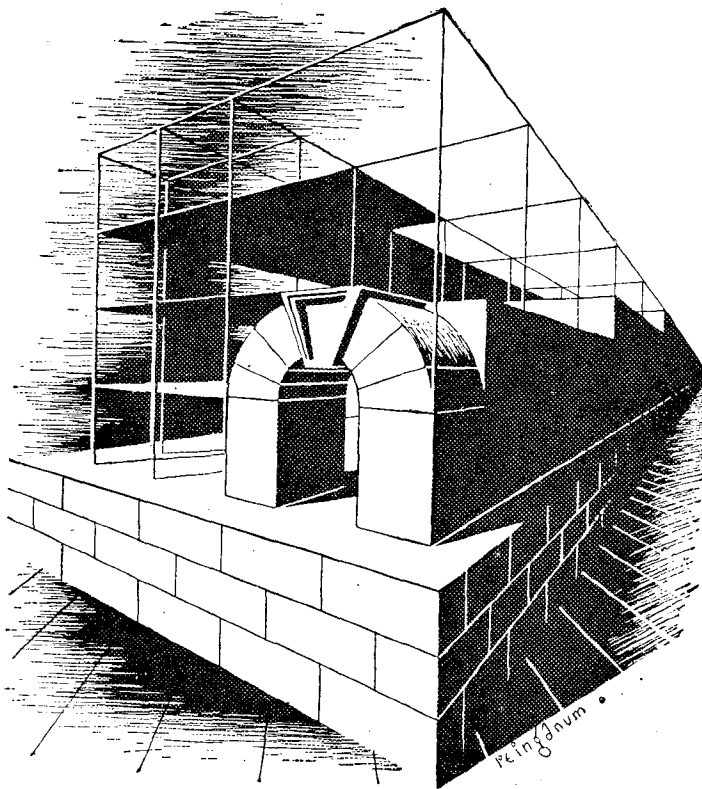
A range of high-performance, space-saving **TRANSFORMERS** and **CHOKES** designed to meet the exacting requirements of modern Electronic and Communications equipments.

- Small in size
- Weighing only 2 ozs.
- Meeting the most rigid Tropical Specification
- Easily mounted in any position
- Manufactured in a variety of windings to meet many diverse applications

WRIGHT & WEAIRE LTD.
HIGH ROAD, TOTTENHAM, N.17

Telephone: TOTtenham 3847-8-9





STABILITY

More than fifty years of ordered progress and purposeful development have laid the foundations on which Philips have built a great commercial enterprise. Its record of achievement and service, in peace and war, reflects the foresight of its builders and the stability of the structure they have created.

PHILIPS



LAMPS • DISCHARGE LIGHTING • RADIO RECEIVERS • TRANSMITTERS • VALVES & THERMIONIC DEVICES • MEDICAL & INDUSTRIAL X-RAY & ELECTRO-MEDICAL EQUIPMENT • ARC WELDING EQUIPMENT & ELECTRODES • LIGHT ALLOY RESISTANCE WELDING PLANT • MAGNETIC OIL FILTERS • MAGNETS • SOUND AMPLIFYING INSTALLATIONS

PHILIPS LAMPS LIMITED, CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2. (110F rev.)

Wireless World

Radio • Electronics • Electro-Acoustics

Vol. XLIX. No. 1

JANUARY 1943

Price 1s. 3d.

Broadcast Receiver Maintenance

Economy in the Use of Wireless Resources

IN the issue of this journal for last August we expressed the view that the time had come to take drastic steps to ensure the continuance of broadcast reception. Since that time there has been no improvement; on the contrary, the position has deteriorated, in spite of the release (at the time of writing, on an apparently rather disappointing scale) of American Lease-Lend valves. It is believed that the number of broadcast sets now out of commission has reached a really significant figure, and, unless effective measures are taken now, the value of broadcasting as the most rapid means of disseminating information will be seriously reduced.

When writing on this subject in August, we examined the relative advantages of the two most obvious schemes for maintaining listening facilities for the majority of the population. The alternative plans were: (1) To devote a sufficient proportion of our wireless productive capacity to the manufacture of valves and components for replacements to keep existing receivers in working order, and (2) to design and mass-produce an extremely simple "austerity" receiver to replace broken-down sets. The second plan was admitted to be extravagant in raw materials, but it was suggested that it overcame the shortage of the skilled servicemen who would be required for the satisfactory operation of the first plan. An ample supply of components is of no avail if there is no one with sufficient skill to diagnose faults and make replacements.

The use of the word "alternative" was perhaps unfortunate. It was not intended to suggest that either plan should be adopted to the total exclusion of the other. Clearly, it is uneconomic under present conditions to substitute a brand-new receiver for one that could easily be restored to working order by fitting a standard valve or component of a type that can still be efficiently produced. But it is equally uneconomic to devote many precious man-hours to the diagnosis of a fault in an out-of-date receiver, and then to spend

many more skilled man-hours in producing inefficiently the replacement part that is needed. In our view, there is room for both the plans to work side-by-side. What proportion of our productive capacity should be devoted to each scheme is a matter for discussion, but there seems to be a clear case for devoting some of that capacity to the manufacture of a simple "austerity" set. As far as producing replacements for sets that are economically repairable is concerned, we should concentrate on valves; also on reservoir and smoothing condensers.

Wartime Economies

In urging the importance of maintaining broadcast receivers in commission we are not unmindful of the needs of the Fighting Services, which must, of course, come first. Before asking for an allocation of some part of our national resources for civilian needs, we must make sure that what we already have is being used to the best advantage, and above all, that there is no waste.

Doubts have been expressed as to whether, in spite of the regulations, the American Lease-Lend valves are in fact being used solely as replacements. A correspondent instances the fact that, by a Ministry of Supply Order, a defective and unrepairable domestic boiler can only be replaced by a new one after making a declaration on an official form. He suggests that similar precautions should be taken in the supply of replacement valves. That seems to be an unnecessarily cumbersome procedure; would it not be sufficient to require that a "dead" valve should be surrendered when a replacement is purchased?

More economy in the use of wireless receivers might be practised by some sections of the public, who still seem to regard broadcasting merely as an all-day background to other activities. The B.B.C. could do good work in encouraging more selective listening, and in explaining what is being wasted when a wireless set is used unnecessarily.

THE NATURE OF AN FM CARRIER

By

CHRISTOPHER TIBBS,

Grad.I.E.E.

UNTIL comparatively recently amplitude modulation was regarded as the only satisfactory means of impressing intelligence on a carrier wave. During the last twenty-five years the other two systems, frequency and phase modulation, have often been discussed, but until 1936 nobody had been able to demonstrate any reasons which would warrant a departure from amplitude modulation. However, in that year Major Armstrong published a paper² in which he made some important claims for one of the neglected systems. He showed that the use of wide-band frequency modulation produced a remarkable improvement in the signal-to-noise ratio. Since that time FM has made rapid progress and is to-day being used by many new commercial broadcast stations springing up in all parts of the United States. The results obtained with FM are claimed to be so superior in both signal-to-noise ratio and reproduction fidelity that the ordinary amplitude modulation receiver has been rendered virtually obsolete.

Most of the initial work on FM was done in or near New York, where the listening conditions are bad. The screening produced by immense steel-framed buildings, coupled with extremely high static levels and a lack of satisfactory aerial arrangements, provided a hothouse atmosphere for the forcing of any system offering a reasonable chance of providing the flat dweller with interference-free reception. Comment is sometimes made on the number of American flats equipped with central receivers and built in two-programme loud-speaker systems. One of the reasons for the popularity of this method of providing radio entertainment is the extreme difficulty experienced in obtaining satisfactory reception in flats which are part of a vast honeycomb packed with every imaginable type of electrical equipment, from hundreds of vacuum cleaners to express lifts.

Frequency modulation is claimed to be the almost perfect counter to these conditions. It offers an improvement in signal-to-noise ratio of more than 1000 to 1 on an

In this article, the first of a series on FM, the properties of a frequency-modulated waveform are dealt with. Sidebands are discussed, and the way they are depicted by the panoramic monitor is described.



Reception conditions in New York, with its giant steel-framed buildings, provided a hothouse atmosphere for the forcing of any new system which would eliminate the background of interference

equivalent amplitude modulation system. Coupled with this it also provides high-fidelity reception. Working on the ultra-short-wave band, it is above the frequency spectrum covered by most forms of natural and man-made static.

Properties of FM.—In the September issue of this journal the author discussed and compared

the closely related systems of frequency and phase modulation. In view of the subject matter covered then, it is proposed to confine the present investigations entirely to frequency modulation.

The diagrams shown in Fig. 1 illustrate the manner in which intelligence is communicated by a frequency-modulated carrier. With the aid of these diagrams it is possible to make a number of deductions relating to the general nature of a frequency-modulated transmission. All the more important features are brought out by the following observations. The carrier frequency is steady at its mean or unmodulated frequency until modulation commences. The application of modulation causes the carrier to swing above and below its mean frequency. The amount of this frequency swing (i.e., the deviation amplitude) is in direct proportion to the amplitude of the modulating signal. The number of times, or the frequency with which the carrier swings above and below its unmodulated value is directly controlled by the frequency of the modulating waveform. It should be noted that the actual deviation frequency has no connection whatsoever with the frequency of the modulating signal.

Another important point is demonstrated in Fig. 1(b), namely, that the carrier amplitude remains constant regardless of the modulation. The general nature of a frequency-modulated carrier is well summed up in the following definition. A frequency-modulated transmission is one in which there is no amplitude modulation of the carrier, and in which the frequency fluctuations faithfully portray the modulating wave shape.

Frequency modulation is by no means a recent invention, it has in fact been discussed ever since the use of a modulated continuous carrier wave became a practical proposition. Early attempts to develop the system were based on the idea that by frequency modulating the carrier to a small degree, say a maximum deviation of only 1,000 cycles, it would be possible to reduce the bandwidth required by a broadcast station. In this

way it was hoped to increase the number of stations on any given band. These early attempts were brought to a conclusion in 1922 with the first mathematical treatment of frequency modulation.

course, suitable means of demodulation, there was an amazing improvement in the signal-noise ratio normally experienced with amplitude modulation. It is this system, now known as wide-band frequency

esting historical sidelight they throw on the art, but primarily because it is the only way of explaining a number of important phenomena. When a carrier is modulated it appears to the observer as though it is merely necessary to alter forcibly either the carrier amplitude or its frequency, depending on the type of modulation being used. As far as an examination of actual waveforms is concerned, this is all that happens; if, however, any serious investigation is to be undertaken, it is necessary to make use of the sideband theory. According to this theory, when a carrier is modulated it remains at its unmodulated frequency and some additional waveforms are brought into existence. These new components, or, as they are termed, the sidebands, interfere with the carrier in such a manner that the resultant combined waveform varies in either frequency or amplitude as required. If the new and additional waveforms are unable to exist for any reason whatsoever, then there will be no signal to interfere with the original carrier and so cause it to vary in the manner desired. This would account for the fact that an AM receiver with a pass-band which is too narrow to transmit the sidebands fails to reproduce the modulation. Without the sidebands the carrier remains at its steady or unmodulated value. In short, remove the sidebands and the modulation is suppressed.

Regardless of whether amplitude,

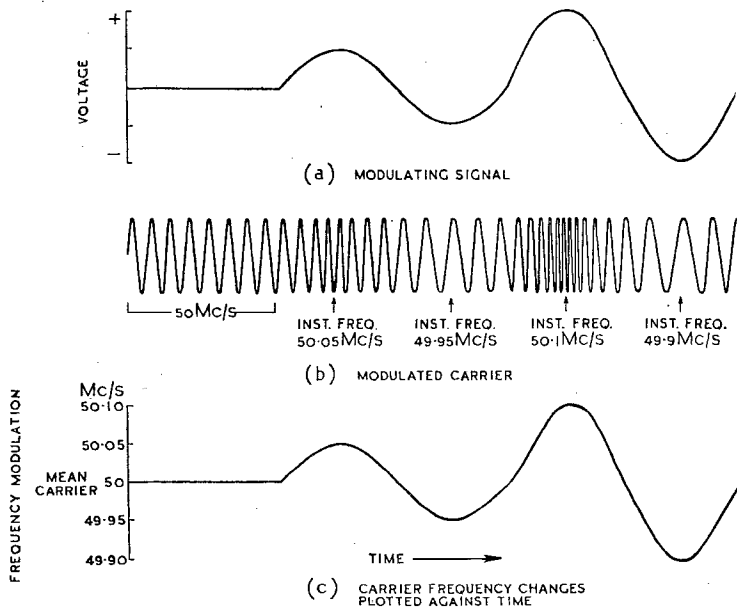


Fig. 1. Diagrammatic presentation of the general nature of a frequency-modulated carrier.

This paper, published by Carson¹, proved that these attempts were based on a fallacy, and that the bandwidth required is at least double the highest modulation frequency.

modulation (FM for short), which is being so successfully employed in America.

For a number of years FM was regarded as of no practical value. However, in 1936, E. H. Armstrong published a paper² in which he set forth frequency modulation not as a method of cramming more stations into the broadcast band, but as a means of reducing the level of every

FM Sidebands.—The failure of the early engineers who attempted to develop the system centres round their inability to grasp the full

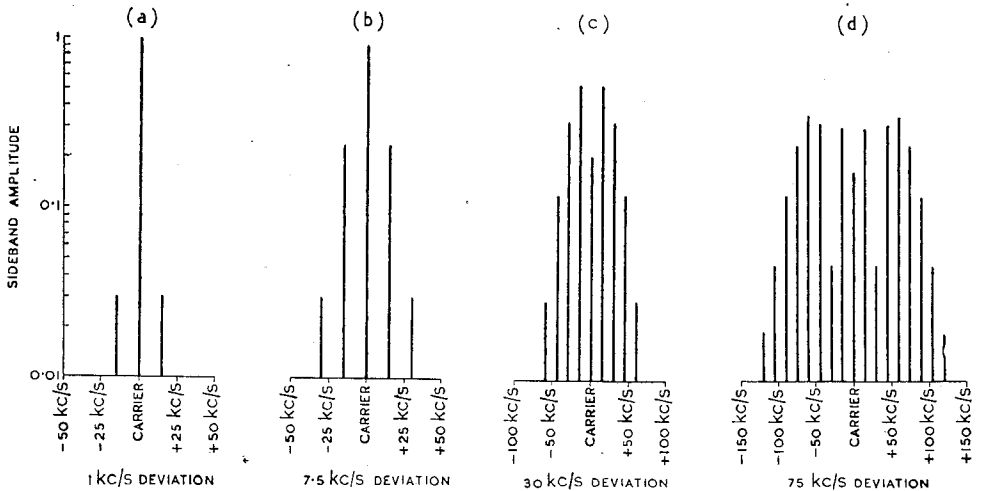


Fig. 2. Sidebands resulting from the frequency modulation of a carrier. The examples are calculated for 15 kc/s modulation and worked out from the formula given in the appendix.

type of interference. He showed that by employing a deviation several times that of the highest modulating frequency, with,

importance or even the existence of FM sidebands. It is proposed to deal with them at this stage, partly on account of the inter-

frequency or even phase modulation are being employed, it is essential that the sidebands which accompany all forms of modulation

The Nature of an FM Carrier—

are passed by the receiver tuned circuits.

The only satisfactory method of arriving at the actual values of these sidebands is mathematically. This is especially the case with frequency and phase modulation, where they are large in number and extremely complex. There have been a number of papers dealing with the calculation of FM sideband amplitudes^{3, 4, 5}. The equation, which has been developed by Roder, for a frequency-modulated carrier is set out in the appendix.

Fig. 2 shows a number of examples which have been calculated with the aid of Roder's formula. It should be noted that there are an infinite number of sidebands, but that for clarity only those with an amplitude greater than 1 per cent. of the unmodulated carrier value have been shown. These sidebands occur at intervals equal to the modulating frequency f_{mod} and on either side of the unmodulated carrier (i.e., at frequencies of $\pm f_{mod}$, $\pm 2f_{mod}$, $\pm 3f_{mod}$ $\pm nf_{mod}$). There are sidebands of quite considerable amplitude above the maximum carrier deviation frequencies. These are necessary, as the waveform resulting from the fusion of the basic carrier and its sidebands will have a frequency within the band they embrace. The sidebands beyond the maximum deviation frequencies are therefore required in order that the final waveform, of which they form a component part, may be "pulled" to its maximum deviation.

The apparently random fluctuations in amplitude, which occur between adjacent sidebands, are the result of the extreme complexity of their phase angle and vector diagrams. When there is no modulation all the sidebands are dormant and have zero amplitude. As soon as the carrier is modulated a single pair of sidebands or a small group of sidebands spring into being, at the same time the amplitude of the carrier itself falls. The result is that the combined waveform is "pulled" from the unmodulated carrier frequency towards that of the sidebands existing at that instant. The amplitudes of both sidebands and carrier are balanced to a nicety, thus maintaining the combined wave at a constant amplitude as its frequency is varied (i.e. avoiding spurious amplitude modulation.)

The Panoramic Monitor. — In order to ensure that the deviation of a frequency-modulated transmitter does not exceed the specified limits (normally a maximum of ± 75 kc/s) some form of continuously operating monitor is required. This equipment, generally known as the panoramic monitor, is essentially an elaboration of the ganging oscillator used for the alignment of broadcast receivers, the essential difference being that by drifting the oscillator of a conventional type of frequency changer the incoming carrier is caused to "scan" the receiver response curve. The oscillograms shown in Fig. 3 are typical of those obtained on the FM panoramic modulation monitor. As each sideband in turn "scans" the receiver response curve its image is reproduced, the height being a measure of the individual sideband amplitude.

FM and Television. — Reference has been made to the attempts of early radio engineers to reduce the

tion. An amplitude-modulated transmission would require a band 30 kc/s wide to reproduce this modulation. Fig. 2 shows that however small the deviation this minimum bandwidth will be required to pass the first pair of FM sidebands. If this bandwidth is reduced the modulation will be suppressed in exactly the same manner for either frequency modulation or amplitude modulation. Any attempt to reduce the receiver bandwidth so that it passes only, say, a 1 kc/s deviation, would automatically eliminate the sidebands produced by any modulation above this frequency. A receiver with a 2 kc/s pass band would in fact suppress all modulation frequencies greater than 1 kc/s.

The latest American television stations have standardised on FM for their sound channel while adhering to amplitude modulation for the vision channel. This decision results partly from the fact that the basic advantages derived from FM are only realised when the deviation is one or more times the maximum modulation frequency. With a television channel handling a maximum modulation of some 3 Mc/s to 4 Mc/s, the bandwidth required by a single FM station, with a deviation ratio of two, would be some 12 Mc/s to 16 Mc/s. On the pre-war bands allocated to television, it would be impossible even to consider such an increase in the station frequency width. It therefore seems certain that if the advantages of FM are to be enjoyed by vision as well as sound, there will have to be a substantial increase in the frequency used for television transmission. There seems quite a good case for operating a post-war service on the 100 Mc/s or even the 200 Mc/s band.

APPENDIX

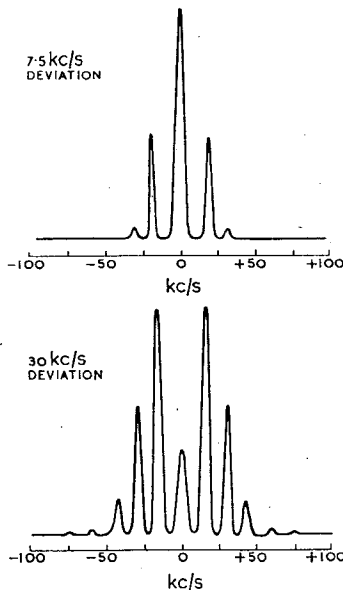
The equation developed by Roder for a frequency modulated wave is somewhat lengthy, as it includes a group of terms dealing with the amplitude of each sideband. In actual fact there is no end to this formula as there are an infinite number of sidebands. However, in practice, their amplitude falls off rapidly above and below the maximum and minimum deviation frequencies.

The sideband equation for a frequency modulated wave is:—

$$e = A \{ J_0(m_p) \sin \omega t + J_1(m_p) [\sin(\omega + p)t - \sin(\omega - p)t] + J_2(m_p) [\sin(\omega + 2p)t + \sin(\omega - 2p)t] + J_3(m_p) [\sin(\omega + 3p)t - \sin(\omega - 3p)t] + \dots \text{etc.} \}$$

Fig. 3. Traces of oscillograph records of sidebands shown on the panoramic monitor. The modulation frequency is in each case 15 kc/s, and the similarity to the corresponding examples in Fig. 2 should be noted.

bandwidth required by a broadcast station. The reason for their failure can now be discussed. The sidebands of a frequency-modulated carrier, as shown in Fig. 2, were calculated for the case of a steady sinusoidal 15 kc/s modula-



Where

- A = The amplitude of the unmodulated carrier.
- $J_n(m_p)$ = Bessel functions of the first kind of order n , for the argument m_p .
- $\omega = 2\pi f_c$ where f_c is the carrier frequency.
- $m_p = F_d/F_m$ where F_d is the frequency deviation and F_m is the modulation frequency.
- $\phi = 2\pi F_m t$, t = time, e = voltage.

It will be seen that for any value of deviation ratio (m_p) chosen, that there is a carrier [$J_0(m_p)$] and an infinite number of sidebands above and below the carrier [$J_1(m_p)$, $J_2(m_p)$, $J_3(m_p)$. . . etc.], the amplitude of each of these values of $J_n(m_p)$ may be evaluated with the aid of a table of Bessel functions^{3,7}. In passing it may be mentioned that such tables present no more difficulty than a table of logarithms. The frequency separation between adjacent sidebands is equal to the audio-frequency (F_m).

The sideband amplitudes shown in Fig. 2 were calculated with the aid of the above formula. It is of interest to compare these results with those

obtained on the panoramic monitor (Fig. 3).

BIBLIOGRAPHY

1. "Notes on the Theory of Modulation," by J. R. Carson. *Proc. I.R.E.* February, 1922.
2. "A Method of Reducing Disturbances by a System of Frequency Modulation," by E. H. Armstrong. *Proc. I.R.E.* May, 1936.
3. "Interference in Relation to Amplitude, Phase and Frequency Modulated Systems" (including a table of Bessel functions), by O. E. Keal. *Wireless Engineer.* January, 1941.

4. "Amplitude, Phase and Frequency Modulation," by Hans Roder. *Proc. I.R.E.* December, 1931.
5. "A Frequency Modulation Monitoring System," by R. J. Pieracci. *Proc. I.R.E.* August, 1940.
6. "Carrier and Sideband Frequency Relations with Multi-tone Frequency or Phase Modulation," by M. G. Crosby. *R.C.A. Review.* July, 1938.
7. "Reference Data for Radio Engineers" (Table of Bessel Functions, page 60.) Published by Standard Telephones and Cables.

REPRODUCING RECORDS WITH LARGE RADIUS NEEDLES

IT has been generally accepted that a needle with a tip of as small radius as possible is desirable for optimum reproduction from lateral-cut gramophone records. This assumption has been based on the theory that the modulations are of equal lateral amplitude throughout the depth record groove, and it was therefore considered that a needle fitting tight to the bottom would penetrate the groove farthest, and so give the greatest high-frequency output.

In a recent paper* it is claimed that some unexpected benefits can be obtained from the use of a needle point of large radius which makes contact only with the upper side walls of the record grooves.

Graphical comparisons were made between three sizes of needle tip, 0.0023in., 0.00275in., and 0.004in., the bottom radius of the groove being 0.0022in., the width 0.006in., and the included angle 88 degrees. It was apparent that the greater area of contact was given by the smaller radius needle tip due to its close fitting in the bottom of the groove. But it must be recognised that the least irregularity or lack of symmetry in the groove shape would reduce the area of contact to even less than that of a 0.00275in. needle.

An enlarged plan view of part of a modulated record groove, with a 0.004in. needle inserted, was also presented. The modulations represented a sine wave of 7,000 c/s near the inside of a 78 r.p.m. standard record with a peak-to-peak amplitude of 0.0004in. It was obvious that the full amplitude could not be traced by a radius tip of such dimensions, and it would seem that an increased amplitude could be obtained by decreasing the needle

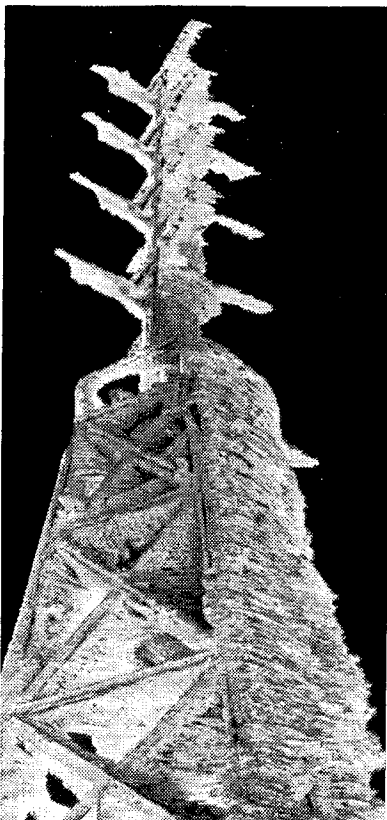
radius, thus allowing it to drop into the groove.

In a curve showing the effect of tip radii, varying from 0.002in. to 0.006in. on the electrical output for a constant frequency of 5,000 c/s with 0.002in. peak-to-peak amplitude, other factors being unchanged, the maximum output was reached with a tip radius around 0.004in.

This increase of high-frequency output results from the fact that HF modulations are not impressed in equal amplitudes throughout the depth of groove, and are less at the bottom, which can be attributed primarily to certain stages in the record manufacture. During processing, the grooves are distorted by the chromium plating, which deposits a heavier coating on the raised surface (corresponding to the groove bottom), and, in pressing, the raised portions (again equivalent to the groove bottom) become worn and distorted by the squeezing of the "biscuit" of record material across the surface.

Two records pressed from the same stamper were reproduced by the same turntable under identical conditions, except for the needle tip radius. An improved signal-to-noise ratio was obtained with the 0.004in. needle. Measurements made of the signal-to-noise ratio in the modulated groove show that a large radius needle tip still retains a superior signal-to-noise ratio at 500 playbacks. Other curves reveal that there is an appreciable reduction in surface-noise at 7,000 c/s with the wider needle, and that the tracking at 94 c/s is more accurate.

In these results Mr. Reid's research, if confirmed by other workers in this field, would seem to reside the explanation for tolerable quality record reproduction with fibre and other non-metallic needles, whose tips must of necessity broaden rapidly. D. W. A.



ICING is an enemy of transmitting aeri- als as well as of aircraft. This photograph shows a heavy deposit of ice on the 4-bay FM aerial at station W39B on the summit of Mt. Washington, Boston, U.S.A.

* "Large Radius Stylus for the Reproduction of Lateral Cut Phonograph Records," by John D. Reid. *Journ. Acous. Soc. Am.* Vol. 13. No. 3, Jan. 1942.

P.M.G. EXAMINATIONS

—and the Training of Marine Radio Officers

By WILLIAM M. MOORE

(Head of the Radio Dept., South Shields Marine School)

ONE of the effects of the war has been the definite lowering of the already comparatively low standard of technical knowledge required by candidates for the various Certificates of Proficiency in Radiotelegraphy issued by the Postmaster-General. A careful comparison between typical questions set for the pre-war 1st Class P.M.G. Certificate and those for Grade III for the City and Guilds of London Institute examination in Radio Communication will show clearly that the standard set for the former was relatively low.

Before the present war, three grades of certificate were issued on the results of examination:—

- (a) Special Certificate.
- (b) 2nd Class Certificate.
- (c) 1st Class Certificate.

The telegraphy standard required for the Special and 2nd Class Certificates was 20 w.p.m. plain language; 16 w.p.m. code, and 10 w.p.m. figures. For the 1st Class Certificate the telegraphy standard is 25 w.p.m. P/L; 20 w.p.m. code and 12 w.p.m. figures. In all cases only negligible errors are allowed.

A candidate for the wartime Special Certificate undergoes a practical examination which includes:—

- (a) Regulating and adjusting the sending and receiving apparatus;
- (b) altering the wavelength;
- (c) testing and charging accumulators;
- (d) varying the transmitted power;
- (e) tracing and clearing simple faults on the transmitter and receiver.

Further, he is verbally examined and is required "to know the functions of the various pieces of apparatus in the wireless installation used for the examination."

For the 2nd Class Certificate a candidate sits for a written examination, which consists of eight questions for which three hours are allowed. This is followed by a practical and verbal examination of a higher standard than that required for the Special Certificate.

The examination for the 1st Class Certificate consists of two papers; the first on electricity and mag-

The author urges the need for higher standards of training and qualification for marine Wireless Officers, who it may be expected, will after the war be responsible for the operation and maintenance of much more complex and highly developed apparatus.

netism, for which two hours are allowed; the second, similar to that for 2nd Class, on marine radio apparatus, for which three hours are allowed. In addition, there is a verbal and practical examination. The paper on electricity and magnetism which is set in the 1st Class examination is elementary and does not call for any mathematics worth mentioning.

The paper on marine installations which is set for both the 2nd Class and 1st Class examinations consists of questions of a descriptive nature.

Since the end of 1939 the ordinary examinations for 2nd Class and 1st Class Certificates have been suspended. Examinations for the Special Certificate are held at regular intervals at radio schools in various parts of the country. The average time taken by students to reach the standard for this examination is approximately five months.

After six months' service as a Junior Radio Officer the holder may sit for a modified examination for the 2nd Class Certificate. This examination consists of a written test of eight questions to be done in three hours. Candidates for this examination are not allowed time to attend a suitable course of instruction ashore and are expected to prepare for it in their spare time at sea.

Criticisms

The pre-war system of examination for P.M.G. Certificates is open to the following criticisms:—

- (a) The technical standard is too low.
- (b) Although the certificates are

called Certificates of Proficiency, a candidate may sit for the 1st Class Certificate without having previously obtained a certificate of lower grade and does not have to prove actual experience as a Radio Officer.

(c) The written examination for the 2nd Class Certificate does not test the candidate's knowledge of electrical principles.

(d) The questions set on the papers on marine radio apparatus are of such a type that a system of cramming by memorising answers to standard questions is in common use among students. This is encouraged by the fact that it is possible before an examination to predict at least half the questions which will appear on the paper.

(e) The practical examination for both the 2nd Class and 1st Class Certificates does not emphasise sufficiently the use of testing instruments in tracing faults and circuits.

(f) The candidate's ability to carry out minor repairs and his familiarity with tools is not tested.

I suggest that the standards of the examination should be raised and that the system of examination should be amended as follows:—

A new applicant for a position as a Radio Officer should first undergo a course of training at an approved radio school and be allowed to sit for a 3rd Class Certificate, which would qualify him to serve as a Junior Radio Officer in any ship.

This examination to consist of:

- (1) A written examination on electricity and magnetism.
- (2) Practical and verbal examination such as is now set for the 2nd Class Certificate.
- (3) Operating tests as now set for the 2nd Class Certificate.

After, say, 12 months' actual sea service the holder of a 3rd Class Certificate would be eligible to sit for a 2nd Class Certificate, the examination for which might consist of:—

- (1) A written examination of three papers on electrotechnology, radiotechnology and marine type equipment.

(2) A practical and verbal test to prove the candidate's ability to operate and maintain a complete marine radio installation, including minor repairs.

(3) An operating test with telegraphy speed 25 w.p.m. P/L; 20 w.p.m. code.

The holder of this certificate to be qualified to act as Officer-in-Charge of Class 2 and Class 3 ships or as Second Radio Officer on Class 1 ships.

After a further period of sea service in one of the capacities laid down in the preceding paragraph the holder of a 2nd Class Certificate should be eligible to sit for a 1st Class Certificate. The examination for the 1st Class Certificate to be on similar lines to that laid down for 2nd Class Certificate, but a higher standard to be required and, in addition, the examination to include the type of apparatus used mainly on very large passenger ships. The holder of this certificate would be qualified to act as Officer in Charge of Class 1 ships.

Candidates for the 1st Class and 2nd Class Certificates should be allowed to sit for an additional receiving test, using a typewriter, and if successful their certificates to be suitably endorsed.

The examinations for 1st Class and 2nd Class Certificates should be divided into two distinct parts: A, operating and procedure; B, technical. In the event of a candidate failing in one part of the examination and obtaining a satisfactory pass in the other part, he should be credited with this pass and at the next examination take only that part in which he failed.

Training Courses

Naturally, the training of Radio Officers is determined by the examinations for which they will have to sit. In the past, training courses have been planned to enable students to pass the examination in the shortest possible time. In other words, a course of instruction designed to produce efficient operators with a thorough understanding of their profession is not the same as one designed to get a student through the examination, especially when the employment of cramming can produce satisfactory passes. The result is that in the past large numbers of Radio Officers have qualified for P.M.G. Certificates without the background of a thorough knowledge of the principles of electricity and radio which is so necessary.

Training courses could be ar-

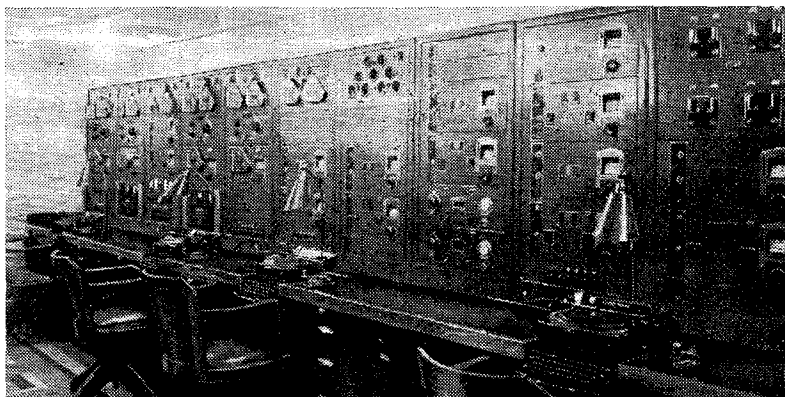
ranged to start with instruction in electrical principles on the lines already approved by the Institution of Electrical Engineers for the evening technical courses for the National Certificates in Electrical Engineering. Particular emphasis should be laid on the types of circuits and machines used in radio practice. In addition to lectures, as much laboratory work as possible should be included. The succeeding course of instruction in radio theory should be arranged so that a large amount of the work can be done in the laboratory.

Experiments demonstrating such things as static and dynamic characteristics of diodes, triodes, tetrodes and pentodes; resonance in AC circuits; production of oscilla-

training and examinations which I have outlined will meet with a great deal of criticism from all who are directly interested. Much discussion will be necessary, and many conflicting interests will have to be reconciled before such a scheme can be adopted. The only satisfactory and workable arrangement will be one which has the goodwill and approval of the Radio Officers themselves, the employers and the Post Office, as the examining body.

Technical Standards

On one point, however, there will, I think, be general agreement, and that is the necessity of a sustained increase in the standards of training and examinations. The



Receiving apparatus and transmitter control gear of the liner *Queen Mary*. After the war, marine installations may be expected to become even more complex.

tions, valve oscillators; modulation; rectification of AF and RF currents can be easily arranged and will prove a valuable form of instruction. Students should build up their own circuits and wind the necessary coils.

The equipment in the radio laboratory should include cathode-ray oscilloscopes, signal generators, voltmeters, ammeters, milliammeters, power packs, potentiometers, valves and batteries, as well as components such as transformers, chokes, condensers and resistances. Students should be given workshop practice and instructed in the use of tools.

The courses of instruction should be approved by the examining body, which should exercise the right to inspect approved schools to ensure that the syllabus is being adhered to and that the instruction given is satisfactory.

It is inevitable that the scheme of

technical standard required and reached by officers of both the navigation and engineering departments of the Merchant Navy is very high. The highest certificates in each department, that of Extra Master and Extra Chief Engineer, are classed as the equivalent of a B.Sc. degree.

By comparison, the standard of the P.M.G. examinations is very low indeed, and this is amply illustrated by the fact that a student of average intelligence with a good elementary education can pass the examination for the 1st Class P.M.G. certificate after eighteen months' attendance at a radio school. An engineer, on the other hand, serves four years' apprenticeship ashore, during which time he attends organised courses at evening classes or a sandwich course at a technical school. He must then serve eighteen months as a junior engineer before being

P.M.G. Examinations—

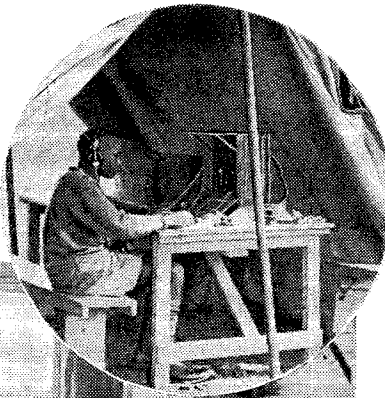
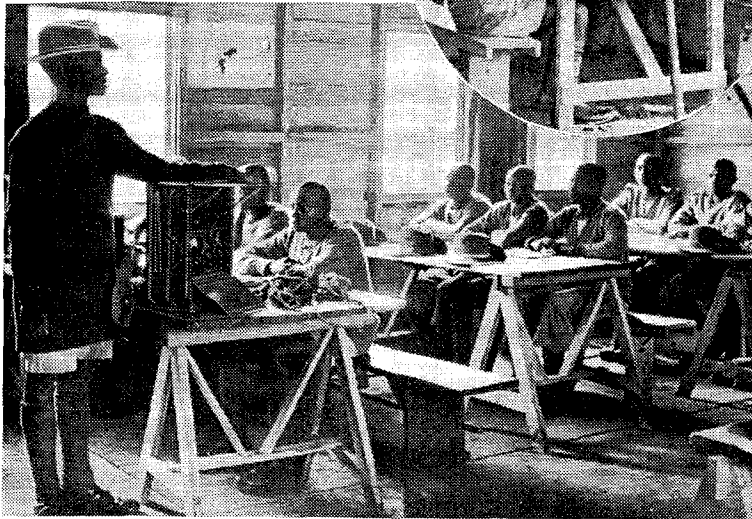
eligible to sit for a 2nd Class Engineer's Certificate and a further eighteen months before sitting for a 1st Class Certificate. For each of these certificates a period of several months' attendance at a suitable school is necessary, and in addition very many engineers take correspondence courses of study while at sea. A long period of study is necessary to reach the standard for the Extra Certificate, and only a small proportion of engineers obtain it.

Complicated Equipment

The radio department on Merchant Navy ships is bound to grow in importance as each year brings further developments. Equipment will, with improved design and wider scope, tend to become more complicated. New ideas in DF apparatus together with, probably, some applications of radiolocation are likely. Any improvement in the standard of technical training and examinations will raise the efficiency of the radio department of the Merchant Navy, and this will be to the benefit of the whole Service.

KENYA'S SIGNALMEN

A Signal Training Centre has been established in Kenya at which selected African recruits are trained as operators, linesmen or despatch riders. The operators undergo a 32-week course, at the end of which they are surprisingly efficient. In the lower picture rainees are seen receiving instruction in the details of a pack set.



Radio officers did a good job of work before the war, often under great difficulties with obsolescent equipment. They are doing a grand job now, for which all honour is due to them. Their unceasing efforts to improve their efficiency and the standing and status of their chosen profession is worthy of complete success. It is their just due that they should be given the opportunity of a comprehensive course of training and a certificate which, while not easy to obtain, will bear comparison with that of their fellow officers.

"KEEP IT GOING!"

MAINTENANCE of civil broadcast reception has now become a pressing problem, and the appearance of this booklet, issued by Murphy Radio, could hardly have been more opportune. One is inclined at first to question whether it is wise to encourage the layman to delve into the vitals of his receiver, but any unworthy doubts on this score are dispelled on reading the contents. Nowhere is the reader encouraged to do anything that is likely to do more harm than good; all the advice given to him is admirable,

and is clearly written from a deep knowledge of the way in which the public is inclined to use—or misuse—its receivers.

The function of "Keep it Going!" is to show the owner of any set—not only a Murphy set—how to do everything in his power, in the absence of professional help, to keep his set working in wartime. The booklet, which costs 6d., is distributed through Murphy dealers, but in cases of difficulty copies are obtainable direct from Murphy Radio, Ltd., Welwyn Garden City, Herts.

BOOKS RECEIVED

Radio Engineering. By Roy C. Norris. Written for those with little previous knowledge who wish to learn about radio. Treatment is practical and expository rather than theoretical, and the scope is very wide, including such aspects as wave propagation, receiving, transmitting, television, servicing, interference suppression and many other subjects. Marine and aviation radio and even wireless manufacturing methods are dealt with. Pp. 512; over 600 illustrations. Published by Odhams Press, Ltd., Long Acre, London, W.C.2. Price 6s. 6d.

Marine Radio Operator's Guide. By H. E. Chamberlain. Information for the newly joined marine Wireless Officer; shipboard life, uniform and kit required, status and etiquette. Though not a technical book, the beginner's normal training is supplemented by information on such matters as direction finding, maintenance of apparatus and short-wave working. Chapters on watch-keeping and various aspects of operating are included. Pp. 72; 4 illustrations. Published by Hutchinson and Company, 47, Princes Gate, London, S.W.7. Price 5s.

Whereas I was Blind. By Ian Fraser. This is not a wireless book, but wireless men will read with great interest the account of how Sir Ian Fraser overcame his disability of blindness. The author has long been associated with various aspects of wireless, and the book discloses some little-known facts about the initiation of the "talking book" scheme, for which electrical reproduction is, of course, employed; few developments have given more comfort to the blind, especially to those who have become blind in later life. A chapter is devoted to Sir Ian's work for the B.B.C. Pp. 169, with portrait of the author. Published by Hodder and Stoughton, Ltd., Warwick Square, London, E.C.4. Price 8s. 6d. net.

Aircraft Radio. By D. Hay Surgeoner. This revised 2nd edition begins with information on the international control and organisation of civil aviation radio services. This is followed by chapters on direction finding, blind-landing systems and aircraft equipment and its operation. Complementary airport equipment (including lighting systems) is also dealt with. Pp. 154; many photographic illustrations, explanatory drawings and circuit diagrams. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 15s.

HIGH-SENSITIVITY DC AMPLIFIER

IN view of the interest which has been aroused in biological circles in the original design for a DC amplifier embodying a "Magic Eye" tuning indicator (*Wireless World*, March, 1942, p. 63), it has been thought desirable to add a few notes on the more complicated arrangement mentioned in that article, which gives a sensitivity increase of over one hundred times.

It will be recalled that the maximum possible increase in sensitivity with the simple arrangement was some ten times; if attempts

Another Application of the CR Tuning Indicator

By

GEORGE A. HAY, B.Sc.

with a resulting increase in sensitivity. It might be thought a more obvious solution to include a cathode resistor, as in the original design, but this gives rise to a circuit which is much less convenient practically. The ultimate results of the two circuits are precisely similar.

As in the original design, the above arrangement gave unmanageable sensitivity accompanied by instability and backlash, and in practice it is necessary to shunt the CR indicator with another resistance to reduce the amount of feed-back. A suitable practical circuit is shown in Fig. 2, which is designed round the Mullard EM1. Other tuning indicators are not so successful on account of rather larger target currents. The amplifier used was a Mazda AC2HL, and, while this gave satisfactory results, if a very high input impedance is required, it might be advisable to use a top-grid valve such as a Mazda SP41 or Osram KTZ41, triode-connected.

It can be shown that the maximum voltage change is obtained when $R_1 = R_2$, but in practice it is better to make $R_1 = 3R_2$ in order to get sufficient target voltage for the EM1.

Fig. 2.—A practical version of Fig. 1, embodying a CR tuning indicator.

In operating the amplifier, the initial grid bias of the triode is first set by adjusting the 1,500Ω resistor to a value sufficient to avoid grid

current. (A value of about 1.2 volts is suitable, and it helps matters to run the cathode at a lower temperature than normal.) The 10,000Ω resistor is then adjusted by trial and error to give the correct amount of feed-back, and the bias potentiometer finally set for zero reading. Owing to the increased complexity of the circuit, precise values cannot be given, as in the case of the simple arrangement, and a certain amount of experimenting with resistance values might be necessary to suit individual valves. It is helpful in this connection to note that the smaller the resistance shunted across the EM1, the less sensitive is the circuit. If very high sensitivity is required, it would be advisable to stabilise both the high-tension and heater supplies to avoid zero drift. The maximum sensitivity obtained with this arrangement with complete stability has been about 0.2 mV for an easily visible movement of the shadow; if a less stable arrangement can be tolerated, this is easily increased to 0.1 mV or even less.

Abstracts and References

THE subject and author indexes to the abstracts and references published in our sister journal, *Wireless Engineer*, during 1942, will again be issued as a separate publication early in 1943. It is understood that supplies will be limited and it will, therefore, be necessary to make early application to our Publishers. A charge of 2s. 8d. (including postage) will be made. The December issue, which was on sale on the first of the month, includes the index

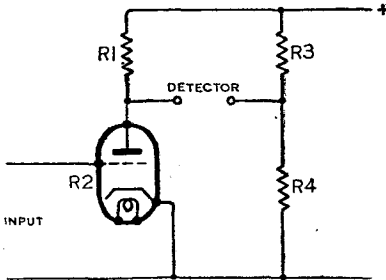


Fig. 1.—Basic circuit of the valve bridge used as a DC amplifier.

are made to increase this, instability results. A much greater increase is possible, however, by making use of an extra valve. Fig. 1 shows the skeleton circuit of a simple DC valve bridge. R_2 is the DC resistance of the triode, and when $R_1/R_2 = R_3/R_4$ the output to the detector will be zero, i.e., the bridge is balanced. R_2 , however, can be varied by changing the DC input to the valve, hence any such variation in input is indicated by a corresponding but much greater change in the bridge output. Using a valve such as the Mazda AC2HL with $\mu = 75$, a voltage gain of fifty times is easily obtainable.

If we use a CR tuning indicator as the bridge detector, a change of 100 mV is easily visible—hence the minimum visible change in input is about 2 mV. This is very little better than the original simple form of indicator previously described. If, however, we replace R_3 , or part of it, by the target-cathode resistance of the "Magic Eye" itself, it will be found that the phase relations are correct for positive feed-back to take place

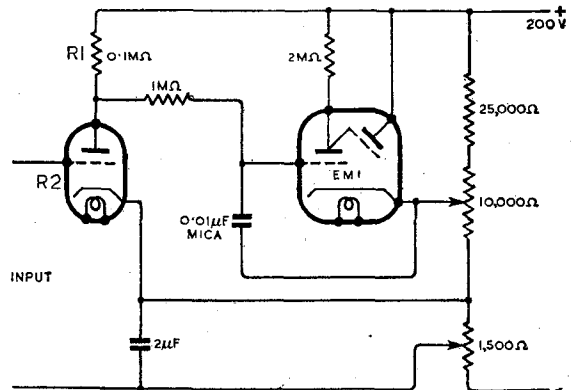


Fig. 2.—A practical version of Fig. 1, embodying a CR tuning indicator.

to the original articles published in Volume XIX, 1942, and to the authors. Issues are obtainable to order through newsgents, or direct from Publishers at 2s. 8d., including postage.

RADIO DATA CHARTS

WITH the growing use of higher and higher frequencies, the transmission line—especially the co-axial type—has become of considerable importance to the radio experimenter and designer. Besides their normal function of transmitting radio frequency energy from point to point as required, lines are being used more and more to replace “lumped” circuit elements which become increasingly difficult to construct as frequencies rise.

Perhaps the most important constant of a transmission line is its characteristic impedance. In passing, it is worth noting that this constant is sometimes referred to as the “surge impedance” and the “iterative impedance” by various authorities, but “characteristic impedance” is more usual. The abac sets out to calculate this constant from geometrical dimensions for six different line configurations. The inductance and capacitance per unit length are useful design data and so are included.

The characteristic impedance of a line is defined as the input impedance of a line of the same geometrical dimensions of infinite length. In any real line, whether of infinite length or not, there must necessarily be conductance and capacitance between the “go” and “return” leads, and inductance and resistance in both, even though their numerical value may be small. It is this fact which causes any line to have an input impedance to AC, and it can be shown (see for instance Everitt’s “Communication Engineering,” 2nd Ed., Chap. 4.) that the input impedance of an infinite line when the capacity, etc., is uniformly distributed along the line is given by:—

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

Where R = resistance per unit length
 L = inductance per unit length
 G = conductance per unit length
 C = capacitance per unit length

Fortunately, when dealing with radio frequencies, ω is large, and ωL becomes large compared with R, and ωC becomes large compared

By

J. McG. SOWERBY,
 B.A., Grad. I.E.E.

(By Permission of the Ministry of Supply)

No. 3 (3rd Series)— The Characteristic Impedance of Transmission Lines

with G. To a close approximation, therefore, we may write

$$Z_0 = \sqrt{\frac{j\omega L}{j\omega C}} = \sqrt{\frac{L}{C}}$$

and this is the relation on which the chart is based.

This assumption of high working frequency which has been made in the case of the characteristic impedance, has also been made in the calculation of the inductance and capacitance scales of the abac. Actually, the assumption comes up in slightly different form, and is that the velocity of transmission is that of light. In addition it is assumed that the distance between the conductors (D) is large compared with their diameter (d). At usual frequencies these assumptions are not very serious; and Hund (“Phenomena in H.F. Systems,” 1st Ed., p. 449) gives the deviation of the transmission velocity from that of light at different frequencies for a typical two-wire line of characteristic impedance 490 ohms. At 16Mc/s the deviation is 0.139 per cent., and at 34Mc/s is 0.095 per cent. At higher frequencies the deviation becomes progressively less. Similar figures are obtained for other line configurations.

For reference

purposes the line configurations and the appropriate formulae are given in Table I.

The Use of the Abac

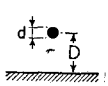
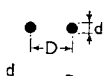
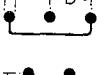
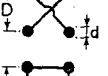
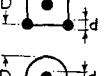
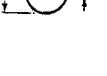
For each type of line configuration, a curve appears on the abac and is used when finding the characteristic impedance of that configuration from its geometry. The capacitance and inductance scales are independent of these curves and are related only to the characteristic impedance scale. A worked example will make this clear.

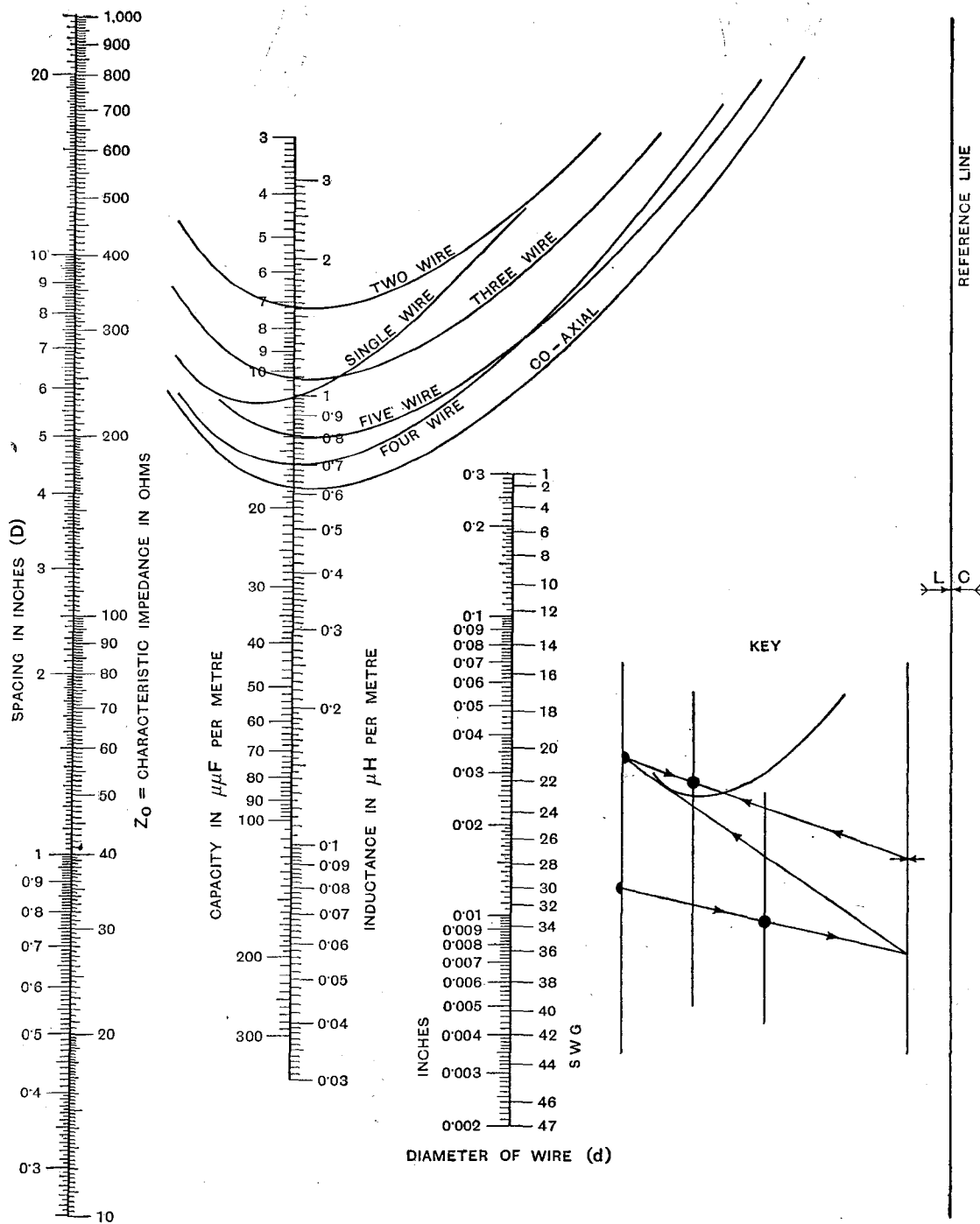
Example 1.—It is proposed to match an aerial to a receiver by means of a two-wire line consisting of two 16 SWG wires ten inches apart. What is the characteristic impedance? Set the ruler on 10 on the D scale and 16 SWG on the d scale. A point of intersection is found on the reference line. From this point draw a tangent to the two-wire curve and the characteristic impedance is read off the Z_0 Scale. It is 689 ohms. What now is the capacitance per metre of this line? Set the ruler on 689 on the Z_0 scale and on the gauge point LC on the reference line. The ruler cuts the capacitance scale at 4.835 $\mu\mu\text{F}$ per metre, the answer required.

Like most abacs, this one may be used backwards, and this is

(Concluded at foot of Col. 1, page 12).

TABLE I.

Line Configuration	Description.	Formula for Characteristic Impedance at RF (Z_0).
	Single Wire	$Z_0 = 138 \log_{10} \frac{4D}{d}$
	Two Wire	$Z_0 = 276 \log_{10} \frac{2D}{d}$
	Three Wire	$Z_0 = 207.3 \log_{10} \frac{\sqrt{4}D}{d}$
	Four Wire	$Z_0 = 138 \log_{10} \frac{\sqrt{2}D}{d}$
	Five Wire	$Z_0 = 172.5 \log_{10} \frac{\sqrt{2}D}{d}$
	Co-axial	$Z_0 = 138 \log_{10} \frac{D}{d}$



CHARACTERISTIC IMPEDANCE OF TRANSMISSION LINES

Wireless World
COPYRIGHT

Does Clerk Maxwell "Date"?

Control of Amateur Transmitters

Question No. 8.—How is Clerk Maxwell's Electromagnetic Theory affected by modern conceptions of the nature of electricity and the absence of the ether as a medium of propagation?

J. C. JEVONS.

Professor G. W. O. HOWE, D.Sc., M.I.E.E., Technical Editor of our associated journal, "Wireless Engineer," replies:—

THE answer to this question depends very largely upon what you understand by Clerk Maxwell's Electromagnetic Theory. Hertz wrote: "Maxwell's theory is Maxwell's system of equations. . . . Maxwell arrived at them by starting with the idea of action-at-a-distance and attributing to the ether the properties of a highly polarisable dielectric medium. We can also arrive at them in other ways. But in no way can a direct proof of these equations be deduced from experience. It appears most logical, therefore, to regard them independently of the way in which they have been arrived at, to consider them as hypothetical assumptions, and to let their probability

depend upon the very large number of natural laws which they embrace."

Again, E. Cunningham writes in Pearson's *Grammar of Science*: "The true function of the ether is merely to assist the mind to a clearer understanding of the sequences of these phenomena. Nothing more is to be predicated of it than the laws that express concisely how these sequences are unfolded. The ether of the electromagnetic theory is to the scientist now nothing more than a vague substratum whose only properties are specified by a number of mathematical equations which will always be associated with the name of Clerk Maxwell."

It will be seen from these two quotations that the ether forms no essential part of Maxwell's theory. It was introduced because it was felt at the time that the phenomena represented by the equations necessitated space being endued with properties which could not be the properties of mere nothingness, and the mind, therefore, filled empty space with this fictitious medium and endued it with all the necessary properties. If one is prepared to endue empty space with the properties necessary to give a working picture of electromagnetic phenomena, and thus make the equations something more than mere mathematical symbols, there is obviously no need to postulate an all-pervading ether. There has been a tendency in recent years to endue empty space with properties which a few years ago would have been regarded as inconceivable—and still are by many people. For example, we are told that a gravitational field acting on empty space endues it with curvature. No harm is done by referring to empty space as the ether so long as one does not go further and begin to ask meaningless questions about it.

When an alternating current of high frequency flows in an aerial it loses energy, which reappears after a very short time in a distant aerial. During the interval the energy was undoubtedly traversing the space between the transmitter and the

receiver. In what form was the energy? It is not very satisfying to be told that it was in the form of some differential equations, although there are those who maintain that this is the limit of our knowledge of the matter. If one believes that the space between two oppositely charged conductors in a vacuum is in a peculiar state known as an electric field, and the space around a current-carrying conductor in a vacuum also in a peculiar but different state known as a magnetic field, and that each field represents an amount of energy, then one will have no difficulty in picturing the electromagnetic wave travelling from the transmitter to the receiver.

It is doubtful whether modern views of the nature of electricity are in any way antagonistic to Clerk Maxwell's electromagnetic theory.

In his book *The A.B.C. of Relativity* Bertrand Russell says: "Throughout all the revolutions which physics has undergone in the last fifty years, these equations (of Maxwell) have remained standing. Indeed, they have continually grown in importance as well as in certainty, for Maxwell's arguments in their favour were so shaky that the correctness of his results must almost be ascribed to intuition." That was written in 1925, but it stands to-day. In his *Electromagnetics* (1938) O'Rahilly says: "We have no difficulty in deciding that the hypothesis of an 'aether,' whatever it is supposed to mean, does not nowadays pertain to the science of physics; for its denial does not make any alteration in any formula."

More views on Question No 6.

(Would not the control of all wireless matters be better vested in some independent body, like the F.C.C. in U.S.A., rather than in the G.P.O.?)

"T.J.R.," questions the accuracy of the querist's premises. He writes:—

DOES the G.P.O. really control all radio matters? It may do so nominally, but its control is rather indirect in the case of, say, broadcasting. Though all listeners have heard of "strong men" at

RADIO DATA CHARTS

(Concluded from page 10)

brought out in the second example.

Example 2.—It is proposed to make a five-wire line of characteristic impedance 300 ohms from 14 SWG wire. What is the requisite spacing? Set the ruler on 300 on the impedance scale and draw a tangent to the five-wire curve. Join the point of intersection on the reference line to 14 SWG on the d scale, and the ruler cuts the D scale at 3.83 inches.

In the majority of cases the pattern of example 2 will be followed, since what is usually required is a line to match a given piece of apparatus. Matching is said to take place when a line is terminated with an impedance equal to its own characteristic impedance. Matching is important, because under these conditions no reflections are set up in the line, and the losses in it are at a minimum.

Broadcasting House, few are aware that the P.M.G. is its real overlord. Again, why should the G.P.O. be any less "independent" than a body like the American F.C.C.? The G.P.O. certainly has interests in telecommunication other than in its capacity as a controlling body, but has no vested interests of a material character, in the sense normally understood. The profits of the G.P.O. go into the coffers of the State, and not to individuals.

Unless one feels that the G.P.O. is unsuited for the job by inherent incapacity for progressive thought, it is just as well for the Government to effect control of radio through it as through some new and untried body. To sum up, what matters here, as in all technical matters of social importance, is that the State should be imbued with a progressive democratic spirit that can be passed on to its executive departments.

A. D. GAY, President of the Radio Society of Great Britain, replies from the point of view of amateur transmitters, whose numbers may be expected to grow greatly after the war:—

WITH the G.P.O. monopoly of wireless communication (and, in fact, of all forms of electrical communication) it seems obvious that the issue of wireless licences must be under its control. Any other body, were it given the powers to grant licences to experimenters, would have to consult the G.P.O. on questions of powers and frequencies and conform to any regulations which may be made at International Conventions from time to time.

It would thus seem that to create an independent body such as the Federal Communications Commission would merely duplicate a department which already exists within the G.P.O. Whether such action would bring about more favourable consideration of requests for licences is exceedingly doubtful. The present Act of Parliament assures that anyone should have a transmitting licence who desires to carry out experiments, provided a certain elementary knowledge of radio is displayed by the applicant.

In the U.S.A. licences are granted to anyone, and for such purposes as third-party message handling. The size of the American continent and the absence of State monopoly over communications facilitates the unrestricted issue of licences. American

amateurs have done valuable work in emergencies, bridging broken communications with portable radio equipment. In this country such assistance by amateurs might cause a loss of revenue to the G.P.O. and has never been encouraged.

The administration of radio matters in America is therefore a much wider and more democratic affair. In the absence of a State department dealing wholly with communications, the F.C.C. is, therefore, necessary, and fulfils the

duties of administration in a less biased manner.

The system in this country could be improved by the invitation of amateur representatives to attend all committee meetings at which amateur activities are to be discussed. A great deal of useful and friendly co-operation exists, for example, the invitation of an amateur representative to attend International Conferences abroad. This amicable state of affairs might be improved at home.

A Demonstration Multivibrator

By E. WILKINSON, Ph.D.

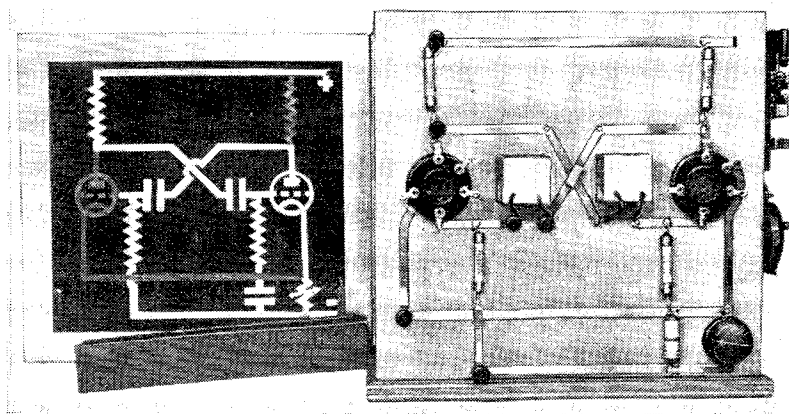
THE apparatus shown in the photograph was developed in Loughborough College to assist students in understanding the working of the multivibrator. It portrays the electrical processes which are taking place in an actual circuit at a speed slow enough to be appreciated.

The circuit is a normal symmetrical multivibrator except for the two grid condensers, which are enormous compared with ordinary standards. Each is an electrolytic condenser of $16\mu\text{F}$ capacity, controlling the oscillation frequency down to one cycle in about three seconds. The layout of components on the breadboard back brings them into positions corresponding to the circuit diagram which is drawn out on a ground-

glass screen. This forms the front face of the instrument, and the rest of the glass is blacked so that individual parts of the diagram may be illuminated from behind.

The operation of the multivibrator depends upon the periodical charge and discharge of the two condensers. This is demonstrated by each condenser circuit automatically lighting up blue when charging and red when discharging.

The lamps illuminating the diagram are switched on and off by a mercury-vapour relay, contained in the main body of the apparatus, and controlled directly by the grid potential of one of the multivibrator valves. The lamps illuminating the charge path of condenser 1 and the discharge path of



Front view of demonstration multivibrator showing components mounted in the positions they occupy in the conventional circuit. The ground glass screen is painted black leaving the circuit diagram transparent so that the charge and discharge conditions may be indicated by pilot lamps of different colour. Gas-filled relays and auxiliary circuits for the automatic control of illumination are mounted inside the case and circuit values are chosen to give a complete cycle every three seconds.

A Demonstration Multivibrator— condenser 2 are fed in parallel from a low-voltage winding on a mains transformer. The lamps in the discharge path of condenser 1 and the charge path of condenser 2 are fed in series with a ballast resistance and the primary of this transformer. The function of the gas-filled relay is to short a high-voltage secondary winding, thereby cutting out the parallel lamps and throwing the

mains supply almost entirely across the series lamps and the ballast resistance. The increased primary current is then sufficient to light the series lamps.

The working of the triggered multivibrator may also be demonstrated. Free running is stopped by increasing the bias resistance and cutting off valve 1. The cover plate, seen in the photograph below the diagram, hides the lower part

of the diagram when the circuit is running free. This is now removed to show the modification in the circuit. Condenser 1 discharges and remains discharged, while condenser 2 becomes charged. This condition appertains until the application of a triggering pulse overcomes the bias and allows a single change over of the illuminated and darkened parts of the circuit.

RANDOM RADIATIONS

By "DIALLIST"

Licence Defaulters

JUDGING by the reports that one sees in the various daily papers the number of set users who don't take out receiving licences has reached an alarming total. One reads estimates of from 1,000 to 10,000 in some of the country's larger towns and the total for Great Britain and Northern Ireland may well run to a million or more. Evasion on this scale is a very serious affair, for it means that the B.B.C. is losing a large proportion of its just revenue at a time when it ought to be putting by a useful nest-egg for post-war repairs, reconstruction and expansion. I've always thought and I still think that one should have to produce one's receiving licence when buying a set or a replacement part. There wouldn't be any "hardship" about this, and it would certainly reduce licence evasion to a minimum, if it didn't end it altogether.



Frequencies and Wavelengths

EVERY reader must have been interested by the Editorial on "Classification of Frequencies" in last month's *Wireless World*. The present position is chaotic, to say the least of it. You may, for example, in one and the same article describing a receiving set find that the term "high frequencies" is used (a) for frequencies above about 4,000 c/s ("this circuit is designed to avoid attenuation of the high frequencies in the AF stages"); (b) for those between 300 and 150 kc/s (in describing the performance of the signal-frequency stages of a superhet in the long-wave band); (c) for those between 1,500 and 500 kc/s (signal-frequency stages in the medium-wave band); (d) for those between 20,000 and 3,000 kc/s (signal frequencies in the short-wave bands). "Intermediate frequency" may also be used in one or two paragraphs to describe

a frequency which would elsewhere in the article be called high. And it's not too easy for the beginner when he comes to wavelengths. His friends who are short-wave enthusiasts probably call the bands between 10 and 100 metres the short waves and those below 10 metres the ultra-shorts. But he may find that the wavechange indicator of his so-called all-wave set shows the bands between about 30 and 80 metres as short and those between 15 and 30 metres as ultra-short. Coming back to frequencies, if the aforesaid beginner at radio owns one of those devices for sunshine treatment in the home, he may be perplexed by the discovery that the book of the words refers to its infra-red radiation as low-frequency and its ultra-violet as high.

Simplification Needed

A considerable straightening out is clearly needed, and here's one way in which a beginning could be made. I do feel pretty strongly that all of us who write on wireless or argue about it amongst ourselves should eschew once and for all such expressions as "high frequency" and "low frequency" stages in a receiver, with their corresponding abbreviations "HF" and "LF." What the aerial delivers to the grid of the first valve should always be called the "signal frequency" or SF, and the frequencies dealt with by the post-detector stages and the loudspeaker should be "audio" or AF. The latter are easily and comprehensibly divided up into upper, middle and lower audio frequencies—UAF, MAF and LAF. That leaves what we now call the "intermediate frequency" to be dealt with. Is any change needed here? I'm not sure that it is, for there doesn't seem to be much chance of confusion, at any rate when speaking of a superhet, if we refer to its departments as SF, IF and AF. If, though, a change is thought to be

desirable in the interests of perfect clarity, we might possibly use "conversion frequency" (CF) instead of IF. I'm sure that the adoption of the nomenclature suggested for the working frequencies of the wireless receiving set would do a great deal towards smoothing the path of the beginner.

Can We Think in Frequencies?

But that is a very long way from being the whole of the story. We are still left with the classification of the whole vast range of electro-magnetic radiation frequencies, or at all events with that part of the spectrum with which wireless is concerned. There are those who claim that the problem would lose much of its difficulty if only we could bring ourselves to think in frequencies. But can we? Like most DX enthusiasts, I think of station frequencies rather than wavelengths and make my calibration charts in kilocycles or megacycles. In circuit-designing one must think and work in frequencies. But we can't go on doing so when it comes to short-wave aerials, transmission lines, and so on, for there we are concerned with the physical lengths of the waves with which they have to deal. Their heights, lengths and spacings have to be worked out in terms of wavelengths so that we can measure off in metres and centimetres or in feet and inches. Hence, thinking in frequencies, helpful though it is in many ways, is not a panacea for all one's wireless headaches.

What is Your Choice?

Each of the two systems given in the *Wireless World* Editorial has a good deal to recommend it—just as each has its drawbacks. I have a feeling that a kind of combination of the two might answer well. Here's what I'm driving at. Once you've got hold of such rather unfamiliar terms as

myriametre, hectometre and dekametre (not so difficult if you remember that in the metric system multiplying prefixes are always Greek numerals and dividing prefixes are Latin), the order in which the wavebands come in the classification should stick in your head. Now, in the frequency side all that we have to do is to take the upper limit for each band. Thus, the myriametre waveband is concerned with tens of thousands of metres and the corresponding frequency range is below 3×10^4 ; it is thus frequency band No. 1. At the other end of the scale the centimetre waveband is concerned with hundredths of a metre and the frequency range corresponding is 3×10^7 , so that it is a frequency band No. 7. Hence the table can become:—

Band	f in kc/s	Waveband name	λ in metres
1	below 3×10^4 ...	Myriametre	above 10,000
2	$3 \times 10^4 - 3 \times 10^5$	Kilometre	10,000-1,000
3	$3 \times 10^5 - 3 \times 10^6$	Hectometre	1,000-100
4	$3 \times 10^6 - 3 \times 10^7$	Dekametre	100-10
5	$3 \times 10^7 - 3 \times 10^8$	Metre	10-1
6	$3 \times 10^8 - 3 \times 10^9$	Decimetre	1-0.1
7	$3 \times 10^9 - 3 \times 10^{10}$	Centimetre	0.1-0.01

What do you think of the suggestion? I think there's something in it; possibly you can suggest something simpler and better.

To Jam or Not to Jam?

THOUGH the Axis Powers do their level best to jam as many as possible of the news and talks broadcasts put out by ourselves, the Americans, the Russians and other Allied peoples, the B.B.C. seldom, if ever, retaliates. Russia appears to indulge in a certain amount of interference with German and Italian transmissions. I don't know what the Americans are doing, but I don't fancy that they are bothering much to spoil reception by their people of the stuff dished out by Goebbels, Gayda and others of the gang. I saw it reported the other day in one of the lay papers that a B.B.C. official when asked "Why don't you jam Germany and Italy?" replied, "Why should we?" Personally, I take rather the same view. Hitler and Musso have such a wealth of broadcasting stations at their disposal in their own and in occupied countries that they can well afford to use a good many of them as jammers if they feel so minded. But we need all the long, medium and short wavelength transmissions that can be spared to give news to the Empire as well as to foreign countries. In any event, jamming, no matter how heavily it's done, is never a hundred per cent. effective; even

when it is combined with terrific penalties for listening to the B.B.C. it does not prevent our news from reaching the people we want it to reach.

Those American Valves

IT seems to take a long while for those American valves which the Board of Trade agreed should be released for replacement purposes in broadcast receiving sets to find their way into the shops. It's a good while since their coming was announced, but there seem to be few of them about yet. Perhaps their distribution will have been speeded up by the time that these lines are in print, and readers whose sets have been silent for want of the necessary "toobs" will once more be able to listen to news and entertainment. Far too many sets are out of action either because spares are unobtainable or because service men can't cope with the work thrown upon their depleted ranks.

Bits and Pieces

Meantime, I've seen some weird sets put together out of the quaintest museum pieces in the way of components, retrieved from the obscurity of junk box or attic. Old straight-line-capacity variable condensers, worked by the kind of slow-motion dial that one hasn't seen for ten years or more, are yoked to tuning coils of the kinds that were illustrated in the advertisement pages of *Wireless World* in the late '20's or early '30's. Fixed condensers, resistances, transformers and switches of almost forgotten makes and types have been resurrected and are doing good service. One set was actually tuned by a variometer of about 1923 vintage. Another had a couple of those big flat variable condensers with mica dielectric that used to be made by the Polar people. I am still hoping to find a vario-coupler dug out from the depths and given a new lease of life. Under the conditions of to-day, when the set need only bring in a couple of medium-wave stations and requires no long-wave band, quite passable reception can be obtained with components that we wouldn't have thought worth bothering about in 1939. One thing is that, thanks to our network of high-powered broadcasting stations, a simple three-valve straight receiver will normally provide adequate reception: at any rate it enables the news bulletins to be heard

almost anywhere in the country. The quality may leave a good deal to be desired, but in wartime almost any kind of set is better than none at all.

Woomph!

CAN anyone explain why it is that those who use receiving sets for bringing in the dance music of the day so often find it desirable to turn the tone control as far counter-clockwise as it will go, or very nearly so? Is it because this takes the edge off the excruciating noises produced by muted trumpets and other strange instruments, thereby rendering them less unbearable? I don't know; I seek more light on the subject. What I do know is that if the news bulletin follows a dance band programme, hardly a word is intelligible until someone has moved the TC knob a long way clockwise. This preference for muffled (mellow is, I believe, the accepted term) reproduction is all the more puzzling since the majority of the sets that one comes across in messes and canteens have little enough "top" anyhow. Someone—I think it was "Cathode Ray"—once wrote that the dial of the average cheapish commercial receiver might well have four positions marked "very woomphy," "woomphy," "not quite so woomphy," and "still pretty woomphy."

Senile Decay?

That, I feel, is no very great exaggeration. But sometimes I am assailed by a doubt: do receivers sound woomphy to me because my aged ears have lost some of their high-note response? Do I like the tone-control turned farther clockwise than the young dance-music enthusiasts would have it owing to the sad effects of senile decay? It is, of course, a fact that once you are over thirty or so your ears respond less and less well to high frequencies. Hence grave and (we hope) reverend seniors might need the tone control turned clockwise in order to be able to hear the upper notes that are clearly audible to gilded youth. Is it then really the ears of the older folk that woomph rather than the loudspeakers of our wireless sets? I hardly think this can be so, for I notice that the young, too, are unable to comprehend the news when it is reproduced with the dance-music settings of their choice.

"Photograms of the Year"

THIS popular pictorial annual, now in its 43rd year, has again appeared. It constitutes a record of the year's progress in the photographic art, and includes pictures from many parts of the world. *Photograms* is issued by our Publishers and is obtainable from booksellers and photographic dealers at 7s. 6d. in paper cover or 10s. bound in cloth.

GOODS FOR EXPORT

The fact that goods made of war 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.

VELOCITY - MODULATION U-H-F GENERATORS

DURING the past few years the focus of interest in radio engineering has been rapidly shifted towards the use of higher and higher frequencies. It is well known that a valve having a conventional electrode structure becomes progressively less and less efficient as a generator or amplifier as the frequency is increased; beyond approximately 100 Mc/s it may be considered useless for purpose.

Although generators for the ultra-high frequency have been available for several years it had not in general been found possible to secure operating efficiencies comparable with those easily achieved at lower frequencies, and considerable research was, in consequence, devoted to improving this position. Much interest was aroused, therefore, when in 1936 and 1937 announcements appeared in the American technical Press of ultra-high-frequency generators called "rhumbatrons" and "Klystrons," for which high efficiency was claimed. The outbreak of hostilities in Europe and the attendant increased importance of

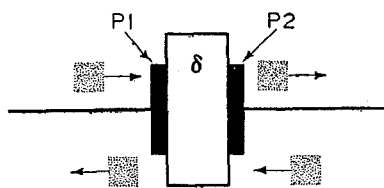


Fig. 1. A simple parallel-plate condenser, showing diagrammatically the relative movement of electron charges.

the ultra-high-frequency field has resulted in little information being published here on recent developments of these generators.

Space-charge Influence Effect.—The first operating principle is that, for an alternating current to flow in a conductor, it is not necessary for the generator to have a conductive connection with the conductor; it may be readily induced by a "space-charge" whose density is made to oscillate. This may be made clear by considering the simple condenser of

Explaining Their Operation

By

GEOFFREY BOCKING

(Pasta Developments, Ltd.)

Fig. 1. P_1 and P_2 are plates of equal area and thickness separated by δ , a dielectric medium. When the condenser is discharged the potential difference between the plates is zero and no lines of electrostatic force pass through the dielectric. If a charge or quantity of electrons is added to P_1 a similar charge or quantity of electrons will depart from the surface of P_2 ; that is, a current will flow within P_2 . Similarly, if the charge applied to P_1 is continually imposed and withdrawn, the current within P_2 will alternate in direction. It is obvious that P_1 here performs the function of a conduction means whereby the proximity to P_2 of a quantity of electrons or charge may be varied. This result may equally well be achieved by using a thermionically emitted electron cloud or space-charge, and varying its density or position with respect to P_2 , causing a varying current to flow in it. This is the *modus operandi* of the troublesome effect met with in certain frequency-changer valves where the oscillations generated in the oscillator section causes an oscillating space-charge to appear before the signal grid; thus undesirable coupling occurs between the two. Consideration of the foregoing will show that for adequate power to be induced in a load connected between the two real or effective plates, this load must possess adequate impedance. In practice, as the frequency of alternation becomes progressively higher, a high impedance becomes more difficult to develop; high resistances become short-circuits and above 100 Mc/s conventional resonant circuits become impracticable. This leads to the second operating principle:—

Cavity Resonators.—In 1894 Sir

Oliver Lodge demonstrated to the Royal Institution that if an electromagnetic generator be placed within a suitably constructed hollow pipe, the electromagnetic energy could be confined within the pipe during its travel along it and projected as a beam from the open end. The mathematical theory of these "wave-guides," as they have later been called, was developed by Lord Rayleigh in 1897, and from then until 1936 their possibilities seem to have been overlooked. In that year, however, W. L. Barrow and G. C. Southworth published results of their independent experiments on guided waves in hollow pipes, and these papers have been followed by many others. It has been found that by so arranging the physical dimensions it is readily possible to develop standing waves in a hollow pipe system, the resulting configurations, called "cavity resonators," having high impedance and convenient practical construction. Various types of wave are possible in cavity resonators and are differentiated solely by the relative disposition of the lines of magnetic and electric force. They may be excited by placing a loop at right angles to the magnetic lines of force (magnetic excitation)

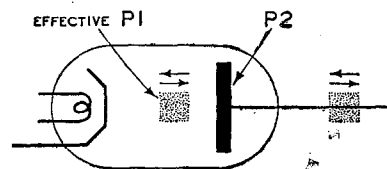


Fig. 2. A condenser in which one effective plate is formed by an electron cloud or "space-charge."

or by a conductor or electron stream parallel to the lines of electric force (electrostatic excitation). This last method of excitation, by an electron stream, is of interest here. Its practical realisation raises difficulties, however, and their solution is dependent upon the third operating principle:—

Velocity-modulation and Phase-focusing.—At low frequencies and in a vacuum electron velocity is so great and consequently the "transit-time" or time taken by

an electron to move from point A to point B in a circuit is so short, that no error arises in considering the velocity to be infinite. At ultra-high frequencies, however, the transit-time may become comparable to the period of one cycle, and the induction by oscillating space-charge as given above is complicated thereby. A considera-

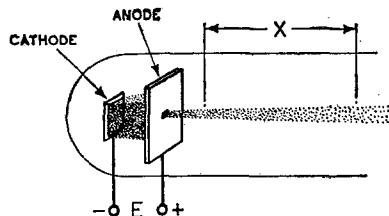


Fig. 3. Simple generation of an electron stream.

tion of this problem is therefore desirable.

The velocity of an electron in a vacuum is dependent upon the square root of the fall of potential through which it passes. Electrons issuing from the hole in the anode shown in Fig. 3 will continue with a velocity given by the formula:

$v = 6 \times 10^7 \sqrt{E}$, where v is the electron velocity in cm/sec. E is the anode voltage in volts.

At this velocity the electron stream will traverse a distance of x cms in t seconds, where $t = x/v$.

It should be emphasised that this time may be varied at will by changing the anode voltage E , practical considerations imposing upper and lower limits to this variation.

As shown in the description of the first operating principle of inducing an oscillatory current in a conductor by means of an electron cloud or space-charge, the density or proximity to the conductor of the charge must be varied at the frequency of the desired oscillation. An electron stream generated as shown in Fig. 3 may be arranged to do this at moderately high frequencies by interrupting the flow of electrons at such a rate that a cloud of electrons arrives opposite the conductor, and in consequence the conductor receives a pulse of energy in phase with the resonant frequency of the load connected to it. This is shown diagrammatically in Fig. 4.

This method is impracticable at ultra-high frequencies, however, for two reasons:—(1) The difficulty of securing a resonant load having a sufficiently high impedance at these frequencies. In consequence

a resonant cavity must be used. (2) The physical dimensions of a suitable cavity necessitate considerable length along the axis of the electron stream. The transit-time of this stream will therefore normally be equal to the period of several cycles of the resonant frequency of the cavity.

The significance of this latter disadvantage may be appreciated by reference to Fig. 5. During the whole of the time that the electron cloud is within the cavity, it has the same influence upon it irrespective of its position (as shown in the upper diagram); whereas for resonance to be excited, the influence should vary as shown in the lower diagram. This might be overcome by making the velocity high and the transit-time short, but this would necessitate increasing the voltage E . Since the power supplied to the generator increases as the square of E ($P = E^2/R$) and the velocity only increases as the square root of E ($v = 6 \times 10^7 \sqrt{E}$), the efficiency falls more rapidly, due to the increase of energy supplied, than it rises due to reduced transit-time effect.

The solution to the above dilemma may be appreciated by considering a well-known schoolboy problem in mathematics: "If a train A starts with a velocity v_1 ,

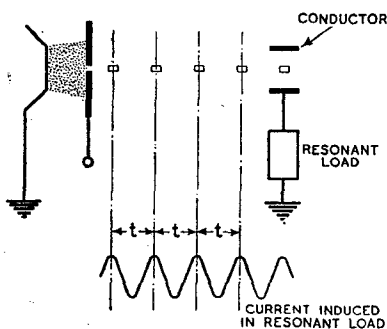


Fig. 4. Excitation of resonance by pulses of current induced by an interrupted electron stream.

and T hours after a second train B starts with greater velocity v_2 , how far must they travel before B overtakes A?" Assuming this to be solved, suppose that at the point at which B overtakes A there is a level crossing, the gates of which have been negligently left closed; it will be obvious that the energy available for the immediate destruction of the gates will be greater at this point where the trains run side by side than at any other point on

the line where one runs in front of the other.

If this principle is applied to an electron stream, the velocity of successive electrons of which is made successively greater, it will be apparent that at one point all electrons will overtake one another to form a "bunch," and that the

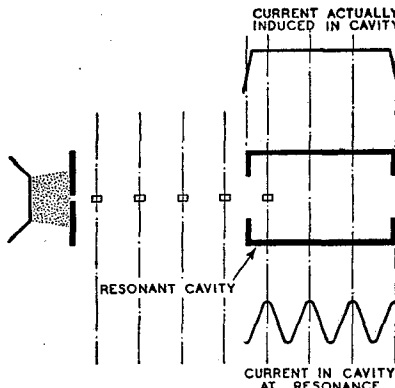


Fig. 5. Showing failure of an interrupted electron stream to induce resonance in a conductor having considerable length along the axis.

influence effect of this bunch at the point of its formation will be greater than that of its component electrons at any other point. In the case of the cavity resonator and electron stream given above, it is possible by suitable design to arrange the bunch to occur once per cycle at, for instance, the point where the stream leaves the cavity. Then, spread out along the stream behind the bunch will be electrons travelling with varying velocities, the net effect of which (some aiding and some impeding the resonant flux) will be very small compared with the large effect of the bunch.

The elements of an efficient ultra-high-frequency generator operating on the velocity-modulation principle are, therefore:

1. Source of electrons and suitable accelerating and focusing means.
2. A device to impress a variation of velocity on the electron stream (buncher).
3. A resonant cavity to receive the energy from the buncher in suitable form (catcher).
4. Coupling means to ensure correct inter-operation of buncher and catcher.
5. DC return path for the electron stream after passing through the system.

Practical Embodiments. — The development of the first generator

Velocity-Modulation U-H-F Generators to operate on the velocity-modulation principle is commonly credited to R. H. Varian and S. F. Varian,

oscillatory energy would be fed back from the catcher *via* the coupling loop to the buncher. As a result of this grids 1 and 2 will alternately become positive and negative with respect to each other

all factors are taken into account, the efficiency is only reduced from a theoretical maximum of 58 per cent. to 40 per cent. in practice.

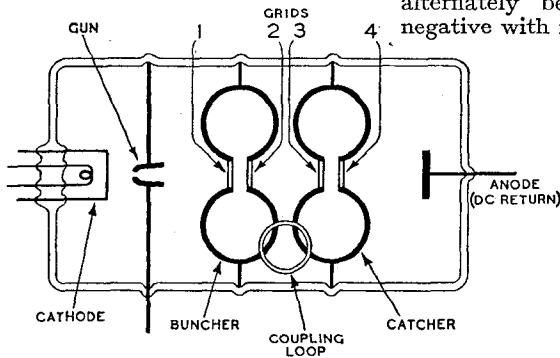


Fig. 6. Essential elements of a Klystron generator. Electrons generated at the cathode are formed into a beam by the gun, whence they pass to the buncher. The buncher varies the velocity of successive electrons and they form bunches just inside the catcher

who in 1936 published details of their Klystron generator. In 1933, however, Arsenjewa-Heil and Heil gave details of a device rather similar to the Monotron, to be described later. The method of function was only generally indicated, but there seems little doubt that it was, in fact, the first of the velocity-modulation generators.

The Klystron.—Fig. 6 shows the Klystron as it was originally described. The buncher and catcher resonators of identical shape and having, in consequence, identical resonant frequencies, are in the form of toroids in which the re-entrant portions, instead of meeting at the centre, are closed in each case by two grids: 1 and 2, 3 and 4. It was shown in Fig. 3 that a variable velocity could be imparted to an electron beam by passing it through an electrode to which a varying potential was applied. To attempt to secure this velocity modulation with a single electrode would be to encounter the same difficulties as in a conventional valve, and a cavity resonator must be used. The operation is then as follows: assuming oscillations to have been started,

at the oscillation frequency; this means that the electric field between them will alternately oppose and assist the acceleration field due to the gun, and a variation of velocity will be impressed on the beam.

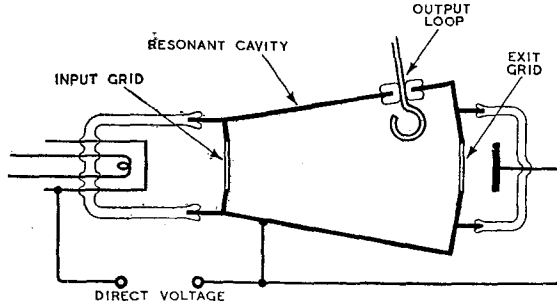


Fig. 8. The Monotron, a simplified version of the Klystron.

The catcher is so disposed to the buncher that the electron stream forms a bunch just within it, the incidence of successive bunches exciting it to resonance.

This explanation is considerably simplified in some respects, but a full understanding can only be achieved in mathematical terms and, in fact, the Klystron has so far defied a complete explanation in such terms. One simplification however, should be immediately apparent from what has already been described: namely, that in a practical Klystron the transit-time within the resonators will be at least an appreciable part of one cycle of oscillation. The electric field will not, in consequence, have a uniform direction during the whole of the transit of the buncher, and velocity modulation must be considered a sum effect of the various accelerations impressed during transit. A simple exercise in integration will show that the effect may be neglected and, when

quenched by application of an incorrect voltage to the resonator, which fact offers a solution to the hitherto difficult problem of modulation. The simplicity of the Monotron and the fact that, unlike the Klystron, velocity modulation

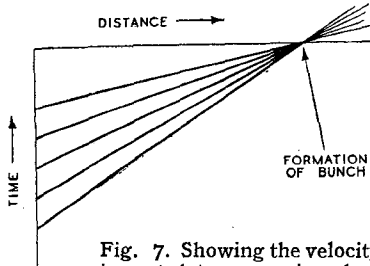


Fig. 7. Showing the velocity imparted to successive electrons arriving after equal time intervals at the buncher.

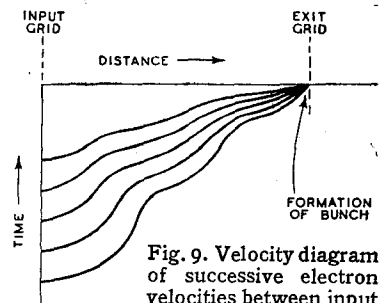
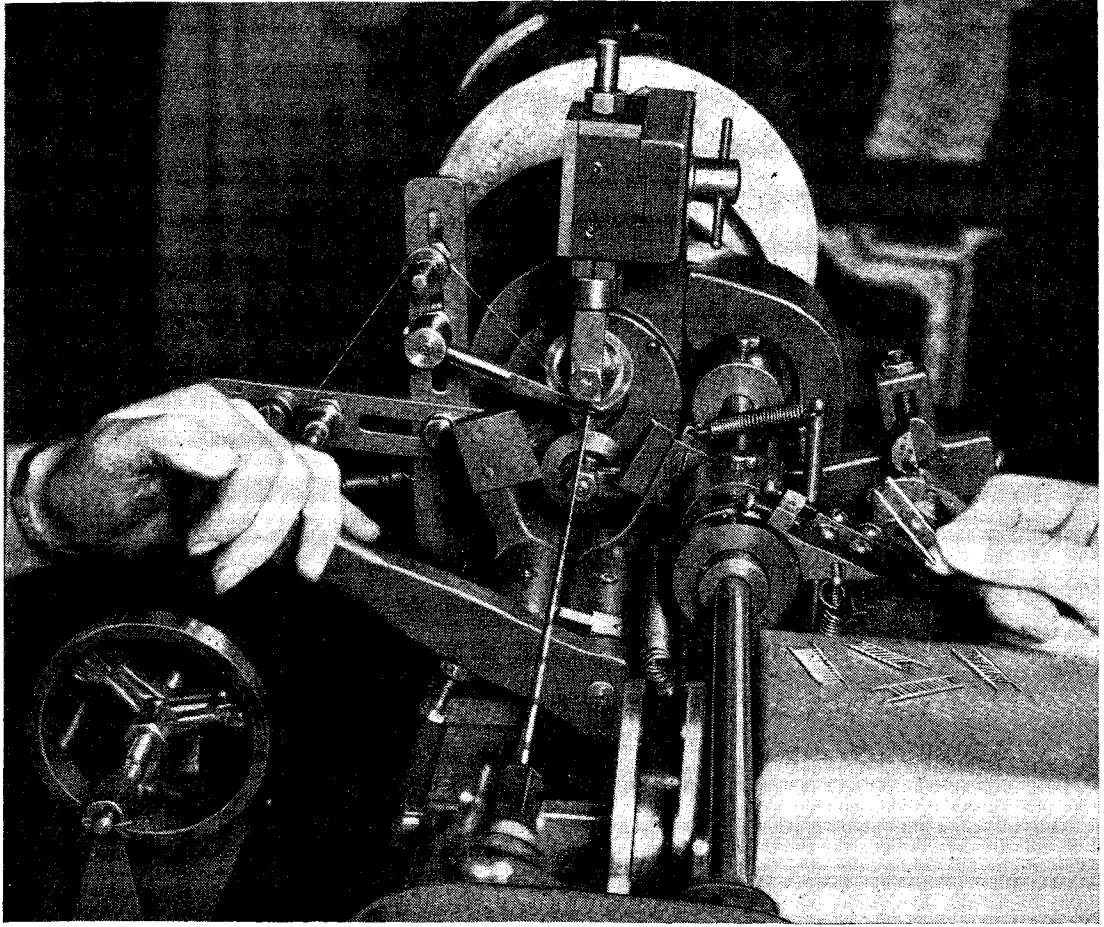


Fig. 9. Velocity diagram of successive electron velocities between input grid and exit grid.

and energy transfer occur at single grids, has led to a concentration of development on this type. The results of these labours must for the present, however, remain a matter for speculation.

Grid Winding

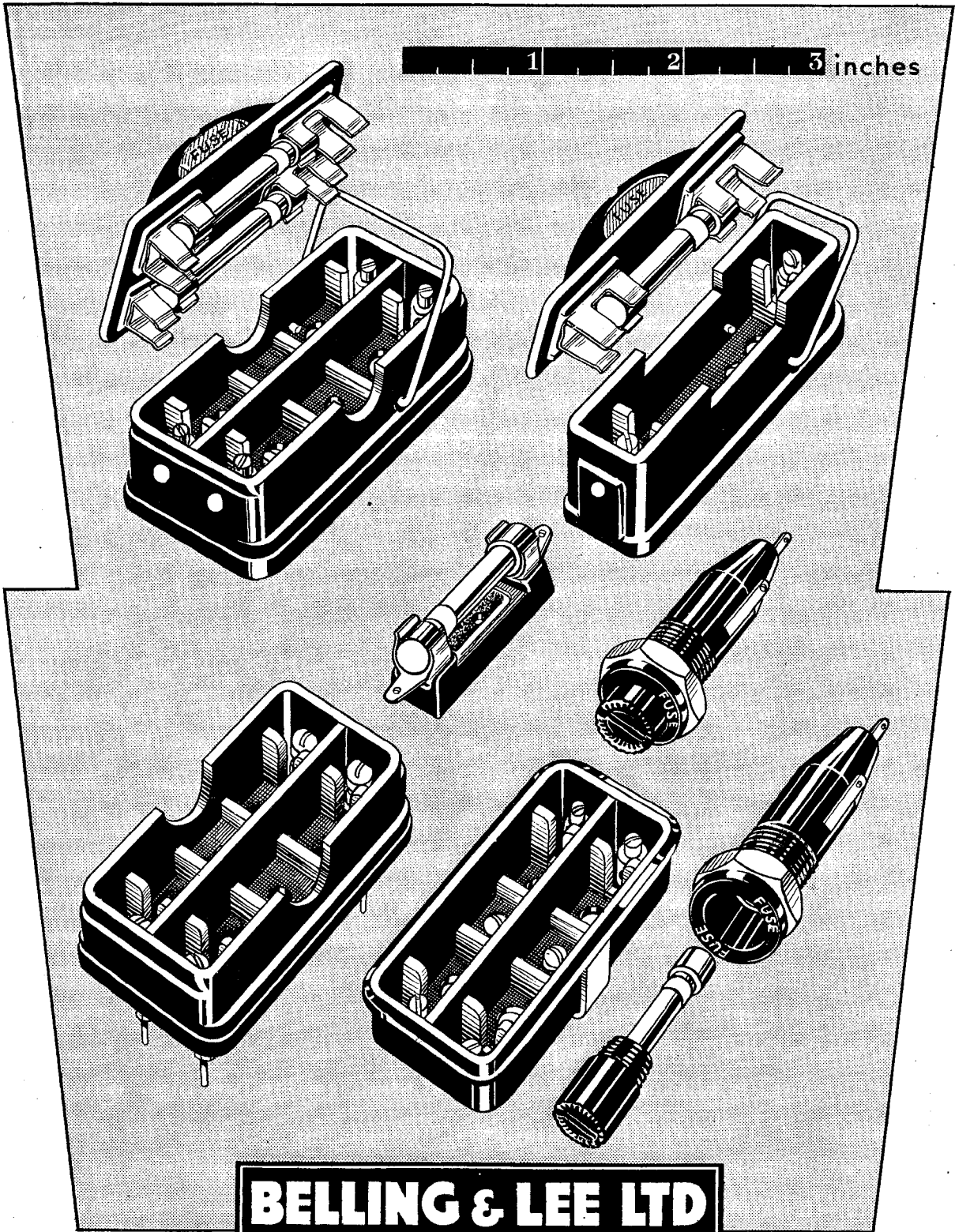


MODERN technique demands the accurate winding of wire down to a diameter of one-thousandth of an inch—less than half the thickness of the average human hair.

It is also necessary to manufacture specially designed exponentially wound grids, and the machine shown in our illustration takes care of this operation.

BRIMAR
BVA
VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.



BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

875

TOLERANCES

Considerations Governing the Fixing of Limits for Radio Components

By

J. T. TERRY

IT is generally realised that some unavoidable errors must arise in the manufacture of any article. Consequently, it is usual to specify tolerances for the more important physical properties, or parameters, to use a mathematical term meaning the same thing.

Now the customer or consumer tends to request fine tolerances on principle, as it were. This tendency is often one of false caution, particularly in radio, for while in civil and mechanical engineering good workmanship and close dimensions are essential for the first-class performance of parts in continuous mechanical motion, in radio parts are fixed in position relative to each other, so that the experience of other industries cannot be translated directly in this respect. In fact, to demand too close a tolerance may actually be inimical to the interests of all concerned, as will be shown later.

All this is more or less realised by manufacturers of components and has received detailed examination in the more specialised communications journals. Also it has led to standard specifications of various components under the auspices of the British Standards Institution and the R.M.A. The reader may nevertheless find interest in a less rigid review of some aspects of the topic.

It is plain that tolerances which are required in practice cannot possibly exceed the accuracy of measurements. A short examination of what accuracies are possible

in laboratory measurement is therefore called for.

Leaving aside the academic question of the fundamental systems of units (e.m.u. and e.s.u.), practical units are derived and commercial laboratory instruments calibrated from the primary standards kept at the National Physical Laboratory and similar institutions in other countries. As explained by Dr. Hartshorn of the N.P.L. in the "Reports on Progress of Physics" for 1939, the units of mass and length may be determined with a maximum accuracy of 1 part in 10^9 . Time intervals, and hence frequency, are common to all systems of units and can be readily checked to within 0.5 parts in 10^6 . A considerable drop in accuracy obtains, however, when electrical quantities are considered. Table I indicates the best which the Electricity Department of the N.P.L. guaranteed in 1936.

hence, the accuracy of works laboratory measurements is generally one or two orders of magnitudes below that of N.P.L. standards, although in some cases incremental readings of the variable standards may be used, e.g., in parallel substitution measurements, yielding results of precision similar to that with which the sub-standard is known. This will be realised on examining Table II.

TABLE II.

Precision of some comparative measurements.

Parameter	Accuracy of Comparison.
Resistance	<0.1 in 10^6
EMF	1 in 10^6
Capacity	$0.001\mu\text{F}$ (calibration of good micrometer condenser)

Table II does not necessarily improve matters unless the customer supplies a sample to the manufacturer for comparison. Rather, Table II indicates that such sources of error as setting accuracy, scale resolving power and backlash may be overcome in good laboratory equipment so as not to impose further limitations on Table I.

Production Aspect

The characteristics of mass produced articles follow the "Normal Distribution Law." This means that when a large number of articles are made and the same parameter is measured for each one of them a graph connecting these values with "frequency" will be of the nature of Fig. 1.* "Frequency" in its present sense has no connection with $\omega/2\pi$, but denotes the number of specimens having the parameter value indicated by the abscissæ. Fig. 1 shows that while the value A is particular among all the other possible values inasmuch as A occurs most frequently (N times) the total number of com-

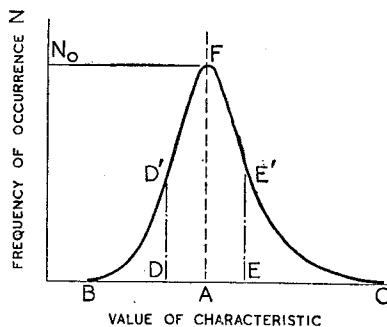


Fig. 1. Frequency distribution curve showing the relationship between the value of a given characteristic and the number of articles having that value.

In addition to this inherent limitation of accuracy it must be remembered that even laboratory standards are subject to drift. Moreover, unknown objects may be measured only by means of multiplying or dividing networks, or variable sub-standards or both;

TABLE I.

Precision of some electrical measurements. (NPL, 1st grade).

Quantity.	Accuracy.
Resistance	10 parts in 10^6
Volt- and Ammeters	1,000 " "
Capacity of screened condenser	100 " " or $0.01\mu\text{F}$ for fixed condenser
Capacity of un-screened condenser	$0.1\mu\text{F}$ for fixed condenser

* See "Statistics and Engineering Practice" by B. P. Dudding and W. J. Jennett, J.I.E.E., July, 1940.

Tolerances—

ponents having other values (i.e. from B to C, excluding A) is much larger. It is consequently not possible to admit of the value A only, in practice. The points E and D illustrate the significance of tolerance limits: the number of acceptable components is represented by the area DD'FE'E, and would have a definite value under given conditions of production. Hence, constant observation of this area is regarded as an essential feature of the modern production process, for any serious defect in the manufacture is likely to show up at once as a reduction. This watch is kept by means of laboratory checks, carried out for the sake of economy and expediency on numerically small samples chosen at random from a large group—the day's output of the component say.

An example may help to elucidate this. Consider Fig. 2 which was obtained from measurements

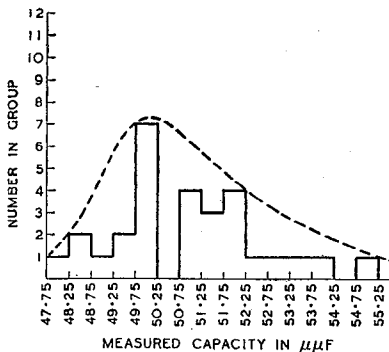


Fig. 2. Distribution curve for 29 condensers with a nominal capacity of $50\mu\text{F} \pm 10$ per cent.

on a sample of 29 condensers with a nominal capacity of $50\mu\text{F}$. Owing to the limited number, the diagram shows discontinuities, but these would gradually disappear if more samples were examined, and the shape of the dotted envelope curve of Fig. 2 would approximate to that of Fig. 1. Fig. 2 shows that some 25 per cent. of the samples are within $\pm\frac{1}{2}$ per cent. of their nominal value. Clearly, it would be uneconomical to specify this tolerance, as 75 per cent. of the production would have to be rejected. Actually, the particular condensers were made to a specified tolerance of ± 10 per cent., and are thus all within the limits.

The example does demonstrate however, the trend towards a higher percentage of rejection if

closer tolerances are specified. Also, allowance should be made for drift in shop sub-standards, as distinct

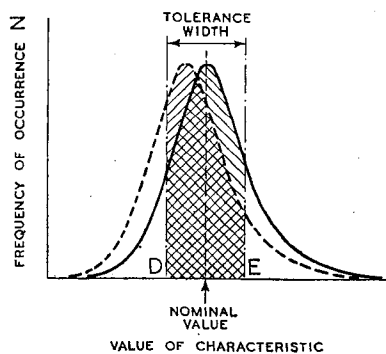


Fig. 3. Showing reduction in number of acceptances resulting from drift in the shop sub-standard.

from laboratory standards. This is illustrated in Fig. 3, showing the effect of a small drift in the value of the shop standard: the distribution curve has been displaced and instead of the number of acceptable articles represented by the shaded area under the full line curve, only the much smaller number (shaded area under the dotted curve) may now be passed.

As many factors contribute to make such displacements unavoidable in practice, expediency demands that the closest tolerance specified should be well in excess of the uncertainty inherent in shop standards. The above also applies although to a lesser extent, where the customer submits his own standards to the manufacturer, as this valuable procedure eliminates uncertainties regarding standards in the laboratory, but not in the shop.

Consumer's Aspect

While cost and delivery time are the only factors to deter the consumer from postulating the closest tolerance possible, he would be served equally well by what might be termed a "functional" tolerance, i.e. a tolerance which is adequate for the function which the component is to perform. For in any wireless instrument, there are some components whose values are not at all critical, and, conversely, others which are very critical; indeed, some in the second group are so critical that even the closest possible tolerance is inadequate; the precise values of such components are adjusted *in situ*, after assembly

of the instrument. Most radio engineers agree that of two contemporary radio sets of similar specification but different manufacture, perfection and permanence of the final adjustments may contribute almost as much as design in making one set superior to the other.

As an example, consider the sensitivity of a receiver. Here, it would be futile to pay much attention as to whether the "Q" of the aerial coil is 100 instead of 105 say, while the mutual conductance of valves varies normally between ± 20 per cent. What counts is the tracking of the aerial and oscillator circuits, and their alignment with the IF stages. Trimming condensers and/or permeability tuned coils are essential for this purpose. The variations possible with the former may be anything between 5 and $100\mu\text{F}$, while the figure is 5 to 100 per cent. of total inductance for coils. In these circumstances, it is irrational but usual for the customer to order quantity produced fixed condensers with a nominal capacity of $100\mu\text{F}$, say, and a tolerance of $\pm\frac{1}{2}$ per cent. This leaves a margin of just five times over guaranteed N.P.L. measurements. Such a procedure will lead to disappointment. A tolerance of ± 2 per cent., say, would have been quite adequate, and a simpler proposition for the makers.

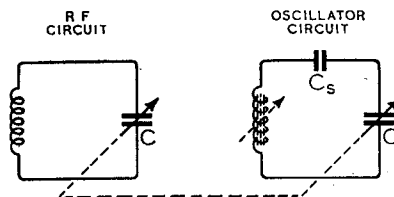


Fig. 4. Basic superhet circuit for the estimation of tolerances.

Next, consider as another example, the series padding condenser C_s in the oscillator circuit of a superhet receiver (Fig. 4): The two nominally identical sections of a variable condenser tune the RF and the oscillator circuits, alignment being provided for in the values of the inductance and the series padder C_s . The effective or total capacity of C_s and C in series is $C_T = \frac{C C_s}{C + C_s}$.

The effect of a change δC_s in C_s on the value of C_T may be calcu-

lated by simple differentiation; this shows that the fractional change in C_T will be

$$\frac{\delta C_T}{C_T} = \frac{C}{C_s + C} \cdot \frac{\delta C_s}{C_s}$$

With a typical variable condenser (50 to 550 $\mu\mu\text{F}$) for C , and a nominal value of 5,000 $\mu\mu\text{F}$ for C_s , the medium wave band extends from 200 to 650 metres say. Then, at 200 m.

$$\frac{C}{C_s + C} = \frac{50}{5050} \doteq \frac{1}{100}$$

and $\frac{\delta C_T}{C_T} = \frac{1}{100} \cdot \frac{\delta C_s}{C_s}$;

and at 650 m.

$$\frac{C}{C_s + C} = \frac{500}{5550} \doteq \frac{1}{11}$$

and $\frac{\delta C_T}{C_T} = \frac{1}{11} \cdot \frac{\delta C_s}{C_s}$

The effect of a small departure of C_s from its nominal value will obviously be negligible at 200 m; while at 650 m, it may cause some error in the calibration of the wavelength scale. Loss in sensitivity will hardly be experienced, owing to the flat top of the aerial circuit response curve. Allowing a maximum error of 3 m. this corresponds to a percentage error of

$$\frac{3}{650} \times 100 \doteq 0.5 \text{ per cent. in}$$

wavelength, and twice this amount, i.e. 1 per cent. in effective capacity.

Hence, $\frac{\delta C_s}{C_s} = \frac{11 \times \delta C_T}{C_T} = \pm 11$ per cent. would be the permissible tolerance of the series padding condenser. A closer tolerance of ± 5 per cent. could be easily guaranteed, yet customers frequently specify ± 1 per cent. for this type of condenser. In a particular case, which probably applies to all manufacturers, a ± 1 per cent. tolerance would have been a simple matter for capacities of the order of 100 $\mu\mu\text{F}$, but very difficult for condensers of the order of 5,000 $\mu\mu\text{F}$: evidently, a little co-operation between customer and manufacturer would have arrived at a wider tolerance, speeded up delivery and, incidentally, reduced costs.

Next to the sensitivity of a set, its selectivity and fidelity may be considered the most important measures of performance. Here again, it may be shown that wide limits for the values of components

are permissible. For instance, cathode bias resistors produce a self-regulating effect and thus allow of quite large tolerances. This is actually well realised, as a consequence, the preferred range of values and tolerances of the larger resistor manufacturers ensures that no item of their manufacture can be rejected because of incorrect values!

Earlier in the war, an advertisement by a well-known firm of set manufacturers revealed that the substitution of 10 per cent. tolerance resistors for 2 per cent. resistors could at the worst lead to a 6 per cent. change in sensitivity; they claimed that this could hardly be noticed. In view of the much wider tolerances usual in valves, not to mention output transformers and loudspeakers, their claim may be viewed as a model of understatement.

Similar considerations apply to measuring apparatus. Since the

screen voltage dropping resistors is essentially determined by the geometry of the valve and the value of the load impedance; while if a large amount of negative feedback is used, the gain is essentially determined by the feedback ratio and rather independent of valve slope and load impedance.

Again, there is the danger of cumulative tolerances. Thus, in the last example but one, tolerances would be cumulative if slope and load impedance were both low, or both high. If the tolerances were ± 20 per cent. and ± 10 per cent. say, the gain of the stage would vary by ± 30 per cent. very nearly; in other words, the difference in the gain of two similar stages, one of low and the other of high value components, would be 60 per cent. Reverting to the case of the simple tuned circuit, it can be shown by simple differentiation that a small change in its inductance or capacitance will change its resonant fre-

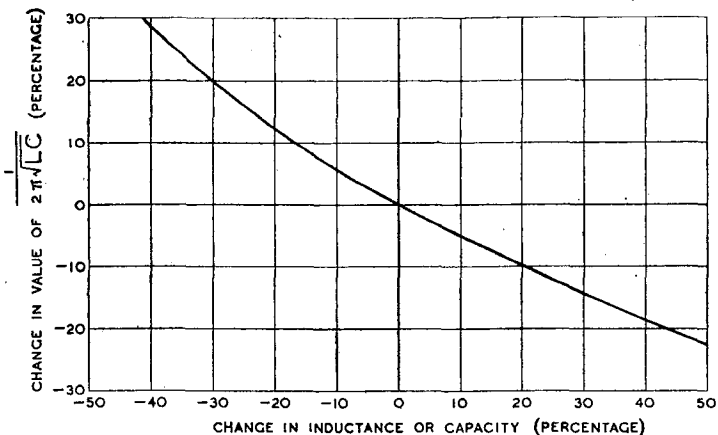


Fig. 5. Relationship between change of inductance or capacity in a tuned circuit and change of resonant frequency.

advent of negative feedback, suitable design renders their precision largely a function of the perfection and permanence of tuned circuits and resistor adjustment, and the conforming of a meter to a specified law—usually of the straight line type. There is some danger in pushing too far the plea for more liberal tolerances, as one might find oneself arguing that the performance of a given circuit is independent of all its component values. This is avoided by careful study of the given problem. As an example, the gain of a Class A voltage amplifier (without feedback) using a pentode with self-bias and

quency by half that amount, and in the opposite direction. For large changes, however, use must be made of the complete formula: Percentage change in resonant fre-

$$\text{quency} = 100 \left[\sqrt{\frac{1}{1+p}} - 1 \right]$$

where p is the fractional amount by which the actual capacity or inductance differs from the nominal. This equation is plotted in Fig. 5 showing that for fairly high positive changes of inductance or capacity changes in frequency are more pronounced than for small or negative component errors.

Tolerances—

Hence, in specifying the widest possible tolerance for a given component, the tolerances of other components in the circuit must be considered at the same time.

Some readers may by now have concluded that sacrifice of quality for the sake of quantity and cheapness is advocated. Quite the contrary; as a matter of fact resources are frequently wasted on ensuring a needlessly close tolerance, and consequently, far more important properties of the component are neglected. To revert to an earlier example, tuned circuits can usually be adjusted as closely as desired to the wanted frequency or frequency law. It is then most desirable that the circuit adjustment should not alter appreciably with time, temperature, humidity and pressure. In other words, what matters is not so much the precise value of the component parameter, but the permanency of this value when adjusted. Yet this is generally ignored by purchasing departments which may specify a very close tolerance for the initial value of a component, but none at all for, say, its temperature coefficient!

Fitness for Purpose

In this connection it is an encouraging sign that one of the most reputable firms of English instrument makers has adopted the slogan "Good enough for the job" in advertising a new product which by its robustness and availability is an improvement over earlier types, while its low tolerances are still adequate in most applications. Since production went up one may

take it that slow if beautiful craftsman's methods had to be put aside. But such a step is basically due to the requirements of mass production technique and merely brought home more rapidly by the war. As mentioned before, it need not lead to a sacrifice of quality. Actually, mass production methods can be combined with a high degree of accuracy and workmanship.

Summary

Present day mass production methods require generous tolerances for component parameters. It is almost always wrong to insist on very close tolerances as this may slow down delivery and lead to more important properties being overlooked. Quality need not suffer if semi-adjustable components are used—possibly as additions to a fixed component—in those sections of the circuit which determine its performance, for such adjustments are necessary at any rate during final test.

Closer co-operation between customer and manufacturer and greater technical awareness of sales and purchasing staffs are essential for the realisation of optimum specifications. The difficulties and requirements of both sides can usually be met if there is sufficient interest to try and understand them. This would increase not only the volume but also the quality of production, and perhaps bring nearer the time when components such as valves, transformers, coils and condensers will be standardised as rationally as resistors are to-day.

BOOKS RECEIVED

The Amplification and Distribution of Sound, by A. E. Greenlees.—This is a revised second impression of a standard work for PA engineers, reviewed originally in the issue of this journal dated March 16th, 1939. The revisions are of a minor character and do not affect the main body of the text. Pp. 255 with 82 diagrams. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 12s.

Instruction Manual for Cossor Ganging Oscillator.—Although intended primarily as a manual for the Cossor Model 343 Oscillator, this booklet stands by itself as a comprehensive treatise on coupled RF circuits and their response curves, and as such is sold separately from the instrument. It is liberally illustrated with circuits and CR oscillograms and contains a useful bibliography. Pp. 44 with 36 diagrams. Published by A. C. Cossor, Ltd., Highbury Grove, London, N.5. Price 3s. 6d.

Frequency Modulation. By K. R. Sturley. This is the first of a series of monographs containing information on specialised subjects to be issued by *Electronic Engineering*. The subject-matter of the present publication is based on a series of articles by Dr. Sturley that have recently appeared in that journal. The advantages and disadvantages of frequency and phase modulation are considered in detail, and there is a very full discussion of the FM receiver. Pp. 58; 30 figures. Published by *Electronic Engineering*, 43, Shoe Lane, London, E.C.4. Price 2s. 6d. (by post 2s. 8d.).

Six-figure Trigonometrical Tables. Giving the six trigonometrical ratios for every minute of arc. Definitions and formulae that are likely to be required in using the tables are included. In pocket size; pp. 54. Published by the Ford Motor Company, Ltd., Dagenham, Essex. Price 1s. 6d. by post.

Experimental Radio Engineering. Second Edition. By E. T. A. Rapson. Describing a number of experiments and methods of measurement devised for use in a three- or four-year course in radio engineering at a technical college. The experiments range from the illustration of simple resonance and the determination of valve characteristics to overall receiver tests and electro-acoustic measurements. Pp. 159; 170 figures. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 8s. 6d.

Foyle's Technical Books Catalogue.—More than 450 subjects, including radio and electrical engineering, acoustics and mathematics for engineers, are dealt with in the November, 1942, edition of this catalogue issued by W. and G. Foyle, Ltd., 119-125, Charing Cross Road, London, W.C.1.

Conserving Paper

THE Waste Paper Recovery Association points out that, as less paper is now going into the home, it is becoming increasingly difficult to meet our war needs by merely salvaging all paper in current use. It is therefore essential that the consumption of paper must be drastically reduced.

Books issued in conjunction with "Wireless World"

	Net Price	By Post
FOUNDATIONS OF WIRELESS, by A. L. M. Sowerby. Third Edition revised by M. G. Scroggie	6/-	6/4
RADIO LABORATORY HANDBOOK, by M. G. Scroggie. Second Edition	12/6	12/11
WIRELESS SERVICING MANUAL, by W. T. Cocking. Sixth Edition	7/6	7/10
HANDBOOK OF TECHNICAL INSTRUCTION FOR WIRELESS TELEGRAPHISTS, by H. M. Dowsett and L. E. Q. Walker. Seventh Edition	27/6	28/3
WIRELESS DIRECTION FINDING, by R. Keen. Third Edition	27/6	28/3
RADIO DATA CHARTS, by R. T. Beatty. Second Edition Revised	6/-	6/3
TELEVISION RECEIVING EQUIPMENT, by W. T. Cocking	8/6	9/-
RADIO INTERFERENCE SUPPRESSION, by G. W. Ingram	5/-	5/4
LEARNING MORSE. 285th thousand	6d.	7½d.
INTRODUCTION TO VALVES, by F. E. Henderson	4/6	4/9

Obtainable from leading booksellers or by post from

ILLIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1

THE WORLD OF WIRELESS

SOUND REPRODUCTION

THE technical basis of sound reproduction was the subject of a paper read by Dr. L. E. C. Hughes at the meeting of the British Institution of Radio Engineers held in the Lecture Hall of the Institution of Structural Engineers on November 21st.

In outlining the scope of his discourse, Dr. Hughes pointed out that a high degree of perfection had been attained in the individual components of the sound-reproducing chain—microphones, amplifiers, etc.—but that there were still many factors which could introduce distortion and unwanted components in the sound reaching the ear. Among these he gave as instances the blurring effect of reverberation, the properties of the ear in relation to loudness and the limitations of single-channel systems of sound transmission.

Listening tests were still the only reliable means of arriving at a final estimate of quality, and he gave details of the methods used to compare the original with the reproduced sound in selecting receivers for approval by the Central Council for School Broadcasting.

A lively discussion of these methods occupied the question time, which gave Dr. Hughes the opportunity of adding statistical evidence of the consistency of the results obtained.

AMERICAN AMATEURS

WHILST the recently formed American War Emergency Radio Service for the maintenance of civil defence communications systems is not exclusively a service for amateurs, it has certainly been a clarion-call to them to make use of their vast experience in communication networks.

It had been suggested that the amateur stations should be linked to form a nation-wide communication system, but this has given place to the present scheme, which does not involve the use of amateur stations as such. It is pointed out by QST that the W.E.R.S. is making temporary use of amateur frequencies and necessarily counting largely on the support of amateurs and the loan of their gear for the establishment of "Civil Defence Stations" by local governments.

The stations will operate in the 112-116, 224-230 and 400-401 Mc/s amateur bands.

BRITISH LISTENERS

IN reply to a recent question in the House of Commons the Assistant Postmaster-General stated that on August 31st, the latest date for which accurate figures were available; there were 8,836,724 wireless receiving licences in force in this country. He also intimated that since that date the number has increased to over 9,000,000.

The figure for August 31st shows an increase of 211,145 over that for December 31st, 1941. This is, however, about 300,000 fewer than the number of licensed listeners on July 31st, 1940.

IMPORTANCE OF RADIO

THE great increase in the importance of wireless communication, radiolocation and other applications of wireless technique in modern warfare were exemplified by two events occurring during December.

Mr. Lyttleton, Minister of Production, announced on December 9th that it having been considered necessary to strengthen the existing organisation for controlling research, development and production in this field, a Radio Board had been set up "as the co-ordinating body in regard to inter-service policy, research, development and production."

Sir Stafford Cripps, the recently appointed Minister of Aircraft Production, who, in addition to his ability as a lawyer, has a scientific bent, will act as chairman in his personal capacity. Much of the work of the Board is carried out through two main working committees, the Production Planning and Personnel Radio Committee, and the Operations and Technical Radio Committee, of which Mr. Garro-Jones, Parliamentary Secretary to the Ministry of Production, and Prof. G. P. Thomson, F.R.S., are respectively chairmen.

The membership of the Board includes representatives of the Admiralty, War Office, Air Ministry, Ministry of Supply, Ministry of Aircraft Production, and General Post Office, as well as several special non-departmental members.

It will be remembered that when the Prime Minister asked Sir Stafford to accept the post of Minister of Aircraft Production he said "the production of aircraft and the development of radio technique lie at the very heart of our affairs."

Another important event concerning radio was that the German-controlled Philips factory at Eindhoven, Holland, had been considered of sufficient importance to send nearly

ASTATIC

CRYSTAL DEVICES

The care and precision with which Astatic Crystal Products are made insures highest operating efficiency and long, satisfactory service. No Astatic instrument ever leaves the factory without first having been thoroughly tested and found to meet the exacting standards of performance that have made these products so desirable. For amateur, studio, public address, intercommunicating sound systems and recording sets Astatic devices are accepted favourites—dependable and yet surprisingly low in cost. Astatic will be ready to supply you again as soon as circumstances permit; in the meantime Astatic crystal devices are doing their part in helping to win the war.

Register your name with our Representative for your future benefit

The
ASTATIC CORPORATION
YOUNGSTOWN, OHIO,
U.S.A.

TORONTO, CANADA

* * *

Exclusively represented by
Frank Heaver Ltd. Kingsley Road,
Bideford, N. Devon

G.I.

VARIABLE CONDENSERS —DRIVES— AUTOMATIC TUNERS

WE are designing and building even better equipment with our enlarged and extended facilities and these improvements will be available for your use when the present struggle is over.

For the time being domestic receiver design and production has ceased but your radio receiver manufacturers will be ready to equip their sets with General Instrument variable condensers, automatic tuners and other G.I. devices as soon as conditions permit.

Always remember General Instruments
**VARIABLE CONDENSERS—DRIVES—
AUTOMATIC TUNERS**

Register your name with our Representative now. He will forward you information on our products as soon as they become available.

**THE GENERAL INSTRUMENT
CORPORATION**
ELIZABETH, N.J., U.S.A.

Exclusively Represented by
Frank Heaver Ltd. Kingsley Road,
Bideford, N. Devon

The World of Wireless—

100 light R.A.F. bombers to deliver a low-level, concentrated attack on the factory in daylight. The works include the largest valve manufacturing plant in occupied Europe, the whole of the production of which goes to the Nazis.

EMPIRE BROADCASTING

TEN years have passed since the opening of the Empire Service by the B.B.C. To record the story of the service and the advance made during this first decade of regular broadcasts from this country for overseas listeners the B.B.C. has issued an illustrated booklet, "Calling All Nations."

Although it was not until December 19th, 1932, that the Empire Service was introduced, it was five years earlier, in November, 1927, that the B.B.C., by arrangement with Marconi's Wireless Telegraph Company, established the 7-kilowatt experimental short-wave transmitter, G5SW, at Chelmsford. It will, however, be remembered that *Wireless World* agitated for the introduction of Empire Broadcasting, a term which we coined, before the opening of the Chelmsford station.

At first the official attitude of the B.B.C. was to throw cold water on the scheme, but we continued to plead that it be given a trial. Our opinions on the practicability of our effective Empire Service were soon confirmed by the successful transmissions to the Netherlands East Indies from the Dutch station, PCJJ, at Eindhoven, in March, 1927.

Great strides have been made in short-wave transmission in the past few years, and with the increased number of transmitters the B.B.C. is literally "calling all nations"—in forty-seven languages. In September, 1939, the B.B.C. was broadcasting in nine languages only.

Whilst for security reasons it is not possible to say how many transmitters are at present in use, it is significant that fourteen short wavelengths can now be employed simultaneously.

Tribute has been paid in the 64-page booklet, which costs rs., to the considerable help given by listeners overseas in building the service. Without their help it would have been impossible, especially in the early days, to determine how successful were the efforts of the broadcasting engineers.

U.S. SHORT-WAVES

SHORT-WAVE listeners will have noticed the considerable improvement in the quality and power of the transmissions from the Schenectady short-wave transmitter of the General Electric Co. This has been due to the inauguration of the new 100-kW WGE0 transmitter. It has been built to replace a similar one transferred to KWID, San Francisco, some months ago to combat Japanese broadcasts in the Pacific.

IN BRIEF

Empire News Bulletins

News in English is daily transmitted by the B.B.C. in its European and World Services at the following times (BST) and in the wavebands listed.

0200 49, 31	1400 25, 19
0345 49	1600 31, 25, 19, 16
0530 49, 41	1700 31, 25, 19, 16
0715 41, 31	1900 25, 19
0900 41, 31, 25	2045 31, 25, 19
1000 49, 41, 31, 16	2245 49, 41, 31, 25*
1200 25, 19	2345 49, 31

* Except Sunday.

Radio Relay Statistics

ACCORDING to statistics just published there were 393,985 subscribers to 278 radio relay exchanges at the end of June, 1942. This was an increase of 11,751 subscribers in three months.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSION

Country : Station	Mc/s	Metres	Daily Bulletins (BST)	Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America				Spain			
WNBI (Bound Brook)	17.78C	16.87	2.0†, 2.45‡, 4.0§, 6.0.	EAQ (Aranjuez) ..	9.860	30.43	6.15.
WRCA (Bound Brook)	9.670	31.02	7.0 a.m., 9.45 a.m.	Sweden			
WRCA	15.150	19.80	2.0†, 2.45‡, 4.0§, 6.0.	SBU (Motala) ..	9.535	31.46	10.20.
WGEA (Schenectady)	9.530	31.48	9.55 a.m., 9.0†, 10.55‡.	SBT	15.150	19.80	4.0.
WGEA (Schenectady)	15.330	19.57	9.0 a.m., 2.0, 3.0, 7.45‡, 11.0.	Turkey			
WBOS (Hull) ..	11.870	25.27	12.45 a.m.†, 12.0 mdt.	TAP (Ankara) ..	9.465	31.70	7.15.
WBOS	15.210	19.72	9.0 a.m., 2.0†, 2.45‡, 4.0§, 6.0.	U.S.S.R.			
WCAB (Philadelphia)	6.060	49.50	6.0 a.m.	Moscow	5.890	50.93	11.0.
WCBX (Wayne) ..	15.270	19.65	11.30 a.m., 3.30, 7.30‡, 9.30.		6.970	43.04	11.45.
WCRC (Wayne) ..	11.860	25.30	11.30 a.m., 3.30, 7.30‡, 9.30.		7.300	41.10	8.0, 9.0, 10.0, 11.0.
WCW (New York) ..	15.870	18.90	3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0.		7.360	40.76	11.0.
WCDA (New York) ..	17.830	16.83	1.0, 2.0.		7.560	39.68	11.0.
WRUL (Boston) ..	11.790	25.45	9.30‡.		9.390	31.95	4.0.
WRUL	15.350	19.54	1.0, 9.30‡.		11.830	25.36	4.0, 6.0.
WLWO (Cincinnati)	6.080	49.34	6.0 a.m., 7.0 a.m.		15.110	19.85	2.15 a.m., 12.40, 11.45.
WLWO	11.710	25.62	7.0, 8.0, 9.0, 10.0.		15.180	19.76	12.40, 11.45.
WLWO	15.250	19.67	3.0, 4.0, 5.0.		15.230	19.70	2.15 a.m., 11.45.
Australia					15.270	19.65	12.40.
VLQ6 (Sydney) ..	9.580	31.32	7.0 a.m.		15.750	19.05	1.0 a.m., 2.0 a.m., 11.45.
YLQ5 (Sydney) ..	9.680	30.99	8.0 a.m.	Kuibyshev	8.050	37.27	8.30.
VLG3 (Melbourne) ..	11.710	25.62	8.0 a.m.		13.010	23.06	6.0 a.m., 2.0, 2.45.
					14.410	20.82	2.0, 2.45.
China				Vatican City			
XGOY (Chungking)	11.900	25.21	2.0, 4.0, 5.15, 9.30.	HVJ	5.970	50.25	7.15.
French Equatorial Africa				MEDIUM-WAVE TRANSMISSIONS			
FZI (Brazzaville) ..	11.970	25.06	8.45.	Ireland			
India					kc/s	Metres	
VUD4 (Delhi) ..	9.590	31.28	8.0 a.m., 1.0, 3.50.	Radio Eireann ..	565	531	1.40‡, 6.45, 10.0.
VUD3	11.830	25.36	3.50.				
VUD3	15.290	19.62	8.0 a.m., 1.0.				

It should be noted that the times are BST—one hour ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of this page.
 ‡ Saturdays excepted. † Sundays only. ‡ Sundays excepted.

Radio and Education

THE President of the Board of Education recently broadcast a talk on education by wireless. He spoke of the increasing part broadcasting was playing in education in this country and concluded: "Broadcasting is a part of the life of the people to-day, and must be part of their education if education is to be up to date."

The Television Society

A VERY satisfactory state of affairs was revealed at the Annual General Meeting of the Television Society, held on December 5th. The impression gained was that the Society will be in a strong position to resume more active work after the war.

All the officers were re-elected, and formal business was followed by a lecture on Colour Television by G. Parr, the Lecture Secretary.

Canadian Apparatus

In a summary of the position of the wireless industry in Canada, a correspondent in the Dominion points out that whilst Canadian manufacturers are unable to make permanent-magnet speakers because of the control of essential materials some British manufacturers are still able to export PM speakers to Canada.

It is estimated that the production of radio equipment in Canada will reach approximately \$250,000,000 in 1943, as compared with \$100,000,000 in 1942.

Brit. I.R.E.

THE British Institution of Radio Engineers has moved to new premises at 9, Bedford Square, London, W.C.1. Until such time as the structural alterations necessary to provide a lecture theatre have been undertaken the general meetings will be held at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1. The next meeting will be held on January 23rd at 6.30, when J. H. Cozens will give a lecture on modern condenser technique, with special reference to electrolytics.

American Pioneer

ROY A. WEAGANT, Chief Engineer of Marconi's Wireless Telegraph Company of America (later Radio Corp. of America) from 1915 to 1920, died recently in U.S.A. He will be remembered by old-time wireless men as the originator of the "Weagant X-stopper," a device designed to reduce atmospheric interference by a balancing-out process. He was also responsible for important pioneer work in valve reaction circuits and direction-finding technique.

I.E.E. Wireless Section

AT the informal meeting of the Wireless Section of the Institution of Electrical Engineers on Tuesday, January 19th, at 5.30, a discussion on "Quartz Crystal Applications" will be opened by Capt. C. F. Booth.

D.C.B. to B.W.C.

A NUMBER of American organisations have recently substituted the word "war" for "defence." The Defence Communications Board is now known, therefore, as the Board of War Communications.

"An Essential Institution"

A FEATURE of the American broadcasting system is the preponderance of small-powered local stations. As a result of a recent survey of listeners conducted by the Medhill School of Journalism of Northwestern University it was revealed that some 90 per cent. of Americans listened habitually to the local station. Commenting on this in a recent article in *Broadcasting* the Director of Research writes: "The local radio station has attained an indispensable place in the social structure of the American community. It is regarded as an essential institution, comparable in usefulness and importance with the schools, the churches, and the Press."

Poland's 20,000 Listeners

GERMAN statistics reveal that in the region of Poland occupied by Germany (with the exception of provinces incorporated in the Reich) only 20,000 people are authorised to have receiving sets. Nothing could better demonstrate the situation in this country of 95,000 square kilometres with a population of more than ten millions, where before the war there were more than a million listeners.

Transmitting Gear in the U.S.

IN an endeavour to ascertain the number of transmitting valves in use in the United States and at the same time to estimate the needs of the broadcasting and telegraph stations for the duration of the war, the U.S. Board of War Communications recently issued a questionnaire to all stations. This is the first move in a scheme to organise a pooling plan for all essential apparatus.

Measuring Cloud Limits

A PHOTO-ELECTRIC cell is incorporated in the latest type of meteorological balloon designed by a United States Government research worker. It is used to indicate the lower and upper limits of cloud through which the balloon rises. The variations in light intensity as the balloon rises into and emerges from a cloud cause the cell to vary the transmitter frequency, the changes in which are recorded by a ground station.

Obituary

WE regret to announce the recent death of Walter L. Fillmore, director of Jackson Brothers, the condenser manufacturers.

St. Dunstan's

THE publication of the twenty-seventh annual report of St. Dunstan's calls to mind the great part that wireless plays in the lives of blinded Service men and women. Until they are able to read by touch broadcasting is their main link with the outside world.

"Wireless World" Index

OUR Publishers advise us that the index and binding case for Vol. XLVIII of *Wireless World*, January to December, 1942, is expected to be ready by the new year. The index will cost sixpence (postage 1½d.) and the binding case 4s. (postage 7d.). Both will be available from our Publishing Office. Arrangements can be made for binding readers' copies at an inclusive cost of 10s., plus 9d. to cover the postage when returning the bound volume.

CROWE

RADIO COMPONENTS

**ESCUTCHEONS
TUNING CONTROLS
DIALS—REMOTE CONTROLS
POINTERS, ETC.**

FOR BOTH HOME AND COMMUNICATION EQUIPMENT

The Crowe organisation, now a part of the Arsenal of Democracy, will have available enlarged facilities after the war.

The Crowe plant will again be devoted to the supply of smartly designed and executed dials, dial scales, escutcheons, pointers and the like for radio receiver manufacturers all over the World.

Crowe also manufactures precision tuning devices for Communication Receivers.

Register your name now with our British Representative for details as soon as available of Crowe Products.

CROWE NAME PLATE & MANUFACTURING CO.

**3701 RAVENSWOOD AVENUE
CHICAGO, ILL., U.S.A.**

Exclusively Represented in Great Britain by
Frank Heaver Ltd. Kingsley Road, Bideford, N. Devon

RAYTHEON

**WORLD'S LARGEST
EXCLUSIVE TUBE
MANUFACTURER**

NEW Electronic developments have created new valve designs. We at Raytheon are indeed fortunate to be placed in the advantageous position of engineering these new intricate designs. Our research engineers have developed special valves to meet the newest of today's electronic developments. We are meeting the demand for valves used in special applications... Raytheon has always been proud of the ability of its engineers to meet any emergency demand for unorthodox valve designs. To-day our pride has been more than justified by the electronic problems they have solved and the quality of the product they are fabricating. When the present conflict is over RAYTHEON engineers will be in possession of priceless electronic experience to build advanced valve designs for better transmission and reception.

Register your name with our Representative now for your future benefit.

**RAYTHEON
PRODUCTION CORPORATION
NEWTON, MASS., U.S.A.**

Exclusively Represented by
Frank Heaver Ltd. Kingsley Road, Bideford, N. Devon

UNBIASED

Thank you, "Cathode Ray,"
but . . .

By

FREE GRID

I WAS greatly moved to learn from his letter, in the correspondence columns of the November issue, that "Cathode Ray" is still in our midst on this war-torn planet, and very glad to have his assurance that the contributions to the world's literature which appeared over his name in recent issues of this journal really did emanate from his obviously versatile pen and not from that of some base usurper, as my recollections of his pre-war writings had wrongly led me to think. Hitler has much for which to answer.

In order to understand the dialectic methods which "Cathode Ray" employs, in replying to the problem which I publicly propounded to him, it is unfortunately necessary to adopt the methods of the psycho-analyst and probe a little into his past. There is, however, no need to go the whole hog and ask him a lot of indelicate medical questions, as it is only necessary to examine the latter part of his letter to see clearly that in his younger days he served his apprenticeship to the political trade like myself. I well recollect that years ago, when I first put up for Parliament, the local party agent urged upon me that the only hope of saving my deposit was to adopt this very same red-herring dodge of fending-off an awkward question by replying vigorously and emphatically to one which



"Fending-off awkward questions."

nobody had asked. I did as he advised, and always think that I owed my success largely to the fact that I promised to oppose strongly any attempt of the other party to repeal Ohm's Law, which I pointed out would mean that all our houses would be plunged into darkness and our cinemas left silent and deserted.

"Cathode Ray" is obviously as practised a politician as myself, for

the question which I asked had nothing to do with that with which he has so vociferously dealt. Briefly, my question was, why is it that a player-piano recording sounds so much more realistic than a gramophone recording of the same pianoforte solo, *ceteris paribus*. I have now been supplied with the correct answer by Mr. A. N. D. Howe, a well-known American savant. The explanation is to be found in our old friend, the "psychic factor" or "mental suggestion." In other words, just because the reproducing instrument is an actual piano, we expect the recording to sound like the original, and so to our befuddled brains it appears to do so.

As for stereophonic reproduction, the player-piano is no more capable of this than a gramophone or radio set, although many of my correspondents seem to think otherwise. I will consider dealing with this question personally in the Brains Trust section, but space and the Editor's temper are both short this month.

Music While You Shirk

AS many of you know the introduction of music-while-you-work programmes into factories is no new thing brought about by the war. It was suggested by myself many years ago that the relaying of wireless programmes to factory operatives might do much to allay the tedium of soul-destroying repetitive work and actually increase production.

I well recollect the first occasion on which my idea was tried out. A large and well-known umbrella factory was equipped with loudspeakers, and all the local dignitaries were invited to take part in the initiation ceremony, the Mayor being delegated to turn on the first programme with a specially made golden switch. Having regard to the nature of the products on which depended the prosperity of everybody connected with the factory from the managing director down to the humblest worker, it was perhaps a little unfortunate that at the moment the Mayor pressed the switch, the B.B.C. orchestra should be churning out, "It ain't a-going to rain no more," a very popular ballad of the period, and it is small wonder that,

as the local paper put it, this unfortunate contretemps put a damper on the whole proceedings.

Actually, it was not the B.B.C.'s fault, as it was purely a coincidence that the loudspeakers were switched on at the moment they were, but the broadcasting authorities cannot be absolved from blame in the matter of the present-day music-while-you-work programmes to which several correspondents have drawn my attention. Apparently the B.B.C. department responsible for these particular programmes is so lacking in imagination and so much behind the times in sociological knowledge that it does not realise that the days when the factory worker was considered to be an ignorant creature, with low and vulgar tastes, have long since passed.

No other explanation is compatible with the dreary daily drool of dismal dirges and cacophonous caterwauling churned out in the music-while-you-work feature. At the request of several of my factory readers, I have made a point of listening carefully to these programmes of late, and I find



Music while you work.

that they appear to consist of nothing but music (?) of this type. There does not seem to be any attempt to put out music of a rather more elevating character. As one of my factory correspondents puts it, good tuneful music seems to be reserved solely for the shirkers, as these tuneful music-while-you-shirk features are not relayed to factories.

I do not ask for super highbrow music which might slow down production rather than speed it up, but is there no *light* classical music available? Even musical comedy stuff would be better than the ultra-low-brow cacophonous crooning, which at present the B.B.C. music-mangling department evidently thinks is suited to what it imagines to be the intellectual level of the average factory worker. It is small wonder that there are ominous reports of secret sabotaging of the PA gear in certain factories.

Letters to the Editor

Hearing Aid "Dangers" ◊ Meter Repairs ◊ Extending Multivibrator Range

Hearing Aids

THIS letter ought to open with an apology for adding yet another contribution to the many already written on the subject of hearing aids, but as a medical practitioner and a reader of *Wireless World* for the past twenty years I feel I have some justification.

Firstly, I should like to point out that there are many diseases and conditions which are the causative agents in the production of deafness. The treatment required may be medical, surgical, physical, environmental or even psychological, or a combination of these. Therefore, I am of the opinion that in the first place, or as soon as possible, the deaf person should consult an ear specialist. He should decide the treatment, and if this includes the use of an aid, he can prescribe in broad outlines the type required.

As regards types, except in the cases of minor degrees of deafness the valve amplifier is the most useful one, and a good quality, mass-produced instrument at a reasonable price would be a boon. At the same time the questions of size, weight, portability and inconspicuousness should also receive consideration. The deaf do not like to advertise their infirmity.

In nerve or inner ear deafness, perception of the higher frequencies is usually impaired to a greater degree than the middle of the auditory range. Therefore, in these cases, an amplifier with a rising characteristic would be of benefit if not always essential. In deafness due to otosclerosis the patients often hear better in a noisy background, and here the carbon microphone is preferable to the crystal type.

An automatic volume limiter would, no doubt, be a great asset, but generally speaking the patient can look after this feature with a manual control. The final test of the suitability of any instrument, however, will depend upon how much it enables the deaf person to hear, and for this a week's trial in home surroundings is essential.

Lastly, as regards the sale of deaf aids the National Institute for the Deaf has attempted to deal with this situation by keeping a list of approved dealers, but hearing aid clinics probably offer the most satisfactory solutions. Retailers with certificates of competency in the electrical and physiological aspects of the subject provide a suitable alternative.

E. M. JENKINS, M.B., Ch.B.
Gatley, Cheshire.

MR. HAMILTON raises, in your November issue, the most important point since the discussion on "Hearing Aids for the Million" started.

He states: "Those who claim that hearing aids should not be distributed through the wireless dealer have still to show that their views are justified by a material number of deaf people being liable to use dangerously unsuitable aids."

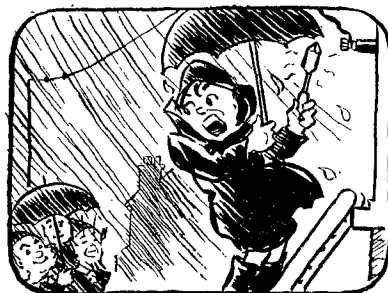
In my experience of nearly 25 years, during which I have come in contact with many thousands of deaf people, I have not met a single person who has complained that any hearing aid has increased his deafness, and deaf people are not reticent with their complaints.

C. B.

Overhauling Moving-coil Meters

"TIFFEY'S" well-written and interesting article gives much valuable information. The following comments may be helpful to the enthusiast who is inspired to try his hand.

"Tiffey's" Fig. 1 is very tempting. But he does not mention that it is about $2\frac{1}{2}$ times the full size of a typical radio meter movement and is, in fact, about the full size of a switchboard meter movement. It is reasonable to assume that the average reader of *Wireless World* is likely to be concerned with the former—an article appropriately referred to by the switchboard-meter-minded as a "miniature." The immediate thought may be, "Yes, but what about the watch-



"All right, m'lads, you can smile,
But I'm what they call 'versatile.'
I can work day or night
Sold'ring wires with FLUXITE,
But weather like this cramps my style!"

See that FLUXITE is always by you—
in the house—garage—workshop—
wherever speedy soldering is needed.
Used for 30 years in Government works
and by leading engineers and manu-
facturers. Of Ironmongers—in tins,
8d., 1/4 and 2/8.

Ask to see the FLUXITE SMALL-SPACE
SOLDERING SET—compact but sub-
stantial—complete with full instructions,
7/6.

Write for Book on the art of "soft"
soldering and for Leaflet on CASE-
HARDENING STEEL and TEMPERING
TOOLS with FLUXITE. Price 1d. each.

TO CYCLISTS! Your wheels will
NOT keep round and true unless the
spokes are tied with fine wire at the cross-
ings AND SOLDERED. This makes
a much stronger wheel. It's simple—with
FLUXITE—but IMPORTANT.

THE FLUXITE GUN

puts Fluxite where you want it by a
simple pressure.

Price 1/6, or filled 2/6.

FLUXITE LTD.
(Dept. W.W.),
BERMONDSEY
STREET, S.E.1.



ALL MECHANICS WILL HAVE

FLUXITE

IT SIMPLIFIES ALL SOLDERING

Letters to the Editor—

maker's eyeglass?" This very useful aid has one drawback. It magnifies all it sees—including the operator's fingers and his tools. Let the beginner therefore set out with no illusions, remembering that the manufacturer employs adolescent female labour for assembling "miniatures," first selecting them for their natural lightness of touch, *and then he trains them.*

Unless he is accustomed to very delicate work the amateur must expect initial disappointments. He may easily ruin at least one instrument before scoring a success. If he can practise on an instrument beyond repair this is the cheapest way of buying his experience. It is not intended to discourage him from trying, but to warn him of the pitfalls. A slightly sticky meter can very easily and rapidly be rendered unusable by the ham-fisted.

"Tiffey" writes: "... the meter itself demands only patience, good eyesight and steady fingers for its renovation." Later he writes: "... these (the repairs) can be attended to by a patient, unhurried and steady-fingered amateur with a little common sense." From these statements there are some rather dangerous omissions. "Unhurried" should be underlined. Steady fingers are not enough. A very light "touch" is essential. If he lacks this the amateur had best confine his activities to the simpler repairs and refrain from taking the meter to pieces. It should be emphasised that in any case dismantling the movement should only be undertaken as a last resort and then only by one who is capable of tackling the successful dismemberment and reassembly of a wrist watch.

Dirt in the airgap is one of the causes of stickiness. It can be removed with a pipe cleaner, a piece of stiff non-magnetic wire and/or the tweezers, without dismantling the movement. If this is fruitless, check the adjustment of the pivots. This is done by waggging the coil *very gently*, holding it with the tweezers. It should not be dead tight, but lateral play should be at a minimum. If the stickiness remains after adjustment, cleaning the jewels and pivots may work a cure, but this is by no means certain. A cracked jewel or damaged pivots may probably be the cause. A pivot in good condition should score the finger nail. A blunt one

will not. Repointing requires skill and experience, a watchmaker's lathe with suitable chuck and a very fine stone. "Tiffey" is probably right in recommending that it shall be left alone. A cracked or scored jewel can be "felt" with the point of a scribe. It is not repairable.

Use only resin as soldering flux. Crack off and remove surplus when cold. It has a habit of coming adrift later and getting in the air-gap.

The simplest and most easily handled balance weight is a helix of lead fuse wire wound on a mandrel of copper wire of suitable gauge. It is fixed with a solution of shellac in methylated spirit. This rapidly dries and sets hard. Adjustments are made later with the second-best pair of tweezers warmed in a bunsen flame. This form of weight is far easier and quicker to adjust than any knurled nut, for which the unsentimental may thankfully substitute it.

One final word. If your meter is usable, leave it alone.

W. R. BISHOP.

London, N.20.

Multivibrators : Extending Frequency Range

IN his article on "Multivibrators" (December, 1942, issue) W. H. Cazaly implies that, in practice, "the upper limit of oscillation frequency is . . . of the order of 200 kc/s or so." I quite agree with this figure for the circuit he shows, but it is by no means a practical frequency limit for a multivibrator.

If a resistance is placed in the cathode circuit of each valve (as in my accompanying diagram), the

Multivibrator circuit with cathode resistors.

maximum anode current of the valves is reduced, due to the cathode bias, and the overall change in anode current, and therefore anode voltage, is lowered. This means that the grid condensers are not charged to so great a potential, and

consequently discharge quicker, so that the frequency of oscillation is raised.

The apparent increase in frequency is to some extent opposed for:—

(a) The grid-leak resistance is effectively raised.

(b) The anode resistance is effectively raised.

(c) The anode-to-cathode resistance of the valves, which forms part of the discharge path for the grid condensers, is increased.

Even with these opposing effects I have found no difficulty in getting a multivibrator to work at 800 kc/s, using ordinary mains-type triodes.

The cathode resistor also cuts down the initial "kick" in the anode current of the valve, and it is possible to get an almost rectangular anode current wave form (see inset diagram).

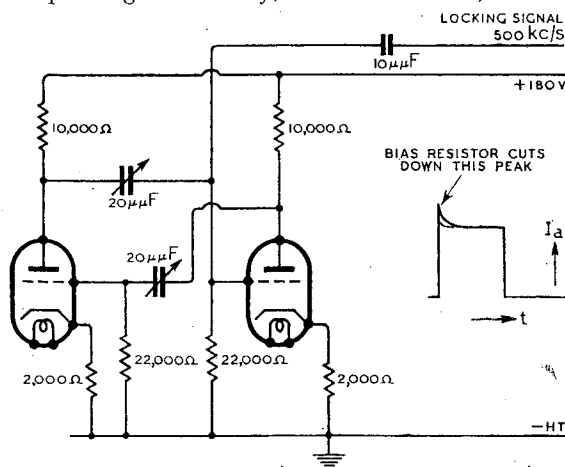
I have had a multivibrator with the circuit constants shown on the diagram running absolutely trouble-free for some 15 months at 500 kc/s.

R. COPSEY.

Worcester Park, Surrey.

Player-piano v. Gramophone

ENCOURAGED by the example of resourcefulness displayed by legal luminaries who base their defence on the twofold plea that their client didn't do it, or, alternatively, if he did do it, it was



justifiable, I face my critics, Messrs. R. W. Haigh and D'Orsay Bell.

First, adopting a technique employed by St. Paul, I set them to fight it out with one another concerning their diametrically opposite views on the pianist's touch con-

troversy (about which I myself expressed no convictions either way). In the resulting confusion I hope to get by with the argument that my stipulation that the player-piano was properly designed and the record properly made would overcome the technical defect mentioned by Mr. Haigh, and, anyway, it hasn't got much to do with stereophony. Finally, I would remind them that it was "Free Grid" I was answering; again with Pauline technique, by being all things to all men.

"CATHODE RAY."

Transmitter Volume Compression

WHILST fully supporting Mr. King's plea, in your December issue, for the adoption of controlled volume compression in post-war transmitters, I feel that there is a danger that his letter may be misunderstood and gain further currency for the very common misunderstandings already existing on this subject.

Mr. King's first point was that the "range of intensities met with in most musical broadcasts is too wide for the average living room," I was glad to note his subsequent (if somewhat grudging) admission that this was not true in the case of high-fidelity reproduction.

It cannot be too strongly, or too often, emphasised that an ideal receiver must reproduce *at the listener's ear* exactly the same intensities and exactly the same range of intensities as would exist *at the listener's ear* if he were seated in his favourite seat in the concert hall. To this end, a very strong case can be made for the view that a controlled compression at the transmitter should be complemented by a controlled expansion in the receiver—both working to the same law.

To support this case, however, Mr. King pointed out that the present manual control of the intensity range by a monitoring engineer "cannot deal satisfactorily with transients." This is only too true, but the statement contains the clear inference that systems of controlled contrast compression or expansion can deal satisfactorily

The Editor does not necessarily endorse the opinions of his correspondents

with transients. This is not the case at present.

A contrast compressor or expander is a system designed for the deliberate introduction of "amplitude" distortion—i.e., it is so contrived that the RMS output of the system is not proportional to the RMS input. Further, the essential difference between "amplitude" distortion and "non-linear" (or "harmonic") distortion is the integration time. Thus, if non-linearity of the system is not a function of the RMS value of the input, but is a function of the instantaneous value of the input, then "non-linear" (or "harmonic") distortion is occurring. It seems an inescapable conclusion that, if transients are to be effectively handled, the control of the compressor and the expander must be instantaneous—i.e., the whole system must be based upon the introduction of inverse "non-linear" distortions.

Most critical matching of the law of expansion to that of compression would appear to be necessary if serious residual "non-linear" distortion is to be avoided. In addition, there would be the problem of that interim period during which the system had been brought into operation on the transmitters, but not on all receivers.

These are difficult problems, but they must be faced after the war. Contrast expansion, as it is used at present, is a sheer absurdity, since it is an attempt to correct an arbitrary (and often misguided) manual compression by a wholly unrelated automatic expansion which is inherently incapable of handling transient or very rapid changes in volume.

J. R. HUGHES.

London, N.W.7.

The Wireless Industry

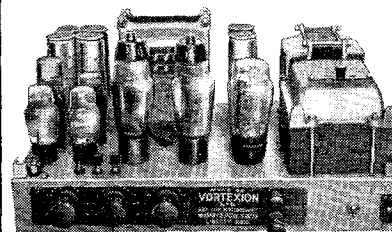
READERS are reminded that a number of firms have prepared calendars for 1943, but, under existing regulations, copies can only be sent on request, and are subject to a charge. For example, the exceptionally useful calendar issued by British Insulated Cables, Ltd., Prescot, Lancs, is still available at 3d.

Grampian Reproducers, Ltd., have moved to Hampton Road, Hanworth, Middlesex. The new telephone number is Feltham 2657/8.

"DESIGNING A RESISTANCE-CAPACITY OSCILLATOR"

A PARAGRAPH heading was omitted on page 281 of this article in the December, 1942, issue, and the last paragraph on the page should begin: "The separator output amplifier should be designed. . ."

The Improved VORTEXION 50 WATT AMPLIFIER CHASSIS



The new Vortexion 50 watt amplifier is the result of over seven years' development with valves of the 6L6 type. Every part of the circuit has been carefully developed, with the result that 50 watts is obtained after the output transformer at approximately 4% total distortion. Some idea of the efficiency of the output valves can be obtained from the fact that they draw only 60 ma. per pair no load, and 160 ma. full load anode current. Separate rectifiers are employed for anode and screen and a Westinghouse for bias.

The response curve is straight from 200 to 15,000 cycles. In the standard model the low frequency response has been purposely reduced to save damage to the speakers with which it may be used, due to excessive movement of the speech coil. Non-standard models should not be obtained unless used with special speakers loaded to three or four watts each.

A tone control is fitted, and the large eight-section output transformer is available in three types: 2-8-15-30 ohms; 4-15-30-60 ohms or 15-60-125-250 ohms. These output lines can be matched using all sections of windings and will deliver the full response to the loud speakers with extremely low overall harmonic distortion.

PRICE (with 807 etc. type valves) £18.10.0

Plus 25% War Increase

MANY HUNDREDS ALREADY IN USE

Supplied only against Government Contracts

VORTEXION LTD.

257, The Broadway, Wimbledon, S.W.19

'Phone: LIBerty 2814

SHORT-WAVE PHENOMENA

TWO abstracts from technical papers of German origin which have recently appeared in *Wireless Engineer* deal with matters of particular interest to those engaged in short-wave work.

The first of these is from a paper¹ by B. Beckmann, W. Menzel and F. Vilbig, and gives details of a particular form of "scattering" in the ionosphere, which results in strong signals being obtained within the skip distance of a transmitter.

As is generally well known, there is, for any particular point on the earth's surface not too far distant from a short-wave transmitter, a certain frequency which, with a given state of ionisation in the ionosphere refracting layer, is the highest that is returned to earth at that point. Waves of higher frequency than this, going up at the same angle, will penetrate the refracting layer, while waves of lower frequency will be receivable at the point in question and also at points nearer the transmitter. Similarly, when the ionisation in the layer is steadily increasing or decreasing, there comes a time for any particular frequency to be the highest which is returned to earth at the given point. At this time all points nearer to the transmitter lie within the "skip distance" for that frequency, and refracted waves are not receivable at them.

Weak and Unsteady Signals

Within the skip distance, and beyond the limits of the ground wave, signals of a kind are, however, normally obtainable, but they are of a generally weak and unsteady nature. These are due to the fact that, during the upward passage of the wave towards the F layer, it passes through the E layer, and here a portion of the energy in the wave is "scattered" by ionic clouds which nearly always exist in the lower layer. Some of this "scattered" energy is sent downwards so as to reach the earth within the skip distance for the refracted wave. It must be stressed, however, that this normal type of scattering provides only weak sig-

Modified Views on Propagation

— — —

nals, which are not to be compared with those due to a refracted wave.

According to the abstract the German workers carried out their observations at Munich and found that, after that place came within the skip distance for the London 25-m. wave, the London 19-m. wave "could almost always be heard at great strength." Of course, Munich would fall within the skip distance for a London 19-m. wave before doing so for a London 25-m. wave. Secondly, the 19-m. transmission of Zeesen, for which Munich was within the skip distance for the whole of the observing period, was frequently audible at *very great strength*, and on these occasions its signals did not, in fact, show any effect of "skipping." These strong signals could not have been due to the normal scattered radiation, and they are explained by the authors as follows: When, after the ionisation in the F layer has fallen below the limit necessary to return the wave to earth at the point in question, the transmission still is not interrupted, because the refracted rays are replaced by other rays which are deflected by the ionic clouds in the E layer on their upward journey, so that they fall more obliquely on the F layer than those going by a direct path. Under these conditions they are refracted by the F layer, and, reaching the E layer, are again deflected, this time downwards to earth.

The E region clouds do not act with the F layer to bring about this result on all occasions, for sometimes there is only the normal weak reception, which is due to the scattering from the E layer clouds acting by themselves. But, the German workers state, the strong reception was obtained during 50 per cent. of the observations, and if this is so it would appear that it should be taken account of in the planning of short-wave communication services to points not greatly distant.

Workers other than the Germans have also observed the fact that, at

these distances, strong reception on frequencies which should normally skip is often obtainable, but whether it is due to some other effect in the E layer is not yet definitely known.

The other matter of interest to short-wave workers is from a paper² by G. Leithauser, dealing with, among other things, the behaviour of the F₂ layer. According to the abstract, the author of the paper is not satisfied with the generally accepted theories seeking to account for the daily and seasonal variations in the F₂ layer critical frequency, and on this point he will, no doubt, find many to agree with him. Certainly, when it comes to practice, there do seem to be some points which still require explanation, more particularly in the matter of the low working frequencies which—if the measured critical frequencies are correct—should obtain during the summer day. Practical results show that these can often be considerably exceeded.

The critical frequency of the layer, i.e., the highest frequency return for a wave sent vertically up, is generally assumed to be that for the wave which is returned from the point of maximum electron concentration in the layer. According to this idea, all waves of higher frequency penetrate to a point higher than this, where the electron concentration is falling, and so they are not returned.

Attenuation and Frequency

The German writer bases his ideas on the fact that when a wave penetrates into the layer it becomes subject to a type of attenuation which increases with increasing frequency. Under certain conditions, he states, when the critical frequency measurements are made, what is obtained is *not* the point of maximum electron concentration but a point from where, as the electron concentration increases, the attenuation rises with increasing frequency. This means that the point of maximum electron concentration lies higher than the point to which the wave of critical frequency reaches, and that higher frequencies fail to return, not because they penetrate the layer,

¹ Abstract 1279, *Wireless Engineer*, May, 1942.

² Abstract 2275, *Wireless Engineer*, August, 1942

COMMUNICATIONS DEPEND...

but because they are completely attenuated. Thus the critical frequencies recorded for the summer day are too low, and this fact may give rise to all sorts of errors when the vertical incidence measurements are applied to the oblique case, as they are in the practical forecasting of working frequencies. Furthermore, according to the author, the error in the measured critical frequency is not confined exclusively to the summer day.

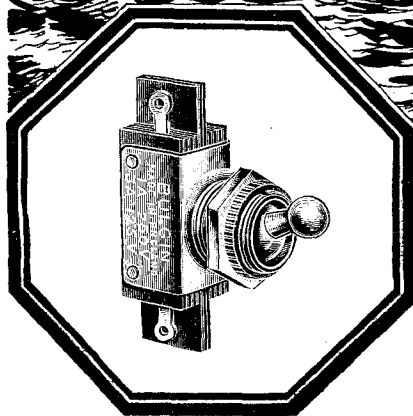
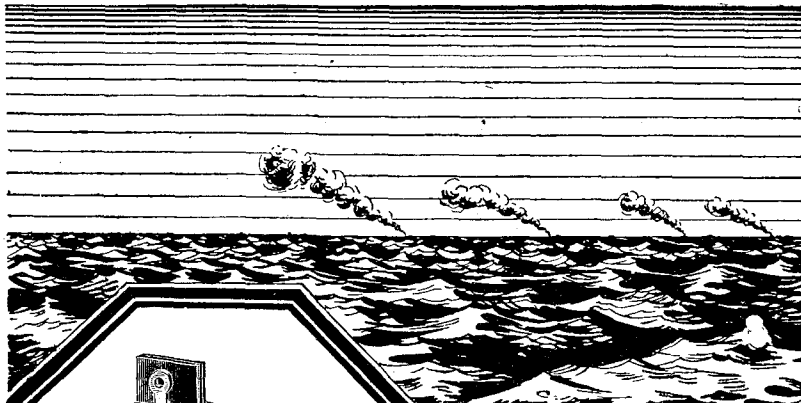
One would have thought, however, that it would have been relatively easy to determine whether the measured critical frequency was, in fact, due to the point of maximum electron concentration having been reached, or whether, on the other hand, it was due to attenuation of the wave with rising frequency. For example, does the virtual height increase very rapidly at frequencies near the critical frequency? If it does not, the implication would appear to be that the point of maximum electron concentration does lie higher in the layer, and that waves of frequency greater than the critical would, if they did not fail to return because of being attenuated, show increased virtual heights. If, however, the curve of virtual height against frequency is rising almost vertically near the critical frequency, one would infer that the point of maximum electron concentration is being reached, and that the failure of higher frequencies to return is due to penetration of the layer.

Power Effect?

Again, does the critical frequency vary with the power radiated? If it does it would appear that attenuation is the deciding factor, because attenuation can be overcome by an increase in radiated power, whereas electron limitation determines the critical frequency quite independently of the power radiated. It ought, therefore, to be possible to determine whether it is, in fact, the true critical frequency which is being measured or not.

On the whole—so far as the abstract goes—one would conclude that, in that part of the paper which deals with F₂ layer behaviour, Leithauser has not quite proved his point, and that, to account for the anomalies previously mentioned, further work is necessary.

T. W. B.



ON SMALL PARTS...

IN countless instances quite intricate pieces of apparatus are wholly dependent on the proved reputation and reliability of their component parts.

All products from the House of Bulgin are pre-eminent for superior design and workmanship and every article bearing our Trade Mark has to pass exacting and exhaustive tests during the course of its production.

We ask the kind indulgence of the Trade on delivery until peaceful conditions return.

The Choice of Critics

BULGIN FOR SWITCHES

The best Radio and small Electrical Switches in the world. Every one is the finest of its class, and the best for any job. Snap-action, low and constant contact resistance, reliable performance for tens of thousands of operations: all these are permanent characteristics.

“The Choice of Critics”

BULGIN

REGISTERED • TRADE • MARK

A. F. BULGIN & CO. LTD., BY-PASS RD., BARKING,

TEL. : RIPPLEWAY 3474 (4 lines).

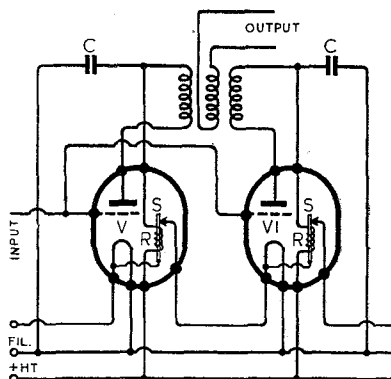
ESSEX.

RECENT INVENTIONS

AUTOMATIC VALVE REPLACEMENT

IT is an advantage, particularly in repeater and other "unmanned" stations, to make provision for automatically replacing any valve-unit developing a fault. In the arrangement shown the valve V includes a thermal strip S which closes a contact as soon as the valve goes cold, and so brings a stand-by valve V₁ into operation. The thermal switch is included in the common filament supply so that both valves are initially in circuit, but as soon as the valve V warms up, the valve V₁ is cut out and remains idle until the first valve develops a permanent fault. The closing of the switch may also be arranged to ring an alarm at the nearest terminal or attended station.

In addition to the ordinary dissipation heat, a further temperature control, in the shape of a resistance coil R in shunt



Thermal valve switch

with the anode, may be wound around the thermal strip. As shown, this resistance in combination with a condenser C also serves as a decoupling circuit.

Standard Telephones and Cables, Ltd., and B. B. Jacobsen. Application date October 11th, 1940. No. 544475.

UHF TUNING

THE resonant frequency of a pair of coaxial conductors depends upon their distributed inductance and capacity. According to the invention, the tuning of a line circuit of this type is varied by means of a rotatable copper vane which is inserted between the two conductors, preferably at the current loop. In one position of the vane it cuts a maximum number of magnetic lines, and so reduces the overall inductance of the system. When turned through a right-angle it will cut no lines, and there will be no eddy-current effect to reduce the inherent inductance.

A lateral projection at the free end of the vane co-operates with a shaped plate on the inner conductor to vary the capacity between the lines from a maximum to a minimum in step with the inductance.

The arrangement is applied to a receiving system to which the vane is automatically rotated to compensate for frequency drift.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of B. Trevor). Convention date (U.S.A.) June 20th, 1940. No. 546069.

A Selection of the More Interesting Radio Developments

SURFACE RESONATORS

A LOW-LOSS tuning device for very high frequencies consists of a hollow ring or toroid of ceramic material with an inside coating of metal, preferably silver. A narrow slit is made around the periphery of the ring to increase the inherent or distributed capacity and to provide an electrode for exciting the element or for coupling it to a load. The internal metal coating screens the ceramic material from the oscillatory field inside the toroid; and so prevents hysteresis losses, as well as frequency drift due to the resultant heating. At the same time the ceramic ring protects the thin silver coating from damage.

Philips Lamps, Ltd. (communicated by N. V. Philips' Gloeilampenfabrieken). Application date July 8th, 1940. No. 544475.

RADIO NAVIGATIONAL BEAMS

RELATES to aerial systems for marking out a navigational course or approach path by means of overlapping beams. In some cases the aerials are arranged to radiate beams both to the front and rear. The forward beams are directed across the landing field and form the proper approach path, whilst the others extend backwards and are used either for identification or orientation purposes.

It may happen that objects such as telegraph wires, buildings or trees come within the field of the back beams and reflect part of this radiation field forward, so that it distorts the true path formed over the runway. The invention describes several ways of effectively screening the front beams from the effects of such undesirable reflection from the rear.

Standard Telephones and Cables, Ltd. (Assignees of A. G. Kandoian). Convention date (U.S.A.) January 3rd, 1940. No. 545876.

"DUPLIX" TELEVISION

WHEN television broadcasting is resumed there would be no great technical difficulty in providing a better service by increasing the number of scanning lines transmitted per frame. The difficulty is that such an advance would render existing receivers obsolescent.

As a compromise it is proposed to transmit a 600-line scan made up of three interlaced 200-line scans. Existing

The British abstracts published here 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.

receivers would then reproduce a 200-line picture, whilst later models, fitted with suitable interlacing means, would benefit to the full extent of the 600-line service. Alternatively, the transmission could be made by scanning a succession of 200-line blue, red, and blue pictures so that the blue lines of the first picture are covered by the red lines of the second picture, and so on. Suitably equipped receivers would then reproduce pictures in colour, whilst older models would still give satisfactory reproduction of a 200-line picture in monochrome.

J. L. Baird. Application date September 7th, 1940. No. 545078.

RECEIVING CENTIMETRE WAVES

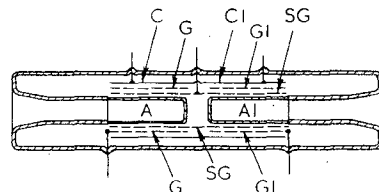
THE filament of a diode, triode or multigrid valve is connected across the centre terminals of a dipole aerial, so that the energy of the received waves varies the electron emission. The filament is preferably pre-heated to a threshold temperature where the effect of the incoming signals is most pronounced.

The terminals of the dipole may be fused into the glass walls of the valve or may even be completely enclosed in it. The filament is connected through chokes to the pre-heating battery, whilst the anode is connected to a high-tension supply through a resistance load across which the rectified signal is developed.

S. R. R. Kharbanda; M. C. Goodall; and Pye, Ltd. Application date, March 21st, 1941. No. 540505.

PUSH-PULL VALVE

THE figure shows a high-powered amplifier or oscillator, for push-pull operation, in which both pairs of electrodes are contained in the same evacuated space. The two anodes A, A₁ are fitted to a re-entrant part of the glass holder, so that both can be water-cooled. They can also be set close to

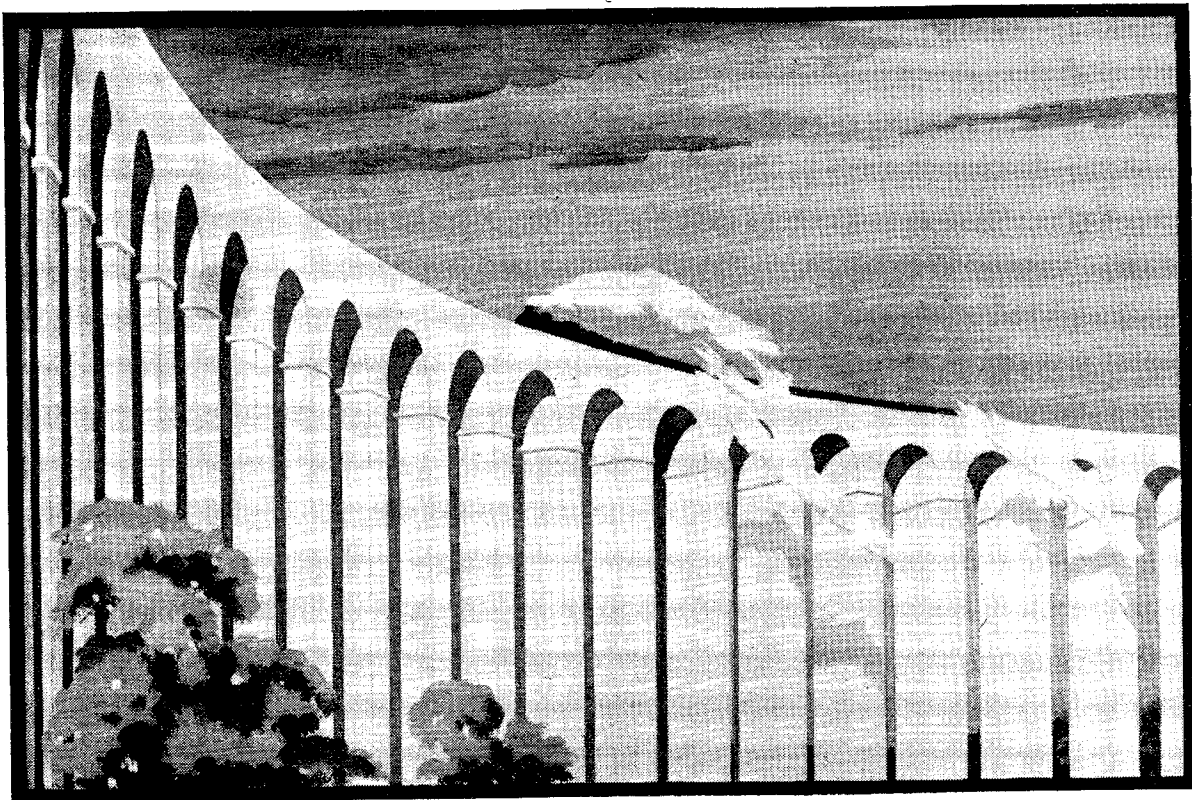


Push-pull valves in one envelope.

each other without creating any high-frequency field likely to destroy the welding between glass and metal.

A single screen grid SG, of cylindrical form, surrounds the anodes, and is associated with separate control grids G, G₁. The cylindrical cathodes C, C₁ are outermost, giving an assembly which is the "inverse" of that normally used. The arrangement permits the use of short grid leads and short cathode supply conductors. Also, since the cathode is of large diameter, it can be made of a number of thin wires, thus giving a high mutual conductance.

Philips Lamps, Ltd. (Communicated by N. V. Philips' Gloeilampenfabrieken). Application date, August 23rd, 1941. No. 546376.



Valves and Viaducts

To the engineer, accurate knowledge of the presence and precise form of vibration is a matter of paramount importance.

The structural engineer needs to define and evaluate the stresses and strains on massive girders and framework; the mechanical engineer is concerned with the smooth transmission of power and the elimination of heavy wear and tear on plant and machinery.

With the aid of Mullard Valves in specially designed apparatus, vibrations having an amplitude as low as a few microns can be easily and accurately measured.

In almost every branch of engineering practice, problems are constantly being solved and the field of knowledge widened through the application of the thermionic valve—and Mullard have the right valve for the purpose.

MULLARD

THE MASTER VALVE

A Valve for Every Purpose

DOMESTIC · COMMERCIAL · INDUSTRIAL · SCIENTIFIC · MEDICAL · EXPERIMENTAL

THE MULLARD WIRELESS SERVICE COMPANY LIMITED, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2. (44A)

IMPORTANT NOTICE

Dear Radio Friends,

Owing to our increased turnover, we have been forced to give up our premises at Ruislip as we find these are too small for the efficient handling of the extra business. We have, then, much pleasure in announcing that we have acquired large and commodious premises at

246, HIGH STREET, HARLESDEN, N.W.10,

where we will in future deal with and dispatch your orders.

As the change-over will take place during the Christmas holidays, we will be fully equipped to deal with all enquiries and orders after December 28th at our new address. We feel sure that with the added floor space and facilities, we shall be able to deal much more efficiently than before with your business, and we shall be able to give a much better service than in the past.

We further have had the good fortune to acquire a number of very large and interesting parcels of all types of valves, both British and American. The change-over then will very appropriately make

J. BULL & SONS

one of the **LARGEST RADIO RETAILERS IN THE UNITED KINGDOM.**

With the compliments of the season and best wishes to my many friends,

I am,

Yours sincerely,

J. BULL.

P.S.—Most of the valves and spares detailed in our previous advertisements are still available for immediate delivery from stock.

J. BULL & SONS

New Address : 246, High Street, Harlesden, N.W.10.

TUNGSRAM VALVES

Our production of Radio Valves is both large and continuous. So, too, is the demand for them for urgent purposes. Some are available for domestic use, but the range is necessarily limited. You may be assured of our willing help whenever possible.

Announcement of

BRITISH TUNGSRAM RADIO WORKS LTD., WEST RD., TOTTENHAM, N.17

LEARN MORSE

THE "CANDLER" WAY

★ Read what these Candler students say!

THE "KEY" TO SUCCESS

"I should just like to state that to anyone desirous of learning Code quickly, the 'Key' to success is given right at the commencement of the Candler Junior Course." *Ref. No. 2102, J. H. L.*

I AM VERY SATISFIED

"The whole course was a pleasure from start to finish, without even a dull moment. I can confidently send and receive at 20 words per minute. I am very satisfied with the tuition." *Ref. No. 2032, O. H. O.*

IN ONLY THREE LESSONS

"I have only got as far as Lesson 3, but I can receive 12 w.p.m., and send much faster." *Ref. No. 4061, J. A. S.*

A GOVERNMENT TELEGRAPHIST

"I had no knowledge of Morse whatever before taking the Candler Course. I have now secured a Government post as a telegraphist." *Ref. No. 3171, R. G. S.*
IMPORTANT.—You or any friend of yours in London can call and inspect the originals of these and many other similar letters from Candler students.

In the "BOOK OF FACTS," which will be sent FREE on request, full information is given concerning the subjects covered by all Candler Courses.

JUNIOR Scientific Code Course for beginners. Teaches all the necessary code fundamentals scientifically.

ADVANCED High-speed Telegraphing for operators who want to increase their w.p.m. speed and improve their technique.

TELEGRAPH Touch Type-writing for those who want to become expert in the use of the typewriter for recording messages.

Terms: Cash or Monthly Payments.

COUPON

Please send me a Free Copy of Candler "Book of Facts."

NAME
ADDRESS

Post Coupon in 1d. unsealed envelope to London Manager
THE CANDLER SYSTEM CO. (Room 55W),
121 Kingsway, London, W.C.2

Candler System Co., Denver, Colorado, U.S.A. (942)



I.F. TRANSFORMERS
of all types
AERIAL & OSCILLATOR COILS
TRIMMER & PADDER
CONDENSERS
"SILVERCAP" CONDENSERS
COIL FORMS, etc.

Our factory has been expanded considerably, our knowledge is increasing daily and our added experience and facilities will be available for you as soon as conditions permit.

We are making many intricate parts for the U.S. Army, Navy, Air and Signal Corps, and we are happy to assist in the great effort to bring this struggle to a successful conclusion.

Sickles I.F. transformers, coils, trimmers and other radio parts will be ready for you again in due course.

Register your name with our Representative now. He will forward you information on our products as soon as they become available.

The F.W. SICKLES Co.
CHICOPEE,
MASS., U.S.A.

Exclusively Represented by
Frank Heaver Ltd. Kingsley Road, Bideford, N. Devon

Procrustes had a Bed

That amiable acquaintance of Hercules, giant Procrustes, had a crude but effective method of dealing with the misfits whom he invited to sleep in his bed. Should they be too long, then off came as much of their legs as necessary... too short, then a gentle stretching on the rack remedied the fault. Such barbaric methods of making things fit, however, do not need to be practised on a Gardner Transformer—each is designed and built to do its job efficiently and well without post-cutting and stretching. There are no misfits and nowhere in the range is this suitability for the job more exemplified than in the Small Power Transformers up to 4 kva. So when next a specification says, in effect, "Procrustes' Bed is out," ask for our co-operation.

We regret that at present Small Power Transformers are available for highest priority orders only.



GARDNERS RADIO LIMITED
SOMERFORD · CHRISTCHURCH · HANTS

CLASSIFIED ADVERTISEMENTS. Rate: 6/- for 2 lines or less, and 3/- for every additional line or part thereof, average lines 5-6 words. Each paragraph charged separately. Press Day: February issue, first post January 15th, one day earlier at branch offices. Box Numbers: 5 words, plus 1/-. Deposit System: particulars on request. No responsibility accepted for errors.

TRANSFORMER DISTORTION

An abbreviated version of the original thesis by Dr. Norman Partridge on "Harmonic Distortion in Audio Frequency Transformers" is now available in booklet form. This has been reprinted from the September, October and November issues of "The Wireless Engineer." The subject is treated technically at length, and from an essentially practical viewpoint.

Copies can be obtained free of charge by professional engineers and technicians upon request. The shortage of paper prohibits distribution to interested amateurs.

N. Partridge

Ph.D., B.Sc., M.I.E.E., M.Brit.I.R.E.,

Kings Buildings, Dean Stanley Street, LONDON, S.W.1. Vic. 5035.

ARMSTRONG

Greetings

to the many friends we have made through The "Wireless World" during the past ten years.

We sincerely hope that 1943 will be a happier and brighter year, and look forward to the time when we can once again resume our normal happy relationship with you all.

ARMSTRONG MANUFACTURING CO.
WALTERS ROAD, HOLLOWAY, LONDON, N.7
Phone: NORth 3213

NEW RECEIVERS AND AMPLIFIERS
£30—Home-built school radio-gram, A.C.-D.C., unusual clarity, meter, etc.—Sundays.—148, Barnhill Rd., Wembley, [1435]
HIGH Fidelity 18 watt A.C.-D.C. Chassis, complete with valves and input and output transformers, base and treble controls, twin faders, 18gns.—Below.
DANCE and Stage Amplifying Equipment, complete transportable units, Universal, 18 watt, twin faders, M/C microphone, folding telescopic pedestal stand, pair auditorium speakers, all cables; 36gns.—Broadcast and Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich. [1441]

£19/10 Only.—7-valve "Wireless World" Quality amplifier chassis, with tone control stage, 8 watts push-pull Triode output; price includes all valves and 12in. speaker with triple cones; as above, but 8 valves 15-watt tetrode output, with negative feed back, £22; limited number.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [1388]

RECEIVERS, AMPLIFIERS—SECOND-HAND
"EDDYSTONE" All World 8 By. Rec. E.Q.P.P., plug-in coils 16 to 2,000 metres; £15.—Sullivan, 96, Hervey Rd., Blackheath, S.E.3. [1414]

MIDWEST Console (English), AC/DC, 1939, 14-valve, 4 to 2,000 metres, overhauled, perfect; 35gns.—Box 2789, c/o *Wireless World*. [1430]

"WIRELESS World" Quality Amplifier, twin speakers and portable electric gram. unit, fine condition.—A.C.S. Radio, 44, Widmore Rd., Bromley, Kent. [1412]

S.S. Four-band Super Six, S.S. 12-watt amplifier, S.S. 4-valve contrast expansion unit. Voigt speaker with domestic horn; offers invited.—Box 2786, c/o *Wireless World*. [1426]

TELEVISION Chassis by Pye, brand new, complete with tube and all valves, limited quantity; £19/10 each.—Imhof's, 112-116, New Oxford St., W.C.1. Museum 5944. [1393]

Wanted

MIDGET Receiver Wanted, new or second-hand, voltage.—Box 2791, c/o *Wireless World*. [1433]

COMMUNICATION Receiver, would collect.—Phone 55011, or write 2, Cliff Road Gardens, Leeds, 6. [1448]

WANTED, high-class American receiver, all-wave, all-mains.—Redway, Lovelace Crescent, Exmouth, Devon. [1402]

COMMUNICATION Receiver, top notch outfit. Will pay high price for new or used set.—Dr. Talbot, Livermead, Torquay. [1404]

WANTED, Quality Amplifier with RF and tone-control stages (modified version), PX4S, or similar professionally built equipment, less valves, speaker.—Box 2783, c/o *The Wireless World*. [1411]

NATIONAL One-to-Ten Receiver, with complete set of coils; battery or mains operated; or similar receiver with a range of from 1-10 metres.—Kenneth Vinson, Boughton Place, Sandway, Maidstone, Kent. [1420]

LONDON CENTRAL RADIO STORES Will Pay Good Prices for Receivers, Radiograms, Amplifiers, Dynamos, Converters, Test Equipment, Electric Gramophone Motors, and all Radio and Electrical Accessories. London Central Radio Stores, 23, Lisle St., London, W.C.2. Gerrard 2969. [9336]

NEW MAINS EQUIPMENT

VORTEXION Mains Transformers, chokes, etc., are supplied to G.P.O., B.B.C., L.P.T.B.; why not you? Imitated but unequalled Orders can only be accepted against Government contracts.

VORTEXION, Ltd., 257, The Broadway, Wimbledon, London, S.W.19. Phone: Lib. 2814. [9942]

NEW LOUSPEAKERS

BAKERS SELHURST RADIO, the pioneer manufacturers of moving coil speakers since 1925.—Bakers' brand new surplus speaker bargains; every music lover interested in realistic reproduction should write for free descriptive leaflet now; £3/10, brand new super quality triple cone speaker, permanent magnet model; limited number available under list price, wide frequency range, even response, ideal for quality reproduction; leaflet giving constructional details of an infinite baffle cabinet suitable for use with the above speaker free upon receipt of stamp.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [1389]

SECONDHAND LOUSPEAKERS

VOIGT Double-cone Speaker in Cast Aluminium Housing, £17.—Harris, Strouds, Bradfield, Berks. [11396]

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

A 65-watt SOLON for general use



This 65-watt Industrial type SOLON Electric Soldering Iron is fitted with an oval tapered bit—a shape which is suitable for most general work. For specialised work the pencil bit model is recommended, whilst bigger jobs call for the 125-watt or 240-watt models.

Supplies of these various models are only available for essential work, of course, and due to heavy demands it is necessary to order well in advance to avoid disappointment in delivery.

Details of this and other models sent on request.



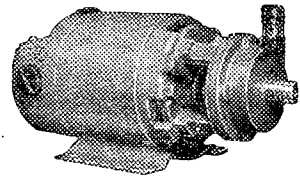
MADE FOR USUAL STANDARD VOLTAGES

W. T. HENLEY'S TELEGRAPH WORKS CO. LTD.
Engineering Dept., Milton Court, Westcott, Dorking, Surrey

L.R.S.

STUART PUMPS

As supplied to Govt. Depts. & County Councils



These Centrifugal Pumps are ideal for Machine Tool Cooling and all pumping purposes—hot or cold water. Supplied complete with foot-valve, strainer and hose union. Suitable rubber hose available from stock.

- No. 10. 100 gals. per hour. Carr. 2/- extra £5 2 6
- No. 11. 280 gals. per hour. Carr. 2/- extra £6 6 0
- No. 12. 560 gals. per hour. Carr. 3/- extra £7 12 0

Please send 2d. stamp for specification.

The **STUART AUTOMATIC FLOAT SWITCH** is the best method of controlling water. Post Paid level. Price complete with all fittings ... £2 6 0

LONDON RADIO SUPPLY CO.

Est. 1925
Ardingly Road, Balcombe, Sussex.



SMALL ELECTRIC BREAKFAST COOKERS

with Dual Boiler, Switch, Imitation Vitreous Enamel Finish, supplied with Lead, 200/250 volts, A.C./D.C., £2.2.0, including tax.

ELECTRIC SOLDERING IRONS

60-watt, with Flex, 200/250 volts, A.C./D.C., Chrome-Plated, best quality, 12/6, tax-free.

LOUDSPEAKER TRANSFORMERS.

SPECIAL OFFER.

Philco Pentode, 4/6; Heavy Duty Pentode, 7/-; Multi Ratio, 8/-; Heavy Duty Multi Ratio, 10/6.

MAINS TRANSFORMERS.

210/230/250 volts, 50 cycles. 600 v., 70 ma. 6.3 v., 1.5 amp. 4 v., 2.4 amp., 25/- each. 200/250 v., 350-0-350 75 ma., 5 v., 2 amp., 6.3 v., 3 amp., 28/- 200/250 v. 350-0-350 120 m.a., 5 v., 2 amp., 6.3 v., 3 amp., 37/6. Two-Way Line Cord replacement for Midget Receivers, 7/6.

ROLA P.M. LOUDSPEAKERS.

	With Transformer.	Without Transformer.
5 in. ...	18/-	13/6
6 1/2 in. ...	19/6	14/9
8 in. ...	24/9	18/9

Only a few left.

ELECTRIC APPLIANCE LEADS.

6 ft. long, with connector one end for kettle, iron, radio, toaster, etc. Light adaptor or 2-pin plug other end, 5/9 each; Iron Connectors, 1/6 each; 2-pin 5 amp. plugs, 12/- doz.; Insulating Tape (best quality American), 3/- per lb.; MILLERS FALLS Radio Mechanic's Screwdriver, 2/11 each. Accumulators to fit No. 8 Torches, rechargeable, 3/6 each, including tax.

CHROME-PLATED ELECTRIC BELLS

with Transformer, A.C. 200/250 volts, supplied with instructions for fitting, 15/6, tax free. WORTH DOUBLE. Do away with that old "Le'clanche" cell or dry battery and fit a reliable door bell.

FIRE BARS WITH ELEMENT

Flat Type, 200/250 volt, 750 w., 3/9 each.

ROUND TYPE BAR

With Spiral, 200/250 volt., 750 w., 3/9 each.

THERMOSTATICALLY CONTROLLED ELECTRIC GEYSERS

1 1/2 gallon, with all fittings, 230/250 volt, A.C. or D.C., as new, from stock of a famous manufacturer, £6.19.0 each. If you need hot water in a hurry an electric geyser is indispensable. It is very economical too.

C.O.D. or Cash with Order, Carriage Paid.

H. H. LINTON & CO. LTD.

2, HIGHGATE HIGH STREET, N.6
Moutview 9431

AFTER THE WAR!

The advance in Radio Technique after the war will offer unlimited opportunities of high pay and secure posts for those Radio Engineers who have had the foresight to become technically qualified. How you can do this quickly and easily in your spare time is fully explained in our unique handbook.

Full details are given of A.M.I.E.E., A.M.Brit.I.R.E., City & Guilds Exams., and particulars of up-to-date courses in Wireless Engineering, Radio Servicing, Short Waves, Television, Mathematics, etc.

Prepare for to-morrow's opportunities and post-war competition by sending for your copy of this very informative 112-page guide NOW—FREE and post free.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 388)

17, Stratford Place, London, W.1.

BRAND New Rola P.M. Loud Speakers. 6 1/2 in., with transformers, 19/-; 8 in., with transformers, 24/-; 6 1/2 in., without transformers, 14/6; 8 in., without transformers, 18/6; the last of these, c.o.d. or cash with order, carriage paid.—Box 2784, c/o *Wireless World*. [1417]

Wanted

WANTED, Voigt h.c. horn, Quality speaker, Goodmans, Rola.—Box 2794, c/o *Wireless World*. [1447]

ONE to a Thousand P.M. Loud Speakers, complete in cabinets; send sample to Duckett, 24, New Chapel St., Mill Hill, Blackburn. [1427]

VOIGT Domestic Corner Horn, complete with Voigt moving coil unit and field rectifier, collectively or separately; state price and condition.—Box 2792, c/o *Wireless World*. [1437]

MORSE EQUIPMENT

MORSE Key and Buzzer, complete in polished wooden case; 10/-—16, Chesterton Rd., Birmingham, 11. [1413]

FULL Range of Transmitting Keys, practice sets and equipment for Morse training.—Webb's Radio, 14, Soho St., London, W.1. Phone: Gerrard 2089. [9553]

TEST EQUIPMENT

TESTSCOPE, used everywhere by radio service engineers, makes 20 important tests. Send for interesting leaflet "R.I."—Runbaken, Manchester, 1.

15 RANGE Avomitor, 47/6; Neobeam oscilloscope, model 151, £20; 700 T.C.C. 0.1mf. condensers, 6/- doz., or offer en bulk; Kraft coil-winding paper, widths 2 1/4 in. and 2 3/8 in., 3/9 lb.; 2 1/2 in. x 2 1/4 in. x 1 1/2 mm. bakelised paper insulating pieces, 4/- doz. lengths; tinned eyeletted tags, 8/- 1,000; 3/4 lb. rolls of 19 S.W.G. enamelled wire, 10/6 doz.; no mitances, please; S.A.E. for details.—Box 2787, c/o *Wireless World*. [1428]

Wanted

WANTED, Universal Avometer, or similar, good price paid.—Bennett, Fakenham, Norfolk. [1398]

GRAMOPHONE EQUIPMENT

LARGE Superior Quality Walnut Radio-gram Cabinet; £25; seen London, King's Cross district.—Box 2790, c/o *Wireless World*. [1431]

MARCONIPHONE, auto-change mechanism, 100-250-volt A.C. motor, complete with pick-up, in good working order; offers.—Sayer, Kirkby Stephen. [1432]

SUPPLIES are Still Available in Small Quantities of Our Low Impedance Cutting Heads at £2/2, and of our special 10-12 watt amplifier, in which is incorporated a Radio circuit for reception of the two Home Service programmes. The response curves of these amplifiers is such that they are very suitable for sound on discs, receiver, or P.A. work. Please state for which purpose they are required, when ordering, as a small modification is incorporated when designed for the latter work; price, including valves, £20. Enquiries invited for all types of sound equipment.—Southern Sound Studios, 2, Mansfield Rd., South Croydon. [1397]

Wanted

FIRST Class A.C. Gramophone Motor.—W. Harrison, Midge Hall, nr. Preston. [1422]

GRAM. Motor and Turntable, 230 volts A.C.—Gomersall, 39, Field Lane, Batley. [1424]

ONE 250 volt a.c. Turntable, with or without pick-up.—A. E. Dees, Ltd., 3, Charlotte Square, Newcastle-on-Tyne. [1400]

WANTED for Cash, record player, good condition, with A.C. motor, with or without P.U.—Write 16, Ranelagh Gdns. Mans., Fulham, S.W.6. [1436]

DYNAMOS, MOTORS, ETC.

ALL Types of Rotary Converters, electric motors, battery chargers, petrol-electric generator sets, etc., in stock, new and second-hand.

WARD, 37, White Post Lane, Hackney Wick, E.9. Tel.: Amherst 1395. [0518]

M.L. Rotary Converter, 12v. D.C. to 400v. 250m.a. D.C., excellent condition, little used.—42, Durley Ave., Cowplain, Hants. [1438]

L.T. Dynamos for Charging or Windmill, Lucas-Rotax, 6-12 volts 8 amps. D.C., 3rd brush, weight 11lb., size 8 in. x 4 1/2 in., unused ex W.D. cost £10, to clear 17/- each, carr. paid; H.T. and L.T. G.E.C. double-end 6 volts and 600 volts, 17lb. ditto, 27/- carr. paid.—Electradix, 19, Broughton St., London, S.W.8. [9993]



KURZ-KASCH RADIO KNOBS—DIALS INSTRUMENT KNOBS

Modern plastics are materially helping to bring the war to a successful conclusion, and Kurz-Kasch with its extensive plant and equipment is assisting in that direction.

Apart from those good-looking and well-designed knobs which form equipment of test instruments and receivers, we are moulding other very important items for the combined Services. Kurz-Kasch Inc. look forward to serving you again as soon as circumstances permit.

Register your name with our Representative now. He will forward you information on our products as soon as they become available.

KURZ-KASCH INC.

Moulders of Plastics, DAYTON, OHIO, U.S.A.

Exclusively Represented by—

Frank Heaver Ltd. Kingsley Road, Bideford, N. Devon



FOR THE RADIO SERVICE MAN, DEALER AND OWNER

The man who enrolls for an I. C. S. Radio Course learns radio thoroughly, completely, practically. When he earns his diploma, he will KNOW radio. We are not content merely to teach the principles of radio, we want to show our students how to apply that training in practical, every-day, radio service work. We train them to be successful!

INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 38, International Buildings, Kingsway, London, W.C.2

Please explain fully about your instruction in the subject marked X.

Complete Radio Engineering
Radio Service Engineers
Elementary Radio Television

And the following Radio examinations:
British Institution of Radio Engineers
P.M.G. Certificate for Wireless Operators
Provisional Certificate in Radio Telephony and Telegraphy for Aircraft
City and Guilds Telecommunications
Wireless Operator & Wireless Mechanic, R.A.F.

Name..... Age.....
Address.....
.....

PREMIER RADIO

Premier 1-Valve de Luxe Battery Model S.W. Receiver, complete with 2-valve valve, 4 coils covering 13-170 metres. Built on steel chassis and panel, 55/-, including tax.

PREMIER MICROPHONES

Transverse Current Mike. High-grade large output unit. Response 45-7,500 cycles. Low hiss level, 23/-.

Premier Super-Moving Coil Mike. Permanent Magnet model requiring no energising. Sensitivity 56db. Impedance 15 ohms. Excellent reproduction of speech and music, 25/5-.

I.F. TRANSFORMERS, IRON CORED

450-473 kes., plain and with flying lead, 5/6 each.

NEW PREMIER S.W. COILS

4- and 6-pin types now have octal pin spacing, and will fit International Octal valve holders.

4-PIN TYPE		6-PIN TYPE	
Type	Price	Type	Price
9-11	2/6	9-15 m.	2/6
04A	12-26 m.	06A	12-26 m.
04B	22-47 m.	06B	22-47 m.
04C	41-94 m.	06C	41-94 m.
04D	76-170 m.	06D	76-170 m.
04E	150-350 m.	CHASSIS	
04F	225-550 m.	MOUNTING	
04G	490-1,000 m.	OCTAL HOLDERS	
04H	1,000-2,000 m.	10/- each.	
New Premier 3-Band S.W. Coil, 11-25, 25-38, 38-86 m., 4/9.			
Rotary Wave Change Switch, to suit above, 1/6.			
Premier 2-Gang S.W. Condensers, 2 x 00015 mfd., with integral slip motion, complete with pointer, knob and scale, 10/6.			

S.W. H.F. CHOKES

10-100 m., 10/-.

SHORT WAVE CONDENSERS

Trolitol Insulation. Certified superior to ceramic. All-brass construction. Easily ganged. 15 m.mfd. 2/4 100 m.mfd. 3/- 25 m.mfd. 2/6 160 m.mfd. 3/7 40 m.mfd. 2/6 250 m.mfd. 4/- Utility Micro Diacs, direct and 100-1 6/6 Brass Shaft Couplers, 1/2 in. bore 7/1d. each Flexible Couplers, 1/2 in. bore 11d. each

"LEARNING MORSE?"

Then purchase one of the new practice Oscillators. Supplied complete with valve, on steel chassis, 27/6. Practice key 3/3, TX key, 5/9. Super model on wooden base, 11/6. Brown's Headphones, 19/6 pair. 3-Henry Chokes, 10/- Good Quality Buzzer, 3/-.

ELECTROLYTIC CONDENSERS

Tubular wire end type: 8 mf., 125v., 1/6 each; 25 mf., 25v., 1/6 each; 50 mf., 12v., 1/6 each; 50 mf., 30v., 3/- each. Bakelite cased type, 15 mf., 50v., 1/- each.

RESISTANCES

Mains Resistances, 600 ohms, 3A Tapped. 360 x 180 x 60 x 60 3/6 1,000 ohms 2A Tapped. 900, 800, 700, 600, 500 ohms, 4/6 each. 2-Way Line Cord Resistance, 50 ohms, per foot, price 1/4 per ft. Valve Screens for International and U.S.A. types, 1/2 each. Push-Back Connecting Wire, 2d. per doz. Resin-Cored Solder, 71d. per coil. Systotex Sleving, 2 mm., 2/6 per doz. yards.

MOVING COIL SPEAKERS

Rola 5in. P.M. Speaker, 25/- Celestion 5in. P.M. Speaker, 25/- Plessey 5in. 2,000 ohms Field, 25/- Above speakers are complete with output transformer. Rola 5in. P.M. Speaker, 3 ohms voice coil, 21/- Rola 6in. P.M. Speaker, 3 ohms voice coil, 25/- Send for details of our Mains Transformers, Smoothing Chokes and Valves available.

MATCHMAKER UNIVERSAL OUTPUT TRANSFORMERS

Will match any output valves to any speaker impedance 11 ratios from 13-1 to 80-1, 5/7 watts, 20/-; 10/15 watts, 26/-; 20/30 watts, 44/6; 50/60 watts, 69/6.

ALL ENQUIRIES MUST BE ACCOMPANIED BY A 2d. STAMP.

PREMIER RADIO CO.

ALL POST ORDERS TO:

JUBILEE WORKS, 167, LOWER CLAPTON ROAD, LONDON, E.5. (Amherst 4723.)

CALLERS TO:

JUBILEE WORKS, or 50, HIGH STREET, CLAPHAM, S.W.4. (Macaulay 2391.) 168, FLEET STREET, E.C.4. (Central 2833.)

D.C. to d.c. Converters, Neco 220v. to 12v. 12a., 24; Crypto 220v. to 15v. 4.5a., 24; Crypto 250v. to 7.5v. 50a., 212/10; M.L. 100v. to 600v. 100 m/a., 24; many others, all sizes in stock.—Below.

D.C. to a.c. Converters, E.D.C. 100 watts in case, 27/10; Janette 300 watts, 212/10; Crypto 500 watts, 215; dozens in stock to 5 kW.—Below.

STUART-TURNER 500 watt 50v. Generating Set, comprising engine dynamo, fuel and water tanks and silencer; 225.—Harris, Strouds, Bradford, Berks. [1594]

COMPONENTS—SECOND-HAND, SURPLUS SOUTHERN RADIO'S Wireless Bargains:—

7/6.—Assorted Components contained in attractive permanent box; 2 volume controls, 12 assorted condensers, 9 assorted valve holders, 6 resistances, choke, wire, plug circuit, etc., 7/6; postage 7d.

25/-.—Assorted Parcel of useful components, including tubular condensers, resistances, sleeving, trimmers, knobs, volume controls, switches, etc., 25/-; postage 1/1.

8/-.—12 assorted tubular condensers to 6mfd. 50 working, 8/-.

10/6.—12 Fixed condensers, sizes including 1 and 2mfd., 10/6.

9/-.—Gross assorted screws and nuts, complete, 9/-.

6/-.—Gross soldering tags, including spade ends, 6/-.

ORMOND Loudspeaker Units, largest 4-pole type, 6/6; smaller unshrouded type, 3/-; Ace P.O. Microphones, complete with transformer, ready for use, 6/6; Goodman 3in. permanent Magnet Speakers, 21/-; postage 1/-; Tungram H.R.210 general purpose battery valves, 4/9. Telsen Radio Magazines, No. 6, complete with 4 circuits, 9d.; wireless crystals (Dr. Cecil), 6d. each, 5/6 per doz.; with cat's-whisker 9d. each, 8/- doz.; permanent detectors, 2/6; binocular H.F. chokes, 1/6; 75ft. wire suitable for aerials (covered), 1/6; small powerful circular magnets, 1 1/2in. diameter, 3in. thick, 1/6 each, 15/- dozen; Bakelite Morse practice keys, 4/-; buzzers, 4/-; engineers' wire brushes, 10d. Many bargains for callers. Post orders postage extra. All goods guaranteed.

SOUTHERN RADIO SUPPLY Co., 46, Lisle St., London, W.C. Gerrard 6653. [1226]

CORED Solder, 1lb. reel, 5/6; pushback connecting wire, 5/6 100ft. coil; solder tags, 2, 4 and 6 B.A., assorted, 4/6 per gross; tinned copper wire, 2/6 per half-pound reel; sent c.o.d. on receipt of your order.—J. Wm. Charge, 34, Wimborne Drive, Pinner, Mdx. [1410]

COULPHONE Radio, New Longton, n. Preston.—Brand new goods only: mains transfs. 350-0-350, 120ma., 6.3v. 3a., 5v. 3a., 28/6; P.M. speakers with transfs. 8in. Rola, and Plessey, 24/6; 5in. Rola, 21/-; 10in. Rola P.M., less transfs., 32/6; Barreiter Resistors, 6/-; Line Cord Replacement Resistors, 800 ohm, 2 adjust. taps, 6/9; electrolytics, 50mfd. 50v.olt, 3/3; Erie 1-watt resistors, all values, 9d. each; pushback wire, 100ft. coil, 6/-; switch cleaner, 2/3 bottle; power-pentode transformers, 6/9; S.A.E. for stock list. [1409]

LASKY'S RADIO, 370, Harrow Rd., Paddington, W.9. offer for sale the following components, spares, speakers, etc.: Rola 5in. speakers, with transformers, 19/6; Rola 5in. speakers, less transformers, 16/6; 8in. speakers, with transformers, 22/6. Condensers: 0.1mfd. 350v. 5/6 doz., 50mfd. 12v. 16/- doz., 25mfd. 25v. 18/- doz., 2mfd. 200v. 2/- each, 8mfd 150v. 2/- each, 2mfd. 600v. block 2/6 each, 1mfd. 600v. block 2/3 each, etc.; 4v. mains transformers, 350/0/35, 17/6; 4v. mains transformers, 350/0/35, Marconi, 25/- each; speaker output transformers, 6/- each; send cash with order or c.o.d. [1416]

RECTIFIERS.—Metal rectifiers, 6v. 0.5 amp., square type, with instructions, 5/9; post 4d. Metal rectifier 6v. 1 amp., with transformer and ballast bulb, charges 2v. to 6v., no ammeter needed, 24/9, post 9d. Instrument rectifiers, bridge type, for meters, bakelite, very good make, 12/6, post 3d. Small battery chargers, "Atlas", in strong steel cases, not flimsy chassis construction, 2v., 4v., 6v., 0.5 amp., 35/-, post 8d. Rothermel "Bullet" crystal microphones for stand mounting, cast aluminium housing finished black crackle, new tilting mount, the best microphone value obtainable to-day, 60/-, post 8d. Miniature crystal microphone for dead aids, etc., 42/6, post 6d. Rothermel new type bakelite pick-up, 67/6.—Champion, 742, Howitto Rd., London, N.W.3. [1434]

GALPINS

ELECTRICAL STORES

21, WILLIAM ST., SLOUGH, BUCKS.

'Phone: SLOUGH 20855

TERMS: Cash with order

Regret Orders from Eire and Northern Ireland cannot be accepted.

AUTO TRANSFORMER, 1,000 watts, tapped 0-110-200-220-240 volts for step up or step down. Price 23/15s.

ROTARY CONVERTOR, D.C. to D.C.; input 220 volts D.C.; output 12 volts at 50 amps. D.C., ball bearing, condition as new. Price 210, carriage forward, or 17/6 passenger train.

ALTERNATOR, output 220 volts, 1 ph., 50 cycles at 180 watts, will give 1 amp. easily, speed 3,000 r.p.m.; self-exciting, condition as new. Price 28, carriage forward, or 15/- passenger train.

SHEET EBONITE, size 12in. by 11in. by 1/32in., best quality. Price 4/- per doz., post free.

ELECTRIC LIGHT CHECK METERS, well-known makers, first-class condition, electrically guaranteed, for A.C. mains, 200/250 volts 50 cy. 1 phase 5 amp. load, 10/- each; 10 amp. load, 12/6, carriage 1/-.

1 KW. FIRE ELEMENTS mounted on fireproof porcelain, for 220 volts, as new, easily mounted. Price 8/6, post free.

CROMPTON DYNAMO, 50/75 v. at 25 amps., four pole, shunt wound, speed 1,750 r.p.m., condition as new. Price 28 10s., carriage paid.

POWER PACKS for smoothing, etc., consisting of two 300 ohm chokes and two 2 M.F. condensers. Price 7/6, post free.

220 V. D.G. KLAXON MOTORS, precision made, ball-bearing, 1/10th h.p., fitted right angle drive and reduction gear to 170 r.p.m. Price 50/-, carriage paid.

LOUD RINGING BELLS, working on 110 volts D.C., 8in. dia. gong (bell metal), plated; waterproof, new. 32/6 each, post free.

1 K.W. TRANSFORMER, input 100 volts at 100 cycles, single phase, output 10,500 volts, centre tapped to earth. Price 24/10/-, carriage forward.

D.C. MOTORS, 110v., approx. 1/10 h.p., series wound, in perfect working order. Price 12/6 each, carriage 1/-.

HEAVY DUTY CABLE, V.I.R., and braided, in first-class condition, size 37/13, lengths 30 to 40 yards. Price by the length 5/- per yard, carriage forward, or 7/- per yard for short lengths, carriage paid.

200 AMP. SWITCH FUSE, three-way, ironclad, unused. 400 volt, size overall 30in. x 12in. x 12in., maker E. N. Bray, Ltd. Price 26, carriage forward.

1 K.W. TRANSFORMER, 200/250 volts input; output, 62 to 76 volts, tapped every 2 volts, in new condition. Price 25, carriage paid.

ROTARY CONVERTOR, D.C. to D.C. Input 12 volts; output 1,100 volts at 30 M/A, ex R.A.F., can also be used as double output generator. Price 50/-, carriage paid.

HEAVY DUTY knife switches, D.P., D.T., quick break, 100 amp., in first-class condition. Price 20/-, carriage paid.

LIGHTWEIGHT HEADPHONES, 120 ohm, complete with headband, cords and G.P.O. standard plug. 7/6 pair, post 6d.

LOW RANGE MEGGAR, by Evershed Vignoles, 500 volts, 100 megohms, size 7 x 7 x 12in., weight 20 lbs., in perfect condition. Price 220, carriage paid.

MEGAR by Evershed Vignoles, 5,000 ohms to 5 megohms, 150 volts, size 7 x 7 x 12in., weight 20 lbs., in perfect condition. Price 212/10/-, carriage paid.

X-RAY TRANSFORMER, in oil-filled tank, medium size, input 120 volts, 50 cycles, 1 ph., output 45,000 volts at 2kW, intermittent rating, in perfect order. Price 220, carriage paid.

ROTARY CONVERTOR, D.C. to D.C., input 48 volts, output 2,500 volts at 1 kW, condition as new and in perfect order. Price 210, carriage paid.

2 1/2 H.P. PORTABLE PETROL ENGINES by Douglas, flat twin, both incomplete, no carburettor, some oil pipes missing, mags, petrol tanks, etc., included. The two engines together would make one good one. Price for the pair 27/10/- carriage paid.

ELECTRADIX BARGAINS

PETROL ELECTRIC PLANTS. Pelapone 500-watt cyl. 2-stroke, water-cooled self-ignition engine; mag. ign. coupled to 50/70 volts, 10 amps. shunt dynamo, 1,000 r.p.m., £32/10/-.
ASTER 4-Cyl. W.C. Engine, 3 kW. Coupled to 100/150v., 25 amps. Crompton D.C. Dynamo.
4 kW. AUSTIN, 4-cyl. water-cooled Engine, mag. ignition and 110 volts 25 amp. Dynamo.
 Dynamo, horizontal Twin Petrol A.B.C. engine, fan-cooled, coupled 1 1/2 kW. D.C. dynamo 50/70 volts 25 amps., mag. ignition.

PETROL ENGINES. Almost new; twin cyl. Douglas, fan-cooled, 1 1/2 h.p., governed, mag. ignition, light weight, £12. Larger, 2 1/2 h.p. ditto, £15.
UNUSED X-RAY VACUUM TUBES. New Government Hospital Surplus, 7/10. dia. bulb. Big solid Tungsten Electrodes. Emission guaranteed. 45/- Packed cases.

LIGHT AND RAY CELLS. Selenium Raycraft, 2/-, Electrocell, self-generating, 35/-, Raycraft outfit with relay, 42/-, Photo-cells for sound on Film G.E.C. £3/10/-, 10,000 ohm Relay, 22/6.
MORSE KEYS. Type B.1, a strong key, 5/-, Bakelite type type 1/6. A first-class key, type P.F., plated, weight well balanced, 9/6. The best key available is type IV, 12/6.

BUZZERS. Skeleton Buzzer, 2/-, Neat brass Buzzer, 4/6, Heavy type, Bakelite cased, 5/6. D.3 Buzzers, multiple windings, no contacts, 5/-, Townsend Micro Buzzer (as illus.), 10/-.

Perfect Morse. Home training with a practice Recording Inker, spring drive, needs no battery, marks direct on tape with dead key. For novice or expert. Govt. type, £3/10/-.

HANDCOMBS. Govt. All-Metal Handcombs, Micro-telephone sets for portable or fixed telephones. These are the famous No. 16 Handcomb, used in so many field sets. Sturdily built with mike finger switch. Brand new with 4-way cord, 15/-. Limited number available. Similar handcombs, less centre switch and no cord, 7/6. 4-way cord, 2/6. A Home Guard can make a complete pocket telephone with these, a mike transformer and buzzer with a torch battery.

HOME GUARD. Field telephone cable, single or twin in 1/4 mile reels. Ceiling Roses, portable, with 2 "scruit" couplers for connect boxes, 6/6 doz. Relays and Drop Indicators, Portable Field Telephones, etc.

DYNAMOS. We have a large range of all sizes of Dynamos, Motors and Rotaries.
DYNAMO BARGAINS. Rotax, 6-12 volts 8 1/2 amps, D.C. 3rd brush size, 8in. x 4 1/2in., 1 1/2 lb., cost £10, unused, 12/6, curr. paid England and Wales. G.E.C. Double-current Dynamos, 6 volts and 600 volts, ball-bearing, 17 lb., new, 27/6, curr. paid England and Wales.
AIR COMPRESSORS. Small vertical type infusers for belt drive, worth a fiver, £3/10/-.

DRILLS. Electric Drills, D.C., Wolf, 110-volt, D.C. Portable Hand type. No. 1 Morse socket for jin. steel. £3/10/-.

PUMPS. Stuart motor pumps, centrifugal, C.D. Shelter, 12 volts D.C. or 230 volts A.C. in stock. Twin-piston pumps with or without motors, for suds or water. 1/2 h.p. Motor Pump, 300 galls., £17/10/-.

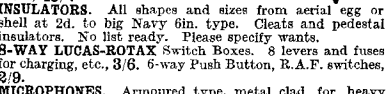
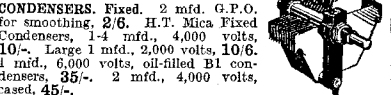
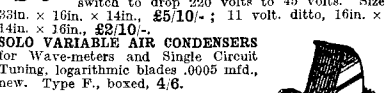
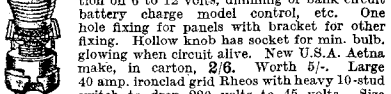
DIMERS OR RHÉOSTATS with "off" 0 to 1 ohm and will carry up to 4 amps., for regulation on 6 to 12 volts, dimming or bank circuit battery charge model control, etc. One hole fixing for panels with bracket for other fixing. Hollow knob has socket for min. bulb. glowing when circuit alive. New U.S.A. Aetna make, in carton, 2/6. Worth 5/-. Large 40 amp. ironclad grid Rheos with heavy 10-stud switch to drop 220 volts to 45 volts. Size 3 1/2in. x 1 1/2in. x 1 1/2in., £5/10/-; 11 volt. ditto, 16in. x 1 1/2in. x 1 1/2in., £2/10/-.

SOLE VARIABLE AIR CONDENSERS for Wave-meters and Circuit Tuning, logarithmic blades .0005 mfd., new. Type F, boxed, 4/6.
CONDENSERS. Fixed. 2 mfd. G.P.O. for smoothing, 2/6. H.T. Mica Fixed Condensers, 1-4 mfd., 4,000 volts, 10/-, Large 1 mfd., 2,000 volts, 10/6. 1 mfd., 6,000 volts, oil-filled B1 condensers, 35/-, 2 mfd., 4,000 volts, cased, 45/-.

INSULATORS. All shapes and sizes from aerial egg or shell at 2d. to big Navy 6in. type. Cleats and pedestal insulators. No list ready. Please specify wants.
8-WAY LUCAS-ROTAX Switch Boxes. 8 levers and fuses for charging, etc., 3/6. 6-way Push Button, R.A.F. switches, 2/6.
MICROPHONES. Armoured type, metal clad, for heavy duty, 5/-. G.P.O. sensitive Button type, 2/6.

Please add postage for all mail orders. Send stamped envelopes for replies to all enquiries.

ELECTRADIX RADIOS,
 19, Broughton St., Queenstown Rd., London, S.W.8
 Telephone: Macaulay 2159



33in. x 16in. x 14in., £5/10/-; 11 volt. ditto, 16in. x 14in. x 16in., £2/10/-.
SOLE VARIABLE AIR CONDENSERS for Wave-meters and Circuit Tuning, logarithmic blades .0005 mfd., new. Type F, boxed, 4/6.
CONDENSERS. Fixed. 2 mfd. G.P.O. for smoothing, 2/6. H.T. Mica Fixed Condensers, 1-4 mfd., 4,000 volts, 10/-, Large 1 mfd., 2,000 volts, 10/6. 1 mfd., 6,000 volts, oil-filled B1 condensers, 35/-, 2 mfd., 4,000 volts, cased, 45/-.
INSULATORS. All shapes and sizes from aerial egg or shell at 2d. to big Navy 6in. type. Cleats and pedestal insulators. No list ready. Please specify wants.
8-WAY LUCAS-ROTAX Switch Boxes. 8 levers and fuses for charging, etc., 3/6. 6-way Push Button, R.A.F. switches, 2/6.
MICROPHONES. Armoured type, metal clad, for heavy duty, 5/-. G.P.O. sensitive Button type, 2/6.
 Please add postage for all mail orders. Send stamped envelopes for replies to all enquiries.

G. A. RYALL, "Arnhemurst," Marsh Lane, Taplow, Bucks, offers radio components.
T.C.C. 0.1 Tubular Non-inductive Condensers, 350v. wkg., in Paxolin tubes and waxed; 6/6 dozen.

VOLUME Controls, British make, 1 meg., at 1/6 each.
SLOW Motion (Epicyclic) Drives, fit 1/4in. shafts, long 1/4in. spindles, well made in brass, with ball bearings, ratios 8:1; 1/3 each.

PAXOLIN Strip, 2 1/2in. wide, as used for group boards, 4 1/2, three 12in. lengths for 1/6; group boards, 12-way, drilled, less tags, four for 1/3.

ERIE Resistors, 1/2-watt type, actual values as used in many well-known sets. 220, 680, 3,300, 27,000, 33,000, 1 1/2 meg., 3/- dozen, new goods; Erie resistors, 2-watt type, 150 560, 820, 3,000, 3,900, 7,500, 75,000, 140,000, 220,000, 560,000, 1-meg., three for 1/6, new goods; Erie resistors, 3-watt type, 680, 700, 1,500, 3,300, 6,800, 8,200, 22,000, 56,000, two for 1/6.

PLESSEY, 3-gang, screened, with one trimmer only, 3/-; straight, no superhet. types; condenser drives, with 2-band scale, less escutch., similar Polar VP, 1/9.

TURNABLES, as used for rotating portables, ball bearing, 1/6 each, soiled; post 9d. extra on single items.

MATT Ebonite new goods, size 12x10, 3 1/2in., 4/6; also odd sheets, soiled, 1/8in. and 1/4in., 14x7 and 16x7, 2/9 each.

THIMBLE-TOP Caps, 36 for 1/3; Click input strips, 2-3-4-way, 2/3 doz.; insulating tape, 2oz. reels, 8 for 1/3.

SWITCHES, Wearite, long type, silver plated contacts, ebonite barrel, will switch band pass, HF, and dial lights, 1/3 each; wave traps, iron core, ex K.B., 1/3 each.

CONE Units, heavy circular, less reads, and small type with reeds, bobbins, mostly O.K., two 1/6, postage 9d.; Yaxley switch screens, 3 3/4x3 3/4, with fixing flange, 4 for 1/3.

SPEAKER "Pots," windings O.K., resistance 750 ohms, 325 ohms, 8,600 ohms, carry 120 m.a., 5/6 each, or complete, oval type, cones broken, 6/9; and 60 m.a. pots, 600, 2,000, 7,500, 3/9, with circular chassis 5/9.

DIAL Plates, 3-band, size approx. 6x5, dial scale 4x2 1/2, white ground, 2 1/3; Burgoyne dial plate, 3-band, brown ground, 6x4, scale 3x2, station list printed on, 2 1/3; dial plate ex Berners, 4-band, in green, red, blue, orange, transparent, brass stiffened edges, 1/6 each; dial and scale, 6 3/4x4.

SPECIAL Note.—We now confine our business to Mail Order.—G. A. Ryall, "Arnhemurst," Marsh Lane, Taplow, Bucks. [1425]

Wanted
PAIR 3-15 ohms High Fidelity Headphones.—Broadfoot, Penylan, Deganwy Rd., Llandudno. [1421]

RADIOGRAM Cabinet, two 8 mfd. 750 volt electrolytics.—Hopkinson, 44, St. Mary's Estate, Theford, Norfolk. [1443]

COIL WINDING MACHINE
Wanted
WANTED, for essential work, Douglas No. 1 or 3 coil winders and Macadie model T.D.S.M., any condition.—Box 2788, c/o *Wireless World*. [1429]

VALVES
VALVES.—Thousands in stock; send requirements s.a.e.—Davies, 28, Mount Vernon Cres., Barnsley. [1073]

LARGE Variety of British Valves in Stock. Send us your requirements. Retail price plus tax.—Napier, 127, Prestwick Rd., Ayr. [1406]

MULLARD, Marconi, Tungsram, Cossor, Brimar, Dario, Mazda valves, speakers, pick-ups, volume controls, etc.; S.A.E. and requirements.—Smith, 6, Shanklin Drive, Nuneaton. [1445]

1,000 Valves in Stock. s.a.e. for printed list. VP4B, 12/10, AC/HL 9/2, VMS4/B 12/10, VP15C 12/10, U6 11/1, EF9 12/10, AZ31 11/-, 42 12/10, 6K7G 12/10 (C.I. 10/- Barreter), 6F6G 12/10; post 6d.—Ransom, 34, Bond St., Brighton. [1363]

NEW Valves.—£10 the lot. Osram, 2 U14, 2 MUI4, 3 UMS4, 2 MH14, 1 VMP4, 1 PX25, 1 LS5, 2 PX4, 1 GT1; Mazda, 1 AC/TP, 1 AC/DD, 1 AC/HL/DD, 1 AC/P, 2 T31, 2 AC/P4, 1 PETB, 1 HE/AC, 1 P650; Six Sixty, 1 LAC; Mullard, 1 354U, 1 I.W.3; 1 VP4A, 1 AC/O44; Cossor, 1 41M.T.S.; American Ken-Rad, 1 UX280, UY224A, 1-57.—Apply Box 2782, c/o *The Wireless World*. [1408]

ARE YOU MINUS MATHS?

If you wish to understand radio or any other technical subject thoroughly, you must know maths.

Our new Mathematics Courses have proved an outstanding success. We have already helped many men in the Forces and in other war-time occupations to qualify for promotion. We can help you too. By our simplified method of Home-Studying, you can now learn maths really thoroughly in your spare-time.

RADIO. If you wish to qualify for radio duties with the R.A.F., or for full-time or part-time radio work, we can train you. Hundreds of men now serving in the Forces, or doing other important radio work, have been accepted solely as a result of our training.

★ Post coupon now for free details ★

T. & C. RADIO COLLEGE

29, Market Place, READING

(Post in unsealed envelope, 1d. stamp.)
 Please send me free details of your Home-Study Mathematics and Radio Courses.
 NAME.....
 ADDRESS.....
 W.W.13

ARDUX

"We have carried out exhaustive tests here, and have satisfied ourselves that, mechanically, it is the best material of its kind we have ever used. The electrical tests also were very satisfactory."—Messrs. The British Transformer Co., Ltd., Hayes, Middlesex.
 Ardux is a quick-setting adhesive for mouldings and laminated plastics.

AERO RESEARCH LIMITED

PIONEERS OF SYNTHETIC ADHESIVES
 DUXFORD CAMBRIDGE Telephone: Sawston 167-8

The Season's Compliments
 to users of the
COIL PICK-UP
 at home and overseas.
H. H. JONES, 62, Worcester St., STOURBRIDGE.

KESSLERS (London) LTD.
For TURNING and MACHINING of PLASTIC MATERIAL.
SIGNAL LAMP CAPS
SWITCH KNOBS and HANDLES
 Albion House, 201-3, Church St., London, N.16
 Tel.: Clissold 6247

WARD ROTARY CONVERTERS
 Petrol Electric Generating Plants, H.T. Generators, D.C. Motors, Frequency Changers, etc., up to 25 K.V.A.
CHAS. F. WARD
 37, WHITE POST LANE, HACKNEY WICK, E.9
 Phone: Amherst 1393

LASKY'S RADIO, 370, Harrow Rd., Paddington, W.9, have a large stock B.V.A. mains and battery valves; send us your requirements; cash with order or c.o.d. [1415]

Wanted

VALVES Wanted, any quantity from one upwards; also test equipment, service sheets and spares.—J. Bull, 246, High St., Harlesden, N.W.10. [9732]

REPAIRS AND SERVICE

L.T.P. Repair All Mains Transformers and Chokes. Prompt delivery.

LONDON TRANSFORMER PRODUCTS, Ltd., Willesden, N.W.10. Wil. 6486 (5 lines). [9552]

MIDWEST, etc., we are the American experts.—Bennett's, 4, Humberstone Drive, Leicester. [1419]

TRANSFORMERS, pick-ups, motor rewinds, repairs of all descriptions to the wireless trade.—Marshall, 137, Windmill Lane, Nottingham. [1439]

METROPOLITAN RADIO SERVICE Co. Guarantee Repairs to American and British Receivers.—1,021, Finchley Rd., N.W.11. Spe. 3000. [9641]

ACCURATE Radio Rewinds, mains transformers, Fields O.P. transformers, etc., and all loudspeaker repairs, prompt service.—Southern Trade Services, 75a, George St., Croydon. [1039]

MAINS Transformers Service, repairs, rewinds, or construction to specification of any type, competitive prices and prompt service.—Sturdy Electric Co., Ltd., Dipton, Newcastle-upon-Tyne. [9651]

"SERVICE with a Smile"—Repairers of all types of British and American receivers; coil rewinds; American valves, spares, line cords. F.R.L. Ltd., 22, Howland St., W.1. Museum 5675. [8934]

DEGALLIER'S, Ltd.—"Service with a Guarantee." If you have an English or American receiver that needs servicing, let American specialists do the job; any set handled from a T.R.F. Midget to a 30-valve Scott; we specialise in Challenger receivers, having serviced since inception; first-class workmanship only; when forwarding, chassis and valves needed only.—Degallier's, Ltd., 9, Westbourne Court, London, W.2. [1442]

TUITION

LEARN Morse Code the Candler Way. See advertisement on page 26. [1292]

RADIO Training.—P.M.G. exams and I.L.E.E. Diploma, prospectus free.—Technical College, Hull. [0611]

PRACTICAL Postal Radio Courses; coaching for I.P.R.E. exams; and post-war appointments; booklet free.—Secretary, I.P.R.E., Bush House, Walton Ave., Henley-on-Thames. [1333]

RADIO Engineering.—Television and Wireless Telegraphy, comprehensive postal courses of instruction. Apply British School of Telegraphy, Ltd., 179, Clapham Rd., London, S.W.9. (Instd. 1906.) Also instruction at school in wireless for H.M. Merchant Navy and R.A.F. [9249]

TECHNICAL TRAINING

GREAT Possibilities Exist for Technically Qualified Engineers, key men in wartime and afterwards. Through the home-study courses of The T.I.G.B. take a recognised engineering qualification, such as A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.S., A.M.I.Chem.E., C. and G., etc., in which examinations the T.I.G.B. students have gained 25 FIRST PLACES and Hundreds of Passes. Write today for "The Engineer's Guide to Success"—Free—containing the world's widest choice of engineering courses covering all branches, including Aeronautical, Mechanical, Electrical, Wireless, Chemical, etc.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN, 82, Temple Bar House, London, E.C.4. [1403]

SITUATIONS VACANT

SERVICE Manager for Valve Deaf Aids, London, W.1., good appearance and capable correspondent, exempt.—Write age, experience, salary required, Box 2780, c/o Wireless World. [1401]

A Manager is Required for the Transmitting Valve Division of a well-known company engaged solely on the manufacture of radio valves; applicants must possess undoubted managerial ability, be qualified engineers, preferably with B.Sc. or equivalent degree, and recent experience of transmitting valve development and manufacture, and should be between 30-45; this is a responsible post offering excellent prospects both now and after the war.—Full details in confidence to Box 2793, c/o The Wireless World. [1444]



WAR-TIME 'ECONOMY' CONSTRUCTOR'S KITS

A.C. BANDPASS TWO. Triode detector and parallel output pentode. Energised speaker. **£5 10s.**

A.C. STRAIGHT THREE. VM. H.F. pen., triode, L.F. pen. (not a superhet), energised speaker. **£6 10s.**

BATTERY BANDPASS TWO. Triode detector, parallel feed transformer. Output tetrode. P.M. speaker. **£3 15s.**

BATTERY THREE. VM. H.F. pen, triode detector and output tetrode. P.M. speaker. **£4 12s. 6d.**

All Wave models of the above, **30/-** extra. (16-50 metre approx.). (All prices less cabinets and batteries.)

All the above kits supplied with B.V.A. valves, blue prints, metal chassis, all necessary components, wire, etc., and provided with pick-up sockets.

SPECIAL 3v. BATTERY KIT for those designing their own set can be supplied as follows:—One undrilled steel chassis, tuning condenser, S-M drive and dial, coils, condensers, resistors, valve holders, etc. Less valves and speaker, **£3.** No circuit supplied except for the coils which are 1 pair dual range, Screened, and 1 pair of short-wave coils.

For SERVICEMEN and CONSTRUCTORS

Parcels containing Volume Controls, Resistors, Condensers, Solder Tags and other useful components, **£1**

S-W "FREQUENTITE" VALVE HOLDERS. 7-pin, chassis mounting, 1/6.

PARALLEL FEED L.F. TRANSFORMERS. Midget, 6/-.

STRAIGHT LINE DIALS, 3-wavebands, Station names, slow-motion drive, 4/-.

CHASSIS. Brand new metal chassis, undrilled. Size 8in. x 6in. x 2 1/2in., 4/6; 10 1/2in. x 8 1/2in. x 2 1/2in., 7/6.

VALVE HOLDERS, English chassis type, 4-pin, 6d.; 5-pin and 7-pin, 6d.; English, Octal, 6d.; American U.X. type, 4-, 5-, 6-, and 7-pin and International Octal, 6d.

465 kc. I.F. TRANSFORMERS. Screened. Iron core permeability tuned, 5/- each.

TAPPED MAINS DROPPING RESISTANCES, approx. 800 ohms, standard for Pye, Lissen, etc., 2 amp., 3/6. 750 ohms, with variable slider, 5/-.

RESISTORS, different values, 1/2-watt, 4d.; 1/4-watt, 6d.; 1-watt, 1/-.

SCREENED VALVE CAPS, 6d. each.

TUBULAR CONDENSERS, T.C.C. or B.1. N.1. 0.0001, 0.0002, 0.0003, 0.0005, 0.005, 0.00015, 6d.; 0.01, 0.02, 0.1, 8d.; 0.25, 1/3; 0.5, 2/-; Tubular Electrolytics, 25 mfd., 25v., 2/-; 50 mfd. 12v., 1/9.

Speakers and Mains Transformers will shortly be available in small quantities. Please send us your enquiries.

HOURS: 9-5 p.m., Saturdays, 1 p.m. C.O.D. orders accepted. Prices subject to alteration without notice. Special terms to members of H.M. Forces and Civil Defence workers. Licence to export to Northern Ireland and Irish Free State. Please add postage for enquiries and mail orders.

51-52 CHANCERY LANE. LONDON, W.C.2. Telephone HOLBORN 4631.

MISCELLANEOUS

LONDON Business Man, middle aged, radio novice, requires facilities and guidance for learning servicing.—Box 2785, c/o Wireless World. [1418]

PATENT NOTICES

THE Proprietors of British Patent No. 513650, dated March 25, 1938 (Convention date, March 31, 1937), relating to Improvements in Cloasures for Evacuated Envelopes, are desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—Inquiries to Singer, Ehlert, Stern and Carlberg, Chrysler Bldg., New York City, N.Y., U.S.A. [1395]

THE Owner of British Patent No. 513975 relating to "Improvements in or relating to Signalling Systems" is desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the invention either by sale of the Patent rights or by the grant of licences on reasonable terms.—Interested parties who desire further particulars should apply to Albert L. Mond and Thiemann, 14 to 18, Holborn, London, E.C.1. [1399]

THE Proprietors of British Patent No. 493846, dated April 14, 1937 (Convention date, May 28, 1936), relating to Improvements in Signalling Systems, such as Public Address Systems, are desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—Enquiries to Singer, Ehlert, Stern and Carlberg, Chrysler Building, New York City, N.Y., U.S.A. [1407]

PREMISES

BUILDING to Let, West London, 75 rooms, heating system, spacious ground floor; commence £1,250 p.a. exclusive.—Box 2781, c/o Wireless World. [1405]

BOOKS, INSTRUCTIONS, ETC.

WANTED, service manuals, back numbers of "Service Engineer" and valve equivalent charts.—G. Lloyd, 36, High Rd., Short Heath, Willenhall, Staffs. [1423]

WEBB'S Radio Map of the World Locates any Station Heard. Size 40x50in., 4/6, post 6d.; on linen, 10/6, post 6d.—Webb's Radio, 14, Soho St., London, W.1. Phone 1, Gerrard 2039. [9947]

CLASSIFIED ADVERTISEMENTS intended for the FEBRUARY issue can be accepted up to First Post on Monday, January 11th.

MATRICULATION
brings Success & Security

Whatever your age, you can now study for the all-important Matriculation Examination at home on "NO PASS—NO FEE" terms. "MATRIC" is the accepted passport to all careers, and opens up opportunities which would otherwise be completely closed to you. Ensure the future success and security of you and yours by writing for our valuable "Guide to Matriculation" immediately—FREE, and post free.

B.T.J. (Dept. 114)

356, Oxford Street, London, W.1.

**We will buy—
at your price**

USED Radios, Television, Test-meters, Amplifiers, Converters, Radio and Electrical Accessories, etc.

Write or 'phone
WE WILL CALL!

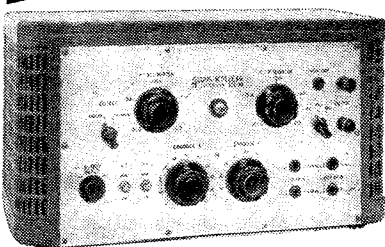
UNIVERSITY RADIO LIMITED
238, Euston Road, London, N.W.1
EUSon 1966 and GERrard 4447

AUDIO AMPLIFIERS

and SUB-ASSEMBLIES

Standard Amplifiers • Special Amplifiers for Industrial Applications • Transformers and Coil Winding • Sheet Metal Work and Stampings • Switch Assemblies • Microphones, etc.

One of our range of Standard Amplifiers available for work of National importance.



ACOUSTICAL
MANUFACTURING COMPANY LTD
HUNTINGDON
TEL: 361

HILL AND CHURCHILL
BOOKSELLERS
SWANAGE DORSET

ENGLISH & AMERICAN BOOKS IN STOCK ON
RADIO AND TELECOMMUNICATION

CATALOGUE ON APPLICATION

W. BRYAN SAVAGE LTD.

Expert assistance in the solution of problems relating to

- TRANSFORMERS, CHOKES
- AMPLIFIERS
- POWER UNITS

and Specialised Equipment embodying
ELECTRONIC CONTROL

WESTMORELAND RD., N.W.9.
COLINDALE 7131

VALVES IN STOCK

AMERICAN National Union, Philco and Tung-ram. 1A4E, 1A6E, 1B4E, 2101, 6Y5V, 1F4, 6U5, 12A5, 7A8E, 10, 15, 24, 7C6, 7Y4, X61M, 6B6, 1F5G, 6B8G, 6G5G, 6H6G, 6K5G, 6J8G, 6K7G, 27, 30, 33, 35/51, 36, 39/44, 49, 50, 41, 56, 58, 78, 6L7G, 6U5G, 6U7G, 6V6G, 01A, 12SA7, 6J5GT, 6K7GT, 12K7GT, 6Q7G, 117LGT.
6-amp. Rectifiers for Tungram Chargers, 4- and 6-pin Barretters.

BRITISH Tungram, etc. VME4, DK1, DD6, EAB1, HP41, 01C, SP4B, SP4, VP4, VP4B, SP220, P215, SS210, DD13, HL13, HP13, DDT13, TX21, TH29, DDT13S, HP2118. 4-pin and side contact Barretters.

Please send requirements and stamp for quotation.
E. H. ROBINS TRADING CO. LTD.
"Torvista," 44 Kyle Crescent South, Whitechurch, Glam.

"UNIVERSAL CIRCUITS"
by R. S. Roberts, M.Brit.I.R.E., A.M.I.R.E.

Three folders and a thirty-six page booklet, presenting the main principles of radio circuit operation in a concise and convenient form for the pocket.

- I. The Transmitter
- II. The T.R.F. Receiver
- III. The Superheterodyne Receiver

By means of hinged flaps, the charts give a large number of recognised alternatives for each stage. To assist the student in memorising and understanding these, a logical five-colour scheme has been adopted throughout.

"Grid Leak" says: "The Charts and Notes are really intended for students and teachers of radio, but are extremely useful to every radio engineer."

Price complete **6/3** post free, from
The Bookstall
NORTHERN POLYTECHNIC
HOLLOWAY, LONDON, N.7

WISH our many friends a Victorious New Year and a return to the good things in life.

The Courts, Silverdale, London, S.E.26
Phone: SYD 6686

TESTOSCOPE

Makes 30 important tests, 100 to 750 volts, A.C. or D.C. Used everywhere by Electricians, Wiremen, etc. From Wholesalers or direct. Send for leaflet "R.14."

RUNBAKEN -- MANCHESTER -- I

LONDEX for RELAYS
for A.C. and D.C.
TWO STEP RELAY LF/FS
(Heavy Silver Contacts)

First Impulse "ON," Second Impulse "OFF."

Also Aerial Change-over Relays.

Ask for leaflet 88A/WW

LONDEX LTD
MANUFACTURERS OF RELAYS
AMERLEY 207 AMERLEY ROAD - LONDON S.E.26

INVENTORS

We invite new inventions which, guided by the technical knowledge, manufacturing facilities and world-wide marketing organisation of the Simmonds Group, may be developed to play vital parts in modern industry.

The SIMMONDS GROUP
LONDON
MELBOURNE
PARIS - NEW YORK
LOS ANGELES

SIMMONDS DEVELOPMENT CORPORATION LTD - BUSH HOUSE - W.C.2

Printed in England for the Publishers, LIPFEE AND SONS LTD., Dorset House, Stamford Street, London, S.E.1., by THE CORNWALL PRESS LTD., Paris Garden, Stamford Street, London, S.E.1. "The Wireless World" can be obtained abroad from the following—AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: Imperial News Co.; GORDON & GOTCH, LTD. SOUTH AFRICA: Central News Agency, Ltd.; WILLIAM DAWSON & SONS (S.A.), LTD. UNITED STATES: The International News Co.



The stars

look down . . .

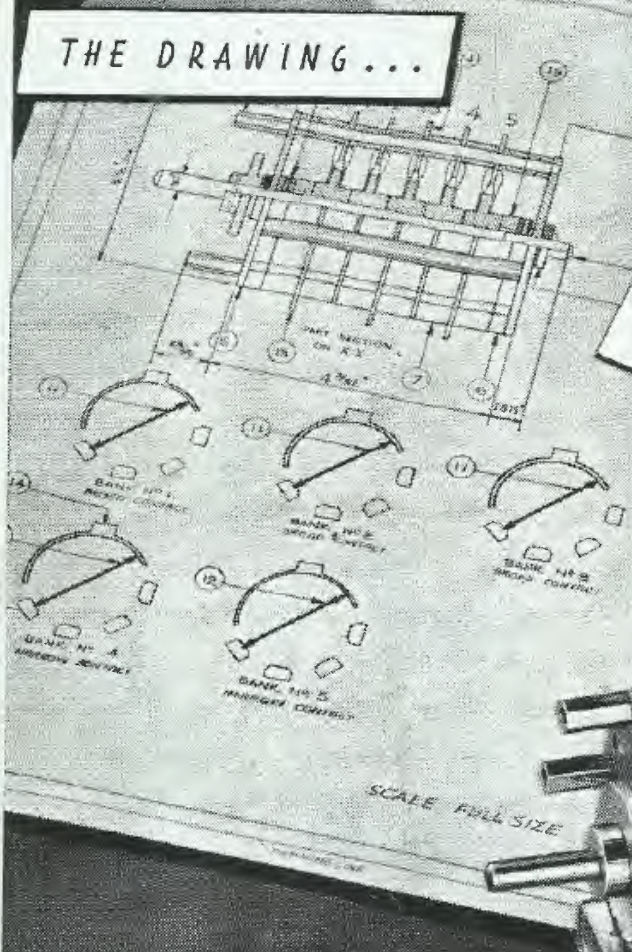
. . . upon the sleeping villages and towns of England. Over the peaceful scene the moon mounts guard with watchful eye. Yet, at any given moment, should the necessity arise, the quietest country village can be in instant communication with the greatest city; can command its resources and enlist its help. Our products for many years have served in spreading human happiness and in forging links between men, and to-day we still proudly play our part in maintaining human fellowship.

DUBILIER
CONDENSER CO. (1925) LTD.



C.R.C. 161

THE DRAWING...



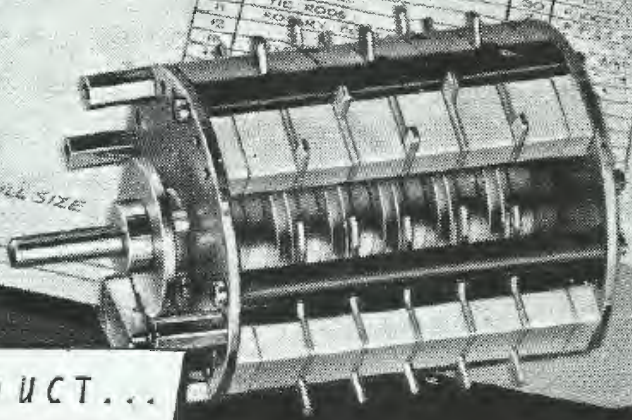
REDIFFUSION SWITCH TYPE S. 1.

Maximum No. of Banks	Single Speed Banks	Double Speed Banks
• Voltage for Working on an Isolated Stator Contact	3000v.	4000v.
• Maximum Rating Above Voltage Rating	7000v.	
• Maximum Frequency for Contacts per Bank	20 mcps.	
• Capacity of Stator and two Stator Contacts to Frame	30 Mc/s.	
• Capacity of Stator and two Stator Contacts to Frame	8	
• Suitable for tropical use	1.5 mfd.	
	9-15 mmf. (according to type)	

THE SPECIFICATION...

1	SHIELD		
2	STATOR WINDING		
3	STATOR WINDING		
4	STATOR WINDING		
5	STATOR WINDING		
6	STATOR WINDING		
7	STATOR WINDING		
8	STATOR WINDING		
9	STATOR WINDING		
10	STATOR WINDING		
11	STATOR WINDING		
12	STATOR WINDING		
13	STATOR WINDING		
14	STATOR WINDING		
15	STATOR WINDING		
16	STATOR WINDING		
17	STATOR WINDING		
18	STATOR WINDING		
19	STATOR WINDING		
20	STATOR WINDING		

THE PRODUCT...



This 20 megacycle 60 K.V.A. switch is a Rediffusion product, used in Rediffusion communication equipment.

REDIFFUSION LIMITED

A subsidiary of
BROADCAST RELAY SERVICE LIMITED

DESIGNERS AND MANUFACTURERS OF COMMUNICATION EQUIPMENT
VICTORIA STATION HOUSE • VICTORIA STREET • LONDON • S.W.1 (PHONE VICTORIA 8831)