# Wireless World

RADIO AND ELECTRONICS



JUNE 1946
1/6
Vol. LII. No. 6

IN THIS ISSUE: SUPER-REGENERATIVE RECEIVERS

In the interests of Greater Production in Loud Speakers for the New Season

# Rola - CELESTION

## make an Important Announcement to the Radio Industry

In order to meet the demand for Loudspeakers by the Radio Industry, BRITISH ROLA LIMITED have arranged to purchase the shares of CELESTION LIMITED as at the 31st July, 1946.

By pooling the resources of the two Companies they feel confident that *a substantial increase in deliveries by both Companies will be achieved.*

***It must be emphasised that the Designs and Technical Development of both Companies will proceed Independently so that each will retain its Individuality under the New Arrangement.***

**BRITISH ROLA LTD.,**
**Georgian House, Bury St., St. James's, S.W.1.**
**Factories : Thames Ditton & Devizes.**

**CELESTION LTD.,**
**Kingston-upon-Thames, Surrey.**

Robert Sharp & Partners CR1

*Regd. Trade Mark*

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**HIGH accuracy, simplicity, exceptional versatility and proven reliability have won for "AVO" Instruments a world-wide reputation for supremacy wherever rapid precision test work is demanded. There is an "AVO" Instrument for every essential electrical test.**


The MODEL 7 *50-Range Universal*

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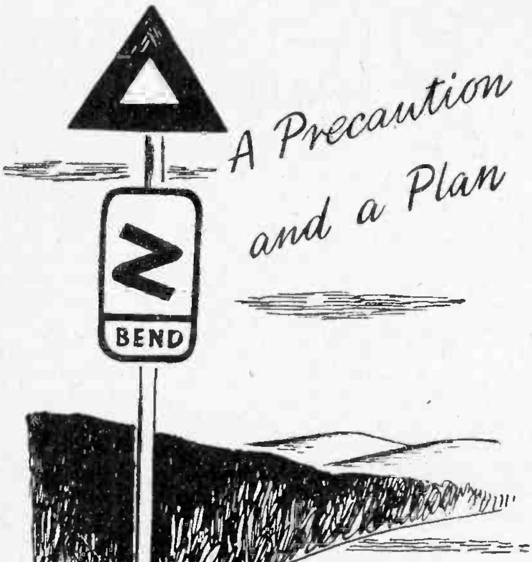
Electrical Measuring Instrument

A self-contained, precision moving-coil instrument, conforming to B.S. 1st Grade accuracy requirements. Has 50 ranges, providing for measuring A.C. & D.C. volts, A.C. & D.C. amperes, resistance, capacity, audio-frequency power output and decibels. Direct readings. No external shunts or series resistances. Provided with automatic compensation for errors arising from variations in temperature, and is protected by an automatic cut-out against damage through overload.

*Sole Proprietors and Manufacturers*

**THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD., Winder House Douglas Street, London, S.W.1.** *'Phone: VICtoria 3404/8*

# EQUIPPING A LABORATORY?




May we suggest a precaution before you decide on measuring apparatus for your laboratory? Consult our advisory staff and evolve thereby an instrumentation plan up-to-the-minute in technique and invention.

Over and over again a preliminary discussion has enabled us to show how the latest Marconi instrument can do the work of two existing models, or can reduce to simple terms an apparently intricate problem of measurement. Certainly by basing your requirements on the extensive range of Marconi apparatus you can be sure that to-morrow you will not discover something just a little better, or a technique just a little more advanced than you knew existed. A Marconi instrumentation plan, therefore, means efficiency in your laboratory with the maximum saving of man-hours and money. Our advice costs nothing but nearly always proves to be rather more than worth while. Let us know your testing problems: we can most probably provide the answers.

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Model **120a**

# *Pocket Size*
# TAYLOR JUNIOR


**21 Ranges.**

**1,000 ohms per volt AC. and DC.**

**Weight 14 ozs.**

**Size $4\frac{7}{8}'' \times 3\frac{1}{8}'' \times 1\frac{15}{16}''$.**

**Price:—**
**£8 . 10 . 0 .**

This Universal Taylor meter has self-contained ranges up to 5,000 volts DC. and AC. at 1,000 ohms per volt and up from 1 ma. to 500 ma. DC. full scale. Resistance ranges with self-contained battery cover from 0.5 ohms to 200,000 ohms and with external battery up to 20 megohms. All voltage resistors and shunts are adjusted to 1% giving a high degree of accuracy on all ranges. The moving coil meter has a sensitivity of 400 $\mu$a. full scale and has a maximum scale length of 2½". Please write for illustrated technical leaflet.

*Send enquiries to your usual factor or direct to:*

**Taylor Electrical Instruments Ltd.**
419-424 MONTROSE AVENUE, SLOUGH, BUCKINGHAMSHIRE
Tel: Slough 21381 (4 lines) Grams: "Taylins" Slough

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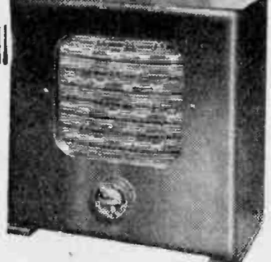
## ? ARE YOU A ONE ROOM RADIO LISTENER—



Now that Stentorian Extension Speakers are coming back to the shops the pleasure of listening again becomes complete. Just plug in one of these superb permanent magnet speakers to your set and you can enjoy its clean, pure tone anywhere in the house: sitting-room, kitchen, bedroom, wherever you happen to be. Supplies are still short, but a Stentorian is worth looking for. Ask your local dealer about them.

***PRICES***

| | |
|---|---|
| *Minor Type MX (for Low Impedance Extension)* - | 29/6 |
| *Minor Type MC (with Universal Transformer)* - | 35/6 |
| *Baby Type BX (for Low Impedance Extension)* - | 43/6 |
| *Baby Type BC (with Universal Transformer)* - - | 49/6 |

WB **Stentorian**

THE PERFECT EXTRA SPEAKER FOR ANY SET

WHITELEY ELECTRICAL RADIO CO. LTD., MANSFIELD, NOTTS.

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## M.R. SUPPLIES

The business which handles only dependable Radio and Electrical material at the right price and effects immediate despatch from stock. All prices nett. All goods brand new.

**Measuring Instruments of the highest grade.** B.P.L. 3½in. flush mtg. precision M/Coil Instruments. 0/100 micro-amp., **75/-**; 0/500 micro-amp., **65/-**; 0/1 milliamp., **59/6**; 0/100 milliamp, **55/-**. Also by same maker. Combined instrument in crash-proof bakelite portable case, 6 by 4 by 3ins., with carrying handle, 1,000 ohms/volt, universal A.C./D.C. Readings: 0/1, 0/10, 0/100 and 0/500 m.a., 0/10, 0/50, 0/100 and 0/500 volts. 0/10,000 ohms. Each range brought in by a positive contact, self-cleaning switch. Complete with cell, **£8 15s.** Also limited offer of Taylor 2½in. flush mtg.. 0/500 milliamp m/coil meters (can be deshunted), brand new, at **35/-**.

**Insulation Testers.** We now have the famous Evershed Wee-Meggers in stock. Pressure 500 volts. Range 0/20 megohms and inf. Supplied with pocket and log books, **£9 10s.**

**Microphones.** excellent range of reliable products. Rothermel D.104, original model in plated housing, with suspension rings, **£5 5s.** Same make BR2S Sound Cell Studio Model for serious work, **£10 10s.** Also Rothermel-Brush Miniature Inserts, 1¾in. dia., **29/6** (all the foregoing are piezo-crystal. Grampian Moving Coil type MCR (15 ohms), in square suspension frame, with ¼in. or 5/16in. fitting, **£4 4s.** Same make, senior model, in all-plated housing with internal switch. Response 60/8,000 c/s.—42 db., **£7 5s.** The new Reslo VMC (12 ohms) in black and chrome, with internal switch, for ¼in. mtg., **£5 10s.** Mu-metal Microphone Transformers to suit all above M/coil mics., **25/-**. Floor stands to suit all, all-chrom., collapsible, ext. to 5ft. 6in., **47/6**. Chrom. cradles (for D.104 only), **8/6**.

**Loudspeakers.**—High-fidelity models, by Vitavox. K12/10 (10 watt), 12in., 15 ohms coil, with 14,500 lines Ticonal perm. magnet, **£7** (despatch, 5/-). Also K12/20 (20 watt), same details, but 17,000 lines, **£11** (despatch, 5/-). Also the Vitavox, Bitone, with 12in. Unit and Tweeter, with 6-cell horn and filter in cabinet, 32in. × 17in. × 15in.—a challenge to any other high-fidelity reproducing system, **£31 10s.** despatch, 6/-). **Note.**—The Bitone is in very limited supply, and if we are out of stock on receipt of order, we will despatch within three weeks.

**Projector Speakers for outdoor P.A.** Obtain now before the seasonal rush Latest Vitavox P.M. 15 ohm Unit with 30in. all-metal horn, **£9 10s.** (despatch, 7/6) or with 42in. all-metal exponential horn, **£10 10s.** (despatch, 7/6). Also "A" type G.E.C., P.M. 15 ohm Unit, with line transformer incorporated, on 30in. horn, **£11** (despatch, 7/6). On 42in horn, **£12** (despatch, 7/6). Immediate despatch.

**Battery Charging Equipment.**—STC Metal Rectifiers. For charging up to 12 volts in conjunction with suitable transformers (see below). 3 amps., **22/6**; 6 amps., **39/6**; 10 amps, **49/6** (despatch, last two, 1/6).

**Step-Down Mains Transformers.**—All prims. tapped 200/250 v., Sec.: 8 and 14 v. 4 amps. (for 22/6 Rect.), **32/6**. Sec.: 5, 12 and 17 v. 6 amps (for 39/6 Rect.), **49/6** (despatch, 2/-). Sec.: 15v. 10 amps. (for 49/6 Rect.), **75/-** (despatch 2/6 Also 22 v. 2 amps. **18/6**.

**Condensers,** hermetically sealed paper, by Aerovox, Sprague, etc. 4 mf. 350 v., **3/6**; 4 mf., 1,000 v., **8/6**; 8 mf., 1,000 v., **13/6**; 10 mf., 400 v., **6/9**; 0.5 mf., 1,000 v., **2/11**; 0.1 mf., 1,000 v., **1/3** (**12/6** doz.); 10 mf., 600 v., **8/6**.

**IN STOCK.**—Vent-axia Extractor Fans, Pyrobraze Soldering and Brazing Equipment, Fuzit Wire Jointers, Londex Relays, Stage Dimmers, Amplifiers, Headphones, Stuart Turner Centrifugal Pumps. Regret no lists at present. Please pay us a visit.

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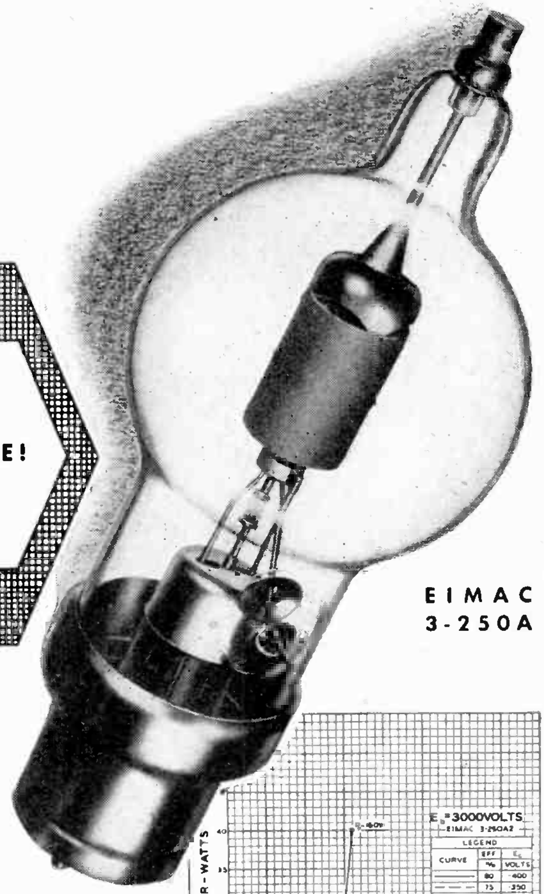
*Telephone: MUSeum 2958*

EIMAC VALVES THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

# NEW ELEMENTS IN THIS EIMAC TRIODE ADD MANY EXTRA HOURS PERFORMANCE

**NEW** NON-EMITTING GRID!
**NEW** LOW-TEMPERATURE PLATE!
**NEW** FILAMENT STRUCTURE!



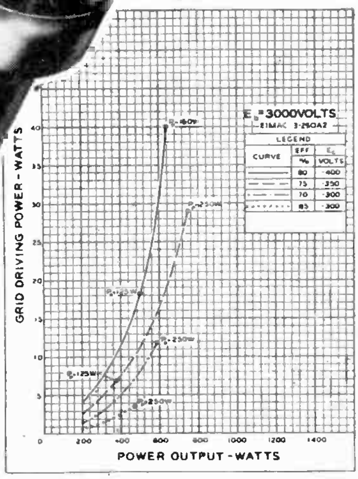
EIMAC
3-250A

Physically the new Eimac 3-250A triode is interchangeable with the old Eimac 250T. The new elements result in better performance and even longer life in a valve that has long been famous for its long life and stamina. This new valve is available in both low mu (3-250A2) and high mu (3-250A4) valve versions.

Its outstanding performance characteristics are exemplified by its low driving power requirements. ... For example, in Class C telegraphy, with 3000 plate volts on a single valve, the Eimac 3-250A2 (low mu) will deliver 750 watts output with only 29 watts (approx.) of driving power. (See chart.)

You can depend upon Eimac year in and year out for leadership in vacuum valve developments.* That's one reason why Eimac valves are today, and have been for years, first choice of leading electronic engineers throughout the world.

**Ask your dealer to give you a copy of "Eimac Electronic Products" just off the press. Or write direct.*




*Follow the leaders to*

EIMAC VALVES

**ELECTRICAL CHARACTERISTICS**

| | 3-250A2 | 3-250A4 |
|---|---|---|
| Filament: Thoriated tungsten | | |
| Voltage | 5.0 volts | 5.0 volts |
| Current | 10.5 amperes | 10.5 amperes |
| Amplification Factor (Average) | 14 | 37 |
| Direct Interelectrode Capacitances (Average) | | |
| Grid-Plate | 3.1 uuf | 2.9 uuf |
| Grid-Filament | 3.7 uuf | 5.0 uuf |
| Plate-Filament | 0.7 uuf | 0.7 uuf |

**EITEL-McCULLOUGH, INC.,** Dept. K, 1211 San Mateo Ave., San Bruno, California.
*Export Agents: Frazar and Hansen, 301 Clay St., San Francisco 11, California, U.S.A.*

Authorised Distributors: BERRY'S (SHORT-WAVE) LTD., 25, HIGH HOLBORN, LONDON, W.C.1.

B

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# *Change of Address*

Customers are requested to note that all works and administrative departments formerly at 12-22 Laystall Street, E.C.1., are now installed at our factory at Tolworth, Surbiton, Surrey. This move will involve no hold-up in the flow of deliveries. Henceforth, all communications should be sent to this new address.

**UNITED INSULATOR CO., LTD**
Oakcroft Road,
Tolworth,
SURBITON, *Surrey*
*Tel: Elmbridge 5241 (6 Lines)*

*Unsurpassed In Ceramics*

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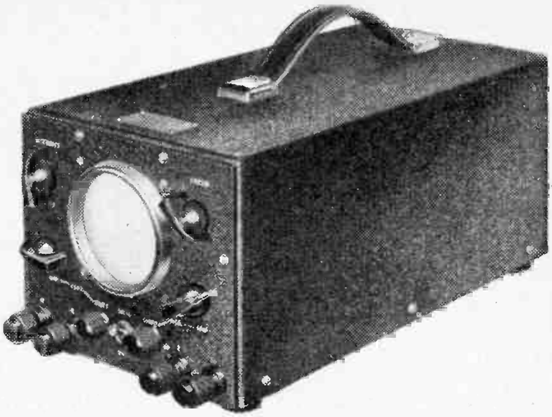

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| CABINET SIZE | WEIGHT | SCREEN WIDTH |
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| $6\frac{1}{4} \times 5\frac{3}{16} \times 12$ inches | $12\frac{1}{2}$ lbs. | $2\frac{1}{4}$ inches |

**Labgear** WILLOW PLACE CAMBRIDGE

*MANUFACTURERS OF HIGH CLASS TEST EQUIPMENT*

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KEIGHLEY, YORKSHIRE

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In the vital reconstruction task now facing the electrical industries this Company will play an important part. Our branch offices, located as above, are staffed and equipped to offer maximum sales service to customers.

**BRITISH INSULATED CALLENDER'S CABLES LIMITED**
NORFOLK HOUSE, NORFOLK STREET, LONDON W.C.2

# WEBB'S *Radio*

*ALL COMPONENTS CARRY WEBB'S UNCONDITIONAL GUARANTEE OF SATISFACTION.*

| | | s. | d. |
|---|---|---|---|
| **ENAMELLED COPPER WIRE** | | | |
| 14 S.W.G. hard drawn (obviates corrosion between strands) | 100ft. | 4 | 6 |
| **VARIABLE CONDENSERS** | | | |
| 2-, 3- and 4-gang, .0005 mfd., 3- and 4-gang with ceramic insulation. | 2- and 3-gang | 14 | 0 |
| | 4-gang ... | 17 | 6 |
| Cyldon 500 pF. precision type—ceramic insulation, removable spindle with extension for ganging | | 15 | 0 |
| **NEUTRALISING CONDENSERS** | | | |
| Type "A," 6 pF. maximum—circular vanes—mounted 2½" ceramic pillar—polystyrene insulation. Minimum capacity approx. 1 pF. ...... | | 9 | 6 |
| Type "B," 8 pF. maximum—1¾" circular vanes, 5,000 v.w. max. Minimum capacity 1.5 pF. ... | | 13 | 6 |
| **P.V.C. SLEEVING** | | | |
| 2 mm. and 4 mm. in 9 colours. | 2 mm. ... per yd. | | 2 |
| | 4 mm. ... per yd. | | 3 |
| **CO-AXIAL CABLE** | | | |
| 0.45" dia. Polythene insulation, copper braided with green P.V.C. outer covering. Impedance 80 ohms | per yd. | 1 | 6 |
| **EDDYSTONE** | | | |
| 4-pin plug-in coil formers DL9 insulation, ribbed but not threaded | each | 1 | 9 |
| **WESTINGHOUSE** | | | |
| Instrument Rectifiers—type MBS. 1, 1 m.a.... | | 10 | 6 |
| **WEARITE** | | | |
| 465 kc. iron-cored I.F. Transformers, new improved type in aluminium cans | each | 7 | 6 |
| **WEBB'S I.F. TRANSFORMERS** | | | |
| 1.6 mc.—ideal for high frequency receivers | each | 12 | 6 |
| **PUSHBACK WIRE** | | | |
| Single strand, good quality cotton insulation, assorted colours. (*Not sold in small quantities*) | 250 yard rolls | 15 | 0 |
| **FLEXIBLE DRIVING SHAFT** | | | |
| 10" long—will drive through any angle. To fit ¼" spindles | each | 5 | 0 |

**WEBB'S RADIO**
14, Soho Street, Oxford Street, London, W.1
Telephone - - - GERrard 2089
Please note our SHOP HOURS—9 a.m. to 5 p.m. (Saturdays, 9 a.m. to 1 p.m.)

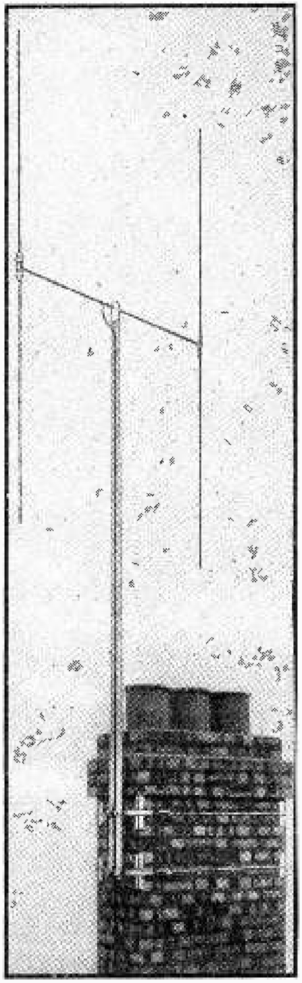
# THE STATIC CONDENSER Co. Ltd.

★ *Manufacturers of STATIC CONDENSERS*

**TOUTLEY WORKS, WOKINGHAM, Berks**
Telephone: WOKINGHAM 708

# TELEVISION AERIAL 'QUIZ'

***Answers to some of the questions we are continually receiving by letter and telephone***



*Television Aerial prices from 37/6 to 110/- with and without reflector. Illustration shows L502L price 110/- Cable L336 extra per yard 9d.*

**QUESTION I.** *What are the advantages obtained when using a reflector with a dipole ?*

**ANSWER.** (*a*) It is necessary in areas of weak field strength to increase the signal input to the receiver.

(*b*) The directional properties can be utilised as a means of minimising interference, particularly so, if the aerial can be installed in such a position that the location of the source of interference is placed behind the reflector in relation to the transmitter.

(c) By rotating the aerial, ghost image can be reduced or eliminated.

**Q. 2.** *Is it advantageous always to erect the aerial on the highest possible point of the building ?*

**A.** No, not always ; sometimes a building can be used to screen against interference.

**Q. 3.** *What type of feeder should be used with a dipole T.V. aerial ?*

**A.** T.V. Receiver designers still fall into three schools of thought:

(1) Coaxial feeder which needs complicated matching and balancing at the dipole end for best results and minimum interference.

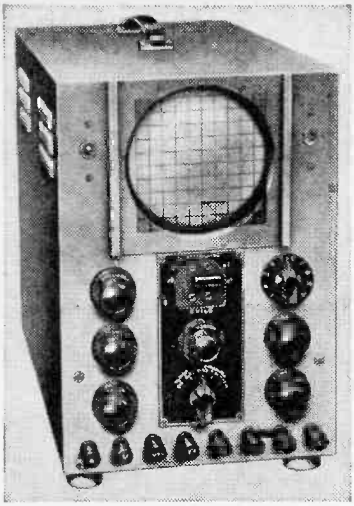
(2) Unscreened twin which is the cheapest but needs a carefully balanced input circuit in the receiver for optimum results and does not provide a screened input to stabilise a super-sensitive receiver.

(3) Screened twin which gives the advantages of both but is a trifle dearer than coaxial.

If the receiver manufacturer makes a strong recommendation for his set it should be adhered to, but otherwise in most localities the cheapest, i.e. the twin unscreened feeder of 70 to 80 ohms impedance, will give no apparent loss even when connected to a coaxial input.

*. . . TO BE CONTINUED*

**BELLING & LEE LTD**
CAMBRIDGE ARTERIAL ROAD. ENFIELD. MIDDX



***STATIC TWO-DIMENSIONAL visual delineation of any recurrent law.***

●

***RELATIVE TIMING OF EVENTS and other comparative measurements with extreme accuracy.***

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***PHOTOGRAPHIC RECORDING of transient phenomena.***

●

***SIMULTANEOUS INDICATION of two variables on a common time axis.***

INDUSTRIAL INDICATING and TESTING afford increasing scope for the Cathode Ray Tube as the only device with the above inherent features of which the last is unique in the Cossor DOUBLE BEAM Tube.

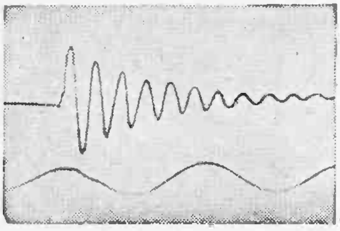
The **Model 339 Cossor Oscillograph** thus equipped is invaluable on all problems of research, production or operational testing, when the effect examined is applied as a voltage. When recurrent the traces are studied visually and when transient are recorded photographically, using Model 427 camera.

## A. C. COSSOR LTD.,

INSTRUMENT DEPT.

Cossor House, London, N.5

'Phone: CANonbury 1234 (33 lines).
'Grams: Amplifiers Phone London.

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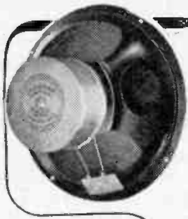

*Here's*

# GRAMPIAN

## QUALITY & VALUE

**38/-**

List Price

*Watts Handling:* 7.
*Chassis:* 9".
*Impedance:* 2 or 15 ohms.
*Flux Lines:* 9,500

★

The Grampian P.M. Unit Speaker offers exceptional quality in return for a very modest capital outlay. It is fitted with a permanent magnet of nickel aluminium and the pole-piece has a non-ferrous locator to prevent dirt from reaching the "gap." A smooth response curve with gently rising characteristics gives superior clarity to speech and music. It is an ideal speaker for Public Address and general-purpose work. Write to us.

**GRAMPIAN**
**LOUDSPEAKERS**

GRAMPIAN REPRODUCERS LTD.,
Hampton Road, Hanworth, Middx. *'Phone: Feltham 2657*

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**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 LOW LOSS CERAMICS**

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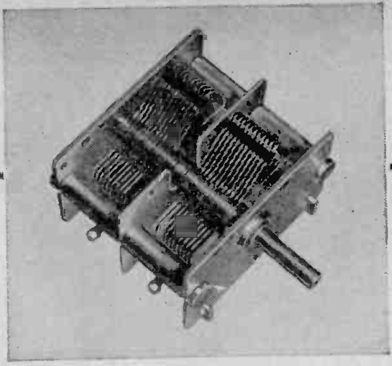

# M.G. 1, 2 or 3 GANG CONDENSER

This small size condenser is of rigid construction, and is made in various capacities up to 540mmf. with tropical finish. It can be supplied with trimmers built in if required. The 2 Gang Frame is $2\frac{3}{4}$"x$1\frac{23}{32}$"x$2\frac{9}{16}$" over all.

REGISTERED JB TRADE MARK

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**BROS (LONDON) LIMITED**
KINGSWAY · WADDON · SURREY
TELEPHONE: CROYDON 2754-5 TELEGRAMS: WALFILCO, PHONE, LONDON

# LEAK

## "POINT ONE" RANGE OF ALMOST DISTORTIONLESS AMPLIFIERS

Here are performance figures, inclusive of output transformer, for the type 15:—

**TOTAL DISTORTION**, including hum and noise, for 15 watts output:—
1,000 c.p.s. - 0·1% (one-tenth of one per cent)
60 c.p.s. - 0·2% (one-fifth of one per cent)

**FREQUENCY RESPONSE:** level within 0·25db. 20-20,000 c.p.s.

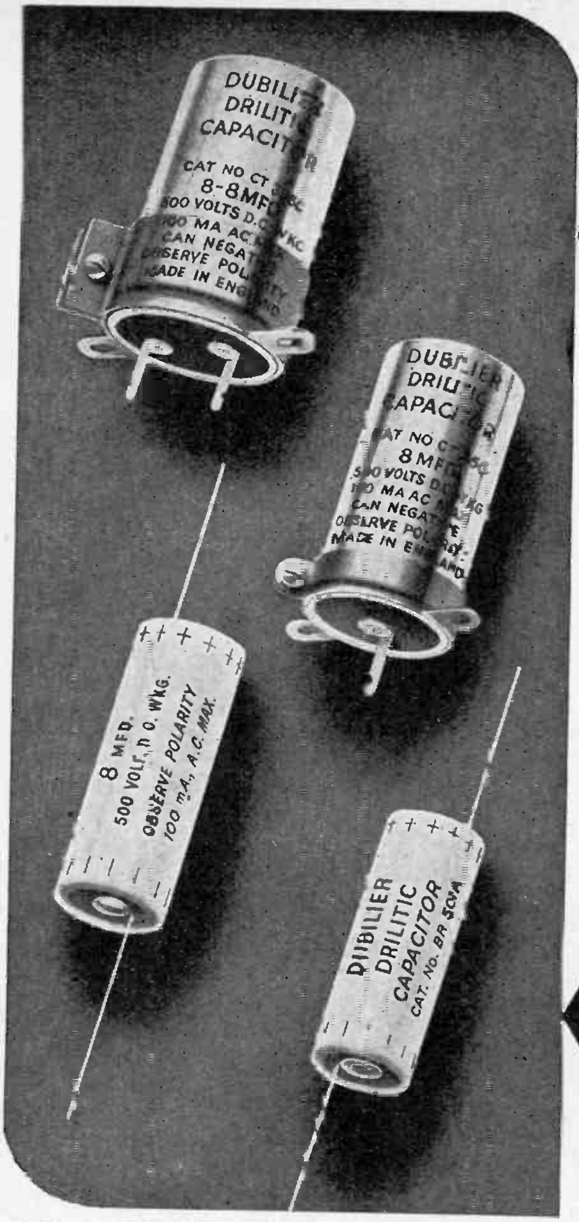
**LOAD DAMPING FACTOR:** 20 (10 times better than for average Class A triode).

**GAIN:** The basic amplifier requires 0·5v RMS at grid impedance. An additional two stages can be supplied built into the chassis, thus reducing the input to 0·005v R.M.S.

**Full information on leaflet S.15**

SPECIAL NOTE · The above figures establish such radically new standards that they may occasion some surprise. We therefore wish to stress that no error appears in this announcement. The circuits are original, and result from war-time research in our laboratory.

H. J. LEAK & COMPANY LIMITED
470 UXBRIDGE ROAD · LONDON · W.12
TELEPHONE: SHEPHERDS BUSH 5626




# Now! a full range

## "DRILITIC" ELECTROLYTIC CAPACITORS

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Radio and Electronics

*36th YEAR OF PUBLICATION*

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## Monthly Commentary

# *Gratitude to an Industry!*

MANY warm tributes have been paid by Government spokesmen to the magnificent job which the Radio Industry did in meeting all the requirements of the Services in radar and radio equipment during the war years.

One special occasion for a formal statement of appreciation was when the President of the Board of Trade addressed representatives of the Radio Industry at a gathering held in London on the 31st August last year.

Tribute had previously been paid to the Service and Supply Departments, the Government Research establishments and the Universities, but this occasion was to make reference to the work of the many firms in the Radio Industry who had been responsible for production.

### Appreciation

In the course of a survey of the fine work done by the industry, the President of the Board of Trade said:

"By the peak of the European war, a quarter of a million workers, men and women, were engaged on the production of radar and radio equipment. Some idea of the wonderful job which these men and women did can be realized when I tell you that, whereas before the war we produced in this country only a few million valves a year, in 1944—invasion year—we produced no less than 38 million valves, of 600 different types, for the three Services."

And again he said:

"As with valves, so with components. With each new development an entirely new range of components was demanded. Industry was responsible for its own development of these, and it is a great tribute to the innumerable firms concerned that even with the rapid changes in types and designs, requirements were always met."

And again:

"An industry with a wartime record such as yours should turn to the tasks of peace with confidence."

Given confidence, the industry could tackle the changeover to peace conditions, but the confidence of the industry is being severely shaken by the conditions under which the changeover is having to be made.

Millions of radio components made during the war by the sweat and industry of those workers, to whom such tribute has been paid, are now being recklessly jettisoned by the Government on to the very market which the Radio Industry had hoped would absorb their current production and so provide full employment over the difficult period of transition to peace.

Particularly after their record of service during the war, those who earn their living in the Radio Industry ought not to be faced with a situation where the very products which earned for them such tributes should now be allowed to return, like a boomerang, and threaten their livelihood.

Nor are these components limited to British products, for quantities are of American manufacture obtained under lease-lend terms, and quite naturally our American friends decline to accept them back for disposal in their own markets.

### Huge Quantities

It is only the vast quantities of these disposal components which create such a menace, for they represent in many cases the accumulation of stocks in anticipation of a long war in Europe and a still longer war in the Far East.

Is there not still time for the Government to reconsider policy in this matter and at least bring about the utilization of these components in some ordered manner over an extended period of time?

Tributes to war work of the Radio Industry have, of course, been appreciated, but what the workers of our industry look for to-day is a policy which will not deprive them of security and full employment now and in the future.

# LINEAR SAW-TOOTH OSCILLATOR

## Transitron Type Time-Base

By W. T. COCKING, M.I.E.E.

ONE of the war-time radar developments[1,2] having immediate application to both television and cathode-ray oscilloscopes is a single-valve linear saw-tooth oscillator. It is of particular interest because its performance is outstandingly good and it is at the same time both simple and economical.

In essence it is a modification of the transitron time-base which has its origins in the Numans oscillator[3]. After lying dormant for over a decade the principle was revived under the new name of transitron,[4,5] but its applications were envisaged chiefly as a sine-wave oscillator using a tuned LC circuit. Its use as a saw-tooth generator[6] was less widely realized, and it was not until 1940 that its capabilities appear to have been fully examined[7,8].

The war-time adaptation of it has resulted in an enormous improvement. In its present form it is really a combination of two things—the union of the pre-war transitron with the war-time Miller integrator—and although it still functions on transitron principles the details of its operation are very different.

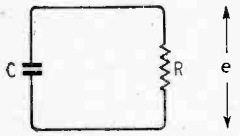


Fig. 1. The basis of a time-base. A charged capacitor is allowed to discharge slowly through a resistor.

Since it is a combination of two circuits it is convenient to consider them separately as far as possible. The Miller integrator will be dealt with first, for this is the heart of the new circuit inasmuch as it is responsible for the linearity of the saw-tooth waveform. It is called the Miller integrator because it depends for its action upon the well-known Miller effect. That is, the effect which makes the input capacitance of a valve (1 + A) times its grid-anode capacitance, where A is the voltage amplification between the grid and anode circuits.

In the normal time-base a capacitance is charged slowly through a resistance from the H.T. supply, and then discharged rapidly through a valve. Alternatively, a capacitance is charged rapidly through a valve and then discharged slowly through a resistance. Considering this latter form, if C in Fig. 1 is charged to an initial voltage E and is allowed to discharge through R, the voltage $e$ at any time $t$ after the start of discharge is $e = E\epsilon^{-t/T}$, where $T = CR$.

The voltage falls exponentially. The slope $de/dt = \frac{E}{T}\epsilon^{-t/T}$. In practice $e$ is permitted to change only a small amount and for this small change the discharge is considered to be linear. Thus, if a change of slope during the discharge of 2 per cent is permissible $\epsilon^{-t/T} = 0.98$ as a minimum and $t/T = 0.02$ as a maximum. Therefore, the change of voltage across C is restricted to 2 per cent of the initial voltage on C.

For time-base purposes, a change of 40 volts across C is usually desirable, and this demands an initial voltage, and therefore an H.T. supply, of 2,000 volts. It is usually uneconomical to provide this.

The Miller integrator in the form adapted for a time-base is shown in Fig. 2; $R_1$ is usually very small compared with R, so that to a close approximation the valve and $R_1$ can be considered as a generator in series with R and C.

The action is most easily understood by starting with C charged to the full H.T. voltage and with the valve drawing some anode current, without bothering for the moment about how the capacitance is charged. The valve current produces a voltage drop across $R_1$ so that the anode $a$ is negative with respect to + H.T., — the point $b$. Therefore, the grid $g$ is negative with respect to $b$ by the sum of the drop across $R_1$ and the H.T. voltage. But the cathode $c$ is negative with respect to $b$ by the H.T. voltage. Consequently, $g$ is negative with respect to $c$ by the voltage drop along $R_1$. Grid current, therefore, does not flow.

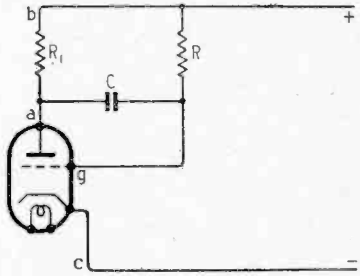


Fig. 2. The Miller integrator adapted for a time-base.

As C discharges the voltage across $ag$ falls and so $g$ becomes less negative with respect to $c$. This increases the anode current and so makes $a$ more negative with respect to $b$. As $V_{ag}$ falls $V_{ba}$ increases ($V_{ag}$ is the voltage by which $a$ is more positive than $g$). If the two were equal the voltage $V_{bg}$ would be constant and the current through R would be constant. This current, however, is the capacitance discharge current and a constant current flowing out of a capacitance means a linear fall of voltage across it.

This cannot be achieved for, if $V_{bg}$ were constant, $V_{gc}$ would also be constant and there would be no change of grid voltage to produce $V_{ba}$. However, by making the amplification large $V_{ba}$ can be much larger than $V_{gc}$ and the linearity can approach perfection.

It is not difficult to show that if A is the voltage amplification ($\simeq g_m R_1$) the discharge current $i = \frac{E}{R}\epsilon^{-t/T}$ where $T = CR(1 + A)$. As far as current is concerned the circuit behaves as if the capacitance were $(1 + A)$ times its actual value.

The anode voltage of the valve varies in the form

$$V_{ab} = E\{1 - A\,(1 - \epsilon^{-t/T})\}.$$

It varies as if C were $(1 + A)$ times its actual value and E were A times the true voltage. With a screened pentode $g_m$ may be 6 mA/V and $R_1$ may be 10 k$\Omega$, making $A = 60$. Now A can easily be 250 volts, so that the effective voltage is 15,000 volts. For 2 per cent linearity, 0.02 of this or 300 volts, would be available as output but for one limitation. The maximum output must be less than the real H.T. voltage. A linear output is obtained only if the valve is acting as a linear amplifier. The maximum possible output is about 80 per cent of the real voltage, and to give a factor of safety it should be rather less than this figure.

When acting as a self-oscillator, the output obtainable is further restricted by the transitron action and is about 20 per cent of the H.T. voltage. For a 250-volt supply the output is about 50 volts, but for this 50 volts the linearity is as if 15,000 volts were acting in the circuit.

The distortion is therefore only

$$\frac{50 \times 100}{15,000} = 0.3 \text{ per cent.}$$

Using a pentode, only the control grid, cathode and anode are needed for this linearizing action and the screen and suppressor grids are available for other use.

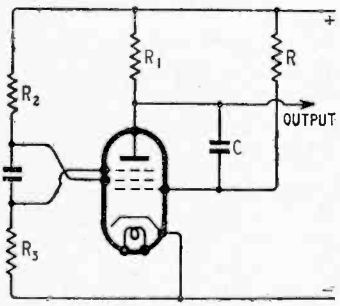


Fig. 3. **The combination of the Miller integrator with a transitron gives a linear saw-tooth oscillator.**

If they are resistance-capacitance coupled a transitron-type circuit is formed and a self-oscillating linear time-base is obtained. The circuit is shown in Fig. 3.

The action depends upon the ability of the suppressor $G_3$ to control the ratio of the anode and screen currents. If the potential of $G_3$ is changed negatively from zero it reduces anode and increases screen current, slowly at first and then quite rapidly. At zero volts the anode current might be 10 mA and the screen current 2.5 mA. When $G_3$ is very negative, however, the anode current may be zero and the screen current 10–12 mA.

To a first approximation the cathode current is independent of the potential of $G_3$ and this electrode acts to control the division of the current between $G_2$ and anode.

Now consider Fig. 3 at an instant when C is fully charged and the valve is conducting. At this time $G_3$ is at or near cathode potential and the screen current is at its minimum. The voltage on $G_2$ is thus a maximum. The valve then functions more or less normally as an amplifier linearizing the discharge of C in the manner already described.

If the potentials of $G_2$ and $G_3$ were constant the action would be identical, but because the $G_1$ potential is changing positively, the $G_2$ current is increasing. This means the potential of $G_2$ is falling. The potential of $G_3$ does not follow this change of voltage of $G_2$ at all well, however, for the time-constant $C_1R_3$ is much less than $CR\,(1 + A)$.

The main effect, therefore, is rather like that of a pentode amplifier without a screen-grid by-pass capacitor, and a form of negative feedback occurs reducing the amplification somewhat.

As this process goes on the total cathode current is increasing as well as the individual anode and $G_2$ currents, but the ratio of anode to screen currents is substantially constant. Now $R_1$ and $R_2$ are of the same order of magnitude, therefore, the voltage change at the anode is greater than that at the screen and at length the anode potential drops to such a degree that its field acting through $G_3$ is no longer sufficient to collect the normal proportion of electrons passing $G_2$. These consequently fall back to $G_2$ and increase its current, thus dropping the $G_2$ voltage.

This change of voltage is passed to $G_3$ through $C_1$ and makes it negative. This further reduces anode and increases $G_2$ current, and so makes $G_3$ still more negative. The action is cumulative

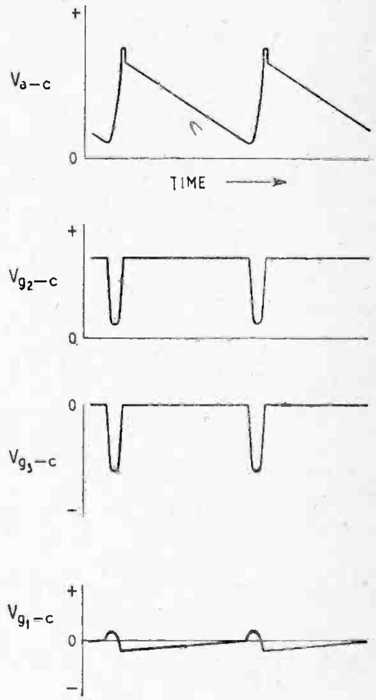


**Fig 4. Voltage waveforms on the various electrodes of the valve in the circuit of Fig. 3.**

and there is a very rapid transition to the flyback state with anode current cut-off, the $G_2$ current a maximum and its voltage a minimum and $G_3$ highly negative.

As anode current is cut-off, there is no voltage drop across $R_1$. The voltage across C is less than that of the H.T. supply, consequently $G_1$ is positive with respect to cathode and C now charges rapidly from the H.T. supply through $R_1$ and the $G_1$—cathode path of the valve. This positive $G_1$ potential tends to increase the $G_2$ current and so reduce the $G_2$ potential further and make $G_3$ still more negative.

The time constant $C_1R_3$ is finite and $G_3$ cannot remain negative indefinitely. It is, however, larger than the discharge time

**Linear Saw-tooth Oscillator—**
constant, comprising only C, $R_1$ and the grid-cathode resistance of the valve. When C is nearly fully charged the $G_1$ grid potential becomes nearly zero and reduces the $G_2$ current. There is a rise of $G_2$ potential and also of $G_3$.

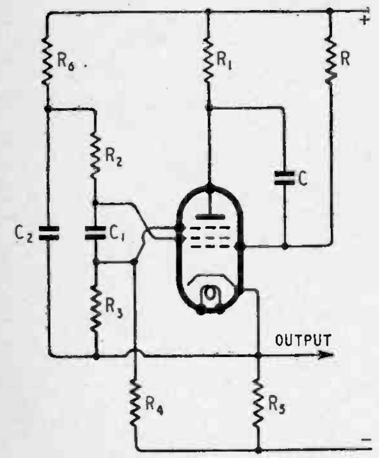


Fig. 5. **Circuit giving a positive-going saw-tooth output at the cathode.**

The anode potential is also substantially at the full H.T. voltage. The rising $G_3$ potential thus permits the anode to draw current again and so reduces the $G_2$ current. This makes the $G_2$ potential rise further and so $G_3$ goes still further in the positive direction. Again there is a cumulative action and a very rapid change-over to the initial condition of $G_3$ at about zero volts and $G_2$ at its maximum.

The various voltage waveforms are sketched in Fig. 4, and well illustrate the action. Synchronization can obviously be effected by applying a negative-going pulse to $G_2$ or $G_3$ at a time prior to that at which the discharge would naturally occur.

The writer has used the circuit of Fig. 3 at 50 c/s with a TSP4 valve. With a 220-volt H.T. supply an output at the anode of about 40 volts is obtainable with $C = 0.02\mu F$; $C_1 = 0.01\mu F$, $R = 4\,M\Omega$, $R_1 = R_2 = 10\,k\Omega$, and $R_3 = 0.5\,M\Omega$. R should be variable as a frequency control. A variable output can be secured at low-frequencies by making $R_1$ a potentiometer, and taking the output from the slider.

The fly-back time is governed mainly by the value of C and can be increased by reducing this capacitance while increasing R to keep the product constant. The above values give a scan-to-flyback ratio of the order of 10 : 1. The TSP4 is not essential and the EF50 should be equally suitable.

In many cases the fact that the output is a negative-going saw-tooth is a disadvantage of the circuit. A positive-going output can be obtained from the cathode, but only about one-half the output can be secured. In addition, the $G_2$ circuit must be decoupled to cathode.

The arrangement of Fig. 5 is satisfactory at 10 kc/s with $C = C_1 = 100\,pF$; $C = 0.1\,\mu F$; $R = 4\,M\Omega$, $R_1 = R_2 = R_3 = 10\,k\Omega$; $R_3 = 0.5\,M\Omega$; $R_4 = 1\,M\Omega$; $R_6 = 20\,k\Omega$. A TSP4 was again used and an output of about 20 volts amplitude secured at the cathode.

The two grid leaks to $G_3$ may seem a little peculiar. This is really only a way of obtaining the effect of a single grid leak returned to a tapping on $R_5$. It was found necessary in order to make the oscillator self-starting. With only $R_3$ present the circuit required an initial kick to make it start, but once started it worked well. When $R_4$ was added, however, it started oscillating without difficulty.

The cathode output is limited by two factors. The first is that $R_6$ is virtually in parallel with $R_5$ as far as voltage changes are concerned, but they are in series for direct current. If the voltage on $G_3$ is to be high enough for satisfactory transitron action, therefore, the values of both $R_5$ and $R_6$ are limited. The second factor is $R_1$; at least one-half of the total output of the valve is developed across this resistance and must be if good linearity and transitron action are to be secured.

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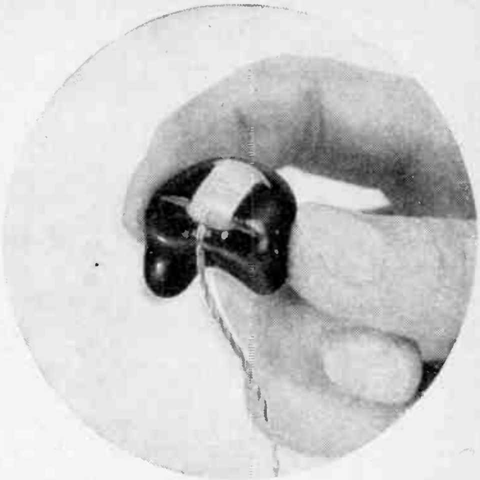
## BUSH EXPORT RECEIVER

NO fewer than eight wave-ranges are covered by this Bush export receiver, Model E.B.S. 84, which has band-spread tuning on the 13, 16, 19, 25, 31, and 41 metre bands. The usual medium - wave range is provided and there is an "intermediate" wave-range covering 48-150 metres. On the bandspread channels an R.F. amplifier precedes the frequency changer, the oscillator section of which includes negative temperature coefficient condensers to compensate for warming-up drift. The vertical illuminated scale is marked with station names on the medium-wave band, metres and megacycles in the "intermediate" band, and an arbitrary 100-division scale on the band-spread ranges. The output power is 3.5 watts from a pentode.

# A NEW EARPIECE

## *Hermetically Sealed Crystal Drive with Inertia Control*

*By C. M. R. BALBI*



THE miniature earpiece is an essential feature of hearing aids and "personal portable" radio receivers. The two simple requirements are:—(1) That it shall be small, light and inconspicuous, and not need any support such as a headband; (2) it shall not be affected by conditions in the ear so that it cannot be clogged by moisture or wax.

A promising line of research for such a device offered itself in a method for the direct stimulation of the auditory nerve by direct electro-telephonic impulses,[1] but this was thoroughly investigated by the author in 1943 in conjunction with Dr. Craik at the Physiological Laboratories, Cambridge, and it was found that although the system required no more than a small electrode in the ear it was fundamentally impossible to transmit sounds of sufficient intensity without discomfort to be of any practical value. The conclusion was that the only method available for the transmission of sound was by mechanical stimulation. From this conclusion the author commenced to develop the "shell" earpiece which was to have the characteristics enumerated. The shell was made to fit the pinna of the ear, which is the part contained by the lobe, so that the device was seated within the ear in the manner of an ear plug. In this form there is no tendency for it to become dislodged.

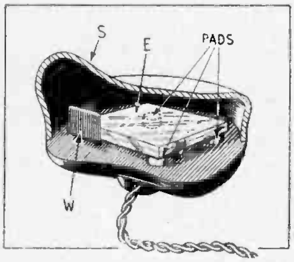



**Fig. 1. Diagrammatic section of the "shell" earpiece.**

The shell was made in plastic, in which no orifice occurred, and is therefore proof against moisture or wax, and can, if necessary, be washed and wiped clean with a handkerchief.

The next problem was to find a mechanism small enough to get it to work efficiently as a telephone. The author having also been responsible for bone conduction in 1919 chose the principle of inertia control and applied it to this air conduction receiver, the feature of which is that it has no diaphragm.

In the design shortly to be produced by Cosmocord, Ltd., of Enfield, the complete receiver weighs about 5 grams, and a piezo-electric crystal (E in Fig. 1) drives the shell S through rubber pads reacting against the weight W. It can be shown theoretically that there are two main resonances in the system which are determined by the elasticity of the contact between the shell and the ear and the mass of the shell, and the other by the elasticity of the pads and the small weight attached to the crystal at one corner. The response of the earpiece may be varied considerably by the alteration of these several factors.

The efficiency of this new earpiece is high, although it may be lower by 10 or 15 db than a sensitive air-conduction earpiece many times its size,[2] and it is comparable in sensitivity with the miniature receivers now commonly used for hearing aids. The response characteristic of a shell earpiece in terms of frequency response in db above one bar per volt is shown in Fig. 2, as taken on an artificial ear, but it should be noted that in making such tests the compliance of the material supporting the shell must be comparable with that of human flesh, otherwise totally spurious results are obtained.

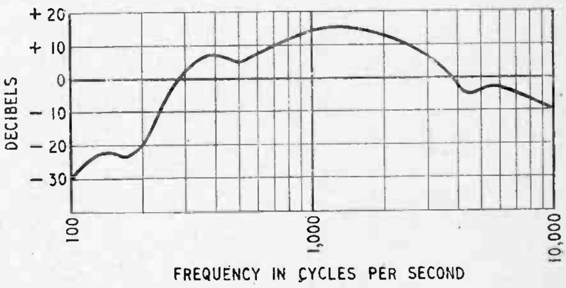



**Fig. 2. Response curve measured electrically with an "artificial ear." Zero level corresponds to 1 bar per volt.**

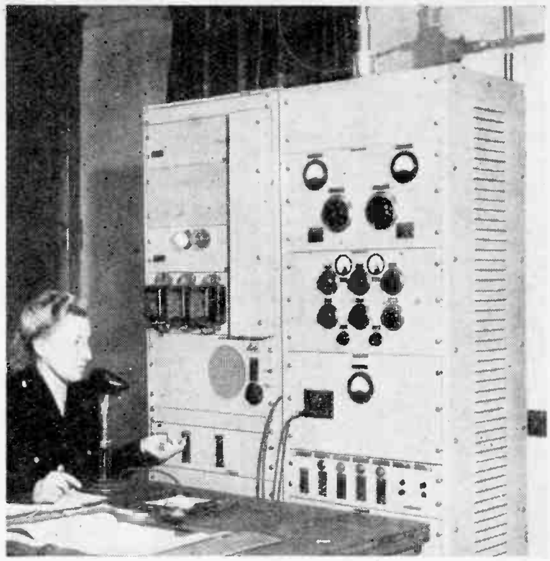
Because this receiver has a high upper frequency response, defects such as harmonic distortion are readily detected which would not be apparent to the ear when an inferior type of earpiece is used. Hence when a comparison of earpieces is being made, a high-grade amplifier should be used.

[1] *Electrical Review*, Oct. 28th, 1932, page 636.

[2] 15 volts gives a working level of 110 db above threshold; 25 volts is about the maximum safe voltage.

# V-H-F COMMUNICATION EQUIPMENT

## *Transmitters and Receivers for Mobile and Fixed Stations*



Transmitter Type 100A and a receiver assembled in adjacent racks for a headquarters station and for local control.

SOME details have now become available of the transmitters and receivers used in the multi-carrier system of communication described in our February, 1946, issue. All the equipment illustrated there was developed by the General Electric Company and those same transmitters and receivers are at present being used by police and fire services in many parts of the country for two-way telephone communication with patrol and staff cars. So far, however, these installations employ the more orthodox single transmitter.

In the diversity system described three different types of transmitters were used, these being rated at 7, 30 and 100 watts power output respectively.

With the exception of the power supply arrangements all these transmitters are identical. For mobile work high tension is obtained from a rotary transformer and the whole installation draws its power from the car battery. At fixed stations, however, these voltages are more conveniently taken from the supply mains.

### Low-power Transmitters

The mobile seven-watt transmitter, Type 7C, and its fixed-station counterpart, 7D, employ one type of valve only for all the radio-frequency stages—the Marconi-Osram DET19 twin triode. In the first stage one triode functions as a crystal oscillator with provision also for frequency doubling, while the companion triode gives a further doubling of the frequency. In the two following stages the valve is used with a push-pull input circuit and parallel output circuit and in each case it functions as a frequency doubler.

Up to this point the crystal frequency will normally have been multiplied sixteen times, being of the order of 100 Mc/s. The final stage, using another DET19, functions as a Class "C" push-pull R.F. amplifier anode modulated by a KT66 valve and a carbon microphone.

When operation between 30 and 64 Mc/s is required fewer doubling operations take place and the eighth harmonic of the crystal is employed. Under these conditions the oscillator section of the first DET19 does not double the frequency. From 64 to 131 Mc/s the output is on the sixteenth harmonic.

The Type 100A transmitter, supplying 100 watts of modulated R.F. power to the aerial, is installed at all the fixed sites in the multi-carrying system and at the majority of the headquarters stations in the single-carrier installations. It provides for operation on M.C.W. telegraphy, on telephony, or from a gramophone pick-up and it is fully equipped for remote control, either by line or by radio links if necessary. The modulating equipment is of sufficiently high gain to permit the use of a moving-coil microphone.

Built in rack form, it comprises six main units; the R.F. power amplifier, R.F driver unit, modulator unit, control panel, modulator supply unit and the R.F. power supply unit.

The R.F. driver panel of the Type 100A can be employed as a 30-watt transmitter when used with scaled-down modulator and power supply units.

### Pre-tuned Receivers

All the receivers used in the various installations have the same chassis and they differ only in the nature of the auxiliary equipment. For some headquarters stations the receiver chassis is assembled in a steel cabinet containing a mains-operated power unit and a loudspeaker. The same combination is also available in rack-mounting form, with or without the loudspeaker, whilst for mobile work the chassis, loudspeaker, and rotary supply units are separated.

The receiver is a 10-valve superheterodyne; as it is designed for pre-tuned operation, an extremely compact layout has been possible. The only controls are on-off switches, the H.T. and L.T. supplies having separate switches, and these can be located in the most convenient positions according to the type of installation. In the mobile equipment, for example, the receiver is generally in the luggage boot of the car, while the controls are grouped on a small dashboard panel.

The circuit consists of one signal frequency amplifier, in which is fitted a special V.H.F. pentode, the Z90. This valve is used also in the mixer stage and for the second frequency multiplier of the two-valve crystal-controlled local oscillator.

Following the mixer is a three-stage I.F. amplifier operating at about 9 Mc/s, and for normal pre-tuned radio telephony it is adjusted for a band-width of approximately 100 kc/s. A twin-diode acts as a series-shunt noise limiter, while a double-diode-triode combines the functions of second detector, A.V.C. rectifier and first-stage audio amplifier. This is followed by a pentode output valve feeding a loudspeaker.

A receiver of this design is capable of very high overall sensitivity, even at the high working frequency of 130 Mc/s, and the G.E.C. Model is no exception. Its test specification requires that for 50 milli-watts output the signal input must not exceed 5 $\mu$V at any frequency and with 30 per cent. modulation.

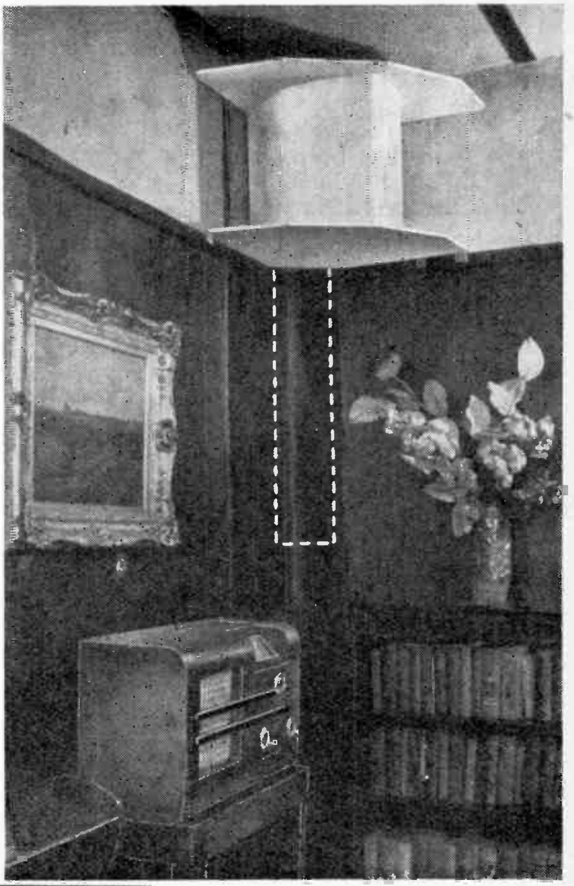
# CORNER DEFLECTOR BAFFLES

THE problem of providing a baffle of adequate dimensions in the average living room has been solved in the "Dynamic Infinite Baffle Corner Deflector," made by Broadcast Acoustic Equipment Co., Tombland, Norwich, by using the walls of the room itself as elements in the combined horn and baffle system. The loudspeaker unit is contained in a rigid plaster casting shaped to give two outward radiating paths of logarithmically increasing section and a diffuser is incorporated to give even distribution of high frequencies. The back radiation from the cone is conducted to a small bass chamber inside the moulding, from which a small triangular hole in the angle of the walls gives access to the open air. A useful feature of this arrangement is the possibility of experiment with acoustic labyrinths of different length formed by the simple expedient of placing a stout board across the angle of the wall as indicated by dotted lines in the photograph.

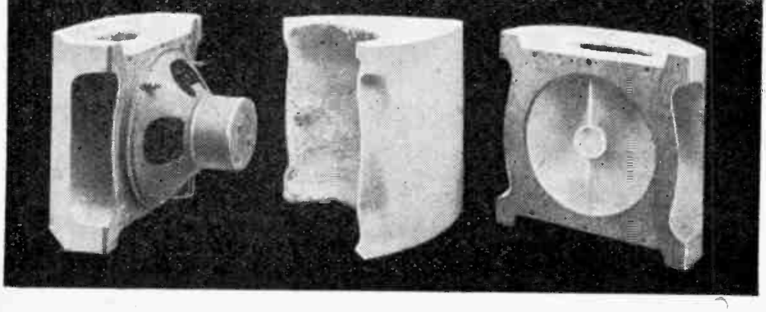
The 12-inch loudspeaker units supplied with these baffles are of good quality with cast frames, detachable diaphragms and Ticonal magnets, and are available with single- or twin-cone diaphragms. The power handling capacity is 15 watts.

We have had an opportunity of hearing one of these baffles, and the results are very good. There is ample bass response, and the unit delivers its full rated power without any signs of overloading. It is also above the average in electro-acoustic efficiency. The single-diaphragm unit gives all the top necessary for gramophone reproduction and the majority of broadcast programmes, but the twin diaphragm would no doubt show to advantage on some local-station transmissions.

The price of the baffle is £6 10s, and the loudspeaker units cost £7 10s for the PM/15, and £8 15s for the PM/15/HiFi model with twin diaphragm.



"Dynamic Infinite Baffle Corner Deflector" mounted in the corner of a room. The dotted lines indicate the possibility of extending the length of the air column behind the diaphragm by means of a board.



Component parts of the deflector showing diffuser for high frequencies and relief holes for the back radiation are shown on the left.

# SUPER-REGENERATIVE RECEIVERS

## *A Re-assessment in the Light of Recent Developments*

By "CATHODE RAY"

ONE can hardly expect anything, I suppose, to keep on being sensational for 24 years, but it does seem to me that the super-regenerative receiver deserves rather more publicity than it gets. Its performance really is sensational. A good single-valve super-regen is as sensitive as almost any receiver can be, regardless of the number of valves. So far from falling off at the ultra-high frequencies, it works better. It includes automatic gain control that would need a multi-valve superhet to equal. On top of all that, it deals effectively with interference of the motor ignition type that is so troublesome on the television waveband.

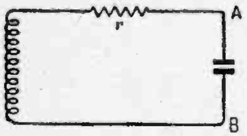



Fig. 1. Simple tuning circuit, in which $r$ represents the effective resistance. In a super-regenerative receiver, $r$ is made to alternate rapidly between positive and negative.

From the fact that the manufacture of all other types of receiver has not ceased, you are correct in deducing that the super-regen has snags. Those usually held up against it are (1) lack of selectivity, (2) noisiness, (3) radiation, and perhaps (4) uncertainty or freakishness of results. All of these can be largely or entirely overcome. The real objections, to my mind, are (*a*) that its performance, which is best at the very high frequencies (where other types of receiver tend to fail), falls off at the lower carrier frequencies, and (*b*) likewise at high modulation frequencies; and (*c*) that it distorts deep modulation rather badly. (*a*) and (*c*) knock it out for broadcast reception, and (*b*) for television. So to the man in the home the super-regen is not "news." It didn't even get much credit for its war service as the heart of the most-produced radar equipment—I.F.F. and beacons—as well as in innumerable "walkie-talkies." Incidentally, its use for I.F.F., where the utmost stability and reliability was essential, disposes of objection (4) on the above charge sheet. There are many other jobs at which the super-regen could be usefully employed if it were better known and understood.

The trouble is that, although the super-regen circuit is simple in appearance and (up to a point) in theory, attempts to produce anything like a comprehensive theory of its action have invariably led to the most appalling mathematics, with each authority arriving at an entirely different and often contradictory result. So the practical man, finding it hopeless to think of designing a super-regen on a rational basis, has tackled it by trial and error, has unleashed a variety of noises and obscure effects unrivalled in any other branch of the art, and in disgust has made a superhet instead.

One reason for this state of things is that the super-regenerative receiver works in quite a different way from any other sort, superficial resemblances notwithstanding. Another reason is that its performance depends on so many variable quantities that it would be an endless job to give a complete account of all the possible combinations; so anyone who sets out to analyse it has to make some assumptions. Different authorities have made different assumptions; hence the conflicting results on record. This is not very encouraging for the ordinary reader, so what I am going to try to do is to give a reasonably simple account of how it works, the conditions that give the best results, and some practical suggestions.

We begin with a simple tuned circuit, Fig. 1. The resistance $r$ is not usually there as a visible component; it represents the unavoidable losses, chiefly in the coil. When a signal voltage arrives, Fig. 2(a), of the frequency to which the circuit is tuned, it builds up a comparatively much greater voltage, Fig. 2(b), across AB, which is then applied to the input of an amplifier, etc. The number of times greater is denoted by Q. For an average sort of tuned circuit by itself, Q is of the order of 100. When the signal stops, the voltage across AB dies away as shown.

Reducing $r$ increases Q and also the amount of the build-up and the time taken to die away. By the use of reaction, $r$ can be reduced to zero and even made negative. What happens then is that any voltage, however small or short-lived, starts oscillation at the natural frequency of the tuned circuit, and the oscillation continues to grow, in the manner shown at the left-hand side of Fig. 3(a), until something happens to reduce the negative $r$ to zero. That something is generally the valve being driven to the limit of amplitude that it can handle. After that, the oscillation continues steadily at constant amplitude, as shown from the time marked $l$ onward. In practice, of course, the pre-$l$ and post-$l$ phases are not so clear-cut, but merge into one another.

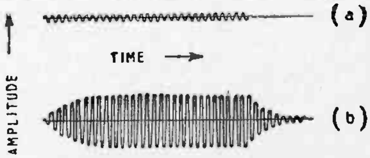



Fig. 2. If $r$ in Fig. 1 is positive, the arrival of a signal voltage (a) in series with the coil causes a magnified voltage (b) to build up across AB. When (a) stops, (b) dies away gradually. This is the normal unassisted behaviour of a tuned circuit.

The way the oscillation grows while $r$ is at a constant negative value is the same as that by which money grows when subject to compound interest; each cycle is a certain percentage larger than the preceding one. The percentage depends on $r$; the greater the negative $r$ the greater the percentage growth, and the quicker the

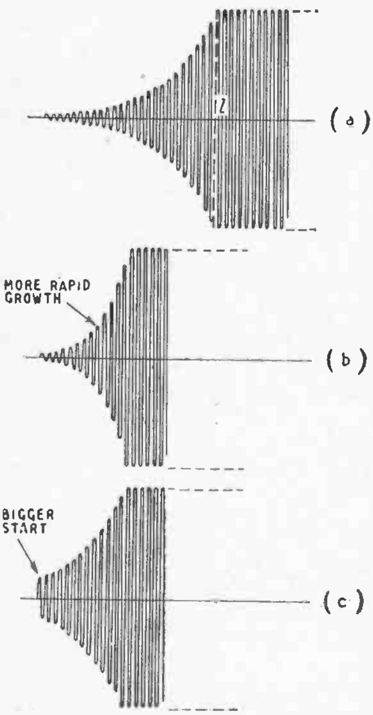



Fig. 3. When, with the aid of a valve and positive feedback, $r$ in Fig. 1 is made negative, oscillation builds up (a) until, at $l$, it is checked by the valve reaching its limit. Either a greater negative $r$ (b) or a bigger start (c) makes oscillation reach the limit sooner.

oscillation will reach its limit from a given start, Fig. 3(b). Another way by which the limit can be reached in a shorter time is by giving a bigger start, as in Fig. 3 (c) (which is just (a) with the first few cycles omitted). Relative to Fig. 3(a), (b) shows the result of a higher rate of interest, and (c) the result of investing a larger capital. Some numerical examples may help to make it clear:—

| Percentage increase per cycle | Initial signal (microvolts) | Number of cycles to reach limit amplitude, say 5 volts |
|---|---|---|
| 5 | 5 | 283 |
| 10 | 5 | 145 |
| 5 | 10 | 269 |
| 5 | 10,000 | 127 |

Fig. 3 is the key to super-regenerative action. Armed with it, we can tackle a receiver circuit, Fig. 4. Apart from the quench oscillator, this is a very simple 1-valve receiver with reaction. Assuming reaction is adjusted to the edge of oscillation (as it generally is in 1-valve receivers), $r$ is almost zero, and a substantial increase in anode voltage will bring it well into the negative region, while an equal reduction will bring it well into the positive region. That is precisely what the quench oscillator does alternately, at a frequency which must be much less than that of the R.F. carrier wave, but greater than that of any modulation of the carrier. The precise frequency to adopt, within these limits, is one of the great super-regen controversies.

Another thing that has a profound effect on the performance (and accounts for many of the discrepancies between different treatises on the super-regen) is the waveform of the quench oscillator. Although not at all typical of actual practice, a square wave is the simplest for explanation. Consider, then, what happens when the quenching wave, Fig. 5(a), goes through its cycle, beginning with the negative half, which keeps the valve well off the oscillation point. There is no incoming signal, shall we say; so the only voltages present in the tuned circuit are the very small ones due to random motion of electrons, called inherent circuit "noise," of the order of a microvolt. These are completely irregular, and only a very small proportion occur at the frequency of the tuned circuit, which consequently is very little excited by their presence. What we have, then, is a very small and very erratic oscillation in the tuned circuit.

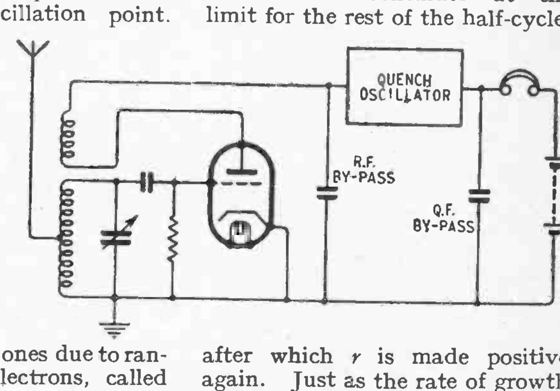



Fig. 4. Simple super-regenerative receiver circuit.

When the quenching oscillator clicks over to its positive half-cycle, oscillations begin to build up, starting at the level at which by pure chance the noise voltage happens to be just then. Whether they will reach the limit during the half-cycle depends on (1) the noise voltage at the start; (2) the rate of growth (which in turn depends on the quenching amplitude and other circuit conditions); (3) the limit amplitude; and (4) the number of R.F. cycles in one Q.F. half-cycle (i.e., the ratio of radio frequency to quench frequency). This is where one begins to see that the problem may soon get out of hand; but there is no need to take fright just yet. In a given receiver, (2)-(4) are all fixed, and it is easy to see that in order to ensure even the smallest voltage building up to the limit in every quenching cycle it is only necessary to make the Q.F. low enough. Let us do that, then.

Oscillation continues at the limit for the rest of the half-cycle, after which $r$ is made positive again. Just as the rate of growth was proportional to the negative value of $r$, so the rate of die-away depends on the positive value. Assuming the two are roughly equal, the oscillation may be expected to have died down to noise level before the next de-quenching half-cycle begins. When it does, the noise voltage at that instant will in general be different from what it was at the

**Super-regenerative Receivers—**
start of the previous (or any other) dequenching half-cycle; so the build-up will be quicker or slower accordingly.

Any sound that is heard in the phones is produced by the current, indicated in Fig. 5(c), due to rectification of the bursts of R.F. If these bursts occurred at an audible frequency they would, of course, produce a loud note of that frequency. But they occur at Q.F., which we have assumed (for one reason which is now clear) to be higher than audibility. The sizes of the bursts are varying, however, according to the noise voltages that happen to exist at the moments when the quench voltage goes from negative to positive. In Fig. 6, OADE represents a rectified burst following the least possible noise voltage, and OBDE one following the greatest noise voltage; so the maximum variation in size is as shown shaded. As the variations within this maximum are erratic, a completely formless sound, like gramophone record scratch, is heard. It indicates the enormous amplification of the super-regen, for there are few superhets, even, that amplify enough at very high frequencies to reveal circuit noise so strongly.

However, this sound, interesting theoretically, and useful for indicating that the super-regen is super-regenerating, regarded as programme material fails to grip the attention for long; so we next consider what happens when a carrier wave is tuned in. If this carrier wave is unmodulated, and much stronger than the noise, the starting voltage is practically the same at every quench cycle, so every burst is the same size (say, OCDE in Fig. 6) and no sound is heard. When the carrier wave is modulated, the sizes of the bursts are made to vary at audible frequency.

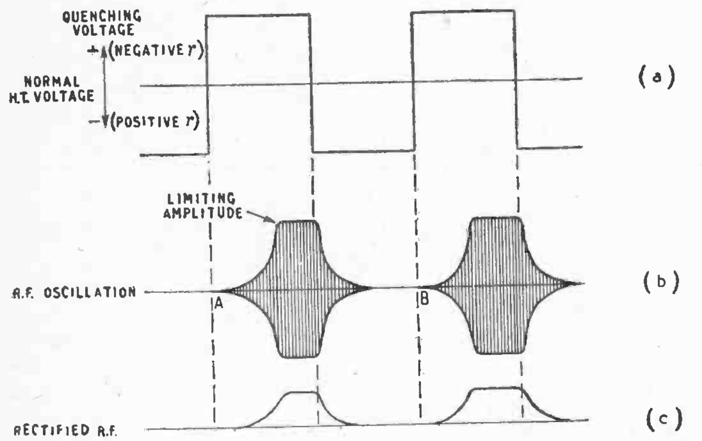



Fig. 5. Application of a square quenching wave (a) causes R.F. oscillations to build up and die away as at (b). The R.F. is rectified in the super-regen valve giving unidirectional pulses (c), and it is the variation in the size of these that is audible. For example, the second one shown here is larger than the first, indicating that the signal at B must have been stronger than at A.

If you have read "Pulse Modulation" in the April issue you will agree that the super-regen process is remarkably like pulse length modulation. The super-regen valve generates R.F. oscillations; the quench oscillator generates fat pulses which modulate the R.F. into what I call wave pulses; the incoming signal modulates the effective length of the wave pulses; and the super-regen valve demodulates the modulated wave pulses, extracting the modulation frequency.

I hope the fog has now cleared away sufficiently to reveal the reasons for most of the peculiarities of the super-regen:—

(1) *Sensitivity*. If a tenth of a penny had been invested at 5 per cent per annum compound interest in the year 1 A.D. it would to-day have grown to

£100,000,000,000,000,000,000,000,000,000,000,000,000,

or roughly a lump of gold as big as the whole world for every 10 seconds through all those years. As the super-regen amplifies on the same principle, a phenomenal gain is only to be expected. Its voltage amplification is limited at one end by the size of the smallest possible voltage (i.e., noise) and at the other by the power-handling capability of the valve, and is of the order of a million. That is assuming the oscillations have time to build up to the limit. The lowest Q.F. that does not cut into speech frequencies is, say, 10,000 c/s, so half a cycle lasts 50 microseconds. Judging from the examples already worked out, it looks as if we ought to allow for several hundred R.F. cycles in this time; say 500. That puts the lowest R.F. for most effective performance at about 10 Mc/s (30 metres wavelength). The lower the R.F., the stronger should be the quench oscillation, in order to build up within the limited number of R.F. cycles.

On the other hand, if the R.F is very high and/or the quench is very powerful, it is better to increase the Q.F., in order to get more build-ups into a given time. The Q.F. giving the most amplification is that which just allows time for full build-up and die-away in each of its cycles.

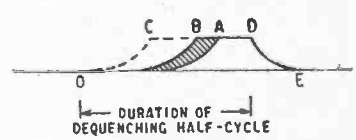



Fig. 6. When only "noise" is stimulating the receiver, the size of the rectified pulses varies to a certain extent, shown shaded. A relatively strong R.F. signal brings it, say, to C. Growth starts at O every time, but with a weak start is not big enough to show in a diagram until some way towards E.

(2) *A.G.C.* The numerical examples showed that a 1,000-fold increase in signal input only reduced the number of build-up cycles from 269 to 127. Let us elaborate this a little. It is the *variations* in signal strength, due to modulation, that are effective in producing audible output. Those variations can be measured

by the variations in the number of cycles necessary to build up to the limit. Let us suppose both signals in question are modulated 50 per cent, as follows:—

| Modulated carrier wave voltage | Number of cycles to build up to 5 volts, at 5 per cent per cycle |
|---|---|
| Average $10\mu V$ { min. $5\mu V$; max. $15\mu V$ | 283, 260 } difference = 23 cycles. |
| Average $10{,}000\mu V$ { min. $5{,}000\mu V$. max. $15{,}000\mu V$ | 142, 119 } difference = 23 cycles. |

So these signals of vastly different strength, when equally modulated, give exactly the same output! A.G.C. action is therefore theoretically perfect. In practice it is not exactly so, because the non-linearity of the valve upsets the compound interest law slightly, and also very weak signals have to compete with noise. Fig. 7 is an actual measured input/output curve.

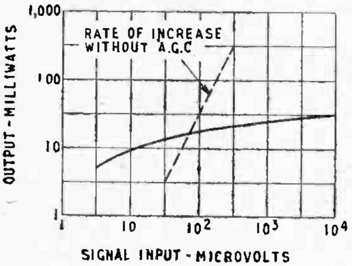



Fig. 7. Actual input/output curve of a typical super-regen receiver, showing A.G.C. characteristics with 30 per cent modulation. The dotted line, for comparison, shows the characteristic of a receiver without A.G.C.

(3) *Noise.* The origin of the characteristic rushing sound of super-regeneration, and the reasons why it disappears when a relatively strong carrier wave is tuned in, are, I hope, now clear. But suppose the Q.F. is increased, or its amplitude on the negative side reduced, so that oscillations have not time to die away, but are still several times stronger than the noise voltage when the next positive Q.F. half-cycle is due to begin. Then the starting level will be this constant oscillation voltage rather than the erratic noise voltage; and the characteristic sound will be absent. That may be hailed as an advantage; on the other hand, when the receiver is tuned through a carrier wave its self-oscillations will cause whistles by beating with the carrier. The situation is even more complicated, because as the tuning is varied the oscillations produce audible stroboscopic effects with multiples of the quench frequency, rather like the strange behaviour of the wheels of moving vehicles seen in the cinema. Without going into all the gruesome details, you may be able to see that there is plenty of basis for the weird effects obtainable with super-regen receivers. The surest way to keep clear of them is to keep the R.F. high and the Q.F. low.

(4) *Interference Suppression.* Interference of the "click" type, caused chiefly by motor ignition systems, is generally the most prevalent on the V.H.F. waveband, for which the super-regen is most suitable; and electrically it consists of very intense but short-lived and isolated pulses. Looking at curve OCDE in Fig. 6, representing a quench cycle during reception, any clicks during the period CD find a receiver already saturated with oscillations of maximum intensity, and therefore practically dead to outside influences. During DE the oscillations are being suppressed. Just at O the receiver is extremely sensitive, but the chance of a click happening exactly then is very small. From O to C the effect produced by interference gets less and less. It is fair to say, then, that most of the interference is suppressed, and very few of the clicks get through with any serious strength.

(5) *Distortion.* Putting together figures we have already had, we see that a 10,000 microvolt signal growing at 5 per cent per cycle builds up to 5 volts in 127 cycles, and that when modulated to a depth of 50 per cent the positive peaks advance the build-up by 8 cycles while the negative peaks retard it by 15 cycles. The output modulation wave will therefore be lopsided, and the distortion rapidly grows worse as the depth of modulation is increased. It is good enough for intelligible speech, however, if the modulation is kept within about 80 per cent, but rules the super-regen out for high-quality reproduction.

(6) *Selectivity.* With the square quenching wave we have been assuming, the build-up time is determined by the amplitude of whatever is in the input circuit at the moment of dequenching. The selectivity is therefore no better than that of the single tuning circuit under quench conditions; that is, it will be just about as poor as with one tuned circuit and no reaction. That may not be at all a bad idea in the V.H.F. or U.H.F. bands, where searching with a highly selective receiver is like looking for the proverbial hay-shrouded needle. But to refute the charge that this very low grade of selectivity is the best the super-regen can offer, it may be pointed out that there are other ways of organizing it. If the quenching voltage, after it has had time to suppress oscillation, is eased off so that for a little while before the dequench point the circuit is near the edge of oscillation, signals of exactly resonant frequency are built up by the ordinary reaction process and are all ready to kick off oscillation

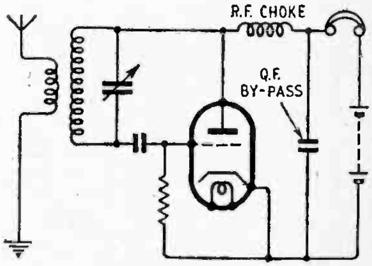



Fig. 8. Flewelling, or self-quenching, super-regen circuit.

with a flying start, whereas off-tune signals and noise are not thus pre-amplified. Selectivity and signal/noise ratio can be improved in this way by using a sine wave quench (which anyway is more natural than a square one) of the lowest possible Q.F. (already recommended), and the minimum quench voltage and

**Super-regenerative Receivers—**

maximum reaction that will work properly. Instead of clicking suddenly over from high positive *r* to high negative *r*, as it does with a square quenching wave, the circuit spends more of its time with *r* near zero.

(7) *Radiation*. It is obvious that the Fig. 4 circuit will radiate furiously, a fact of which use is made in transceivers; if it is necessary to prevent it, a preliminary R.F. stage with proper screening is the remedy.*

(8) *Erratic Performance*. Some of the causes have appeared already; too high a Q.F. is about the commonest. Another is trying to make one valve do everything, including generating the quenching wave. In Fig. 4, the square box will normally contain a valve oscillating at Q.F., and appreciable power is needed to quench the super-regen valve in its anode circuit. But it is a good stable job. Economizing by quenching at the grid introduces complications, and a larger share

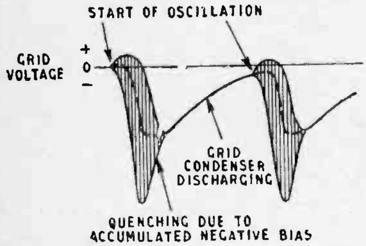



Fig. 9. Variation of grid voltage during two quenching cycles in the Flewelling circuit. The dotted line shows the average grid voltage during oscillation.

of skill or luck is needed to get good results.

Lastly, a few remarks on some special sorts of super-regen. What is called the Flewelling circuit (Fig. 8) is the ultimate in economy and simplicity. It is adjusted to oscillate so furiously that the accumulated negative bias chokes itself off, and it has to wait until the grid condenser has discharged before it can start again. If it does this a super-audible number of times per second, it combines the functions of R.F. oscillator and quenching oscillator. The Q.F. depends mainly on the vigour of R.F. oscillation and on the values of grid condenser and leak. The grid voltage goes through working cycles rather as shown in Fig. 9; and they look almost ideal for encouraging selectivity. The Flewelling is not a very flexible circuit, but it is quite a good one for working on a fixed and very high radio frequency.

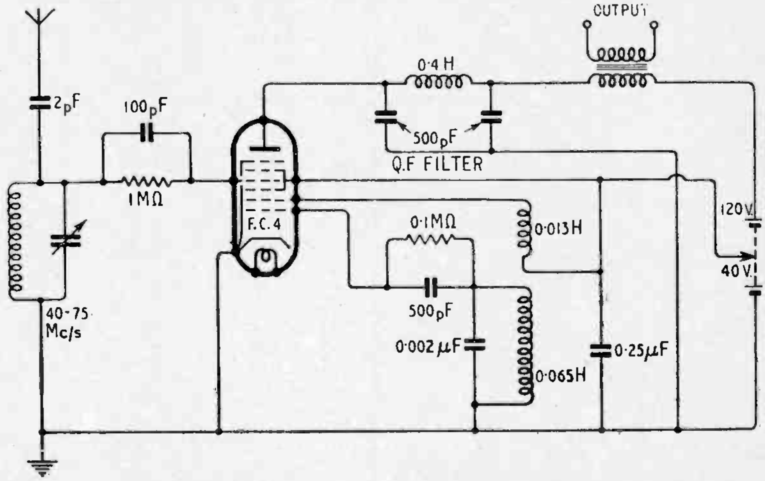



**Fig. 10. Recommended super-regen circuit, using a frequency-changer valve.**

Personally, I think the most satisfactory 1-valve super-regen circuits are those using frequency-changer valves. Fig. 10 shows one built around an octode, but heptodes can be used, and no doubt triode-hexodes, too, with slight modifications. The first two grids, normally used for the local oscillator in a superhet, are employed to generate the Q.F.; and the R.F. goes in, also quite normally, at the control grid. At least, it looks normal for a superhet but quite abnormal for a super-regen, as there is apparently no reaction! Nevertheless, it works, at V.H.F., because the effective cathode is somewhere between the visible cathode and the control grid, and stray capacitances cause the circuit to oscillate in the Colpitts manner.

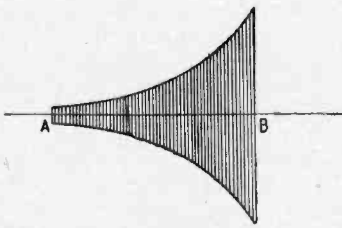



Fig. 11. In the non-limited or linear type of super-regeneration, the dequenching half-cycle, starting at A, stops at B, before the limiting amplitude has been reached.

Everything so far has been based on the assumption that oscillations are allowed to build up to the limit. If, on the other hand, the Q.F. is raised so high that they never have time to do so, the performance is quite different. In Fig. 11, if oscillation is started from, say, 10 microvolts at A and allowed to grow at compound interest, say, 5 per cent, until B, each cycle will be 1.05 times greater than the one before it. Suppose there are 150 cycles. Then the amplitude of the final one will be $10 \times 1.05^{149}$, which is $10 \times 1440$. If the starting level had been, say, twice as great, the output would have been double, too. Output is exactly proportional to input. Working this way, there is less amplification per quench cycle, but more quench cycles, less selectivity, no A.G.C. action, and no distortion. In various ways this suits I.F.F. receivers, which have to respond to very brief pulses from radar stations, so they use super-regeneration of this second type.

If you want to study the first sort of super-regeneration more thoroughly, I can recommend F. R. W. Strafford's paper on the subject in the *Journal I.E.E.*, Part III, January 1946.

* See for example O. J. Russell, "Super-Regeneration," *Wireless World*, Dec. 1944.

# MULTI-CHANNEL PULSE MODULATION

## Details of Army Wireless Station No. 10

A BRIEF account of the operational use of the No. 10 set appeared in the December issue of *Wireless World*, and another article in the same issue described the principles of pulse-width modulation. Details are now available of the Signalling Equipment No. 10, the units in the 10 set which produce and demodulate width-modulated pulses. These pulses, once produced, are used to modulate in turn an ultra-high-frequency transmitter working in the 6–7 cm band. At the receiving end the width-modulated pulses appear in the output of the receiver and are then demodulated by the Signalling Equipment No. 10. The equipment is divided into two main units—the *pulser* and the *separator*.

The chief details of the circuit of the pulses are given in Fig. 3. Before discussing this, however, it may be as well to explain briefly the object of the apparatus. Narrow pulses recurrent at 9 kc/s are width-modulated by the A.F. signals which are to be transmitted. The pulses are narrow with an average duration of 3.5 μsec. Each of the eight speech channels modulates a separate train of pulses of the same recurrence frequency, but all the trains are staggered in time so that they can fit together without interference. A synchronizing pulse is also included to control the receiving apparatus which sorts out the pulses, demodulates them and routes the A.F. signals to the proper output circuits.

The pulse starts with a 9-kc/s oscillator of sine waveform. Its output takes the form shown in Fig. 1(a). From this oscillator is derived a sequence of rectangular pulses which are repeated for every cycle of the 9-kc/s oscillator. This sequence consists of a synchronizing pulse followed by eight "channel" pulses and they may be represented as in Fig. 1 (b).

The channel pulses are so-called because each one is width-modulated by one of the telephone lines coming into the station and thus provides a "channel" for conveying intelligence. The idea is easier to grasp from Fig. 2, which is Fig. 1(a) and (b) combined and reduced in scale. Here a number of pulse sequences is shown, and it will be seen that all the pulses marked "1" can be grouped to form a series of width-modulated pulses comprising the intelligence conveyed on channel 1, all those marked "2" can carry the intelligence conveyed on channel 2, and so on. It is by this system of interleaving pulses that a number of channels can be made to modulate a U.H.F. transmitter.

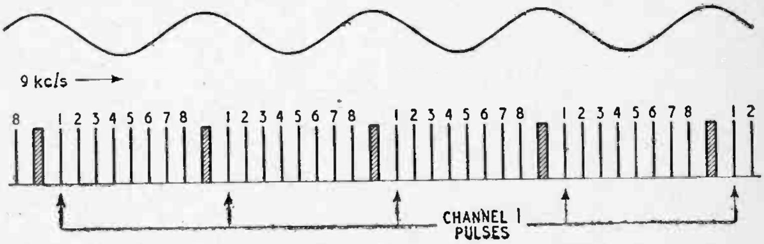



Fig. 2. This diagram shows essentially the same waves as Fig. 1, but to a reduced scale so that several cycles of the wave can be seen. Pulses numbered "1" convey intelligence for channel 1, "2" for channel 2 and so on.

The method by which the various A.F. channels are recovered from these pulse sequences in the receiving part of the Signalling Equipment No. 10 is described later in this article. This operation is performed by the "separator." It is best at this point, however, to look at the pulser circuits in more detail.

Fig. 3 shows the circuit of the pulser. The inset rectangles show the shape of the wave-forms at particular points in the circuit. so that the way in which the final pulses are built up can be seen.

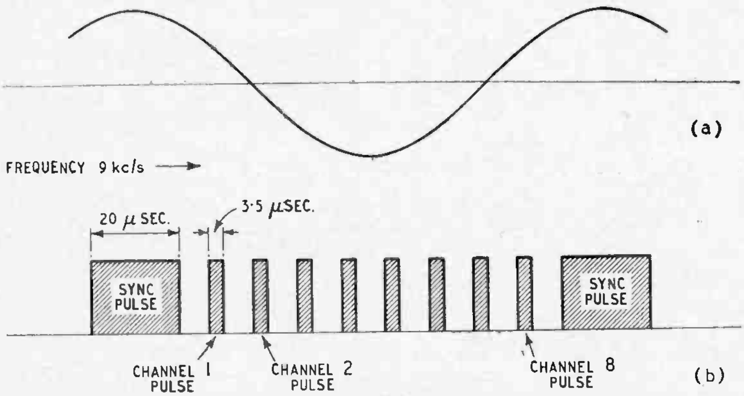



Fig. 1. The sine wave used to control the pulse generation is shown at (a) and the complete pulse sequence produced from it at (b).

**Multi-channel Pulse Modulation—** They should be referred to as each stage in the circuit is described.

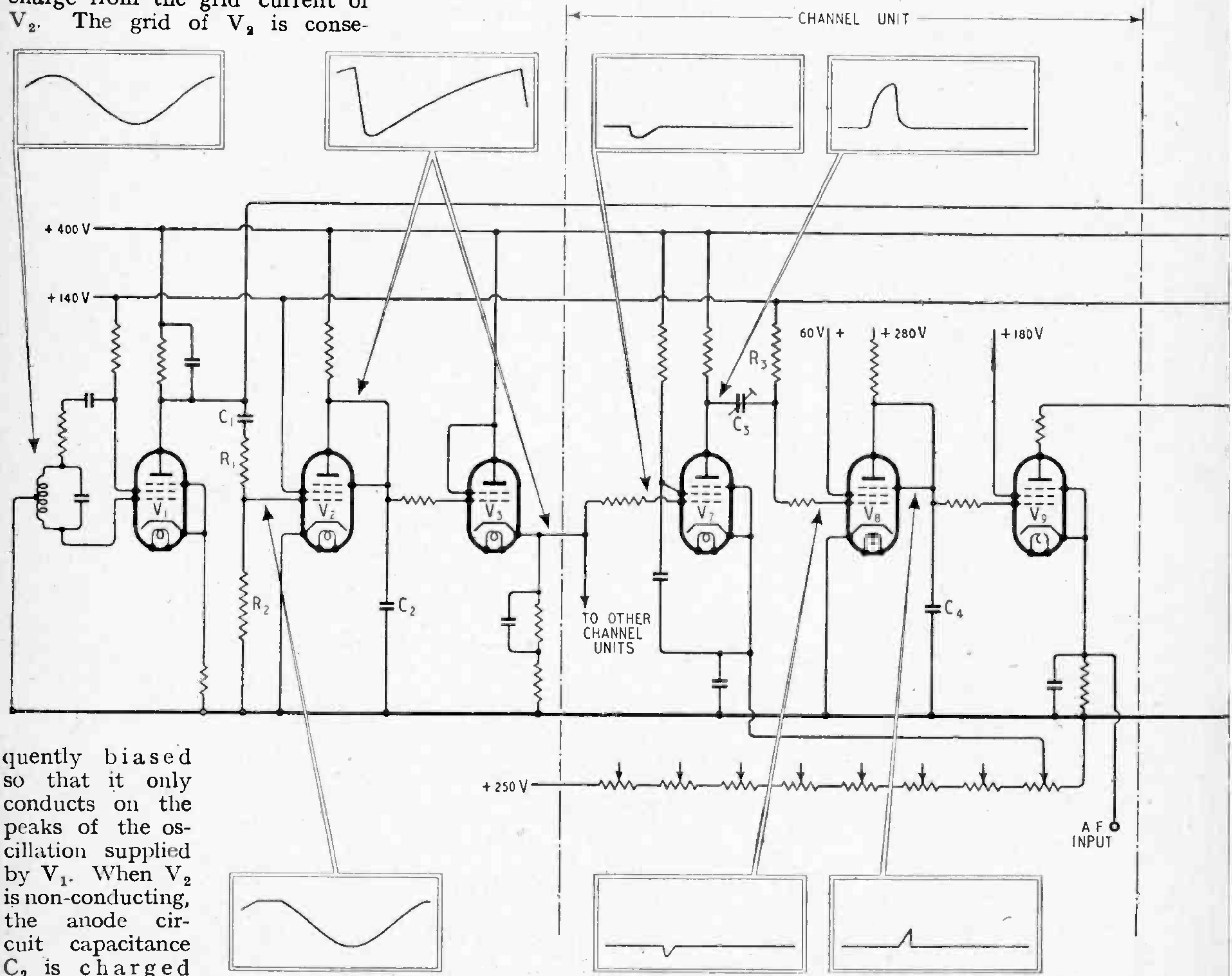
The 9-kc/s pulse-recurrence frequency, as it is termed, is generated by $V_1$. It is a normal type of electron-coupled Hartley oscillator—the output being taken from the anode. This provides a certain buffering effect between the oscillator and later stages.

The saw-tooth generator is $V_2$ in which $C_1$, $R_1$, and $R_2$ have a time constant large compared with the period of 9-kc/s oscillator; therefore $C_1$ acquires a mean charge from the grid current of $V_2$. The grid of $V_2$ is consequently biased so that it only conducts on the peaks of the oscillation supplied by $V_1$. When $V_2$ is non-conducting, the anode circuit capacitance $C_2$ is charged by the H.T. supply through the anode resistance. Before it has time to become completely charged, however, $V_2$ takes current and $C_2$ is rapidly discharged through the conducting path provided by the valve.

This process is continually repeated and thus a saw-tooth voltage is generated which is applied to the cathode-follower stage $V_3$. This acts as a buffer and its output is distributed to eight channel units, each dealing with the input from one telephone line. We will deal with the channel unit concerned with channel 1, which is the only one shown in Fig. 3. The saw-tooth voltage in the output of $V_3$ is applied to the grid of the first valve $V_7$ in the channel unit. The action of the circuit can best be understood by considering what happens when the saw-tooth voltage gradually rises from its lowest potential.

The cathode of $V_7$ is given a positive bias so that the valve will not conduct at first. As the saw-tooth voltage on the grid becomes increasingly positive, however, a point is reached where the grid is more positive than the cathode and the valve suddenly conducts. This produces a steep fall in the potential of the anode and consequently in the potential of the junction between $C_3$ and $R_3$. The latter potential will however, rapidly recover, the time taken to do so depending on the time constant of $C_3$ and $R_3$. Thus a negative-going pulse is transmitted to the grid of $V_8$.

It should be noted that the initial part of the pulse shown as the anode waveform of $V_7$ is positive-going. This is the recovery from the saw-tooth flyback and remains the same for all channel units. In other units the voltage remains constant between



the end of this rise and the start of the fall when $V_7$ becomes conductive. This interval depends on the bias on $V_7$ and the greater the bias the more the voltage fall is delayed and the later the pulse on the grid of $V_8$.

The grids of $V_7$ on the remaining seven channels are each biased positively, the bias increasing progressively on each channel. The application of the saw-tooth to all the channel units, therefore, results in a series of successive negative-going pulses, one at the grid of each valve $V_8$. This latter valve constitutes a saw-tooth generator. Its grid is biased positively so that normally the valve is taking current. The application of the negative pulse to the grid, however, stops the current for a short time. During this time the capacitance $C_4$, which is normally short-circuited through the conducting path provided by $V_8$, is charged by the H.T. supply. Before it has time to become fully charged the valve $V_8$ conducts again and the capacitance is very rapidly discharged. Due to this action a saw-tooth voltage is applied to the grid of $V_9$. This is the modulator and A.F. from the line corresponding to channel 1 is applied to its cathode. This valve produces width-modulated pulses of approximately rectangular shape at its anode.

In Fig. 4, "A" represents a saw-tooth voltage pulse on the grid of $V_9$. In the unmodulated state the cathode is given a certain positive bias represented by "B" in Fig. 5. It will be seen that the valve will only conduct during a certain time "*t*" when the voltage between grid and cathode is more than that required to cut off the anode current and thus a pulse is produced at the anode, of width

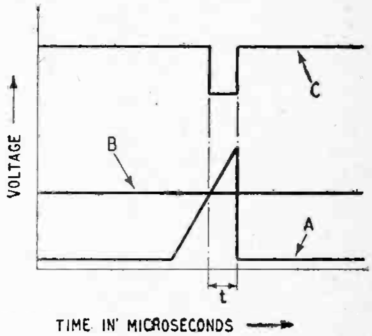



**Fig. 4. The saw-tooth voltage on the grid of $V_9$ is shown at A, the cathode bias at B, and the pulse produced at the anode at C. The width of the pulse depends on the magnitude of B.**

"*t*." This is represented by "C" in Fig. 4. When a modulating voltage is applied to the cathode the line "B" has the appearance shown in Fig. 5, and as a consequence the pulses at the anode vary in width. Since the trailing edge of the saw-tooth is vertical it is the leading edges of the pulses which are modulated.

The output of $V_9$, in common with that of similar valves in the other channel units, is fed to the grid of $V_5$, a synchronizing pulse being applied to the suppressor.

The synchronizing pulse is produced by the valve $V_4$, the grid of which is fed with the 9-kc/s recurrence frequency from $V_1$. The grid circuit is similar to that of $V_2$, i.e. the, grid having a negative potential so that the valve will only conduct on the peaks of the 9-kc/s sine wave. This produces negative-going pulses at the anode of $V_4$ and the valve is biased so that these are of 20 µsec duration. This pulse occurs on the peak of the recurrence frequency and the channel pulses occur during the rest of the cycle. Consequently the output of $V_5$ consists of the synchronizing pulse followed by the eight channel pulses.

This series of positive-going pulses at the anode of $V_5$ is fed to $V_6$ which amplifies and squares the pulses and passes them to the

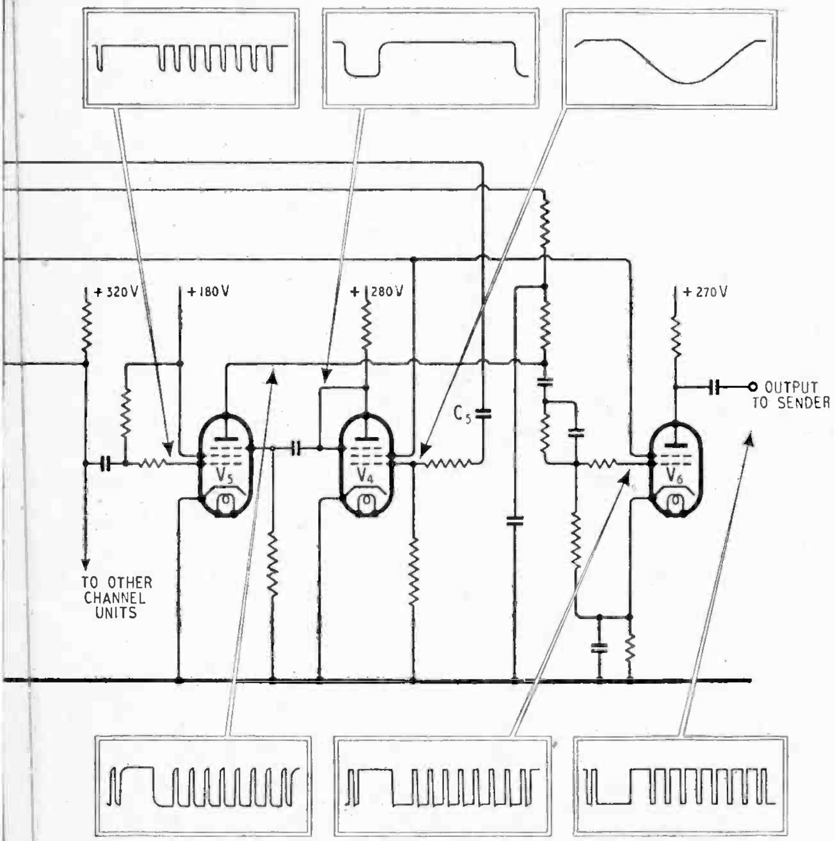



**Fig. 3. The circuit diagram of the pulses, simplified by the omission of non-essential components such as test points. The wave forms at important points are indicated by miniature graphs enclosed in rectangles. The portion of the equipment between the vertical dash lines is repeated for each channel. As they are all identical only one of the eight is shown.**

**Multi-channel Pulse Modulation—**
U.H.F. sender. The output from $V_6$ will, of course, be negative-going pulses since the grid is fed with positive-going pulses.

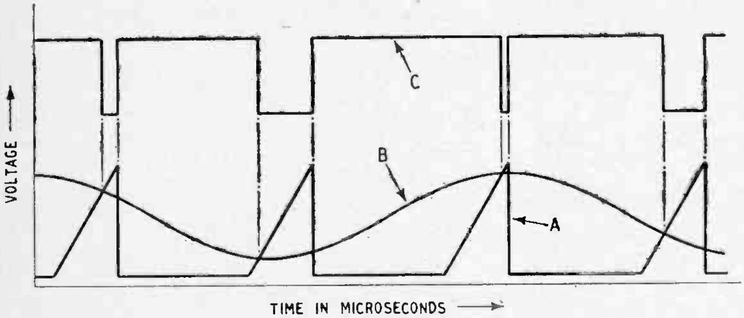



**Fig. 5. This diagram illustrates the action of $V_9$ with an A.F. signal applied to its cathode. The cathode bias B varies with the signal and so the pulse width varies as shown by C.**

At the receiving end the pulses corresponding to individual channels have to be separated from their fellows, demodulated and the resultant A.F. passed to the appropriate telephone line. This is done by a system of " gating " pulses. Fig. 7(a) represents the synchronizing pulse followed by two of the channel pulses.

These pulses are all applied to individual units, one for channel 1, one for channel 2, etc. The arrival of the synchronizing pulse causes gate pulses to be generated at certain intervals. The gate pulse is of longer duration than a fully-modulated channel pulse. That for channel 1 occurs at about the same time as the channel 1 pulse itself and similarly for channel 2, etc. Each channel unit will only admit a channel pulse during the brief period when a gate pulse is applied to it. Thus in the case of channel 1 unit, although all the channel pulses are applied to it in succession only the channel 1 pulse will be accepted since the gate is only open for long enough to allow the channel 1 pulse to go through (Fig. 7 (b) ). Immediately it has passed, the gate pulse ends and the unit is barred from accepting any more pulses until the next channel 1 pulse arrives. In the same way, immediately channel 1 gate is closed, channel 2 gate opens and admits the channel 2 pulse into the channel 2 unit and so on for the remainder of the eight channels (Fig. 7 (c)).

The output of the U.F.H. receiver is in the form of positive-going pulses corresponding to the negative-going pulses produced by the pulser unit. These are fed to the diode $V_1$ in the separator unit (Fig. 6). The time constant of $C_1$ and $R_1$ is long compared with that of the pulses so that the potential of the junction between $C_1$ and $R_1$ follows that of the incoming pulses. On receipt of a pulse the cathode of $V_1$ is made more positive than the anode and the valve does not conduct. Therefore $C_2$ commences charging but does not have time to become fully charged before the end of the pulse has arrived. At this time $C_2$ discharges rapidly through the valve, the anode of which is now more positive than the cathode. The synchronizing pulse, being longer than the channel pulses, gives $C_2$ an opportunity to charge to a higher potential than the shorter channel pulses. Thus a series of saw-tooth pulses is passed to $V_2$ the pulse arising

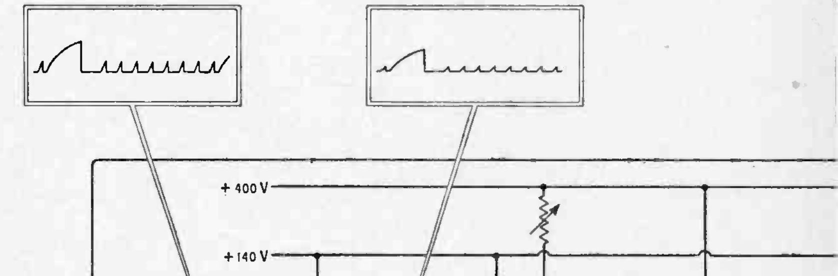


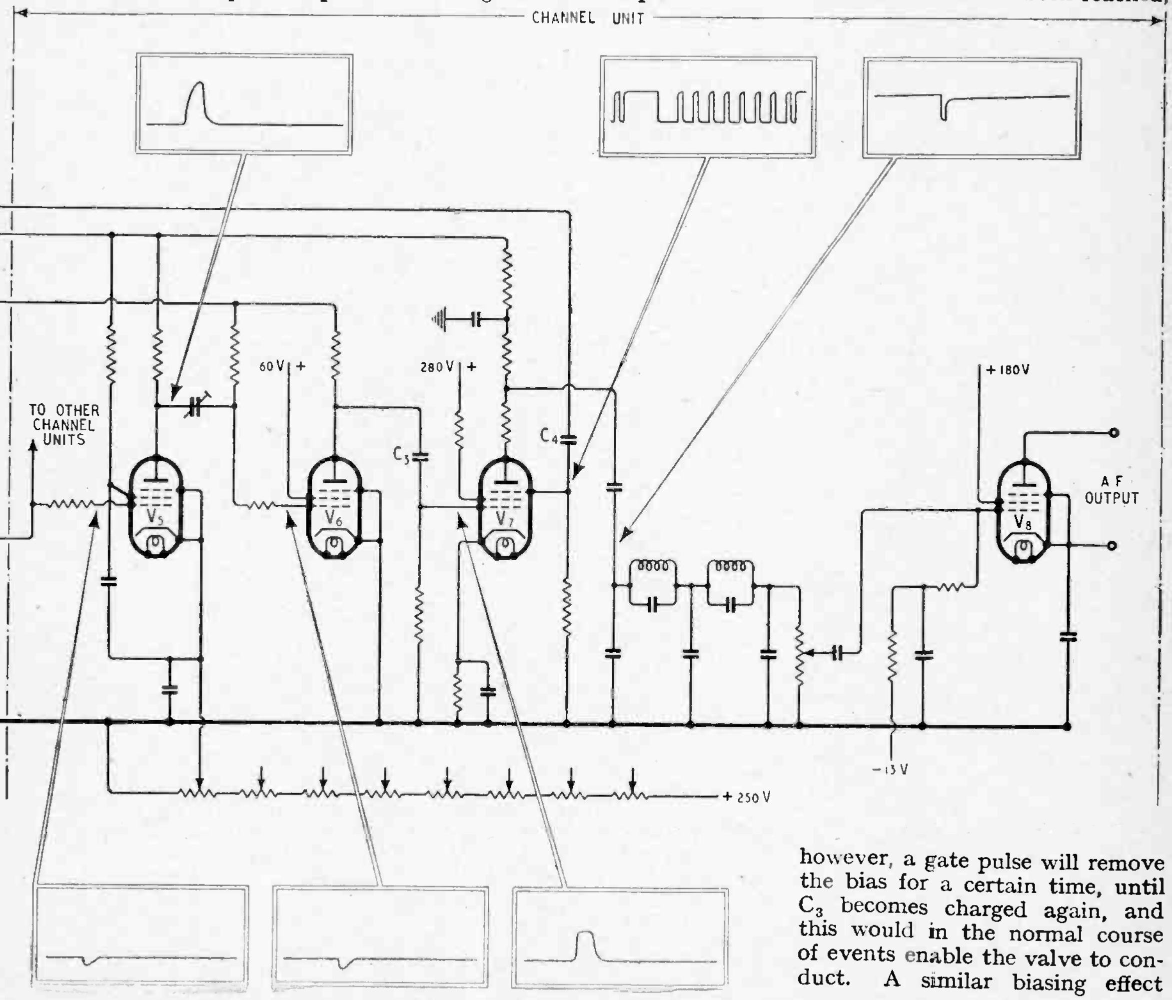

**Fig. 6. The circuit diagram of the separator which, by generating gating pulses, separates the channel pulses and develops the A.F. outputs correctly routed to the proper output lines. $V_1$ is an integrator to separate the sync pulse which controls the saw-tooth generator $V_3$. Equipment to the right of the dash line is provided for each of the eight channels.**

from the synchronizing pulse being of much higher amplitude than the following channel pulses.

A cathode-follower buffer-stage $V_2$ is interposed between $V_1$ and $V_3$ because the grid circuit of $V_3$ takes current and would, therefore, interfere with the operation of $V_1$ if it were connected directly to it. $V_3$ is a saw-tooth generator and operates in a similar manner to $V_2$ in the pulser unit. The saw-tooth is triggered off by the synchronizing pulse (which rises to a higher potential than the main channel pulses) in the same way that the crest of the 9-kc/s oscillator $V_1$ triggers the saw-tooth generator $V_2$ in the pulser unit. The grid current produces a bias sufficiently large for the channel pulses to have no effect. The output from $V_3$ is applied to a cathode-follower $V_4$ which operates in a similar manner to $V_3$ in the pulser. From $V_4$ the saw-tooth is distributed to eight separator channel units. We will deal with the separator channel unit concerned with channel 1.

The circuit of $V_5$ works in the same way as $V_7$ in the pulser channel unit and produces a negative-going pulse at the grid of $V_6$. The constants of the circuits are so chosen that this pulse is about 8 μsec in duration. By a system of biasing similar to that used in the pulser channel units it is arranged that the $V_5$ valves in the eight channel units produce their pulses in uniform succession following the reception by the separator of the synchronizing pulse. These pulses occur about the same time, relative to the synchronizing pulse, as the original channel pulses.

Reverting to channel 1, the valve $V_6$ produces at its anode a sharp positive pulse also of about 8 μsec duration. This comes about because the grid pulse is steep and the anode voltage is comparatively low. This is the gate pulse and is wide enough for the corresponding modulated pulse (3·5 μsec ± 2·33 μsec) to fit inside. The gate pulse is applied to the control grid of the gate valve $V_7$ and the train of pulses from the U.H.F. receiver, to the suppressor grid. The control grid is normally biased so that the valve will not conduct. It reaches this condition after the first few gate pulses pass when the set is started up—the pulses causing the valve to draw grid current which charges up $C_3$ and thereafter keeps the grid negative. After this state has been reached, however, a gate pulse will remove the bias for a certain time, until $C_3$ becomes charged again, and this would in the normal course of events enable the valve to conduct. A similar biasing effect



**Multi-channel Pulse Modulation—** is associated with the suppressor grid of $V_7$, the capacitor responsible being $C_4$. Thus, unless a pulse is present at both grids, the valve will not conduct, but when two pulses are present at the same time it will conduct for the duration of the shorter pulse only. The $V_7$ (channel 1) will therefore pass the channel pulse associated with channel 1 since the gate pulse is only present on that particular valve for just

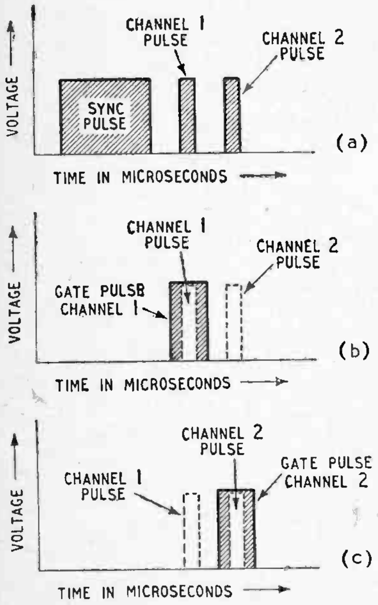



**Fig. 7. The synchronizing pulse is shown at (a) followed by two channel pulses. It generates a series of gating pulses which permit channel pulses to pass only when channel and gating pulses are coincident. The two are shown at (b) for channel 1 and at (c) for channel 2.**

sufficient time to allow the valve to conduct for the duration of the channel 1 pulse.

Similarly $V_7$ of channel 2 will "capture" the channel pulse associated with channel 2 and so on for the other channels. The output from each $V_7$ anode is thus a series of negative-going width-modulated pulses. On passing these through a suitable A.F. low-pass filter (cut-off 4 kc/s.) the modulation frequencies are recovered and amplified by $V_8$ before being passed to the appropriate telephone line.

# WORLD OF WIRELESS

## LONDON'S NEW MAST

IMPROVED reception of the B.B.C.'s London transmitter at Brookmans Park is promised for listeners in East Anglia, Kent and Sussex by the erection of a 500-foot anti-fading mast radiator.

In the past the Corporation has not been permitted to use masts higher than 200ft at this station, which has seriously restricted the service area after nightfall.

Details of the mast, which it is expected will be brought into service in the autumn, are not available.

## GOVERNMENT SURPLUS

A CONSIDERABLE part of the annual report of the Radio Component Manufacturers' Federation is devoted to the question of the disposal of surplus Government stocks. It states that proposals were made for the purchase of all surplus stocks, at a nominal price per unit, all handling, storage, testing and subsequent disposals to be undertaken by the industry, and any profits arising from the resale of usable items to be shared with the Government. These proposals were rejected.

It appears, says the report, that the Government is pursuing a short-sighted policy of snatching at quick returns, presumably to satisfy Treasury demands, with complete disregard for the effect of unregulated disposals upon the industry.

## POST OFFICE RESEARCH

REPLYING to a plea by Mr. Cobb, M.P. for Elland, for more fundamental research in telecommunications in this country, Mr. Burke, Assistant P.M.G., stated in the House on May 3rd that the Dollis Hill Research Station will shortly devote its whole resources to research and that new premises will be found in the Midlands for the section at present occupied with the training of engineers.

The Press were recently given the opportunity of seeing some of the activities of the station, which included demonstrations of the working of multi-channel coaxial lines, apparatus for producing synthetic fading signals and "Vocoder" speech analysis and synthesis.

At the request of the Medical Research Council the Dollis Hill Research Station recently undertook a series of tests to find the characteristics of a hearing aid which would fulfil the needs of the majority of deaf people. They also designed a miniature hearing aid embodying the results, and this was shown. It includes a three-valve amplifier in a moulded case 3in × 2½in × 1in (the batteries are carried separately), and it is estimated that the cost of manufacture will be less than £10 and the running cost for batteries less than 1d per hour of continuous use.

Speaking of this development in the House, Mr. Burke said: "It is true to say that the Post Office in the past has been far too modest. It has just been successful, in working in association with the Medical Council, in bringing out an ear aid which, I hope, will not fall into the hands of private people to be exploited. I am sure it will be of benefit to thousands of deaf people in this country. It is one of the little things the Post Office does, as it were, in its stride, and which many people do not get to know about."

## MARINE RADIO-NAVIGATION

AS a preliminary to the establishment of an international standard for marine radio-navigational systems a meeting opened in London on May 7th at which representatives of all the maritime countries of the world were present.

During the conference, which ended on May 22nd, papers were read and demonstrations given to inform other countries of the work done in this country in the field of radio aids to navigation and by means of informal discussion delegates were able to state what is being done in other countries.

Among the papers read were "Radio-wave Propagation in Relation to Marine Navigational Aids" by Dr. R. L. Smith-Rose and "Allocation of Frequencies" by A. H. Mumford. Sir Robert Watson-Watt was chairman.

A report on the demonstration in H.M.S. *Fleetwood* is given elsewhere in this issue.

## RADAR SIMPLY EXPLAINED

RADAR—what it is, what it does and how it works—is explained simply and lucidly with the aid of some 60 drawings and photographs in a book of 140 pages by R. W. Hallows, who is well known to *Wireless World* readers.

As Chief Instructor in A.A. Fire

Control at one of the Army's schools the author had to devise methods of training large numbers of men and women, most of whom had little or no knowledge of wireless, in the theory and use of radar. That he succeeded in his task of making an extremely difficult and abstruse subject appear simple is borne out in this book, which is based on the explanations given to operators. It contains no mathematics and calls for no previous knowledge of radio or electricity. It is, in fact, for the man-in-the-street.

Published by Chapman and Hall the book "Radar—Radiolocation Simply Explained," costs 7s 6d.

## FIELD-DAY LICENCES

MANY of the recently re-formed radio clubs are planning field days but are in doubt as to the need for securing a licence for a portable transmitter as no official statement has been issued on the subject.

On enquiry it was learned that societies planning field days should get in touch with the G.P.O., giving details of the station, operator's name and the areas to be covered, asking for formal permission to operate a portable transmitter.

The application should be made to the Director of Telecommunications, G.P.O., St. Martin's le Grand, London, E.C.1.

## SWORDS INTO PLOUGHSHARES

SALVAGED German Army radio equipment is being used to manufacture 3-valve utility civilian sets at the rate of more than a hundred a week in a Hanover factory.

According to details given in the *British Zone Review* they are being sold at 250 RM and priority is given to schools, youth clubs and bombed-out families. Ten per cent of the factory's output goes to Army Welfare Services for distribution to British troops.

## TELEVISION SETS

WITH the restarting of the B.B.C. television service on June 7th many people have been asking if sets will be available by then. The answer given by each of the manufacturers to whom the question has been put is, no.

Although production is well in hand and in some cases chassis are coming off the line, cabinets are non-existent—licences for wood being unobtainable.

The Government has licensed the production of 78,000 sets this year, but as C. O. Stanley stated recently "the industry has not yet got used to building houses without bricks!"

In addition to the production difficulties manufacturers are still awaiting a Government announcement regarding purchase tax, which, if it is fixed at a high rate would kill the industry at birth.

## *PERSONALITIES*

**Sir Edward Appleton,** F.R.S., lectured at the recent 60th anniversary conference of the Société Royale Belge des Ingénieurs in Brussels and also in Amsterdam.

LESLIE C. GAMAGE, M.A., joint-managing director and vice-chairman of the G.E.C., has been elected President for 1946-47 of the Radio Industries Club, which now has a membership of 601.

**L. R. Batten,** O.B.E., who served as a Wing Commander in the Second Tactical Air Force, has been appointed secretary of the Radio Communication and Electronic Engineering Association—one of the constituent associations of the Radio Industry Council. The Association is now at 59, Russell Square, London, W.C.1.

**W. J. O'Brien** has been awarded a Royal Society of Arts' prize of £50 for his invention of the Decca Navigator.

**A. J. L. Collinson,** B.Sc. (London), has been appointed Works Manager of the Radio Works of Allander Industries, Ltd., Milngavie, Glasgow.

**W. A. Jackson,** of the Telephone Manufacturing Company, was elected chairman of the Radio Component Manufacturers' Federation, and **R. W. Merrick** (Wright and Weaire) vice-chairman, at the recent annual meeting.

**James K. A. Nicholson** has retired from the post of Engineer-in-Charge at the B.B.C.'s Newcastle station which he has held since 1924.

**Dr. A. T. Starr,** M.A., has taken up an important appointment with Standard Telecommunication Laboratories, the new subsidiary of Standard Telephones and Cables.

**E. O. Willoughby** has resigned from the radio engineering staff of Standard Telephones and Cables to take up his appointment to the newly created Chair of Electrical Engineering at the University of Adelaide, Australia.

## *OBITUARY*

It is with regret we record the death on May 5th of **Dr. S. H. Long,** O.B.E., Assistant Engineer-in-Chief in charge of development for the Marconi Company, at the age of 55. In 1929 he joined the Marconi International Marine Communication Co. as Technical Manager, and as Technical Adviser to the M.W.T. Co.

## *IN BRIEF*

**Batteries** of not less than 15 volts and not more than 45 volts, specially designed for hearing aids and using layer-type cells not exceeding 6 millimetres in thickness, with zinc elements of which each face does not exceed 500 square millimetres, are now exempt from purchase tax.

**Income Tax Allowances** for expenditure on "scientific research undertaken by a trader," which is allowable under the new law in operation from April 6th, is explained in a pamphlet, No. 470, issued by the Board of Inland Revenue, Somerset House, London, W.C.2.

**American Amateurs** have been granted another band of frequencies. In addition to those given in last month's issue, they are now using the 3.7-4 Mc/s band.

**French Amateurs** have been granted permission to use the 14-14.4 Mc/s band in addition to the 5- and 10-metre bands.

**Soviet Wireless Network.**—Soviet News Agency announces that a network of wireless stations is to be opened in the Kara-Koum desert which is situated just north of the Persian frontier.

**School Broadcasting.**—Over 13,000 schools in England and Wales are registered as listening to school broadcasts. This is an increase of 1,300 over last year's figures and does not include the 1,684 schools registered in Scotland.

S. J. TYRRELL, Celestion's chief engineer for design and engineering, has been appointed a director of the company.

**International Standards.**—The American Radio Manufacturers' Association has decided to make the industry's engineering standards avail-

**World of Wireless—**

able to other countries in an endeavour to encourage some measure of international standardization in radio sets.

**Interplanetary Communication** is among the aims of the British Interplanetary Society, Albemarle House, Piccadilly, London, W.1. Details regarding membership and the local groups established at Manchester, Birmingham, Eccles and Farnborough are obtainable from the Secretary.

**Back Numbers.**—Our Publishers are anxious to obtain copies of our sister journal "Wireless Engineer" from 1941 to date for supplying to countries previously occupied by the enemy. Copies of "Wireless World" for July-December, 1939, and January-December, 1940, are also required. Readers willing to dispose of their copies are asked to write to the Publisher, Dorset House, Stamford Street, London, S.E.1.

**Publication Resumed.**—Devoted to reporting the practical application of the results of the research work undertaken at the Philips Laboratories, Eindhoven, "Philips Technical Review," which ceased publication during the war, has reappeared.

**Research Reports.**—A new scientific journal devoted to the results of pure research work undertaken in the Philips Laboratories entitled "Philips Research Reports" is to be published bi-monthly. The first issue, dated October, 1945, appeared in April.

**"R.C.A. Review,"** which suspended publication in 1942, has reappeared. It will be published quarterly by R.C.A. Laboratories, New Jersey.

**"The Signal,"** the official organ of the Radio Officers' Union, celebrated its silver jubilee with the publication of the May issue. A. D. Crisp has been Editor throughout the 25 years.

## COMPANY NEWS

**Cossor Radar** has been formed to take over A. C. Cossor's interests in the manufacture of radar equipment. It will operate from Cossor House, Highbury Grove, London, N.5.

**Antiference Installations,** a subsidiary of Antiference, Ltd., has been formed to handle the installation of the company's aerial equipment. The address is 1-3, Hale Lane, Mill Hill, London, N.W.7.

**Electro-Acoustic Industries** has been formed by E. H. Stoner and G. A. Barden, both of whom recently resigned from Goodmans Industries, to manufacture loudspeakers, microphones, transformers and chokes. Mr. Barden was chief engineer at Goodmans for 12 years. The company's address is Stamford Works, Broad Lane, Tottenham, London, N.15. (Tel.: Stamford Hill 5606.)

**Marconi.**—It is announced that the English Electric Co. has purchased the whole interest of Cable and Wireless in Marconi's Wireless Telegraph Company.

**Belling and Lee** ask us to state that their Arterial Road, Enfield, factory and offices will be closed for the annual holiday from June 22nd-30th inclusive.

**Metro-Vick and Siemens** have concluded an agreement regarding the marketing and servicing of radar and audio-type equipment for marine navigational purposes.

**Société Anonyme Wild-Barfield** has been formed to handle the sale and service of Wild-Barfield equipment, which includes R.F. heaters, in Belgium, Holland and Luxembourg. Enquiries should be addressed to S. A. Wild-Barfield, 165, Rue Belliard, Brussels, Belgium.

**Johnson, Matthey and Co.** are to hold an exhibition at Dorland Hall, Lower Regent Street, London, S.W.1, from June 13th to 26th, inclusive. Admission to the exhibition of the company's products will be by invitation card only, application for which should be made to the Exhibition Secretary, Johnson, Matthey and Co., 73-83, Hatton Garden, London, E.C.1.

**Imperial Chemical Industries** have organized an exhibition of chemical research which will open on June 5th at the Tea Centre, Lower Regent Street, London, S.W.1. In the section devoted to "The Chemist and Plastics" displays will show the contribution of polythene to radio and radar.

**British Rola** has acquired 97 per cent of the share capital of Celestion, but each company will continue to operate independently so far as research and development are concerned.

**Cintel** is the new trade name for products of Cinema-Television, Worsley Bridge Road, Lower Sydenham, London, S.E.26.

**United Insulator Co.** have removed to Oakcroft Road, Tolworth, Surbiton, Surrey. Tel.: Elmbridge 5241.

**British Mechanical Productions** state that orders for their Clix products should now be sent to 21, Bruton Street, London, W.1. Tel.: Mayfair 5543.

**Electrothermal Engineering.**—The postal district of the address of this firm was incorrectly given in our April issue—and should be E.7.

**Delco-Remy and Hyatt,** of 111, Grosvenor Road, London, S.W.1, inform us that in future their works and sales departments will work a five-day week and be closed on Saturday mornings.

## TRADE ENQUIRIES

**Belgium.**—A radio engineer in Brussels desires exclusive agency for radio and television receivers, components and equipment. Letters addressed O.I.E.M., c/o The Editor, will be forwarded.

**India.**—The managing director of Electronics, Ltd., of New Delhi, is visiting this country this month and will be pleased to hear from component manufacturers regarding exports for set manufacture in India. Letters addressed to Mr. Sham Sundra will be forwarded.

**Rumania.**—Component manufacturers interested in exporting to Rumania are invited to write to the Bureau Electro-Technique, Bucharest. Letters addressed c/o The Editor will be forwarded.

## CLUBS

**Bolton** and District Radio Society has resumed its activities and meetings are now held on the first Tuesday of each month at 7.30 at Gaskell House, 7a, Churchgate, Bolton. N. Moorcroft, 3, Beaconsfield Street, Bolton, is secretary.

**Ilford** and District Radio Society has recommenced activities and is now meeting on alternate Thursdays at St. Albans Church Hall, Albert Road, Ilford, at 8.0. The next meeting is on June 6th. Secretary, C. E. Largen, 44, Trelawney Road, Barkingside.

**Leicester.**—"Industrial Electronic Instruments" is the subject of the lecture to be given by S. W. Burfitt, of the G.E.C., at the meeting of the Leicester Radio Society at the Charles Street United Baptist Church Hall on June 4th. Particulars of the club are obtainable from O. D. Knight, 16, Berners Street, Leicester.

**Maidenhead.**—A new club has been formed and meetings are held at 7.30 on the second Tuesday in the month at the Toc H Hall, Marlow Road, Maidenhead. The secretary is R. F. Woodruff, Maidenhead Amateur Radio Club, "Oaklands," College Road, Maidenhead, Berks.

**Slade Radio.**—The next meeting of Slade Radio will be held on June 28th at the headquarters, Broomfield Road, Slade Road, Erdington, when the subject for discussion will be direction finding. Secretary, L. A. Griffiths, 47, Welwyndale Road, Sutton Coldfield, Birmingham.

**Surrey** Radio Contact Club has resumed activities and now meets on the second Tuesday of each month at 7.30 at the Blacksmith's Arms, South End, Croydon. Details of membership are obtainable from the Secretary, L. C. B. Blanchard, 122, St. Andrew's Road, Coulsdon, Surrey.

**West Bromwich.**—A wireless society has been formed and now meets twice a month at The Gough Arms Hotel, Jowetts Lane, West Bromwich. The next meeting is on May 27th at 7.30. Secretary of the West Bromwich and District Radio Society is G. Johnson (G2BJY), 22, Lynton Avenue.

## MEETINGS

**Institution of Electrical Engineers**

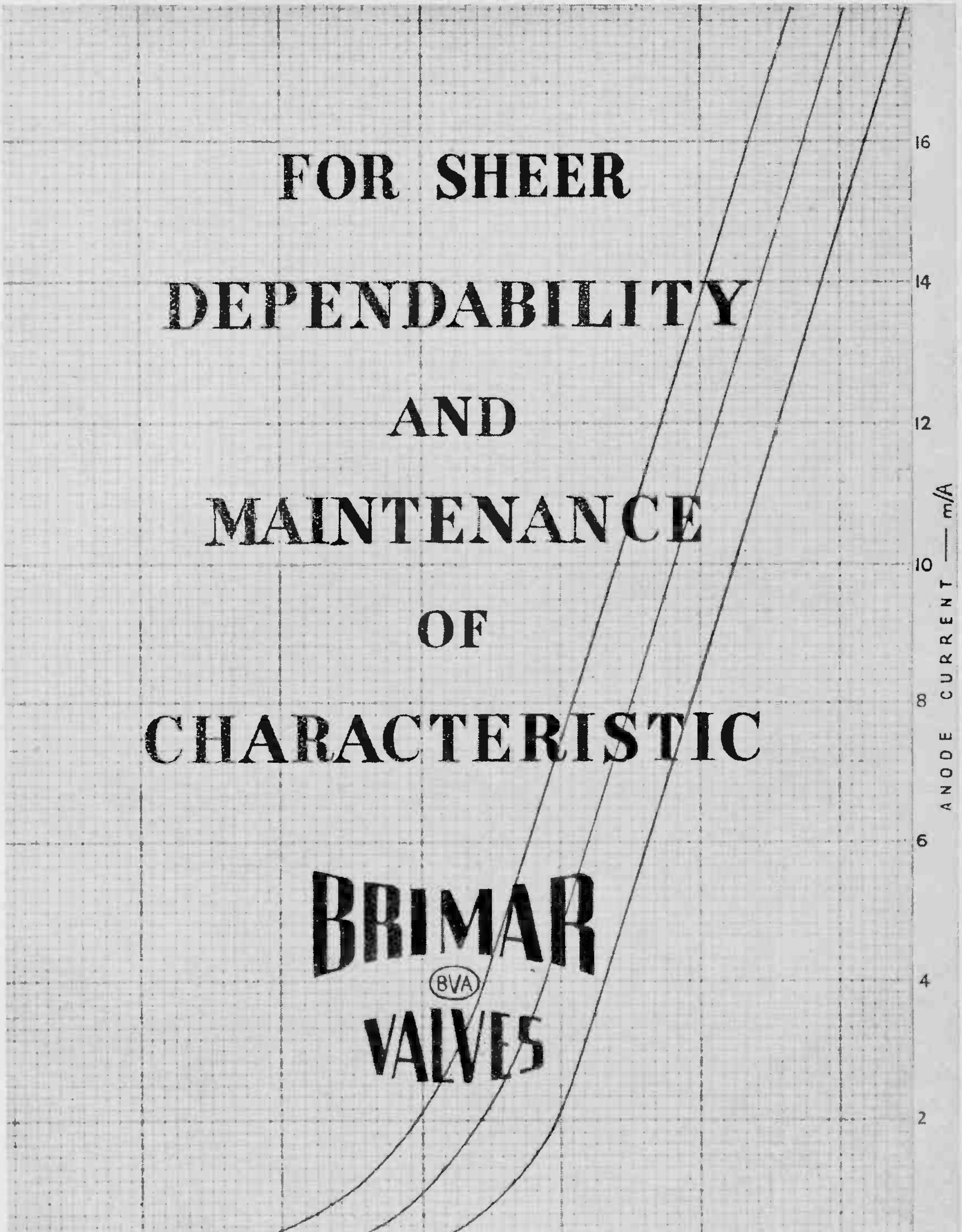
*Faraday Lecture.*—Dr. T. E. Allibone's lecture on "Atoms, Electrons and Engineers," which, illustrated by films and demonstrations, was originally given on May 9th, is to be repeated at the Central Hall, Westminster, on Wednesday, June 5th, at 6 p.m. As the lecture will be open to the public no tickets will be required.

**Institute of Physics**

*Electronics Group.*—A summer meeting will be held in the Research Laboratories of the General Electric Co., Wembley, at 2.30 on June 15th, when a series of papers will be given.

**Radio Society of Great Britain**

"Centimetric Radar for Precision Gun-laying," by H. A. M. Clark, B.Sc. (G6OT), at 6.30 on May 31st at the I.E.E., Savoy Place, London, W.C.2.

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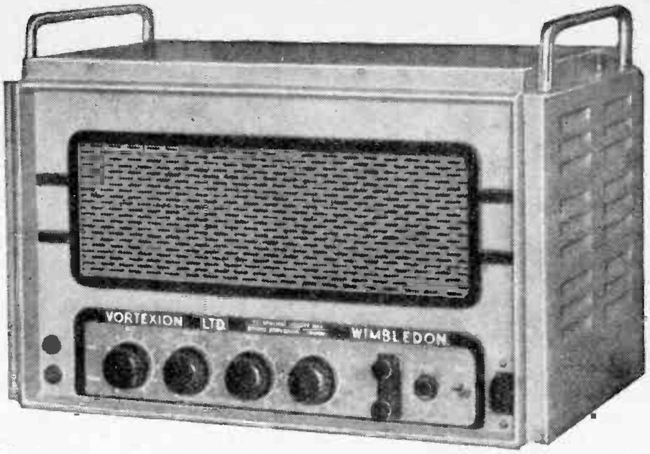


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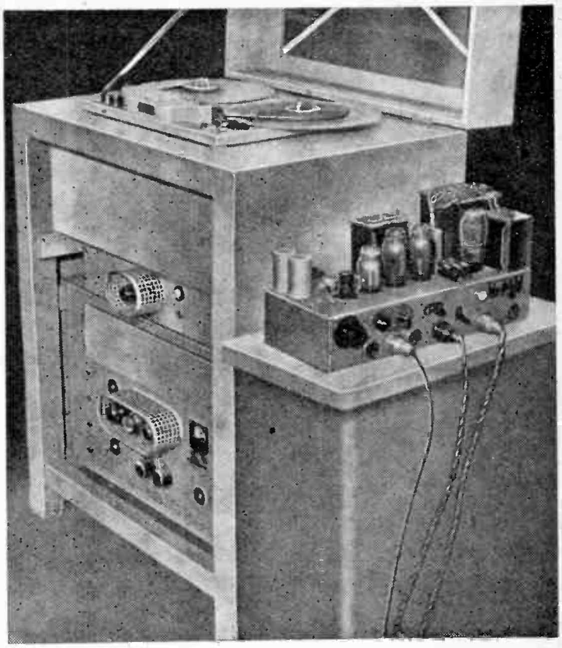
# THE GERMAN MAGNETOPHON

## Developments in Recording with Impregnated Plastic Tape

By R. A. POWER

IN 1930 a patent was taken out by Pfleumer for using a paper or plastic tape coated with iron dust to replace the steel wire or tape used with magnetic recorders. This development was taken up by Allgemeine Electricitäts-Gesellschaft (A.E.G.) and the I. G. Farben chemical company, with the idea of producing a general purpose recorder. I. G. Farben produced the tape, and A.E.G. undertook to produce the recording machine. Later these two companies combined to set up the Magnetophon Gesellschaft, Berlin.



A.E.G. Magnetophon high-quality tape recorder, Type H.T.S.

The principle used for the recorder is as follows. A band of cellulose acetate covered with powdered magnetite runs tangentially past a gap in a toroidal electro-magnet head. If this toroid is energized by D.C. or A.C. with period large compared to the time a given particle spends near the gap, then this particle passing the gap will be left with a residual longitudinal magnetism, proportional to the energizing current. This follows for all the particles carried past the gap by the plastic film.

In practice three magnetic heads are used. The first is the erasing head. This ensures that any previous magnetic modulation is wiped off, and the tape is ready to receive the A.F. impressed on it by the second (recording) head. The third head is the "pick-up" or "play-back" head, and enables the recording to be monitored.

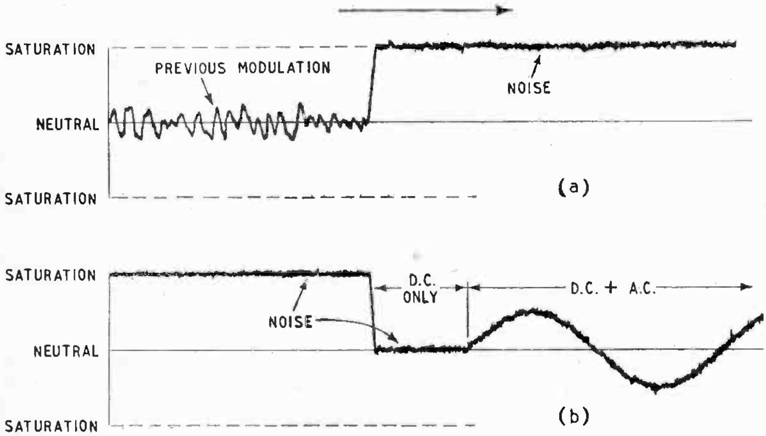



**Fig. 1. Magnetization of tape in early models with D.C. bias (a) at erasing head (b), at recording head.**

Early models use D.C. erasure A direct current is passed through the coil of the erasing head, and its value is made large enough to create a field which will magnetically saturate the particles coming under the influence of the head. The recording head is fed with D.C., whose direction is such as to produce opposite magnetization to that of the eraser, and whose amplitude is such as to bring the particles back to magnetic neutral. The A.F. current is fed in series with this D.C., and the required recording is impressed on the tape. The magnetic variations impressed on the tape by the erasing and recording heads are shown diagrammatically in Fig. 1.

It is believed that the D.C. applied at the recording head, besides its main purpose of returning the tape to magnetic neutral, serves to agitate the particles, reducing the inertia the A.F. has to overcome and the distortion this would cause.

The noise modulation in this D.C. system is fairly high, and this is one of the defects overcome in the latest model.

The erasing head is straightforward. It is made of soft iron

**The German Magnetophon—**
with negligible retentivity, and shaped to have maximum field strength at the gap.

The recording and pick-up heads are not so straightforward. It must be appreciated that they have to operate at A.F. and must have very small retentivity. They are made in the form of a ring in two halves, each half made up of very thin laminations of high permeability iron. Special bobbins fit over these laminations, and the winding is equally divided between the two halves. Besides a front air gap for recording (or pick-up) of approx. 0.02 mm, there is a larger air gap at the rear. This rear gap is to reduce the residual magnetism due to large current pulses, and is about 0.25 mm wide. Fig. 2 illustrates the construction of these heads. The two halves of the head are clamped together to make the finished job, leaving the air gaps as previously detailed. The erasing recording, and play-back heads are mounted side by side, with a cover over them so designed as to allow the tape to run past them, and to screen the heads from one another magnetically. The impedance of the heads varies in different models. The current required for recording is very low, of the order of 5 mA or so.

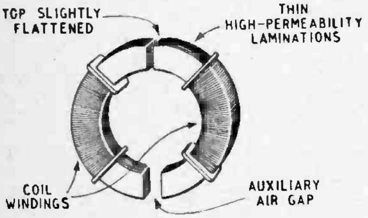



**Fig. 2. Construction of recording and pick-up heads in the Magnetophon.**

The field strength across the recording slit is proportional to the current in the coil, and the coil represents an inductive load. Because of this, the recording head is fed with A.F. current from a constant current source (pentode or beam tetrode). This gives an approximately flat response characteristic until the higher frequencies are reached. Then the time a particle spends under the influence of the magnetic field becomes an appreciable part of the A.F. period. Under these conditions the phase of the magnetic force may change while the particle is under its influence, reducing the residual magnetism left on the tape. Taking an extreme case, if the particles are under the influence of the gap for a period equal to one cycle of A.F. the residual magnetism would be nil, owing to the fact that the particle would have been magnetized an equal amount in opposite directions.

This " slit loss " causes a falling off in reproduction at the higher audio frequencies, and from the foregoing analysis of this loss it is evident that, all other things equal, the highest frequency reproducible is proportional to the velocity of the tape (i.e., inversely proportional to the time a given particle spends under the influence of the recording head.) To equalize this loss, a top boost is given to the recording amplifier. The tape and amplifier noise is mostly at the higher audio frequencies, and for this reason it is usual to over-boost the top when recording, and attenuate the top when playing back.

At the play-back head, the voltage induced in the coil is proportional to the rate of change of flux—in other words the voltage output increases with frequency. To compensate for this and the over-boosting of the top, a simple capacity-resistance filter is included in the play-back amplifier.

A signal/noise ratio of about 38db was obtained with these early models, with a frequency range limited by the associated amplifiers to about 50-6,000 c/s, at a tape velocity of 77 cm/sec. The standard reel of tape is 1,000 metres long, and forms a reel about 10in in diameter. This, at 77 cm/sec, gives a playing time of 22 mins.

The tape is wound on metal hubs in self-supporting reels, which are placed on horizontally mounted discs. One disc is provided for the feeding reel, and one for the take-up reel. Each of the reels is driven by its own series-wound motor, and the tape is pulled past the heads at a constant velocity by a synchronous motor.

The feed reel motor is run at reduced power during recording or play-back, and acts as a brake The two reel motors serve to keep the tape under tension, while the speed is kept constant by the synchronous motor. For re-winding, the synchronous motor is disengaged from the tape, the power of the feed motor is increased, and that of the take-up motor decreased. Solenoid brakes are fitted to prevent tape slackness on switching off. The series-wound motors are fitted with governors to prevent runaway under " no-load " conditions.

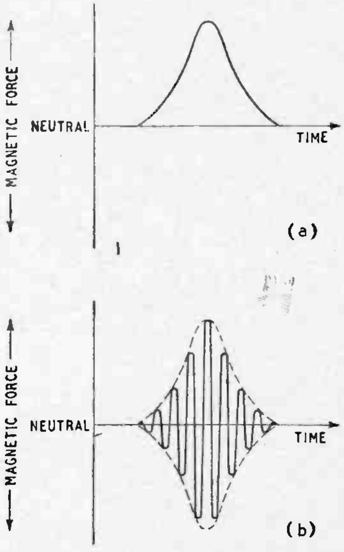



**Fig. 3. Magnetic force on an element of the tape while passing over the gap ; (a) with D.C. bias, (b) with supersonic excitation.**

In designing the latest high-quality Magnetophon some minor modifications were made to the mechanical system to ensure constant tape velocity, and this side of the system was considered above reproach. The frequency range could be extended by suitable design of amplifiers. The biggest snag was the poor signal/noise ratio, caused by noise on the tape.

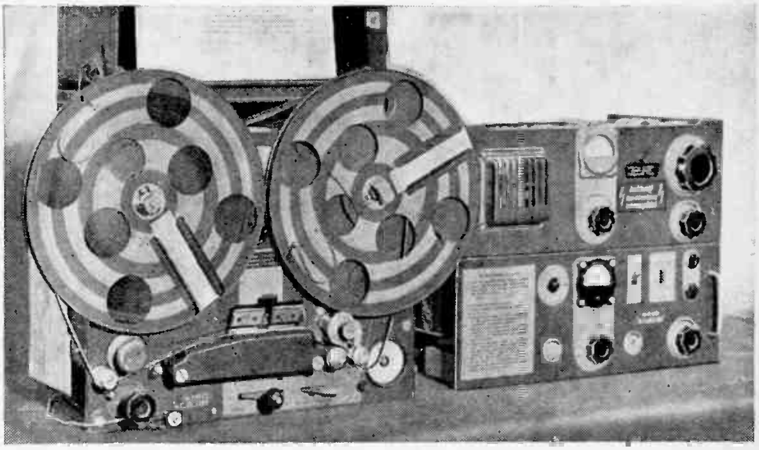
During 1941 came the development which enabled the Magnetophon to give a performance which places it among the foremost commercial recording systems in existence.

Whilst the Magnetophon was undergoing tests for broadcast transmission at the Reichrundfunkgesellschaft, Drs. Braummuhl and Weber discovered that a great improvement in signal/noise ratio was obtained by using supersonic currents for erasing and "pre-magnetizing."

This system is now used and the D.C. erasing head of the early models is replaced by a head suitable for A.C. operation (similar to the recording and pick-up heads previously described, but with a larger gap). It is supplied by a 6-watt oscillator with a frequency of about 40 kc/s. The effect on particles coming under the influence of the field is shown in Fig. 3. Fig. 3 (a) shows the influence of the field on the particle with a D.C. system, in which the particle would be left with a residual magnetism. With the supersonic system the particle is subject to rapidly changing magnetic fields in both directions, Fig. 3 (b), and emerges magnetically neutral.

At the recording head a supersonic frequency is fed in as well as the A.F. It is derived from another 6-watt oscillator and has a frequency of about 100 kc/s. The action of this supersonic frequency is thought to be to agitate the particles and thus to reduce the inertia the A.F. field has to overcome. The residual magnetic modulation will be proportional to the A.F. current. The value of the supersonic pre-magnetizing current applied at the recording head seems to have an optimum value, although it is not critical, nor are the frequencies of the supersonics critical.

The supersonic erasing and re-



Tonschreiber B magnetic recorder used by the German Army.

cording process is illustrated graphically in Fig. 4. Comparing it with the representation of the D.C. system (Figs. 3a and 3b), it shows the noise modulation has been reduced to negligible proportions. This enables the latest type Magnetophon to have such a wide dynamic range. Several theories have been put forward as to why the use of supersonics should so reduce the noise, but up to the time of writing proofs as to the validity of any particular one seem to be lacking.

The tape is about 6 mm wide and between 0.04 and 0.05 mm thick. The earlier tape consists of a film of cellulose acetate supporting the active layer of 0.01 to 0.02 mm thickness. This layer consists of 90 per cent. magnetite and 10 per cent. cement, the grain size when lying flat is about 0.002 mm. With this tape and the supersonic recording system, background noise is better than with D.C. bias but still limits the dynamic range to 50-55 db.

The latest tape has the magnetite impregnated in it. The band consists of a plastic carrier "Igelit PCU," a vinyl-chloride polymer into which an equal amount (by weight) of finely powdered magnetic $Fe_2O_3$ is mixed. The mixture is kneaded and thermoplastically laminated into a film 1,000 metres long. The $Fe_2O_3$ possesses the same crystal structure as natural magnetite $Fe_3O_4$, the crystals measuring about one micron in size. The magnetic properties of this new form of $F_2O_3$ are stated to be due to its magnetic crystal form. With this impregnated tape and the supersonic system of recording, background noise is low enough to permit a dynamic range of 65-75 db. Under favourable conditions this can be increased to 80 db.

These tapes retain their magnetic properties indefinitely. The earlier tape tends to become brittle with ageing, but the im-

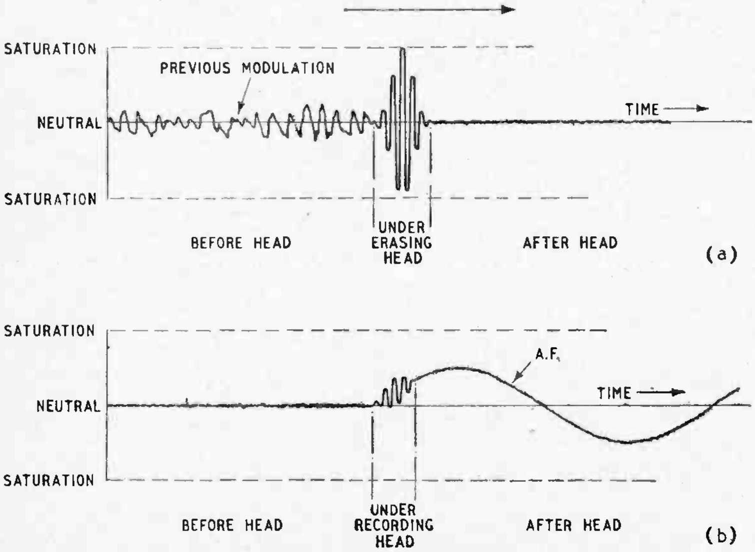



Fig. 4. Graphical presentation of magnetic state of tape with supersonic excitation (a) erasing, (b) recording.

**The German Magnetophon—**

pregnated tape overcomes this defect.

***Conclusions.***

Besides the high-quality, semi-fixed Magnetophon, portable models are made, and a series of lightweight models known as "Tonschreibers" was made for wartime purposes. By sacrificing top response in these models, the reel of tape can be run more slowly and longer playing time obtained (70 mins as against 22 mins for high quality).

In common with other tape or wire recording systems, the Magnetophon system enables records to be listened to directly after recording, no processing being required, and the records may be played thousands of times without noticeable deterioration of quality.

In comparison with other tape or wire recorders, the Magnetophon has the following advantages :—

(a) Better quality is obtained (frequency range 25-10,000 c/s at tape speed of 77 cm/sec, dynamic range 65-75 db, distortion 2 per cent.).

(b) The plastic tape is lighter, cheaper, and wears better than the steel magnetic carriers.

(c) Tape may be cut and spliced at will, enabling editing, etc., as with cinematograph film.

(d) Notes, titles, etc., may be written along the roll—non-magnetic tape may be inserted for this purpose.

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# INTERFERENCE FROM INDUSTRIAL ELECTRONIC APPARATUS

## *Discussion by the Radio Section of the I.E.E.*

RADIO-FREQUENCY heating equipments with powers comparable to those used in broadcast stations are increasing in number and constitute a grave source of potential interference to communication channels. To establish a basis upon which a code of practice or, if need be, legislation could be formulated a discussion was held by the Radio Section of The Institution of Electrical Engineers on April 16th. It was opened by M. R. Gavin, M.B.E., M.A., B.Sc., who pointed out that most of the valve generators used in industry for heating purposes are self-oscillators and that considerable changes of frequency are experienced over each heating cycle due to changes in the electrical properties of substances under treatment. In some circumstances the variation might be as much as ± 5 per cent compared with the 0.05 per cent allowed for radio transmitters. To achieve a comparable stability in heating equipment, crystal control was essential and automatic tuning control would be necessary for the final stage of the power amplifier. This would increase the cost of high power generators by about 50 per cent and considerably more on low powers. If a ± 1 per cent variation could be tolerated it might be possible to use a self-oscillator stabilised by a high Q circuit for such applications as thermoplastic sealing. Restriction of the amplitude of the power radiated by screening was the most hopeful method of combating interference.

If it were decided that a permitted level of interference should be fixed by law, then it was suggested that the level should be set at a relatively high value, e.g., 1 mV/m at the low frequency end of the radio band. Any equipment giving a level less than this should be approved unless it be found to cause interference. In that event the supervising authority should have the power to enforce further suppression, but before taking such action the case should be considered on its merits, taking full account of the relative importance of the heating application, the service being interfered with, and of the steps necessary to achieve the greater suppression.

In the discussion which followed the difficulty of assessing interference in terms of field strength was emphasized and the need for further research to establish data upon which a code of practice could be formulated was stressed. A case might be made for arbitration in each individual case of interference as it arose, but this would require a host of inspectors armed only with their own judgment; it seemed better for a definite level to be specified though most speakers thought that this would be several orders of magnitude lower than the 1 mV/m put forward for debate.

Most speakers thought that the question should be settled without reference to the ambient interference from other industrial sources. Acceptance of this level as a permissible maximum for fresh sources of interference would lead to a cumulative rise in the aggregate level which would call for a corresponding rise in the power required by broadcast stations to give an adequate signal/noise ratio.

There was general agreement that effective screening rather than segregation of radio heating frequencies in restricted bands in which free radiation would be permitted was the more promising solution. For screening to be effective attention would have to be given to the maintenance of mechanical joints, interlocking mechanisms and the thorough filtering of power supply leads. Very efficient screening could be achieved by building factories underground. The problem of screening openings for doors, ventilators, etc., was discussed and it was suggested that instead of the usual wire mesh screen, a short corridor in the form of a waveguide might be used to give the necessary attenuation. It was stated that for a suitably proportioned corridor 6 ft high an attenuation of 10 db per metre was possible for a wavelength of 5 m.

The meeting showed the existence of a sincere desire on the part of both radio heating and communication engineers to collaborate to solve their common problems; as was perhaps to be expected the majority of the former had been trained originally in communications and fully appreciated their obligations.

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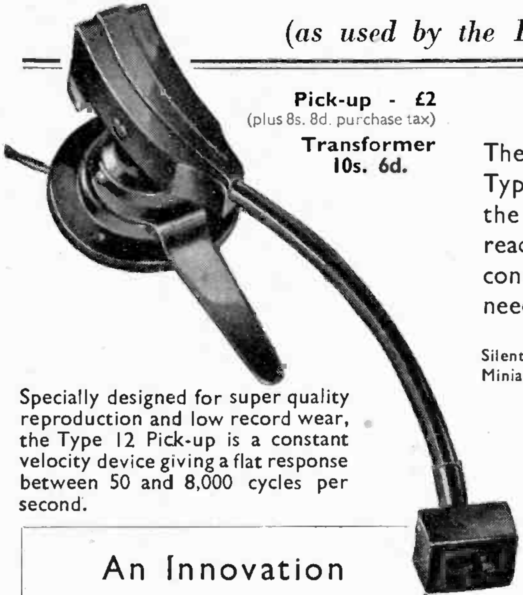

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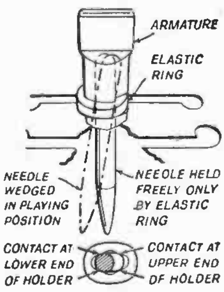

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**YAXLEY TYPE SWITCHES.** 2-pole 3-way 2-bank, 5/6 ; 2-pole 6-way 2-bank, 5/6 ; 2-pole 3-way 3-bank, 7/- ; 2-pole 6-way 3-bank, 7/-. Any of the following types at 4/- ea. 1-pole 8-way, 1-pole 11-way, 2-pole 3-way, 2-pole 5-way, 3-pole 3-way.

**S/W VARIABLE CONDENSERS.** All Brass "Polystyrene Insulation." extended spindle for ganging. Noiseless. 15 mmfd., 2/11 ; 25 mmfd., 3/3 ; 40 mmfd., 3/3 ; 100 mmfd., 3/11 ; 160 mmfd., 4/8 ; 250 mmfd., 5/8.

**FULL VISION S/M DRIVES.** Calibrated 16-47, 200-557 and 700-2,000 with station names, 8-1 Escutcheon size, 7½in. × 4½in., 10/6. Junior Model. Calibrated 200-557 and 700-2,000 and station names. Escutcheon size, 5in. × 4in., 8-1, 10/6. Epicyclic Reduction Drives, 8-1, 2/9.

**UTILITY MICRODIAL.** Communication Type. Slow and Fast Motion Dual Knob and silver engraved, 4in. circular dial with hairline cursor 100-1 reduction. Fits entirely on front of panel, 8/6.

**MAINS DROPPER RESISTANCES.** Variable Type with sliding adjustment. 800 ohms, .3 amp., 5/6 ; 1,000 ohms, .2 amp., 5/6.

### PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTS are ceutre tapped.

| Output | Price | Output | Pric |
|---|---|---|---|
| 175-0-175 v. 50 m/a. 6.3 v. 2-3 a. 5 v. 2a. | 25/- | 350-0-350 v. 150 m/a. 4 v. 1-2 a. 4 v. 2-3 a. 4 v. 3-6 a. | 36/- |
| 175-0-175 v. 50 m/a. 4 v. 1 a. 4 v. 2-3 a. | 25/- | 350-0-350 v. 150 m/a. 4 v. 2-3 a. 4 v. 3-6 a. 4 v. 1-2 a. 4 v. 1-2 a. | 39/- |
| 250-0-250 v. 60 m/a. 6.3 v. 2-3 a. 5 v. 2 a. | 25/- | 350-0-350 v. 150 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 2-3 a. | 36/- |
| 250-0-250 v. 60 m/a. 4 v. 1-2 a. 4 v. 3-5 a. | 25/- | 425-0-425 v. 200 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-6 a. | 47/- |
| 300-0-300 v. 60 m/a. 6.3 v. 2-3 a. 5 v. 2 a. | 25/- | 425-0-425 v. 200 m/a. 6.3 v. 2-3 a. 6.3 v. 3-5 a. 5 v. 2-3 a | 47/- |
| 300-0-300 v. 60 m/a. 4 v. 2-3 a. 4 v. 3.5 a 4 v. 1-2 a. | 25/- | 500-0-500 v. 150 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-5 a. | 47/- |
| 350-0-350 v. 100 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. | 29/- | 500-0-500 v. 150 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 3-5 a. | 50/- |
| 350-0-350 v. 100 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-5 a. | 29/- | 500-0-500 v. 250 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 3-5 a. | 65/- |

**PLAYING DESKS.** A few only available. Consist of an Electrical Gramophone Motor with automatic stop and speed regulator, a quality magnetic Pick-up mounted on a strong metal frame. Price complete £6 17s. 6d.

**MIDGET RADIO KITS.** Complete with drilled chassis, valves and loud speaker, only cabinet required, medium and long wave T.R.F., size 10 × 6 × 6, 4 valves, inc. rect., tone control, AC/DC operation, 200/250 v. Circuit and constructional details supplied. Price, including tax, £6 17s. 6d.

**AMAZING OFFER.** We have purchased the following material which must be cleared. Special prices will be quoted for large quantities. Super Quality Lease-Lend Aerovox oil-filled Paper Condensers fitted with Standoff Insulators and vertical fixing clip, 2 mfd. 1,000 volts working, 2/6 each, or 20/- per dozen, size 3¾in. × 1¾in. × ¾in. ; 2 mfd. 600 volts working, 1/3 each, or 10/- per dozen ; 1 mfd. 600 volts working, 1/-, or 8/- per dozen, size 2in. × 1¾in. × ¾in. 0.1 mfd. 500 v. working, miniature aluminium can, wire ends, oil filled, insulation good as Mica, 9d. each, or 7/6 per dozen.

**MICAMOLD POSTAGE STAMP CONDENSERS.** 0.01, 0.001, 0.002 mfd., 600 volts working, 9d. each, 7/6 per dozen.

**CELESTION 10in. SPEAKERS.** 2,100 ohms field, handle 8 watts. A super production with curved cone and dustproof voice coil, 50/-.

**·0005 CONDENSERS.** Ceramic insulation. "Bar" Type. Single gang, 5/-. Twin gang, 8/6 ; three gang, 10/- ; four gang, 10/-.

**P.M. SPEAKERS.** 5in., 21/6 ; 6½in., 22/6 ; 8in., 24/- ; 10in. 6 watt 15 ohm, 47/6 ; 12in. 15 ohms 15 watts, a high fidelity job, £6 15s.

**Brand New GOVT. SURPLUS. Many items at less THAN COST**

**ROTARY TRANSFORMERS,** input 12 v., output 180 v. 30 m/a. 4 v. 3 a. with 19 volts input, output is 50 per cent. higher. May be used on D/C mains as L.T. Charger. With small conversion could operate as D/C Motor. Original cost over £5. Employ powerful ring magnet. Price 10/- each.

**ROTARY TRANSFORMERS.** Input 6 v., 12 v. or 24 v. D.C., output 250 v., 550 v. or 1,200 v. 70 m/a. respectively, 40/-.

**ELECTROLYTIC CONDENSERS.** 8 mfd. 500 v.w., 3/- ; 32 mf. 550 v.w., size 4 × 2 × 1½, 5/- ; 16 mf. 700 v.w., size 5 × 4 × 2, 7/6 ; 16+8 mf. 350 v.w., 7/6.

**MAINS TRANSFORMERS.** All 230 v. primary, 4 v. 1-2 amps., 7/6 ; 1,250+1,250 v. 250 m/a., £5 ; 6 v. 4 a. twice, 20/- ; 4 v. 10 a. twice, 10/-.

**CO-AXIAL CABLE.** Super quality, consisting of a stranded centre core, a low-loss ribbed polyvinil resin type insulator, a flexible screen, a weatherproof P.V.C. outer cover. Just the thing for Television Lead-in or Super Mike Cable, 6d. per foot.

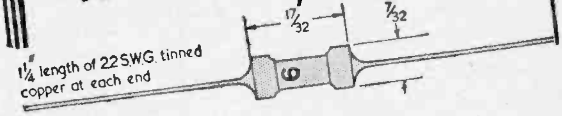
**TRANSFORMER CARCASES.** Ideal for rewinding. All in perfect order with 230 v. primaries but odd type secondaries. 50 watt size, 7/6 ; 100 watt, 10/- ; 150 watt, 12/6 ; 250 watt, 15/-.

### FIRST GRADE MOVING COIL METERS

Flush Mounting Bakelite Cases

| | 1 milliamp. | 500 microamp. | 100 microamp. |
|---|---|---|---|
| 3½in. dia | £2 12 0 | £2 18 6 | £3 8 3 |
| 4½in. dia. | £3 5 0 | £3 11 6 | £4 11 0 |
| Internal Resistance | 100 ohms | 600 opms | 900 ohms |

# MINIATURE WESTECTORS




The Miniature Westector is designed to carry 1, 2, 3, 4 or 6 series elements protected from the outside atmosphere by compressing a neoprene ring between the metal end caps and the phenolic body to give a positive seal; this Westector is therefore suitable for tropical use and no reduction in the rating is necessary at ambient temperatures up to 55°C. (131°F.).

**WESTINGHOUSE**

# *METAL* RECTIFIERS

*Write for Data Sheet No. 47*

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


IT is a fact that although VITAVOX K12/10 and K12/20 P.M. Speakers are not available in unlimited quantities, their quality is such that they are well worth waiting for.

It is a fact too that all specification figures are actual and not nominal.

VITAVOX LIMITED, WESTMORELAND RD., LONDON, N.W.9. Phone Colindale 8671/3

## Design Data (5)

# LOW-FREQUENCY CORRECTION CIRCUIT

### Increasing Bass Response

THERE are many occasions on which it is necessary to give an A.F. amplifier a characteristic rising at the lower frequencies. Probably the most notable example is the case of an amplifier intended for reproducing gramophone records. Frequencies below some 250 c/s are attenuated in the recording process, and if the pick-up response curve is level, an equal increase in amplification is needed at such frequencies to correct for it.

One of the most satisfactory ways of achieving such correction is by means of the circuit shown in the diagram and it also gives some small amplification. This stage will normally be fed from the pick-up through the usual potentiometer-type volume control and its output will be fed to the grid of the first valve in the amplifier proper.

The stage can also be used as a low-frequency tone-control of the bass-lifting type by arranging a switch to change the value of C. The low-frequency response can then be varied without appreciably affecting the gain over the middle and higher audio-frequencies.

The design of a stage of this kind is based upon the fact that it is desirable for the valve to work into a load impedance of not less than twice its anode A.C. resistance. If the load is below this value it has only a small straightening effect on the valve characteristics, and the liability to amplitude distortion is increased. The values of components given by the appended design formulæ are such that the load on the valve is twice its A.C. resistance at the higher frequencies and somewhat greater at low frequencies.

### Example

The use of the equations is best illustrated by an example. Suppose that it is desired to determine circuit values to correct for a recording curve such as that shown dotted in Fig. 1, and that the valve has $R_a = 15{,}000\ \Omega$ and $\mu = 40$. Correction below 50 c/s is usually unimportant and it is satisfactory to take this as the lower frequency $f_1$; the higher frequency $f_2$ should be chosen at a point where the attenuation is small, say, at 200 c/s.

The curve shows a response of $-10$ db at 50 c/s and $-0.75$ db at 200 c/s, therefore, $B_1 = +10$ db and $B_2 = +0.75$ db. Consequently, $y_1 = 10$, $y_2 = 1.19$ and $f_2/f_1 = 4$. Then carry out Step 1 in order to determine whether it is possible to obtain this degree of correction with this circuit. For the left-hand side of the inequality $y_1 = 10$. For the right-hand side, $1 + 16 \times 0.19 = 4.04$. The left-hand side is greater than the right-hand and the required performance cannot be obtained.

Examination of the inequality shows that to obtain practical values it is necessary to reduce $y_1$ or increase $y_2$ or $f_2/f_1$. Increases of $y_2$ and $f_2/f_1$ are virtually the same thing, for if $f_2$ is increased it means that the response at the old value of $f_2$ is greater.

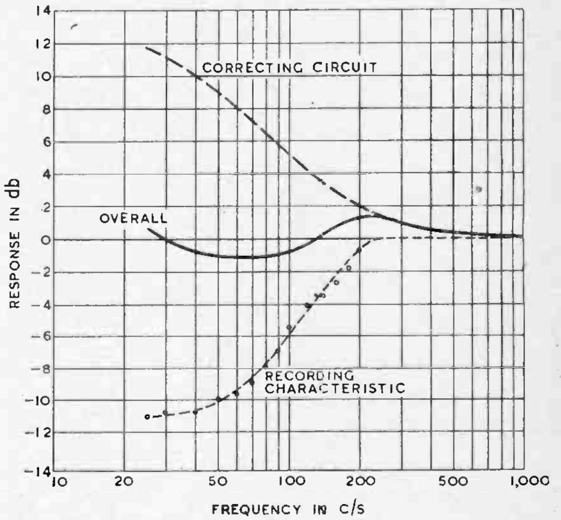



Fig. 1. Illustrating the application of the design data.

Now in practice small variations of response of the order of 1 or 2 db are negligible, for they are inaudible. The best way of obtaining a practical circuit, therefore, is to modify the requirements somewhat. Instead of demanding 10 db correction at 50 c/s, try 9 db, and instead of calling for a rise of only 0.75 db at 200 c/s, permit 2 db. The overall response will then be $-1$ db at 50 c/s and $+1.25$ db at 200 c/s, which is quite good.

With $B_1 = +9$ db, $y_1 = 7.95$ and with $B_2 = +2$ db, $y_2 = 1.59$. Now repeat Step 1. This gives, left-hand side = 7.95 and right-hand side = 10.44. The inequality is satisfied and the circuit is possible.

Step 2 comes next and gives $x = 0.211$ and $T = 0.000975$. Then comes Step 3, and the component values are: $R_1 = 45{,}000\ \Omega$; $R = 21{,}400\ \Omega$; $R_2 = 68{,}500\ \Omega$; $C = 0.0456\ \mu F$. The amplification $E_o/e_{in}$ is 6.33 times.

Step 4 follows and $R\sqrt{1 + 1/\omega_1^2 T^2}$ is determined. Its value is 73,000 $\Omega$ and $R_3$ must be much larger than

**Low-frequency Correction Circuit**

this. A value of 2 M$\Omega$ for $R_3$ is suitable and it will affect the response only to a small degree. Such a value will also usually be permissible for the grid leak of the following valve. Now $C_1$ must be very large compared with 0.00159 $\mu$F. A capacitance of 0.02 $\mu$F would be suitable.

A valve of the type selected for this example will usually need $R_5$ about 2,000 $\Omega$; therefore, $C_3$ must be very large compared with 1.59 $\mu$F. A value of 25 $\mu$F or 50 $\mu$F will be satisfactory.

The response obtained from the circuit, neglecting the small effects caused by $C_1R_3$ and $C_3R_5$, is shown by the dashed curve of Fig. 1 and the solid curve shows the combination of this with the recording curve. Although no attempt has been made to obtain correction below 50 c/s, it so happens in this case that it is better below 50 c/s than at this frequency.

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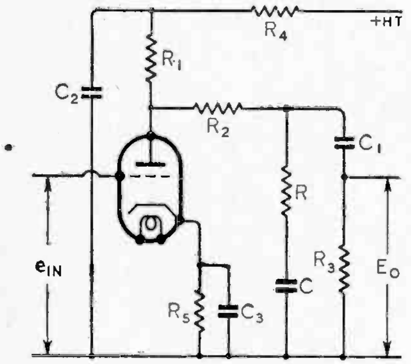
## Design Data (5): Low-frequency Correction Circuit




Given: $R_a$ (ohms) = anode A.C. resistance of valve.

$\mu$ = amplification factor of valve.

$B_1$ (db) = increase of response required at a low frequency $f_1$ (c/s).

$B_2$ (db) = increase of response required at a higher frequency $f_2$ (c/s).

**Step 1**

Check that the values of $B_1$ and $B_2$ are such that the required performance is possible with this circuit. It is necessary that

$$y_1 < 1 + (y_2 - 1) f_2^2/f_1^2$$

where $y_1$ = antilog $B_1/10$ = power ratio corresponding to $B_1$ db.

$y_2$ = antilog $B_2/10$ = power ratio corresponding to $B_2$ db.

**Step 2**

Enumerate :—

$$x = \sqrt{\left[\frac{1}{y_1} \cdot \frac{(y_2 - 1) f_2^2/f_1^2 - (y_1 - 1)}{(y_2 - 1) f_2^2/f_1^2 - (y_1 - 1) y_2/y_1}\right]}$$

$$T = \frac{1}{6.28 f_1} \sqrt{\left[\frac{1 - x^2 y_1}{y_1 - 1}\right]}$$

**Step 3**

Determine component values :—

$R_1 = 3R_a$ ($\Omega$)

$R = \frac{27}{4} R_a x$ ($\Omega$)

$R_2 = 6R_a (1 - \frac{9}{8}x)$ ($\Omega$)

$C = 10^6 T/R$ ($\mu$F)

$E_o/e_{in}$ = voltage amplification of stage at high frequencies $= \frac{3}{4}\mu x$

**Step 4**

Choose $R_3$ and $C_3$ in accordance with normal procedure for a resistance-capacitance coupled stage. This means usually

$$R_3 \gg R\sqrt{1 + 1/\omega_1^2 T^2} \quad (\Omega)$$

$$C_1 \gg 10^6/\omega_1 R_3 \; (\mu F) \text{ where } \omega_1 = 6.28 f_1$$

Choose $R_5$ to give the required grid bias for the valve, and make $C_3 \gg 10^6/\omega_1 R_5$. ($\mu$F)

Make $R_4$ as large as possible consistent with obtaining an adequate anode voltage on the valve (50,000 $\Omega$ is usually of the right order). The value of $C_2$ depends on the amount of amplification following this stage and must be large enough to make feed-back effects negligible (8 $\mu$F is usually adequate).

If it is required to know the overall response, it may be calculated from the formula :—

$$B = 10 \log \frac{1 + \omega^2 T^2}{x^2 + \omega^2 T^2} \text{ db}$$

where $\omega$ = 6.28 times frequency in cycles per second.

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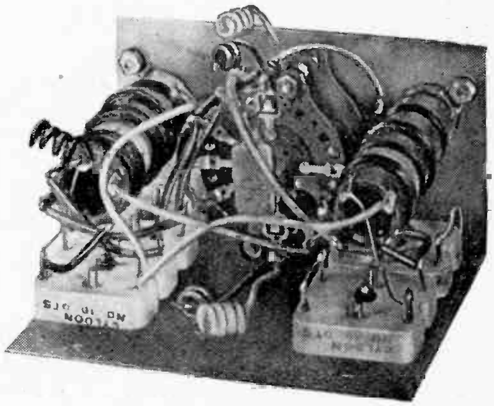
FOR THE CONSTRUCTOR



**Three-waveband coil pack for superheterodynes made by Weymouth Radio Manufacturing Co., Crescent Street, Weymouth. The unit comprises aerial and oscillator coils with trimmers and waverange switch and covers 19-50, 200-550 and 1,000-2,000 metres.**

# NAVIGATIONAL AIDS

## *Demonstrations in H.M.S. "Fleetwood"*

TO give delegates to the International Meeting on Radio Aids to Marine Navigation an opportunity of seeing some of many systems of radio position-finding in action, a series of sea trials were run last month in H.M.S. "Fleetwood."

The ship was fitted with radar and in addition to the standard wireless receiver which is all that is necessary to make use of shore rotating beacon stations such as Orfordness and the more modern multiple-lobe Consol, the ship carried a representative medium wave D/F receiver and special receivers for hyperbolic navigation with the continuous wave "Decca" and the pulse-operated "Gee" systems. Of course, no attempt was made to "sell" any particular system and in the descriptive programme prepared by the Admiralty Signal Establishment the advantages and limitations of each method were set out with scrupulous fairness.

The radar demonstration of pilotage in narrow waters followed the lines of the Thames Estuary experiments in H.M.S. "Pollux" already reported in the March issue of this journal. The equipment installed in H.M.S. "Fleetwood" has been "cleaned up" from the engineering point of view; detail improvements include a continuously variable range scale and an automatic reversing switch for the scanning motor so that when the chart comparison mirror is lowered to give direct vision, the optical reversal is automatically corrected.

Perhaps the most important development is the provision of automatic monitoring of the performance of both the transmitter and the receiver. This is essential if the ship is in fog in mid-ocean, when a blank display must mean that there is no other ship within range—and nothing else. The automatic monitor consists of a resonant cavity containing a crystal rectifier and a small spark transmitter and mounted a short distance behind the rotating aerial reflector. Each time the beam sweeps past the monitoring box the received energy is integrated by a long time-constant circuit to give a D.C. meter reading. The received pulses are also given a suitable time delay and used to actuate the spark transmitter which sends a feeble pulse back to the aerial to test the receiving gear when it is not occupied with the main display. The rectified output from the receiver is added to the transmitter test output and if the combined current does not reach the required value a relay shuts down the display.

A second monitoring device enables the operator to put on the C.R. tube a number of vertical lines representing voltages in various parts of the equipment. These have been adjusted so that they are all of the same height under normal conditions and in the event of deterioration of performance the probable cause can be quickly located.

It has been suggested that a gyro compass to provide the repeater signals necessary to keep the display "right way up" on the screen might add prohibitively to the cost of the equipment. To meet this objection the Admiralty have produced a transmitting magnetic compass of simple and reliable design. The liquid in the compass bowl is made conducting by the addition of a trace of electrolyte and four electrodes are sealed into the sides of the bowl to form a wheatstone bridge. The compass card carries a light semicircular metal strip on the underside which modifies the resistance of two arms of the bridge. It is arranged that the bridge is balanced when the lubber line coincides with north on the card and the metal strip is symmetrically placed between the arms of the bridge. The bridge is energised with A.C. and any out-of-balance current is amplified and applied to motors which cause the bowl to rotate until the balance is restored. The movement of the bowl is transmitted to repeaters by magslip motors.

# PROPAGATION OF ULTRA-SHORT WAVES

## *Super-refraction Radio "Ducts" and Abnormal Radar Ranges*

ON March 27th a session of the Radiolocation Convention being held at the Institution of Electrical Engineers was given over to the consideration of a number of papers on the propagation of waves used for radar. These are radio waves of the metre, decimetre and centimetre class, and, since such waves may be employed for numerous purposes other than radar, information about their propagation acquired during the war is likely to be of great general interest.

In a paper, "Elements of Radio Meteorology: How Weather and Climate Cause Unorthodox Radar Vision Beyond the Geometrical Horizon," Dr. H. G. Booker gave several examples of radar vision far beyond the optical horizon, i.e., of radar signals being returned from phenomenally long distances. One instance was that of radar vision of the low, flat coastline of Holland from a station in East Anglia. The author explained that radio rays in the atmosphere are normally not quite straight, but curve slightly downwards owing to the decrease of atmospheric density with height. Sometimes—generally in the body of air just above the surface—this curvature is much increased and there arises the case where a ray leaving horizontally from a transmitter at a certain height would curve to the same extent as the earth's surface. This gives rise to the formation of what is called a radio "duct," for rays leaving horizontally from transmitters situated lower down than that just specified would curve even more, and so would be propagated by successive hops around the earth's surface. They would, in fact, be "trapped" within the duct instead of going off into space as under normal conditions. These radio ducts are effective only for waves of the order of one metre or shorter, and longer waves are not affected because the rate of change of refractive index in the atmosphere is not such as to lead to the formation of such very large ducts as would be required to "guide" them.

The excessive curving effect is said to be due to "super-refraction" of the waves, and their successive hops lead to phenomenally long radar ranges. It occurs when there are unusual gradients of temperature and humidity in the atmosphere, and Dr. Booker went on to discuss the meteorological and climatic conditions which give rise to such gradients. The requirement is that the upper atmosphere should be exceptionally warm and dry in comparison with the air in contact with the earth's surface, and this most usually occurs when the weather is fine and calm. High winds or bad weather give rise to more orthodox propagation of the waves.

The details of the meteorological effects mentioned are too complex to deal with here, but there are distinct diurnal and seasonal effects, and in tropical climates the requirements for the formation of ducts are more often present than in temperate ones, and so super-refraction of ultra-short radio waves more frequently occurs.

### Weather Conditions

A paper by E. C. S. Megaw, M.B.E., "Experimental Studies of the Propagation of Very Short Waves" dealt comprehensively with the results of wartime experiments on the propagation of ultra-short waves over certain land and sea paths. Striking evidence of the dependence of propagation under weather conditions was given in the results of an experiment between the Isle of Man and a ship at sea. When the weather was rough the field strength at a distance followed almost exactly that calculated for a standard atmosphere, but when fine weather set in there was a remarkable increase in the field at considerable distances. The author also dealt with the subjects of reflection and scattering from sea and land, and with the effects of obstacles.

Interesting contributions to the subject under discussion were made by Lt. Cdr. F. L. Westwater, J. W. Ryde, Dr. R. L. Smith-Rose, Lt. B. S. Starnecki, J. M. C. Scott and T. L. Eckersley, F.R.S.

The concluding remarks by Sir Edward Appleton, F.R.S., dealt with the effects of extra-tropospheric phenomena upon the propagation of ultra-short waves. The normal ionosphere layers would not affect this, provided the waves used were below a certain wavelength. At least they would not affect it in these latitudes where we had sufficient data on the ionosphere to be sure about the matter, but there were parts of the world from which no data had yet been obtained, and it was possible that in some of these the ionisation might reach such values as to cause modification of the wavelengths used for certain purposes. There was, however, the phenomenon of "Sporadic E," and this might give rise to undesired refraction at times, whilst the "bursts" of signals on ultra-short wavelengths thought to be due to the ionisation caused by meteorites indicated another possible source of trouble. Finally, there was the radio noise coming from the Milky Way and from the Sun, which was of relatively considerable intensity on these wavelengths and which was therefore a factor which must be studied and taken into proper consideration.

T. W. B.

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### PYE 65a BATTERY RECEIVER

A BATTERY counterpart of the Pye 15A receiver reviewed in our January, 1946, issue has been introduced by Pye, Ltd., Radio Works, Cambridge. It employs a Q.P.P. output stage and has the quick chassis release, flywheel tuning and tone control features of the A.C. model. The price is £15 15s plus £3 7s 9d purchase tax.

**Letters to the Editor**

# Tribute to Blumlein • B.B.C. Secretiveness • Servicing Troubles • Feedback Tone Control

### *Miller Integrator ?*

A CIRCUIT device that ranks with the cathode follower among the most valuable of recent years is that called the Miller integrator. I suggest that this name is inappropriate and misleading, as although the circuit is related in principle to the Miller effect it is actually due to the late Mr. A. D. Blumlein. It would be some small recognition of the many contributions of Mr. Blumlein to circuit technique if this circuit were renamed the Blumlein integrator. As the present name has not yet been given much publicity it should not be too late to make the change, which I therefore strongly recommend for your consideration.

M. G. SCROGGIE.

### *B.B.C. Transmitters*

INFORMATION as to how the B.B.C. distributes its programmes over its medium- and long-wave transmitters does not seem to be common knowledge at all and I would like to suggest that some information on this subject might be given. This could take the form of a map showing the location of the stations, together with a chart showing the programmes, wavelengths and power.

A. T. DRAKE.

Cheltenham.

### *Soldering v. Spot Welding*

WITH reference to Richard Arbib's letter in your April issue, as ex-inspector of Admiralty radar equipment I would put the causes of poor or dry solder joints in the following order: First, incorrect iron temperature; second, careless or indifferent work by the operator.

I found in the course of my work that even with an iron of correct temperature, a good class solder and ample time to make a good job it was still hopeless to expect some operatives to turn out a job free from bad or dry joints.

I consider that provided the requirements mentioned above are met with there is absolutely no excuse for bad soldering.

With regard to spot welding of joints, imperfect work could be still found here, and whatever the job, good or bad, in the main it always rests with the person performing it.

G. AUSTIN.

Haywards Heath.

### *Valve Metalizing*

A COMMON fault experienced in servicing radio receivers is that caused by faulty valve metallizing. As is well known, instability and erratic behaviour go hand in hand with sets developing this particular trouble.

Surely, it is not beyond the wit of British valve manufacturers to design a contact to the metallizing that is well and truly anchored and at the same time will remain permanent during the life of the valve?

Ipswich. A. ADCOCK.

### *Telephone Recorders*

THE Federal Communications Commission, in Washington, D.C., recently started an enquiry on the use or abuse of sound recording devices in connection with telephone conversations. Witnesses for the telephone industry and the recording industry have given testimony, the former contending that some form of restriction which would assure positive notice to all parties of a telephone conversation that it was being recorded was essential, and the latter claiming that "a warning notice to the outside party is unnecessary because of the public acceptance of electronic or mechanical recording and of secretarial monitoring of telephone conversations. If any

**Letters to the Editor—**

notice should be held desirable, a notation in connection with the subscriber's listing in the industry would suffice.''

This matter may not seem to be of great import or urgency in Great Britain, but when magnetic wire or tape recorders, as well as long-playing disc reference recorders, become generally available here, this problem will have to be faced.

Telephone recording devices are already in use in this country,[1,2] but their price has precluded widespread use so far. The G.P.O. has approved certain of these equipments and, for a nominal fee, permits a direct connection to their lines, but, of course, with induction coil coupling no actual physical contact with the telephone is needed, and it is possible to employ such a device without any indication to the persons telephonically linked or the G.P.O.

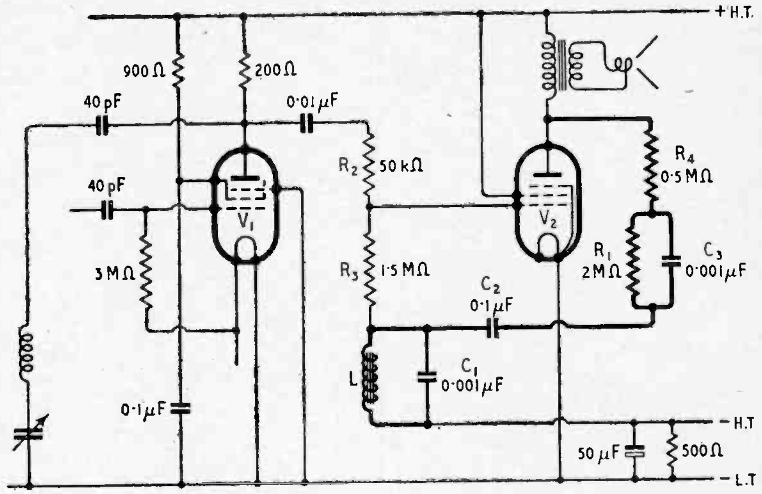
Space does not permit me to dilate on the legal, moral and technical pros and cons of employing recording devices on telephone circuits,[3] but it is obvious to anyone with imagination that the use of such apparatus is fraught with many possibilities, and not all necessarily beneficial to the community.

As I am intimately connected with the recording profession I, naturally, am anxious to see an increasing use of sound recording devices for innumerable applications, but not by misuse to bring recording into disrepute. Therefore, with your kind co-operation, it would be interesting and helpful to have a few opinions of recording technicians and telephone subscribers on this question ventilated in your columns.

DONALD W. ALDOUS,
Tech. Secretary, British Sound Recording Association.
London, W.C.1.

## *Tone Correction*

A CIRCUIT I recently discovered while experimenting may prove of interest to those who wish to combine negative feedback with tone compensation and simplicity of design. It is particularly applicable to the average battery set where bass and treble boost is missing. The circuit about to be described is found to give these benefits comparatively cheaply. The diagram shows the detector pentode and output pentode of a typical battery set, and the additional feedback network is shown in heavy lines.




The inductance L is a 5 : 1 transformer and its approximate total inductance is 150 henrys. $C_3$ controls the frequency of the bass boost, and can be adjusted to suit the speaker and output transformer and personal requirements. The output transformer is of the average type with primary inductance 15 henrys. $C_1$ controls the frequency of the treble boost and $C_2$ is a blocking condenser. $R_2$ is inserted to reduce the effect of feedback on the anode of $V_1$ and $R_1$ is adjusted to reduce bass reverberation. $R_3$ and $R_4$ control the extent of feedback, and could be used to vary the extent of bass and treble boost.

The circuit can be analysed quite simply as follows. At low frequencies there is a complete phase reversal resulting in positive feedback. This phase reversal also takes place to a reduced extent at high frequencies. At medium frequencies, i.e. at the resonance of $C_1L$, negative feedback takes place. A certain amount of negative feedback also takes place at the bass resonance of the speaker, which improves the tone, the positive feedback occurring at a considerably lower frequency.

When this system of feedback was added to a battery set, the tone was vastly improved, distortion was reduced and there was no appreciable loss in amplification.

L. GREGORY.
Upton, Cheshire.

## MEASURING INTERFERENCE

WITH the increasing output of domestic electrical equipment there is considerable interest in the question of suppressing interference. There is, however, a dearth of equipment suitable for measuring the interference as prescribed in the British Standard No. 727.

In an endeavour to meet the need the G.P.O. is adapting a number of Army interception receivers Type R206 for the purpose, and they will be made available as cheaply as possible to manufacturers of electrical equipment.

As only a limited number of sets will be available it is probable that the demand will exceed the supply. The British Standards Institution has, therefore, been invited by the Post Office to advise as to their most useful allocation. All enquiries should be addressed to the Director, B.S.I., 28, Victoria Street, London, S.W.1, quoting the reference OC/1/3.

[1] *Wireless World*, July 5th, 1935, p. 5.
[2] *Wireless World*, June 29th, 1939, p. 611.
[3] *Telephony*, August 11th, 1945, p. 13.

In advising as to the allocation, the B.S.I. will take into account the competence and willingness of the applicant to act, within reasonable and practicable limits, as an "approved testing station" for samples of the products of other manufacturers, as well as of his own, and the importance, from the radio interference point of view, of the range of products to be tested, particularly the applicant's own products.

The tolerable limits of interference are given in British Standard No. 800.

## B.B.C. YEAR BOOK

A WEALTH of information on the past year's broadcasting in all the services of the B.B.C. is contained in the "B.B.C. Year Book, 1946."

The Corporation's engineering developments during the war are outlined by the Chief Engineer, details are given of the underground headquarters built in the Clifton rocks, and some facts on the expansion of the engineering division are included in this 152-page book, priced 2s 6d.

The book is well illustrated and concludes with a useful reference section.

# UNBIASED

*By* ***FREE GRID***

## *U.S.W. Telepathy*

A KINDLY reader has sent me along a cutting from *Picture Post* in which a correspondent of the Editor of that journal points out how unnatural it is for us to dwell in two- or three-storied houses "situated," as the house agents say, many feet above Mother Earth. He has, so he says, solved the problems induced by this unnatural practice, by earthing his big toe. I cannot myself profess to know much about the nature cult, having rigidly eschewed it since they attempted to remove my bowler hat at the entrance gates of a nudist camp to which Mrs. Free Grid sent me in the vain hope of my doing a black-market deal in unwanted clothing coupons.

A nasty flash-over.

However, the whole affair reminds me very vividly of some researches which I made during the war into the vexed question of telepathy. As you know, the B.B.C. have tried it with very indifferent results, although few will deny that genuine cases of this irritatingly elusive mental faculty do exist. I had long supposed that this thought-transference business was done by U.S.W., and only occurred in those comparatively rare instances where "transmitter" and, "receiver," or, in other words, two minds happened to have the same natural wavelength.

It was but a step further for me to visualize that if this were true, as I had every reason to believe, it only remained for me to devise some method whereby the wavelength of each mind could be varied at will to bring about mutual syntony. At first I went hopelessly astray and commenced very crudely by equipping Mrs. Free Grid and myself each with a metal cap like they use in the U.S.A. for electrocution purposes, attaching thereunto an ordinary aerial system. For Mrs. Free Grid's case I provided no earth connection, reckoning that the capacity of her body to earth would, ample as it was, be all that was needed and herein, of course, lay my undoing, as she accumulated a very considerable static charge which eventually resulted in a nasty flash-over, all of which would have been avoided had I only adopted the simple precautions advocated by the correspondent of *Picture Post.*

However, I had eventually to abandon my project entirely, as apart from a reluctance on the part of Mrs. Free Grid to co-operate further, I was legally advised that I was for all intents and purposes establishing a transmitter and as it was wartime the consequences were likely to be serious. I am hoping very shortly, however, to recommence my work in this matter as I am convinced that telepathy is just as much a question of U.S.W. as in rhabdomancy, concerning which one of *Wireless World's* most erudite contributors (D'Orsay Bell) wrote some weighty words of wisdom many years ago.

# A SIMPLE OSCILLOSCOPE

## *Using the Mains as a Time Base*

*By F. P. WILLIAMS*

BEING in need of a frequency comparator for calibrating a B.F.O. against 50-cycle mains, the writer purchased cheaply a 7in "magnetic" cathode-ray tube and resolved that the auxiliary apparatus should be on equally economical lines.

The resulting oscilloscope has proved very satisfactory in use, not only for its original purpose, but also for the examination of phenomena whose period of recurrence is, or can be adjusted to, an integral multiple of 50 c/s.

Deflecting and focusing coils, roughly following normal television practice, were quickly made up. No iron was used in the magnetic circuits, and the focusing coil was wound to suit a 2-volt D.C. supply which was available. The only other components required were a H.T. supply transformer of the small kind with a 2-volt filament winding (half a centre-tapped 4-volt winding), a

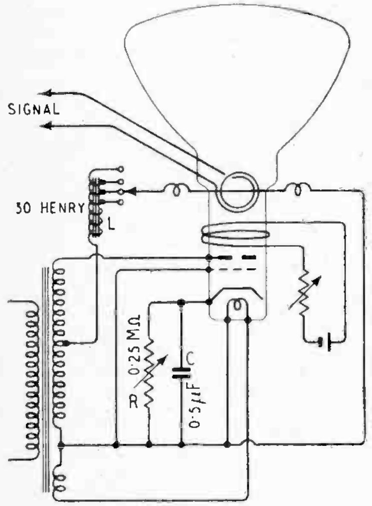



Fig. 1. Circuit diagram of oscilloscope. The anode is fed with raw A.C.

tapped choke and the variable resistances for focusing control and grid bias. The circuit arrangement, which could hardly be simpler, is shown in Fig. 1.

The anode is fed with raw A.C. of about 700 volts peak, and the steady grid bias voltage developed across C is adjusted so that the spot is only visible on or near the positive peak of anode voltage. The idea is to use the straight "middle cut" of the sine wave for the time base and adjust the phase of this so that the middle of the base is reached at peak anode volts.

To this end a choke L is included in the horizontal deflecting coil circuit. The deflecting current, $I_d$, and therefore the field produced, lags behind the anode voltage $V_a$ by nearly 90 degrees. The tappings on the choke serve to adjust the length of the time sweep. Fig. 2 shows the relation of anode voltage to deflecting current. An anode voltage, not dropping below 90 per cent. of the peak value, covers 50 degrees of the cycle; over this period the time sweep is as linear as makes no difference. 50 degrees of a 50-cycle wave is 2.8 milliseconds, which is long enough for one complete cycle at 350 c/s. The available length of base being about 12 cms, a 14,000 c/s wave is 3 mm from peak to peak. Higher frequencies may be observed by tapping down the choke so that the time sweep is well off the tube screen each end, the only limits being overheating of the deflection coils and progressive dimming of the trace as the writing speed gets higher.

For some purposes it is useful to know the "sense" of the time base and to have it writing from left to right, say. This may be done by disconnecting the time base deflecting coils and passing current from a 2-volt cell through them in such a direction that the spot is moved to the right. Note which coil terminal is connected to positive of the cell, and, when reconnecting for use, join this terminal to the choke.

It is worth noting that the use of a condenser instead of a choke to obtain the phase shift is unsatisfactory, since this discriminates in favour of the harmonics present in the mains supply and spoils the linearity of the trace. One other point: with only 700 volts on the anode, the deflec-

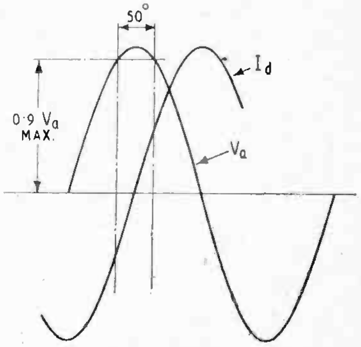



Fig. 2. With the correct phasing inductance the anode voltage remains practically constant over the straight portion of the deflecting current curve.

tional sensitivity of the tube is high (a useful feature), so that, unless a Mumetal screen is employed, the transformer and choke should be mounted not less than 2ft from the tube.

### CATALOGUES RECEIVED

BOOKLET giving technical data on electrical resistance materials manufactured by Johnson, Matthey and Co., 73-83, Hatton Garden, London, E.C.1.

"Replacement Capacitors for the Service Engineer" (catalogue C.258) from A. H. Hunt, Ltd., Bendon Valley, Garratt Lane, London, S.W.18.

Leaflet describing solventless impregnating varnishes from Jenson and Nicholson, Ltd., Carpenters Road, Stratford, London, E.15.

Catalogue of mica and ceramic capacitors, hermetic seals and metallized bushes from the United Insulator Co., 12/22, Laystall Street, London, E.C.1.

List of sound recording and reproducing equipment from the Recordomat Co., 19, Exmouth Market, Rosebery Avenue, London, E.C.1.

# SHORT-WAVE CONDITIONS

## *Expectations for June*

By T. W. BENNINGTON
(Engineering Division, B.B.C.)

DURING April, the *average* daytime maximum usable frequencies for this latitude were about the same as during March, whilst due to the longer duration of daylight the night - time M.U.F.'s were considerably higher than during that month. Communication on the *exceptionally* high frequencies by way of the *regular* layers was, however, less frequently possible, particularly to the U.S.A., and it will probably become still rarer to that country as the summer approaches.

There was less ionosphere storminess during April than during the previous month. Nevertheless, storms did occur on the 9th, 14th-16th, and 23rd-26th. The latter was a disturbance of great intensity and during its course short-wave communication was greatly upset, whilst the aurora borealis was widely observed in this country. "Dellinger" fadeouts were reported on the 3rd, 10th and 18th, and, on at least one of these occasions, the solar "hissing" noise was heard on the short wavelengths.

**Forecast.**—During June, the working frequencies for *long-distance* transmission should, generally speaking, be somewhat lower than during May in the daytime, but the night-time usable frequencies should continue to increase. Daytime frequencies will, on many circuits, remain of use for a longer period of time than during May—for example, 15 Mc/s should be *regularly* usable till well after midnight. For *medium-distance* transmission—up to about 2,000 miles—the E or $F_1$ layers will control transmission for considerable periods during the daytime, and, in this case, daytime as well as night-time frequencies should be higher than at present.

Sporadic E is likely to be particularly prevalent, and so, on frequent but unpredictable occasions, communication up to 1,400 miles may be possible by way of this medium on frequencies far above those usable by way of the regular layers.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during June, for four long-distance circuits running in different directions from this country. In addition, a figure in brackets is given, this indicating the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the *regular* layers.

**Montreal:** 0000, 15 Mc/s (20 Mc/s); 0200, 11 Mc/s (18 Mc/s); 0900, 15 Mc/s (22 Mc/s); 1200, 17 Mc/s (25 Mc/s); 2300, 15 Mc/s (22 Mc/s).

**Buenos Aires:** 0000, 15 Mc/s (20 Mc/s); 0200, 11 or 9 Mc/s (15 Mc/s); 1000, 17 Mc/s (25 Mc/s); 1600, 21 Mc/s (27 Mc/s); 2000, 17 Mc/s (25 Mc/s); 2300, 15 Mc/s (20 Mc/s).

**Capetown:** 0000, 15 or 11 Mc/s (18 Mc/s); 0200, 11 Mc/s (15 Mc/s); 0600, 17 Mc/s (25 Mc/s); 0900, 21 Mc/s (32 Mc/s); 1400, 26 Mc/s (34 Mc/s); 1600, 21 Mc/s (31 Mc/s); 1900, 17 or 15 Mc/s (23 Mc/s); 2100, 15 or 11 Mc/s (18 Mc/s).

**Chungking:** 0000, 15 Mc/s (20 Mc/s); 0600, 17 Mc/s (24 Mc/s); 2000, 15 Mc/s (22 Mc/s).

Short-wave conditions are usually relatively undisturbed during June, and stable conditions may be expected, which is not to say that no disturbed periods at all will occur.

## OUR COVER

THE cover picture illustrates a number of radar aerials. The two "telegraph poles" are 10-cm A.I. aerials. One is a dipole and reflector and the other a dipole with director and reflector. The reflector elements are longer, and the director shorter, than the dipoles and the arrays are used in conjunction with a mirror.

The skew-mounted array is used in automatic gun-laying turret equipment. It rotates at high speed and is provided with a counter-balance weight. The rotating joint is of the capacitive type.

The aerials shown are manufactured by B.I. Callenders Cables.

# RANDOM RADIATIONS

## By "DIALLIST"

### The "Smallweldpencil"

A KIND Danish reader, whose wartime activities as a member of the organization formed for sabotaging enemy activities in his country brought him literally into the closest contact with many German technical developments, sends me some particulars of the miniature spot-welding tool which was made by the Siemens-Halske Company. Despite its mouthful of a name—Smallweldpencil, all in one word—it seems from the illustrations sent to be a neat little tool. It was, I gather, largely used in the assembling of radio components such as transformers and resistors and my correspondent states that it made very effective connections with wires up to 0.5 mm diameter. One use suggested by the makers is for mending broken heater coils of electric fires. They claim that it replaces soldering for all kinds of fine electrical work and bid you use the Smallweldpencil and be free for evermore from *soldermentaluneasiness.* A pretty little word, that last!

□ □ □

### Fair Do's!

IT is disconcerting to learn from an American technical writer that German radar was better than ours when the war began in September, 1939. The truth is that in radar we were always a long way ahead of the Germans. German gun-control radar never got beyond the decimetre-wavelength stage and then it must have given far from accurate results. The wavelength was actually of the order of 0.6 metre and the apparatus used half-wave dipoles with parabolic reflectors. You will see that the huge reflectors needed can hardly have been capable of smooth and steady movement in azimuth or in elevation, particularly if there was any wind. Our centimetre A.A. radar, using the cavity magnetron (developed in the first half of the previous year), was ready to go into production well before the end of 1941. The components, circuits and detailed layout which I saw in January, 1942, differed little from those of G.L.3 when it made its appearance in the field a short time later.

□ □ □

### Must Be a Hard Life!

OFTEN have I thanked my lucky stars that Fate did not ordain that I should be a wireless dealer or a wireless serviceman. Being by nature one of those fools who do not suffer other fools gladly, I should long ago have been hanged by the neck for the murder of one or other of my more irritating clients. The other day as I waited in a small queue in an electrical and wireless shop, hoping misguidedly to be able to obtain certain small items such as soldering tags, a few yards of No. 30 Eureka and a couple of octal-base valveholders ("Sorry, we're expecting some next month"), there were in front of me two ladies, one frankly elderly and the other of similar years, but less frank about them with the doubtful aids of the beauty parlour, the hairdresser and the wishfully thinking modiste. The former bore under her arm a horrible little midget receiver; the latter swung by a carrying handle a small *mass*-plate accumulator. When I say swung, I mean swung: she was a lady given to speaking in italics and to emphasizing her remarks with movements of the arms. Remembering that my last clothing coupons and pretty well the limit of my overdraft were embodied in the new pair of flannel bags that I was wearing, I put in some agile work dodging the fell movements of that acid-splashed and acid-splashing cell. At length came the turn of Lady No. 1. Her first trouble was that the line-cord of her loathsome little set did not look as neat as when she had brought the thing in for repair some weeks previously. It was patiently explained to her that it had been necessary to cut out and replace a defective resistor. The set, she continued, seemed "to act so quickly" that she sometimes missed the point of some of the jests of the Governor of Tomtopia. She was told that the witticism frequency of Mr. Thomas Handley not seldom outran the receptive comprehensive capacity (R.C.C.) of the human brain. She retired, murmuring something about trying another shop. Lady No. 2 wasted no words. Her accumulator was *quite* run down; not a *sound* from the set; but she *specially* wanted to hear the *wonderful* concert at 8 o'clock that evening. (I leapt from side to side like any young goat as swings of the cell synchronized with her emphasis.) *Could* she call for the *charged* cell that *afternoon*? She was *sure* Mr. Snooks would *oblige* so *old* a customer. No? Well. . . . With a final acid broadcast, literal and figurative, she also left for another shop.

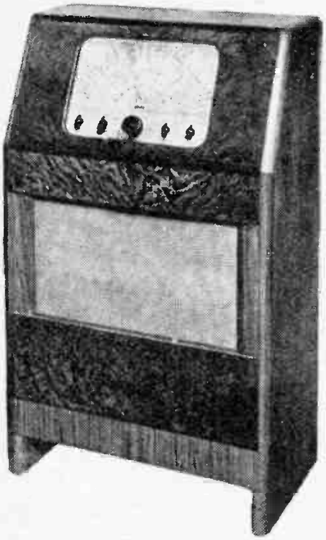
□ □ □

### What's in a Name?

DO you know how $H_2S$ got its name? $H_2S$ is an airborne type of radar by means of which a picture of the ground below is "painted" on the screen of a P.P.I. tube in the navigator's compartment by means of a radial revolving time base, which is synchronized with a revolving aerial. Most of the radar names have a meaning more or less appropriate to the applications of the systems to which they belong, though the connection between name and application is often of the vaguest for reasons of wartime security. G.L. (gunlaying), A.S.V. (aircraft-to-surface-vessel), A.I. (aircraft interception) and C.H.L. (chain home low-flying) are examples. Some names—Gee, Oboe, Rebecca-Eureka—were pure fantasy. $H_2S$ does not appear at first sight to belong to the latter class and for long I sought its meaning. No one whom I asked could tell me and until the very last lecture of the I.E.E. radar conference it remained a mystery. Then all was explained. The idea was a natural development from A.S.V., which was first demonstrated at fleet manœuvres in 1938. When it was first put forward for the august consideration of a Very Important Person, he thought over for some time and then delivered the opinion: "It stinks." Actually, it was one of the outstanding successes of radar development and one with vast peacetime possibilities; but its malodorous name commemorates the chilly reception which, like so many other ideas that were later to prove pure gold, it received when it was originally mooted.

## DYNATRON CONSOLE RECEIVER

THE specification of this receiver makes pleasant reading after so much austerity. Eleven valves, nine tuned circuits, four degrees of selectivity, 9 watts undistorted from push-pull triodes, 9 kc/s whistle filter, 12in P.M. loudspeaker, four wavebands incorporated in two chassis housed in a walnut cabinet 38in high, 23in wide and 13in deep. The price is £92 8s plus £22 6s 7d purchase tax, and the makers are Dynatron Radio, Ltd., Ray Lea Road, Maidenhead.



Dynatron "Merlin" Type B119 Console receiver.

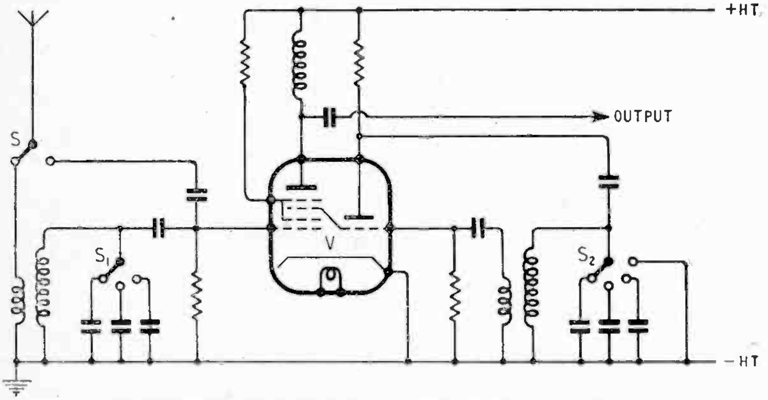
# RECENT INVENTIONS

## A Selection of the More Interesting Radio Developments

### SHORT-WAVE CONVERTER

A MIXER valve which is used primarily as a short-wave converter is also arranged to act as an aperiodic amplifier when the set to which it is attached is receiving signals on the long- or medium-wave bands.

For receiving short waves, the switch S is in the position shown and the switches $S_1$ and $S_2$ are on one or other of their associated condensers. The input grid of the hexode section of the valve V is then tuned to the middle of the selected short-wave band, whilst the triode section of the valve generates oscillations to the receiver. When the switch S is moved to the right, and the switch $S_2$ is on the extreme right-hand contact, medium- or long-wave signals pass directly to the grid of the hexode, which then operates as an aperiodic amplifier, whilst the triode or local oscillator circuit is out of action.




Combined frequency changer and aperiodic amplifier.

The inductance of the aerial coil is sufficiently small (a) to shunt long and medium-wave signals to earth, and (b) to damp the various tuned grid circuits to a degree which ensures an approximately uniform input for any selected setting of the switch $S_1$.

*J. Lips. Convention date (Switzerland), November 10th,* 1942. *No.* 571452.

### SILENT INTER-STATION TUNING

IN a receiver for frequency-modulated signals, a pair of resistance-coupled valves, which normally serve to remove or limit amplitude variations, are automatically converted into a multivibrator unit, in order to eliminate disagreeable "noises" when tuning the set from one station to another.

A feedback circuit, including resistance and capacitance in series, connects the output of the second valve to the input of the first. So long as signal voltages are present, the relatively low amplification between the valves keeps the feedback link ineffective. But in the absence of a signal, the prevailing biases are such as to allow any "noise" voltage that occurs during inter-station tuning to build up automatically between the two valves until the pair oscillate as a multivibrator unit. One or other of the valves is then non-conducting, so that the loudspeaker is mute. An incoming signal will at once develop biasing voltages sufficient to cut out the feedback effect, and restore the limiter stages to normal operation.

*The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), January 30th,* 1943. *No.* 571404.

### REMOTE TUNING INDICATORS

THE tuning of a circuit to renonance is indicated at a remote point of control in a simple and inexpensive manner.

The tuning control shaft is made of one of the thermo-plastic materials that are known to have the property of "piping" or transmitting light rays without appreciable loss, and a small glow lamp of the "grain-of-wheat" type is placed near one end of it, and in the field of the distant circuit, so that the lamp will glow when the circuit is in resonance and carries a large circulating current. Light from the lamp then passes through the control shaft to illuminate the boss or centre of the tuning knob. In another arrangement, a copper tuning slug is mounted at the end of a control shaft of the push-pull type, so that it slides in and out the tuning inductance, which is in turn coupled to the flashing coil of the small indicator lamp.

*Standard Telephones and Cables, Ltd. (assignees of H. R. Sherwood). Convention date (U.S.A.), February 13th,* 1943. *No.* 571970.

### STATIC ELIMINATORS

A CIRCUIT for limiting the effect of static and like impulses is based on the theory that short disturbances of irregular phase and amplitude produce only positive or "outward" peaks of modulation on the carrier-wave, as distinct from the positive and negative variations produced by the more regular signal voltages.

The main signal rectifying diode is shunted by a reversely-connected diode, which is separately biased to short-circuit any "noise" in excess of a selected level. A second signal channel, closely coupled to the first, and including an auxiliary rectifier, supplies the threshold control bias. This is derived from the negative or inward peaks of the modulated carrier, so that the level at which the disturbances are cut out rises and falls with the prevailing signal strength. The arrangement is said to be free from the usual tendency of an eliminator circuit to "open-up" under the effect of large or repeated surges of interference.

*The British Thomson-Houston Co., Ltd., Convention date (U.S.A.) October 5th,* 1942. *No.* 570466.

### SIGNALLING SYSTEMS

THE wave radiated from a telephony transmitter always includes a certain amount of surplus carrier energy, except during the comparatively rare periods when the modulation reaches 100 per cent.

In order to diminish this waste of power, the signals are sent out in intermittent pulses of waves of constant frequency and amplitude. Each pulse is of variable duration, but successive pulses are separated by an interval during which no energy is emitted. The length of each pulse, i.e., the number of waves contained in it, is determined by an electronic switch of the multivibrator type, under the conjoint control of the signal voltage and of an auxiliary oscillator of supersonic frequency.

The average power contained in a succession of pulses is thus always regulated by the prevailing intensity of the signal voltage. At the same time, the "silent" intervals represent a definite saving of energy, without affecting the apparent continuity of the received signals.

*The Westinghouse Electric International Co. Convention date (U.S.A.), October 22nd,* 1942. *No.* 571627.

**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.**

Rate 6/- for 2 lines or less and 3/- for every additional line or part thereof, average lines 5-6 words. Box Numbers 2 words, plus 1/-. Press Day: July 1946 issue, first post Thursday, June 6th. No responsibility accepted for errors.

## NEW RECEIVERS AND AMPLIFIERS

AIRMASTER 5-valve 4-waveband (12-2000 metres) ac mains 200-240v superhet chassis with 8in R & A mains energised speaker and Mazda valves.
OUTPUT approx 5watts, chassis size 14½in ×8in×3in, cream cellulose finish, illuminated glass dial 8in×5in with coloured waveband scales and station names, pickup and extra L.S. sockets.
PRODUCT of one of the largest radio manufacturers, precision made to the highest standards; ideal for incorporating in radiogram or own cabinet; art photographs available to genuine enquiries; price £17/12, carriage paid per pass. train; ready to switch on.
WE are official agents for Pye, Ekco, Philips, Cossor, Philco, Ferguson, Ultra, Alba, R.G.D., etc., and new sets are available according to manufacturers' release schedules.
MAIL orders receive prompt attention.
COMPONENT parts; we have good stocks of these and will be glad to forward our list on receipt of 2d stamp.
H.P. RADIO SERVICES, Ltd., 55, County Rd., Walton, Liverpool, 4. Tel. Aintree 1445. Estab. 1935. [5198

R.M.E.69, little used, best offer over £50; National H.R.O., power pack and 5 coils, good condition; offers.—Box 7319. [5202

T.R.F. ac/dc midget kit of parts: 200-250v wkg. £4, valves £2/9/6, speaker £1/7/6, cabinet £1/7/6, list prices; send for lists; cash with order or c.o.d.
HENRY'S, 5, Harrow Rd., Edgware Rd., W.2.

NEW ac 4v T.R.F. 1.8-28mcs receiver and 2v 25w C.W. transmitter with valves and coils, a complete station; £28/10.—G3LB, 25, Clotherholme Rd., Ripon, Yorks. [5187

AMPLIFIERS. — Complete equipment for P.A. industrial, dance and stage installations and portable apparatus from 15 to 150w; early deliveries; illustrations and spec. on request.—Broadcast and Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [2903

ANELOY RADIO now offer improved set of components for med. and long wave semi-midget 4-valve a.c.-d.c. t.r.f. receiver, incl. striking cream cabinet, valves, drilled chassis, 6½in speaker, screws, etc.; nothing more to buy, £8/10.—Aneloy Radio, 36, Hindmans Rd., E. Dulwich, S.E.22. [5020

WHAT is the Moreton Cheyney receiver? It gives you the performance of the communications set and the quality of local station reception at will; a precision-built instrument of fine performance, with craftsmanship and reliability; do not miss this opportunity. —Send 2½d. stamp for details to the Moreton Cheyney Company, 52a, Gaol Rd., Stafford.

BAKER'S.—New 7-valve "Wireless World" Quality amplifier with tone control stage, 8 watts push-pull triode output, price includes super Quality triple cone, 12in permanent magnet speaker, with large output transformer and all valves; also as above but with 15 watts tetrode output, ideal for realistic reproduction for public address; 2½d. stamp for particulars, prices, etc.—Bakers Selhurst Radio, 75, Sussex Rd., S. Croydon. Croydon 4226. [3680

## RECEIVERS, AMPLIFIERS—SECOND-HAND

RME69 DB20 spkr., £52/10; Fox modulator, 12w, £12.—Trewin, Exminster, Devon.

15-WATT Trix amplifier, mike, stand, 2 speakers, portable; £20.—Box 7392.

BRIERLEY 5-watt quality amplifier, used three weeks, surplus to requirements; £6/10.—Box 7758. [5287

H.R.O. Senior power pack, full set coils, including band spread, perfect condition; best offer over £75.—Box 8119. [5339

R.C.A. Communication receiver, model 88, 535-30,000 kc/s, condition as new, number spare valves.—Offers to Box 8052. [5325

A.C.S. RADIO, 44, Widmore Rd., Bromley, Kent, offer small selection com. sets, radio receivers and amplifiers; list free.

HALLICRAFTER (S-27D) rbk VHF receiver, range 27.8 to 143 mcs AM & FM, perfect condition; what offers?—Box 7358.

ARMSTRONG A.W.93 P.P. chassis ac, 3-wave band, 8w P.P. output, with matched Rola G.12, perfect condition; £16, or nearest offer.—Box 7393. [5232

RADIOGRAM, ac, all mains, all wave, H.M.V. model 661, upright walnut cabinet, perfect order, overhauled; £55.—Tel. Reliance 2821. [5286

COMMUNICATION receiver, Jng. Nikolaus Eltz, 7 valve, 110-220 ac, 24 dc, 3 band, 20-2 mc/s, B.F.O., manual and A.V.C. volume controls, 6 spare valves, as new, £35; Low ohmeter, Evershed, 0-3, 0-30 ohms, new, with case, £6; 954 R.C.A. valves, meters, coils, trans; send s.a.e. with requirements.—Box 7802.

# Partridge News

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The process of reverting to peace-time production continues and we are able to manufacture special transformers and chokes to your own specification in about 28 days. We would, however, draw your attention to the fact that many components can now be despatched per return (see last paragraph).

### TELEVISION COMPONENTS

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*Phone: BYRon 3704*

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G.8.R.G. selling complete transmitting station, 150 watt output, high power valves, G.E.C. milliamp metres, etc., H.R.O. receiver. —Apply G. Dee, Alderclose, Egham Hill, Egham, Surrey. Tel. Egham 202. [5278

HALLICRAFTERS SX-28, 500 kc/s to 43 mc/s, 110-230 volts ac, 11 valves, with two 6V6 in push-pull, instruction book, some spare valves, stored 5½ years, as new; view N. London area.—Offers to Box 8107. [5331

SCOTT Phantom 16-valve radio receiver and amplifier unit, complete with cabinet and 14in auditorium speaker, in excellent cond.; £50 or nearest offer.—Write or 'phone, 17, The Oval, Bessacarr, Doncaster. Tel. Don. 55181.

G.E.C. De Luxe 14watt amplifier, 190-250-volt, ac supply, 40-100cycles, complete with microphone, G.E.C. make, with 3 loudspeakers, 2 in cabinets, 1 without; Philco-phone intercommunication complete with 4 speakers and cabinets.—Box 8255. [5416

INTERNATIONAL Majestic 22 valve, 60 mgs. to 150 kc/s, 5 waveband, matched speakers, Rola G12, 2 pairs 6V6s p.p., preselector gain control, bass expander, treble atten'tor, maintained as new, walnut cabinet; £135 or near offer.—Tel. Rav. 2375. [5320

COMMUNICATION receiver, PX4 push-pull quality output, 10 valves plus magic eye, 16-100 and 200-4,000 metres, bass and treble tone controls with boost, b.f.o., gram input, complete with Grampian loudspeaker; £35.—8, Gladstone Rd., Wimbledon, S.W.19.

SOUND SALES super aud. ener. speaker £10; or in special acoustic cabinet, £13; field supply unit, £3; 4-band Super Six chassis, £26; h.t. unit, £3; kit of parts for 12-watt W.W. para. amplifier, with valves, £18; Motorola remote control a.c. set, £20; parts for battery electric clock, £5.—Particulars from Rockwood House, The Oaks, Bolton.

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H.M.V. Universal auto gram, remote control, 20 records mixed, handsome cabinet, £35 or offer.—Box 7398. [5237

H.M.V. hypersensitive pick-up with trans., £5; Avo 40, £12/10; both perfect.—3, Hungerford Ave., Slough, Bucks. [5196

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£5/18/6.—New Baker Super Quality 12in Auditorium permanent magnet speaker with triple cone, manufactured by Bakers Selhurst Radio, the pioneer manufacturers of moving coil speakers since 1925, wide frequency range, even response, ideal for quality reproduction, fitted with magnet, having exceptionally high flux density in the air gap suitable for public address equipment when quality reproduction is first consideration; send 2½d. stamp for leaflet giving details of above and constructional details of a new acoustic chamber designed to extend loud speaker frequency range.

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SMALL Ali Can elecs, 500v 8mfd, 3/-; post extra under 12.—Cooke, 25, Langdale Rd., Sheffield, 8. [5283

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MODEL 20 coil pack, aligned and tested, only 5 connections, 39/6; i.f. trans. 465Kcs, high "q," aligned and tested for gain, 17/6 pair; model 20 tuning heart, fully assembled, with 3 valves, £6/15/10; handsome tuning scale, glass, esc., and s/motion drive for above, 12/6; amplifier kits, really well-designed, ac models, 6watt, £7, 12watt, £11; ac/dc, 5watt, £7, 15watt, £12; tuning units, 3w/band s/het type, assembled cpte. with valves, ac or ac/dc, £6/17/6; TRF type, two med. wave stations only, high fidelity design ac or ac/dc, £6; other kits available, send 1d. for lists, circuits and tech. desc. for any above, 2/6; post trade only at present, send c.w.o. if possible—saves clerical work, orders over £5 post free, no c.o.d. under £2.

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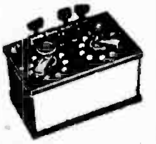

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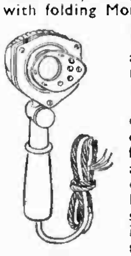

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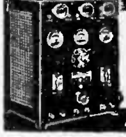

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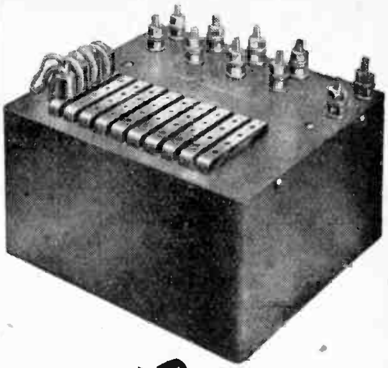

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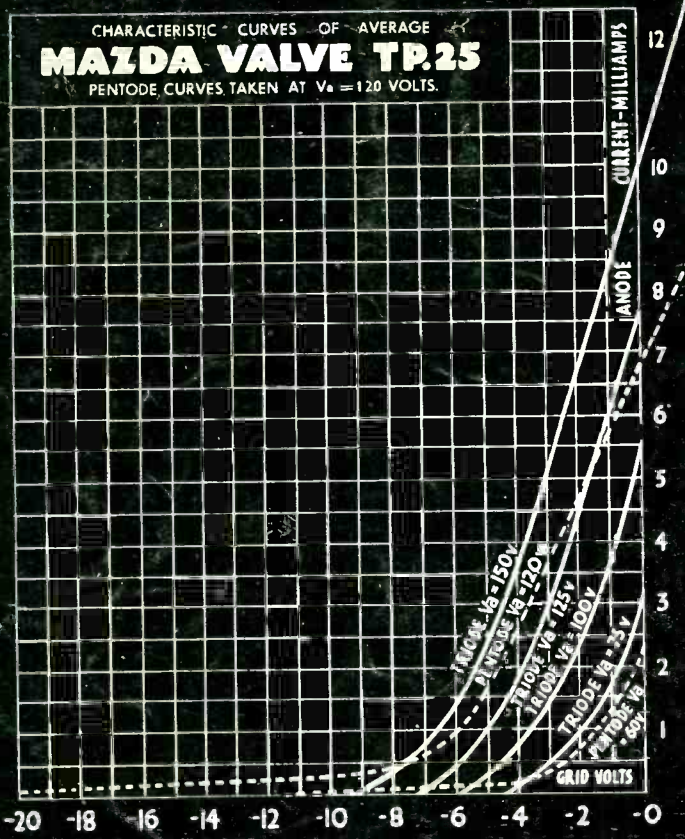


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