Here is a VALVE TESTER

with sufficient scope for YOUR requirements!

£60

When purchasing a Valve Tester ask the following questions:—

Is it a simple Go/No Go instrument, or will it enable you to take measurements at any point on a characteristic curve?

The "AVO" Valve Characteristic Meter can be set up in a matter of seconds and used as a simple Go/No Go tester if required. It will, in addition, produce sufficient information to enable the **valve's static characteristic curves** to be plotted.

Does the instrument depend for its operation on pre-determined empirical data issued by its manufacturer?

The "AVO" Valve Characteristic Meter simulates normal working conditions for the valve under test and thus is capable of reproducing **the valve manufacturer's data.**

Will a high slope valve, when placed in the instrument, burst into spurious oscillation, thus giving rise to incorrect readings and possible damage to the valve?

The "AVO" Valve Characteristic Meter incorporates a specially designed panel layout and wiring system (prov. patent) which virtually eliminates spurious oscillation.

Does the instrument contain valves which may need replacing from time to time?

With the exception of a small protection diode, there are no internal valves to deteriorate or break down and cause misleading readings to be given. Thus, expensive periodical replacements are not required.

Will the instrument detect grid current and indicate its direction and magnitude?

The "AVO" Valve Characteristic Meter will indicate the direction of flow of grid current and give its magnitude in microamps.

Does the instrument test diodes and rectifiers under load?

The "AVO" Valve Characteristic Meter checks diodes and rectifiers under load conditions.

If you are called upon to select a pair of accurately matched valves, will the valve tester carry out the required checks, and maintain your reputation as an expert?

The "AVO" Valve Characteristic Meter enables the slope, and anode, screen, or grid current of a multi-electrode valve to be checked with any voltage between 0 and—100V on the control grid.

Before any information can be obtained about a valve, must the instrument be provided with a complex series of accessories which may become lost, mutilated, or are not available when an unusual or new type of valve has to be tested?

The "AVO" Valve Characteristic Meter is provided with two handbooks. The first gives detailed information on the technique of valve testing, full circuit diagrams and adequate operating instructions. The second is a quick reference Data Manual covering more than 3,000 British, American and Continental valves, and gives inter-service equivalents. The Valve Data Manual is issued for the convenience of the instrument user, but even without it **valves can, if necessary, be checked using data taken from the valve maker's data sheets.**

The "AVO" Valve Characteristic Meter measures inter-electrode insulation in megohms with valve cold or hot, also cathode/heater insulation with the valve hot, and indicates any breakdown below 10 megohms. It will carry out tests on small thyratrons, tuning indicators, etc. It is fitted with bases for most valves in current use and adaptors will be available to keep the instrument fully up-to-date should new bases come into use. A special form of polarised relay is incorporated to give protection against inadvertent overloads or valve failure.

Write for fully descriptive literature

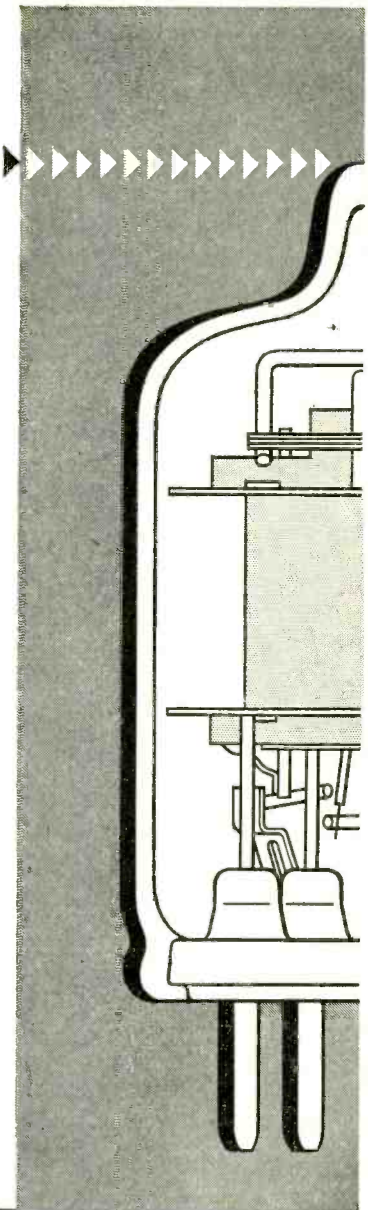
The AVO Valve CHARACTERISTIC Meter

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON S.W.1 Telephone VICtoria 3404-9

AVOCET TRADE MARK

VC.5

EF95



A NEW R.F. PENTODE WITH

1. ***Recommended Frequency Limit 400 Mc/s.***
2. ***Mutual Conductance 5.1mA/V***
3. ***Filament Consumption 175 mA.***

The Mullard R.F. Pentode, EF95, provides a better size to performance ratio than that previously obtainable from British valves of a similar class. It is constructed on the B7G miniature base and works efficiently at frequencies up to 400 Mc/s. Some of the more outstanding features of this valve include low input capacitance, low anode to grid capacitance, high mutual conductance and low heater consumption. These features, together with an operating voltage of 180 volts (120 volts under certain conditions), will particularly interest designers of compact communications equipment. In circuits involving a number of R.F. and I.F. stages, the EF95 may be used throughout, with a resultant marked saving in total heater consumption. Furthermore, the use of only one valve type in such applications enables maintenance problems to be reduced. The EF95 has similar electrical characteristics to the American 6AK5, and may be used as a direct replacement for it. Full technical information on this and other types in the Mullard range of communication valves is available on request.

TECHNICAL DATA

HEATER

V_h	-	6.3V
I_h	-	0.175 A

CAPACITANCES

c_{in}	-	4.0 µµF
c_{out}	-	2.8 µµF
$c_{a\text{-}g1}$	-	0.02 µµF

CHARACTERISTICS

V_a	-	180 V
V_{g2}	-	120 V
V_{g1}	-	−2.0 V
I_a	-	7.7 mA
I_{g2}	-	2.4 mA
g_m	-	5.1 mA/V
r_a	-	690 KΩ

LIMITING VALUES

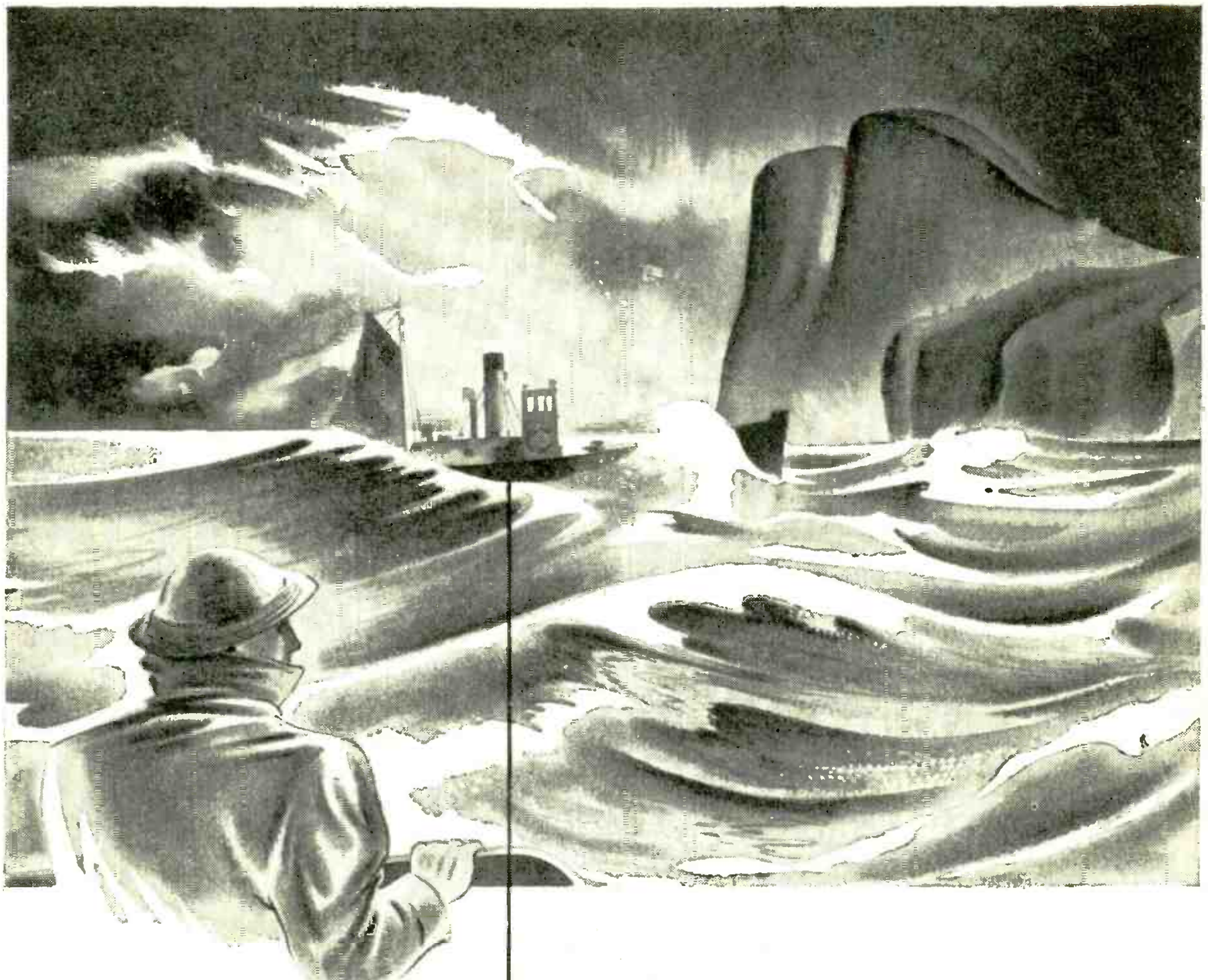
V_a	max.	-	180 V
p_a	max.	-	1.7 W
V_{g2}	max.	-	140 V
p_{g2}	max.	-	0.5 W
I_k	max.	-	18 mA

BASE B7G

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT133



The Vital Link . . .

. . . with safety in the hazardous enterprise of the deep sea trawler is its radio and radar equipment upon which safe navigation depends. Thousands of soldered joints contribute to the efficient functioning of this delicate apparatus. One dry or H.R. joint could mean the breakdown of a circuit, the destruction of the vital link, a perilous voyage.

FAULTLESS FLUXING PRESERVES THE VITAL LINK

Dry or H.R. joints are impossible with Superspeed for the flux is always released in exactly the correct proportion. This faultless fluxing action is

achieved by the unique STELLATE core which gives six points of rapid solder collapse. At soldering temperature the activated rosin flux is released immediately for effective spreading and wetting. Superspeed is being used more and more in the production of radio and radar equipment where faultless joints are essential.

Superspeed

"WHITE FLASH" ACTIVATED ROSIN-CORED SOLDER

for general electrical, electronic and telecommunication work and all standard uses. A.I.D. and G.P.O. approved. Complies with M.O.S. Specification DTD 599. In all standard tin/lead alloys, 10-22 s.w.g. Also available in a range of coloured cores, indispensable for simple intermediate and final inspection and circuit or operator identification. Samples of Superspeed and the comprehensive Superspeed booklet gladly sent on request. Technical advisers are available for free consultation.

Cored and solid solder rings and solid solder washers supplied to customers' specifications.

MANUFACTURED BY THE **ENTHOVEN** *GROUP*

Marketed by Enthoven Solders Limited, Enthoven House, 89, Upper Thames Street, London, E.C.4. Tel. Mansion House 4533

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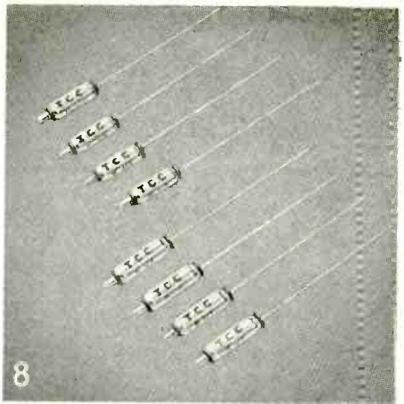

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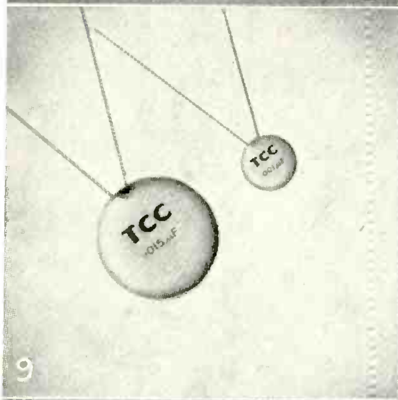
...as shown at the R.E.C.M.F. EXHIBITION IN LONDON...



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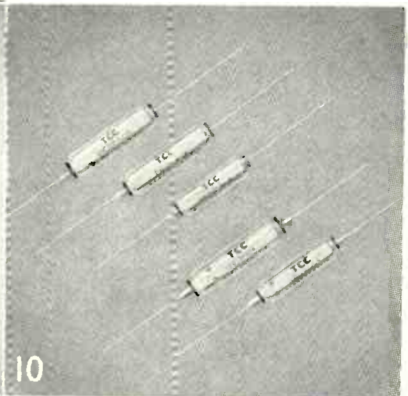

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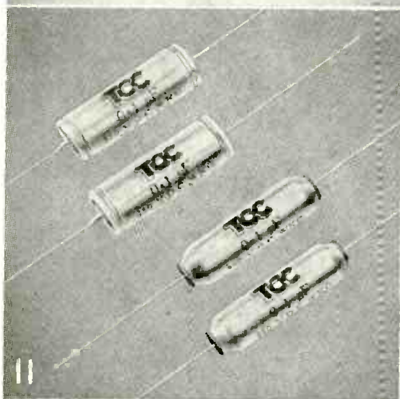

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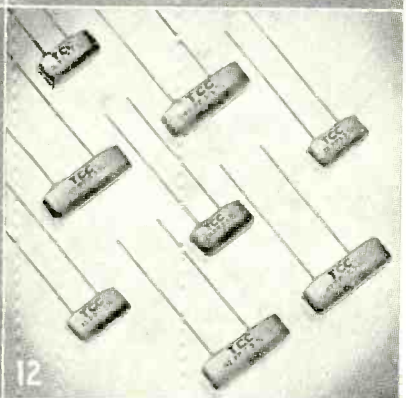

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Obviously, there is no room in this announcement for full technical data on these various Condensers.

We shall be happy to supply complete details of any range in which you are particularly interested, or to advise you of the types most suited to your particular requirements.

8. SUB-MINIATURE ELECTROLYTICS for HEARING AIDS & TRANSISTORS

Smallest Electrolytic ever made. Two sizes available—6 μF for 3 v. D.C. working and 8 μF for 6 v. D.C. working.

9. Hi-K CERAMIC DISC

For T.V. de-coupling and spark suppression. Two sizes—10 mm. and 20 mm. diam. Capacity range .001 μF to .02 μF.

10. IMPROVED "PICOPACK" ELECTROLYTICS

Smaller sizes and higher ratings are now offered. Voltage range extended to 450 v. D.C. at 70°C. Entirely new range for 85°C. working.

11. METALLISED POLYSTYRENE CONDENSERS

Small size tubulars for Tuned Filters. Excellent electrical properties. Max. capacity is .5 μF for 350 v. D.C. wkg. at 70°C.

12. CLOSE CONTROLLED TEMPERATURE COEFFICIENT CERAMICS

For Temperature Compensation in Oscillator and I.F. circuits. "Plimoseal" finish improves stability. Available in 6 temperature Coefficients.

13. HIGH VOLTAGE ELECTROLYTICS

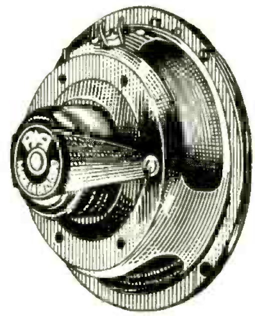
Type 928—8μF. 800 v. D.C. working. 900 v. surge at 60°C. 700 v. D.C. working. 800 v. surge at 70°C. All-Aluminium Internal Construction: Chassis mounting. Fully tropical.

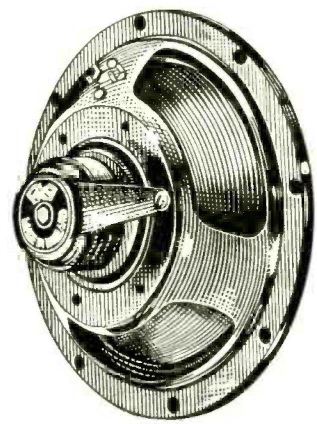
14. CLOSE ACCURACY PLASTIC FILM CONDENSERS

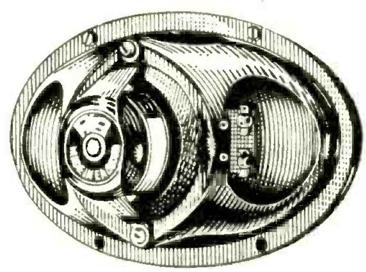
For Tuned Filters in Carrier Telephony equipment and Reference Standards. Exceptionally stable capacity, better than 0.1%. Tolerances $\pm\frac{1}{8}\%$.

THE TELEGRAPH CONDENSER COMPANY LIMITED

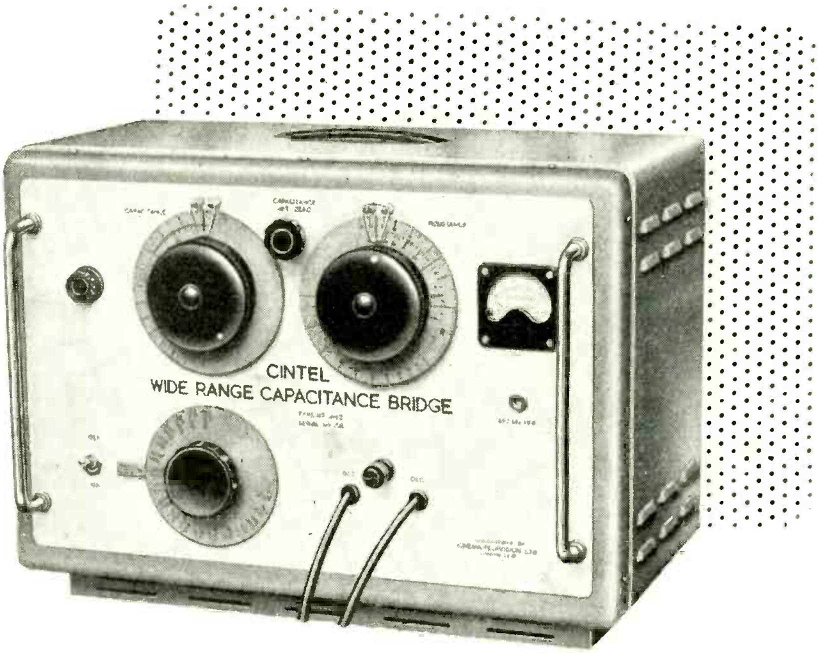
RADIO DIVISION: NORTH ACTON · LONDON · W.3 · Telephone: ACORN 0061 (9 lines)







WIDE RANGE CAPACITANCE BRIDGE



For the accurate measurement of *in situ* capacitance or resistance, all measurements being made in the form of a three terminal network.

Capacitance range — 0.002 pF to 100μF in 18 ranges.
Resistance range — 1Ω to 10,000MΩ in 18 ranges.
Ranges increase in alternate decimal multiples of 3 and 10.
Frequency 1592c/s (ω = 10,000).
Accuracy ±1.0% of full scale on all ranges.

Full technical details are available on request.

BRITISH INSTRUMENT INDUSTRIES EXHIBITION
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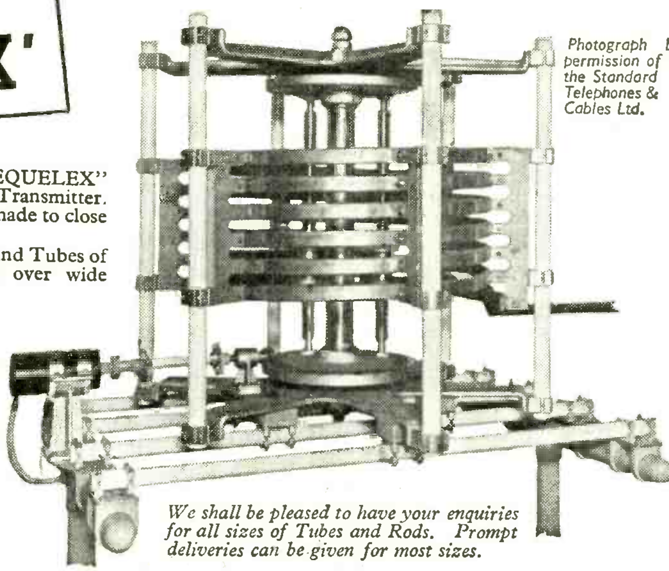
SALES AND SERVICING AGENTS	F. C. Robinson & Partners Ltd., 287 Deansgate, Manchester, 3	Hawnt & Co., Ltd., 59 Moor St. Birmingham, 4	Atkins, Robertson & Whiteford Ltd., 100 Torrisdale Street, Glasgow, S.2.

FOR HIGH-FREQUENCY INSULATION

specify

'FREQUELEX'



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The Tuning Coil shown is supported by our "FREQUELEX" Ceramic Rods, and forms part of a 200 K.W. Radio Transmitter. This is only one of many applications where Rods made to close limits are required.

We specialise in the manufacture of Ceramic Rods and Tubes of various sections in several classes of materials over wide dimensional ranges.

The Principal Materials are :—

1. Porcelain for general insulation.
2. Frequelex for High Frequency insulation.
3. Permalex and Templex for Capacitors.

The degree of accuracy depends on the size of the Rod or Tube, but the standard degree of accuracy is outlined in the Inter Service Component Manufacturer's Council—Panel R Specification embodied in our Catalogue of Radio Frequency Ceramics, copy of which will be sent on request.

Large Rods up to 44″ long and $1\frac{1}{4}$″ square are used as supports for Tuning Coils, etc.

We shall be pleased to have your enquiries for all sizes of Tubes and Rods. Prompt deliveries can be given for most sizes.

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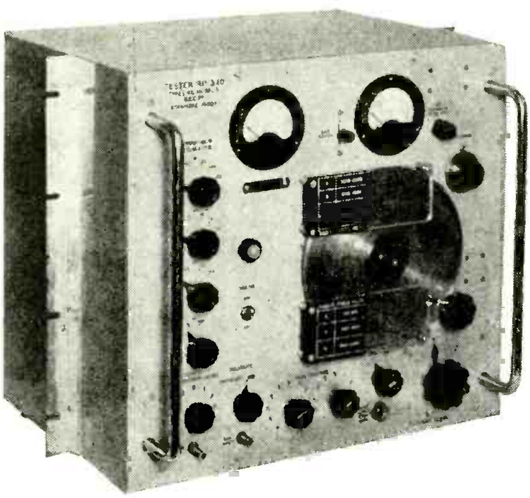

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TRANSMISSION MEASURING SET

MODEL RP 3110

Designed and manufactured for G.P.O.

This is a precision instrument for measurements on multi-circuit coaxial cable carrier systems by means of a comparison with locally generated signals of known frequency and level.

Frequency coverage: 60 Kc/s—3 Mc/s in 7 ranges.

Calibration accuracy: below 0·2% or 2 Kc/s whichever is the greater.

Power supplies:
200 — 250 Volt. 50 c/s

Range of measurements:
through levels + 10 db to - 61·5 db
or terminated levels + 10 db to - 81·5 db
referred to 1mW in 75 ohms

BRITISH COMMUNICATIONS CORPORATION LTD.

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Telephone: WEMBLEY 1212 Cables: BEECEECEE, WEMBLEY

Mullard Ferroxcube being extruded into rods for H.F. cores.

(390)

A Technical Handbook for Electronic Engineers

This Handbook contains the fullest information about all types of Ferranti Valves and Cathode Ray Tubes, giving for each type *complete* data such as physical details, base connections, ratings, operating conditions, with graphs, etc., where necessary.

The whole is a most valuable book of reference to the electronics engineer. It is in loose-leaf form, so that new data can readily be inserted.

Price 5/-

Additional data sheets will be sent to subscribers from time to time.

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FERRANTI

FE 155

An unsolicited
TECHNICAL REPORT

given by the

NATIONAL FEDERATION OF GRAMOPHONE SOCIETIES★

on

AXIOM HIGH FIDELITY LOUDSPEAKERS

MODEL 150 MARK II 12" TWIN CONE
101 8" SINGLE CONE
102 8" SINGLE CONE

BY THE COURTESY of Messrs. Goodmans Industries Ltd., we have recently had the opportunity of submitting these speakers to thorough tests.
The 150, Mark II, is a very definite improvement on the Mark I model, with a firmer, smoother middle register and lower fundamental resonance (nominally 35 c.p.s.). It was not possible to house the speaker in the cabinet designed for the purpose by Messrs. Goodmans, but mounted in a labyrinth which absorbed virtually all the sound from the back of the cone the outstanding characteristics of this reproducer were hard, clear bass, very even response in the middle and upper registers and low needle hiss of unobjectionable quality. Response extends to 15 k.c. This is an excellent single unit which should give every satisfaction to Societies. It will handle up to 15 watts.
The main difference between the Models 101 and 102 is the increased sensitivity and flux density of the latter. These qualities are, naturally, accompanied by improved damping and increased price.
These are undoubtedly the best 8" units which we have so far tested, and the maker's claim for response within 3-4 db. from 40 to 15,000 c.p.s. was fully substantiated. They showed no signs of distress when fed with peak inputs up to 6 watts.
Excellent results were obtained running the Axiom 101 in parallel with the Axiom 150 to secure wider distribution of sound, and also by running two 8" units in parallel. In the latter case there was rather less weight in the extreme bass.
A very pleasing effect of light and air in the treble and wide sound source can be secured by using an 8" unit on a small baffle reflecting into a corner in parallel with another cabinet-mounted 8" or 12" speaker. The top speaker should have a 2 mfd. condenser (NOT electrolytic) in series with the voice coil.
For their size and price the performance of the Axioms 101 and 102 is outstanding in quality.

AXIOM 150 Mk. II
£13 . 11 . 5 *(incl. purchase tax)*

AXIOM 22 Mk. II
£19 . 8 . 4 *(incl. purchase tax)*

AXIOM 101
£6 . 12 . 1 *(incl. purchase tax)*

AXIOM 102
£9 . 18 . 2 *(incl. purchase tax)*

★ *We acknowledge with thanks the permission to reproduce the above report which is an extract from the January issue of the Society's private journal*

All these models are stocked by the leading dealers, but in case of difficulty please order direct from us. We invite you to write for further details of any unit. Remember we can give you outlined dimensioned drawings of reflex chambers for all Speakers mentioned.

A TRADITION OF EXCELLENCE — FIDELITY — EFFICIENCY

GOODMANS

"Axiom" and "Audiom" are registered Trade Marks of:

GOODMANS INDUSTRIES LTD., Axiom Works, Wembley, Middx.

Telephone: WEMbley 1200 *Cables: Goodaxiom, Wembley, England*

NEWS! WE NOW INTRODUCE—
THE "TELE-VIEWER"

5 CHANNEL TELEVISOR

A Design of a Complete 12 in. or 9 in.
SUPERHET T/V RECEIVER FOR THE HOME CONSTRUCTOR

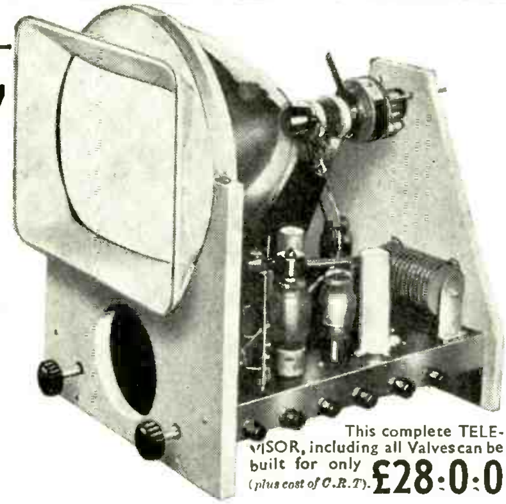
This receiver has been developed after most careful research and affords a high standard of Television entertainment by producing a picture of *really outstanding* quality.

We confidently believe that not only have we achieved a T.V. Receiver that surpasses in efficiency any other designed for the home constructor, but that successful construction, even by the most inexperienced is assured by the step by step wiring detail and diagrams provided, and at about half the cost of the nearest comparable commercial receiver.

Here are some of the features which combine to make this such a fine receiver :

- The Superhet circuit *easily* tuned to any of the five channels, i.e. LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE and KIRK-O-SHOTTS. (The extreme ease of tuning is accomplished by the provision of pre-aligned I.F.T's).
- A lifelike, almost stereoscopic, picture quality made possible by the following factors :
  - a. Excellent band width of I.F. circuits.
  - b. A really efficient video amplifier.
  - c. C.R.T. Grid modulated from low impedance source.
  - d. High E.H.T. voltage (approx. 10 kV.)

  The picture brilliance is also much above the average and enables comfortable viewing with normal room lighting or daylight.
- FIRM picture "HOLD" circuits (Frame-Line) ensure a steady picture, free from bounce or flicker even under the most adverse conditions met with in "fringe" areas and excellent "interlace" ensures the absence of "liney effect."
- Picture linearity better than 5% ! (Some commercial receivers are passed at 15%).
- Negative feedback is used in the audio frequency circuits which provide 2/3 watts of High Quality Sound.
- Entire receiver built on two chassis units, each measuring 14½in. x 6½in. x 3½in.
- Rigid C.R.T. mounting enables entire receiver to be safely handled with tube in position.



This complete TELEVISOR, including all Valves can be built for only (*plus cost of C.R.T.*). **£28:0:0**

- All pre-set controls are mounted on side of chassis enabling all adjustments to be carried out whilst facing the C.R. Tube.

As no hire purchase terms are available the receiver can be bought in five separate stages (practical diagrams and circuits are provided for each stage) thus enabling hire purchase interest rates to be avoided. The complete set of ASSEMBLY INSTRUCTIONS will be available about 23rd May, price 5/- (refunded against first order). The instructions include really detailed PRACTICAL LAYOUTS, WIRING DATA AND COMPONENT PRICE LIST.

ALL COMPONENTS ARE AVAILABLE FOR INDIVIDUAL PURCHASE. A CABINET WILL ALSO BE AVAILABLE.

STERN RADIO LTD.
109 & 115, FLEET STREET, E.C.4
Tel.: CENTRAL 5812-3-4

There are 8 different types of 'ACRU' Neon Indicator Lamps

During the past 4 years over ¼-million 'ACRU' Neon Indicator Lamps have been installed by hundreds of firms with not a single complaint about a failure.

The Minimum life of 'ACRU' Neon Indicator Lamps is 25,000 hours.

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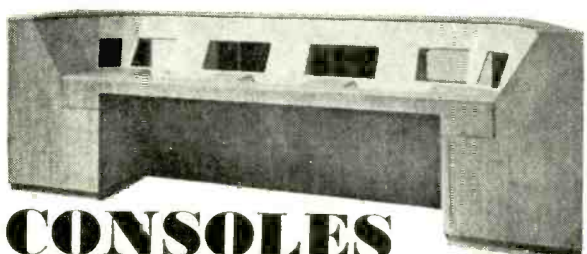
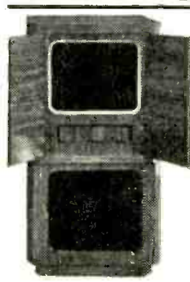
THE ACRU ELECTRIC TOOL MFG. CO., LTD.
Chapel St., Levenshulme, Manchester 19
Tel.: RUSholme 4613



CONSOLES



For Major Film Mixer Suites to Individual requirements.

"VIEWMASTER" CONSOLES

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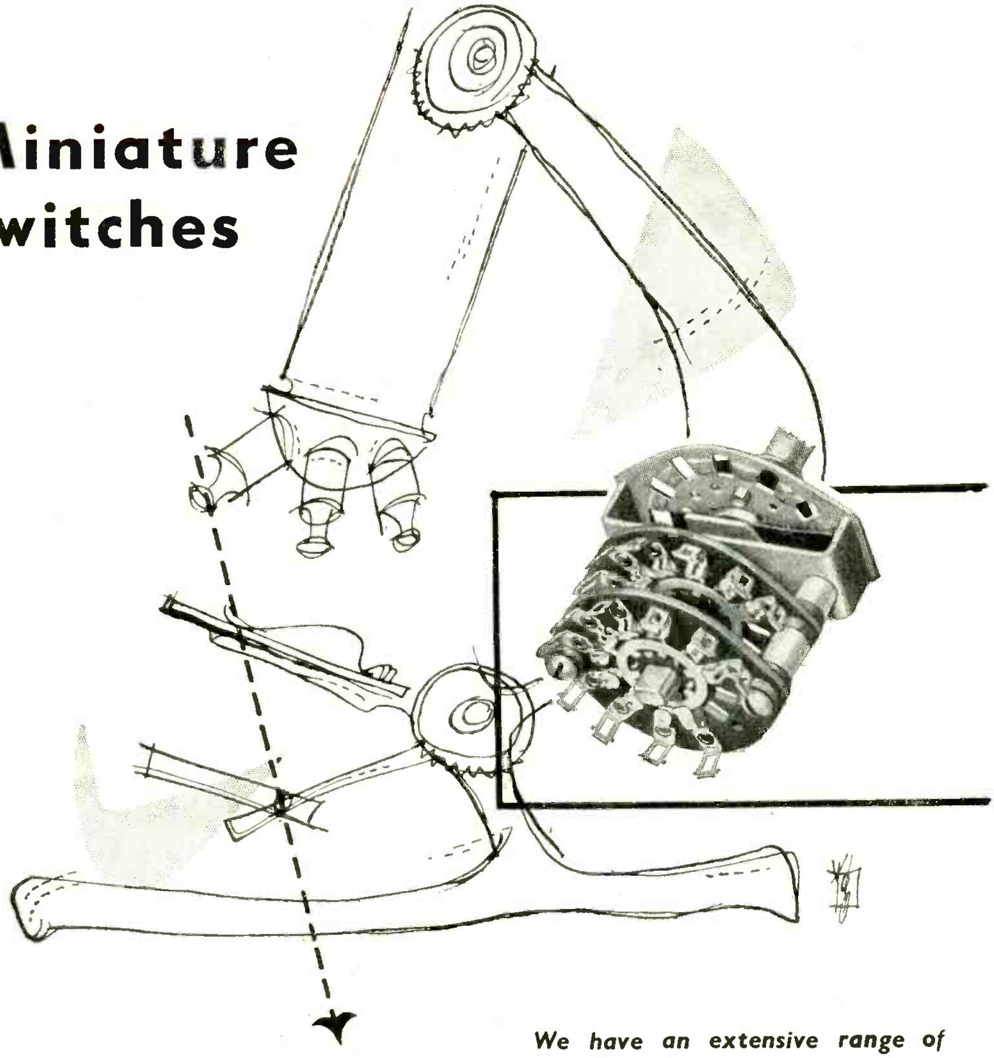
Standard "VIEWMASTER" model as shown **£13.0.0**
With Full Length Doors **£14.0.0**
Universal Model for all 16" tubes now in preparation.
Carriage and Packing 15/- extra.

Fitted with shelf for easy mounting. These are **NOT** mass produced and dimensions can be altered to suit personal requirements.

Individual and Trade Enquiries to

H. ASHDOWN
CABINET MAKER
98 HERTFORD ROAD, EDMONTON, N.9
Phone: TOT. 2621

Miniature Switches



"A chip off the old block"—this refers of course, to the miniature version of the well-known A.B. "H" Type switch. It combines all the virtues of the Standard "H" Type—yet takes up so much less space. Of sound and robust design it is capable of operating under widely varying conditions.

We have an extensive range of switches for all radio and electronic equipment.

Manufacturers are invited to make full use of our Technical Service and we will be pleased to supply our free illustrated catalogue on request.

Individual specifications welcomed

Metal Products Ltd

16 BERKELEY STREET, LONDON, W.1

'Phone: GROsvenor 5206/7.

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We carry extensive stocks of all accessories and detail below a selection of these. Pay us a visit—it will be worth while, and you will be able to see and hear the remarkable **Burgoyne Recorder, at only £33 . 12 . 0.**

MICROPHONES

	Cash	Deposit	12 Monthly Payments
ROTHERMEL			
Crystal Microphone 2AD56...	£2 19 6	—	—
RESLO			
Reslo RV High or Low Impedance	£9 0 0	£3 0 0	13 4
UR High or Low Impedance	£7 5 0	£2 5 0	11 8
UR-S as above with switch ...	£7 10 0	£2 10 0	11 8
RONETTE High Fidelity Crystal Microphones			
CORONATION Hand or Desk Microphone	£2 12 0	—	—
B110 Reporter Microphone ...	£2 12 0	—	—
BURGOYNE 044 Desk Microphone	£2 15 0	—	—
HM Hand Microphone with Filtercel Insert	£4 7 6	£1 7 6	8 0
088 Ball Microphone with Filtercel Insert	£4 10 0	£1 7 6	8 3
088U, do. do. with Universal Joint	£5 2 6	£1 12 6	9 0
088/F, do. do. Mounted on Flexible Chrome Tube with Universal Joint	£6 19 6	£1 19 6	11 6
G210. Streamlined Tilting Head Microphone with Filtercel Insert	£4 19 6	£1 9 6	9 0
Microphone Desk Stands ...	17 6	—	—
Table Stands	£2 12 6	—	—

TAPE TABLES

	Cash	Deposit	12 Monthly Payments
BURGOYNE MARK IV Half Track High Impedance, High fidelity heads 7½in./sec. Fast rewind through heads, with spare spool ... (Carriage and Packing 7/6).	£16 10 0	£5 10 0	£1 1 8

TAPE TABLES (cont)

	Cash	Deposit	12 Monthly Payments
LANE MARK IV do. do. ...	£17 10 0	£6 10 0	£1 1 8
TRUVOX 2 speed. Push Button Control. 3 Motor Drive, Half Track, Low Impedance Heads ... ... (Carriage and Packing 10/-).	£23 2 0	£7 14 0	£1 9 0

CABINETS

	Cash	Deposit	12 Monthly Payments
A suitable Cabinet for Transportable Recorder, as used in Burgoyne Recorder, 21½in. x 13in. x 12¾in.	£4 10 0	£1 10 0	8 4

AMPLIFIERS

	Cash	Deposit	12 Monthly Payments
BURGOYNE 5 Valve Record/Playback Amplifier A6, completely wired and tested ready to use	£11 15 0	£3 18 0	16 5

COMPLETE RECORDERS

	Cash	Deposit	12 Monthly Payments
BURGOYNE Dual Track Transportable Recorder ... (Carriage and Packing 21/-).	£33 12 0	£11 4 0	£2 2 9
GRUNDIG Reporter, 2-spd. (See illustration).	£84 0 0	£28 0 0	£5 7 0
GRUNDIG Console, 2-spd.	£99 15 0	£33 5 0	£6 7 0

HEADPHONES

	Cash	Deposit	12 Monthly Payments
S. G. BROWN. Type A, adjustable Reed Movement...	£4 5 0	£1 5 0	8 0
S. G. BROWN. Type F, Featherweight General Purpose	£1 15 0	—	—
S. G. BROWN. Type K, Moving Coil for High Fidelity	£5 10 0	£1 10 0	10 0

TAPES

	Cash
BURGOYNE 1,200ft. High Coercivity	£1 15 0
BURGOYNE 600ft. High Coercivity ... ... (Specially imported for high fidelity use).	£1 1 0
EMI 600ft. High or Low Coercivity	£1 1 0
EMI 1,200ft. High or Low Coercivity	£1 15 0
FERROGRAPH 1,200ft. High Coercivity	£2 5 0
B.A.S.F. MAGNETOPHON 1,200ft. High Coercivity	£2 0 0
SCOTCH BOY 600ft. Medium Coercivity	£1 1 0
SCOTCH BOY 1,200ft. Medium Coercivity	£1 15 0
SOUND MIRROR 1,200ft. Paper Tape	£1 5 0

TAPES (cont)

	Cash
GEC 1,200ft. Medium Coercivity	£1 10 0
AGFA 1,200ft. High Coercivity	£1 17 6
AGFA 600ft. High Coercivity	£1 2 6
Tape Spools 1,200ft. ...	4 6
Tape Spools 600ft. ...	3 6
B.S.R. Type FP.10 Clock or Anticlock-wise. 1,400 r.p.m.	

MOTORS

	Cash
4 pole 3in./03 Torque ...	£1 18 0
B.S.R. Type SR.1, 2,750 r.p.m. 2 pole 3in./03 Torque...	£1 12 0
B.S.R. Type SR.2, 2,750 r.p.m. 2 pole 2in./03 Torque...	£1 5 0
COLLARO Clock or Anticlockwise. (Inc. cooling fan), 1,400 r.p.m. 4 pole 4in./03 Torque	£1 18 6

**Post and packing extra where not shown.*

HEADS

	Cash
BURGOYNE high impedance, half track width, built in tape guides, fully enclosed, single hole fixing. Record Playback or Erase	£1 17 6
TAMSA high impedance, half track width, Record/Playback, Playback or Erase Series 100	£2 7 6

OSCILLATORS

	Cash
BURGOYNE Oscillator Unit, complete with 6V6 Valve	£2 2 0
LANE Oscillator Unit, complete with 6V6 Valve ...	£3 10 0
BURGOYNE Oscillator Coil for high impedance heads ...	8 6
TAMSA Oscillator Coil for high impedance heads ...	10 6
WEARITE 579 Oscillator or Bias Transformer	7 6

THE NEW BURGOYNE AMPLIFIER AND TONE CONTROL UNIT MODEL A.7/8

In response to widespread demand we have decided to introduce an entirely new Amplifier equipment, capable of a high standard of performance, at the extremely low figure of **£9.19s.6d.** complete. This low price is made possible by the increased production now available from our factory.

The Amplifier is built as two units :—

1. **THE TONE CONTROL AND PREAMPLIFIER** section consists of a pentode and triode valve and is capable of fully loading the main Amplifier when used with the current high fidelity, low output type of pick-up. A wide range of bass and treble control is available; approximately 20 DB cut and lift at each end of the scale. A three position input switch is incorporated :—RAD10-78-33/45. Each position brings into use the correct compensation for the particular input, with special attention to the rising frequency characteristic of LP records.

2. **THE MAIN AMPLIFIER** consists of a 6J7 pentode feeding a 6V6 output valve. In view of the large signal obtained from the preamplifier, considerable overall negative feed-back is permissible and the quality achieved sets an entirely new standard for inexpensive equipment.

The division of this 5 valve Amplifier into two units permits the small and comparatively light preamplifier unit to be mounted in an easily accessible position, i.e., on the top board of the cabinet, and an engraved indicator panel is included in order that a smart appearance may be achieved. The main Amplifier, which includes power pack, may then stand in the bottom of the cabinet, thus simplifying any installation problems to a considerable degree.

The complete equipment may be heard at our showroom and we suggest that you bring along a favourite record and judge it for yourself. You will hear the sort of reproduction associated normally with 25-30 guinea equipment, and we feel quite confident that you will be amazed at the fidelity and " punch " of such a modestly priced outfit.

£9 . 19 . 6 *Carriage Paid.*

ON HIRE PURCHASE TERMS

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12 monthly payments of **15/-.**

DID YOU KNOW? . . . . .

At one time we were leading Government Surplus Stockists—a fact which will be to your advantage if you call at our Showrooms. We have left miscellaneous quantities of surplus electronic equipment, in very great variety and this will be offered at unheard of and unrepeatable Bargain Prices for a limited period. Do not fail to pay us a visit. A showroom is being allotted to the display of this material which can be inspected at your leisure.

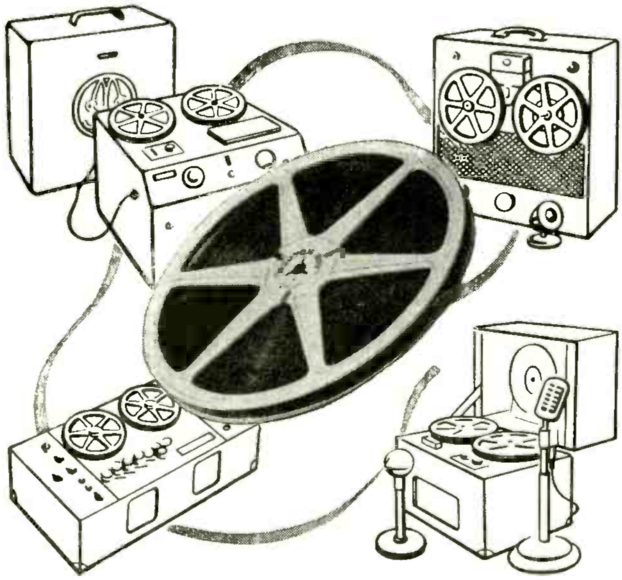
MOS

If you wish to be included in our revised Mailing List please send your Name and Address (BLOCK LETTERS) with 6d. fee.

MAIL ORDER SUPPLY CO., *THE RADIO CENTRE,* **33, Tottenham Court Road, London, W.1**

"SCOTCH BOY" TRADE MARK MAGNETIC RECORDING TAPE TYPE MCI-III

gets the best out of ALL makes of tape-recorder



'Scotch Boy' fits all makes of tape recorders. It brings new clarity, new fidelity, an all-round improvement to your own recordings.

'Scotch Boy' is a medium coercivity, plastic-backed tape with a frequency range of 50 c/s to 10 kc/s at a tape speed of $7\frac{1}{2}''$ per second. It is available in six reel sizes from 300 ft. to 1,000 metres, to provide a wide range of playing times.

'Scotch Boy' is used by the B.B.C. and most other big recording and broadcasting corporations.

Ask your dealer for 'Scotch Boy' and hear the difference it makes on your own machine.

Another 3M COMPANY Product

Write for further details of

MINNESOTA MINING & MANUFACTURING CO. LTD
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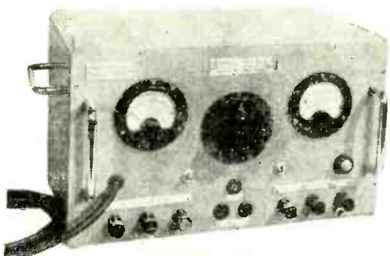
POWER SUPPLY UNITS



SERIES 100

DC Output, Stabilised, 200-350V 120mA, continuously variable.

AC Output, Unstabilised 0-4-6.3v 3.0A.

Bench Model as illustrated	**£58.**
Rack Mounting Model	**£59.**

Delivery ex stock.

Available with negative bias supply at **£63** and **£64.** Power Supply Units and other special electronic equipment made to customers' specifications.

Pamphlet and full particulars from :—

HARVEY ELECTRONICS LTD.

Precision Mechanical and Electrical Engineers

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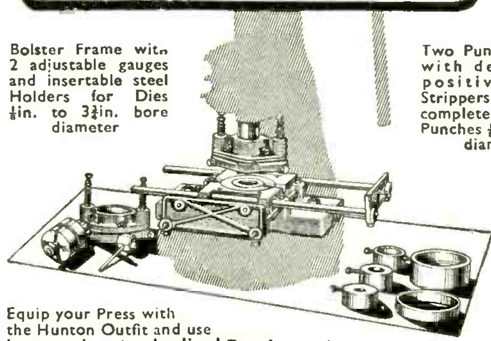
THE HUNTON UNIVERSAL BOLSTER OUTFIT FOR SHEET METAL PIERCING AND BLANKING ON FLY PRESSES

Bolster Frame with 2 adjustable gauges and insertable steel Holders for Dies $\frac{1}{8}$in. to $3\frac{3}{4}$in. bore diameter

Two Punch Holders with detachable positive-action Strippers take the complete range of Punches $\frac{1}{8}$in. to $3\frac{3}{4}$in. diameter.



Equip your Press with the Hunton Outfit and use **inexpensive standardised Punches and Dies $\frac{1}{8}$in. to $3\frac{3}{4}$in. diameter, obtainable from stock—in $\frac{1}{32}$in. sizes** —when required.

Standardised Tools also available at short notice for Square, Oblong and other shapes, Louvre Forming (up to 8in. long), Corner Notching, Corner Radiusing, Angle Iron Notching and Piercing, etc.

Get the Outfit now—Buy Punches, Dies and Tools as you need them

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Phoenix Works, 114-116, Euston Road, London, N.W.1

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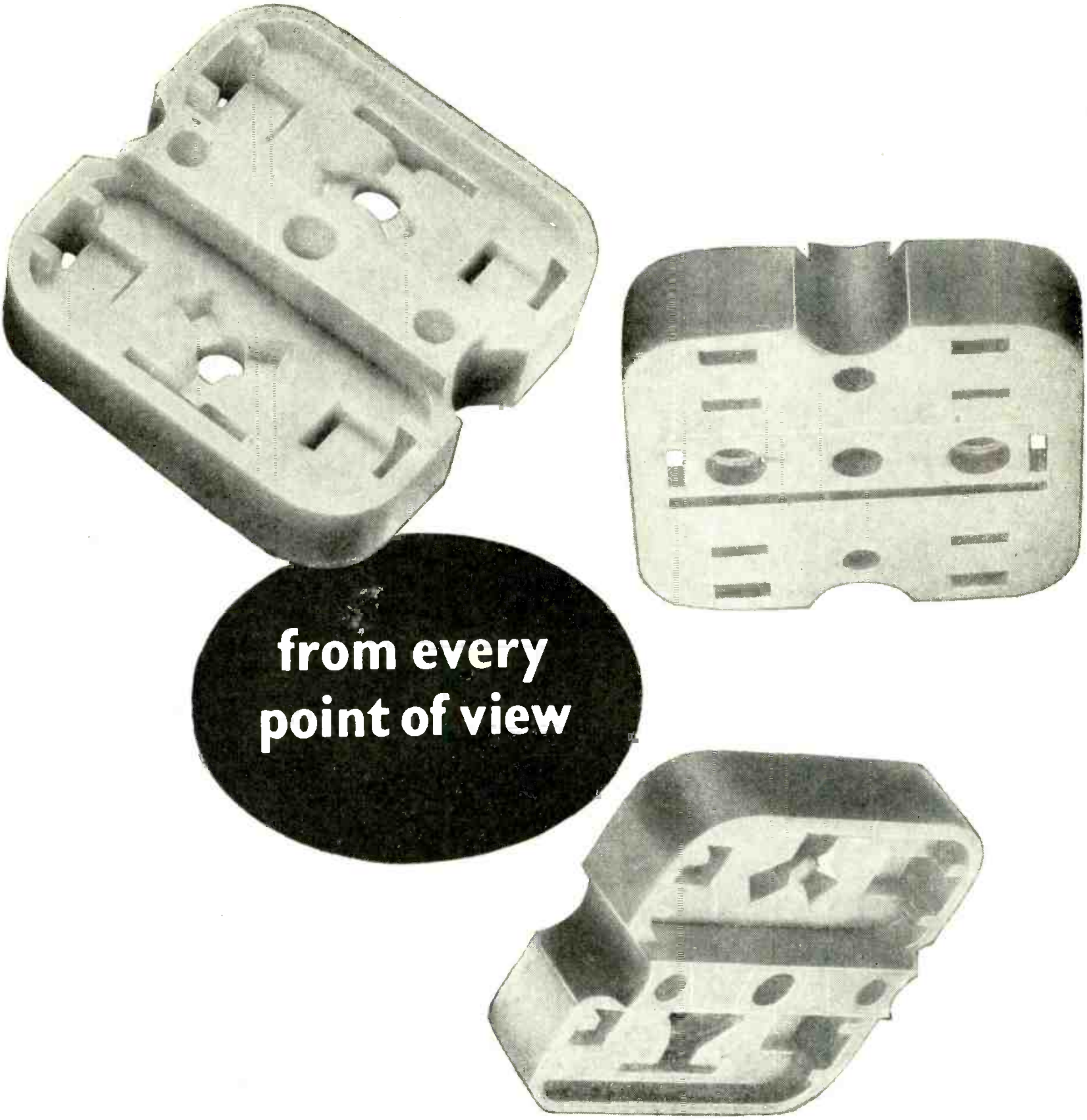
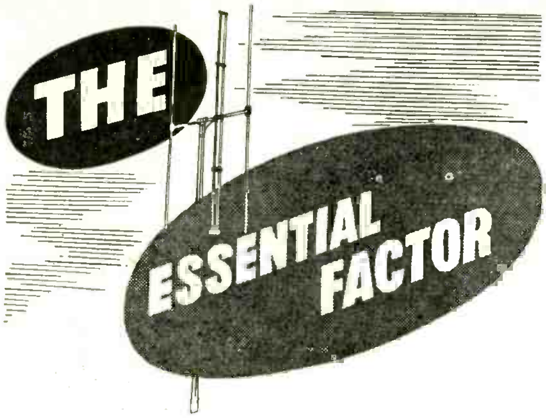


"Frequentite" is the most suitable insulating material for all high frequency applications. Seventeen years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

STEATITE & PORCELAIN PRODUCTS LTD.

Head Office: Stourport-on-Severn, Worcestershire. Telephone: Stourport 111. Telegrams: Steatain, Stourport

S.P.77



It is the aerial which provides the vital link between transmitted waves and the receiver. Its efficiency in terms of maximum forward gain, high front/back ratio, broad bandwidth, and accurate matching governs the picture strength, quality and freedom from interference. That is why it is wise to specify Aerialite aerials—designed and manufactured by an organisation with 21 years specialisation in this field. Some of the television aerials in the Aerialite comprehensive range are :—

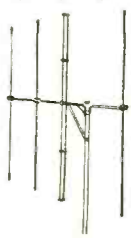
63A

The AERFRINGE Models are three element fringe types which have a folded dipole construction for extra broad bandwidth and high definition.

The Model 63A (Illustrated) has a forward gain of 8.0 dB which ensures excellent reception even in difficult and distant areas. Retail price : £13/5/- complete with 2in. x 10ft. light alloy mast, double chimney lashing brackets, etc.

64

The AERBEAM Model is a four element folded dipole aerial with an extra high forward gain of 11 dB and a very narrow beam. It is suitable for outer fringe areas and is available for channels 3, 4 and 5 on vertical polarisation and channels 1 and 5 on horizontal polarisation. Retail price : £13/5/- complete with 10ft. mast, double chimney lashing brackets, etc.



77

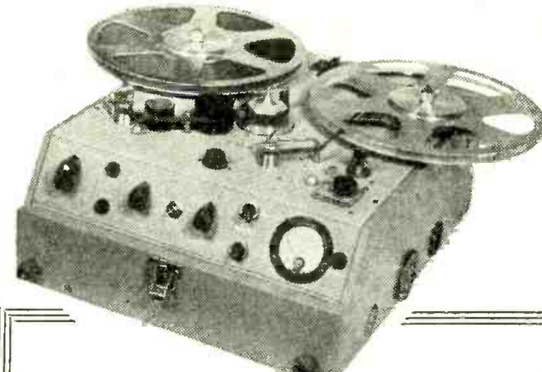
The DUBLEX range was first introduced at the 1952 National Radio Show and has proved its value as an inexpensive yet high gain aerial with excellent interference rejection properties. The novel double folded element construction gives a forward gain of 6.0 dB with a max/min ratio of 25 dB. Retail price : 77S with 7ft. mast etc., £4/8/6. 77T with 10ft. x 2in. o.d. mast, double lashings £7/15/-. 77X array only £2/15/-. For horizontal polarisation retail prices are 10/- extra on above.

For Belfast and Newcastle Transmitters. The majority of Aerialite T/V aerials are suitable for horizontal polarisation and provide same high level of aerial efficiency. Please add the suffix HOR to the model number when ordering.

Aerialite

Specify and use Aerialite R.F. Cables for T/V Aerial Installations.

AERIALITE LTD., STALYBRIDGE, CHESHIRE



"EXCEL"

MAGNETIC TAPE RECORDERS

Used as a first class recorder for high fidelity work ; also employed with EXCEL Synchroniser Unit for high quality synchronised sound with sub-standard film projectors. Standard full track ; *also half track to order.*

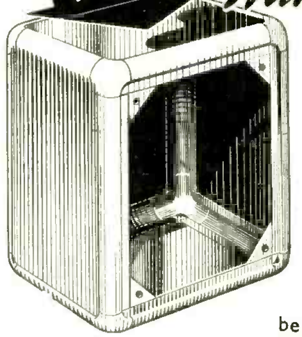
- WIDE FREQUENCY RESPONSE
- FREEDOM FROM "WOW" AND FLUTTER
- 10½in. DIAMETER FLYWHEEL
- SUPERIMPOSING
- NOISE SUPPRESSION
- TAPE CAPACITY : Standard 3250 ft. single sided spools and NAB 2400 ft. double sided spools.
- PORTABLE. WIDTH 14¾in. DEPTH 17½in. HEIGHT 8½in.

For full details and nearest Agent please write to

EXCEL SOUND SERVICES LTD.
NORWOOD WORKS, NORWOOD AVE., SHIPLEY YORKS.
Telephone : Shipley 51291

7/16" RADIUS

Widney-DORLEC REGD
CABINET SYSTEM
Miniature Gauge



The unique Widney-Dorlec feature of components which enables any size of Cabinet to be built is again incorporated in this gauge. Made from mild steel, assembled by spot welding giving a very neat external and internal appearance. Removable panels can be fitted using special corner gusset plates.

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A Widney PRODUCT — USED ALL OVER THE WORLD
ESTABLISHED 1898
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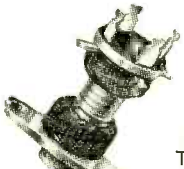
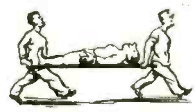


It's a knockout—the vast improvement that arises from the use of OSMOR "Q" Range Coils. No wonder our customers are enthusiastic! They tell us these "mighty marvels in miniature" are super selective and sensitive to a degree they never dreamed possible. And we guarantee them—they're the outcome of patient scientific research plus the highest technical ability. They put real "punch" into a set and score an easy win on these plus points—

★ Only 1in. high. ★ Packed in damp-proof containers. ★ Variable iron-dust cores. ★ Fitted tags for easy connection ★ Low loss Polystyrene formers.

4/- EACH

COILPACKS. *Now at new lower prices!* A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1¾in. high x 3¼in. wide x 2¼in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WARTIME UTILITY and others. Aligned and tested. with full circuits, etc. Fully descriptive leaflets available.

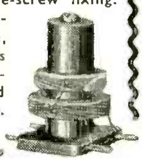


With OSMOR Lines—you're on the right lines!

A spotlight on just one of the range of **OSMOR** *"Q" coils.*

H.F. CHOKE Type Q.C.1.

Frequency coverage 150 kc/s. to 20 m/c. Iron-dust core and single-screw fixing. Prototype tested and approved by M. G. Scroggie, B.Sc., M.I.E.E. Ideal as anode load in TRF receivers, for decoupling and general purpose. Price 4/-.



TWO for the Price of ONE!

The NEW OSMOR CHASSIS CUTTER

of entirely new design. Cuts two sizes of holes with any one reversible punch and die; and can be operated with a spanner or tommy-bar. Blanks easily removed.

Prov. Pat.

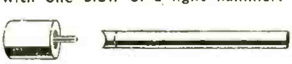
Type	Hole Sizes	Price
1	1in. x 1⅛in.	19/6
2	⅞in. x 1⅛in.	18/9
3	⅞in. x 1½in.	22/6
4	1¾in. x 2in.	27/3

Post and Packing 1/- (any type).

Tommy Bars .... 1/3 each

The OSMOR "JIFFY PUNCH"

For cutting smaller holes neatly and quickly with one blow of a light hammer.

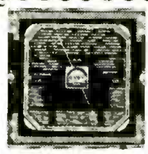


Prov. Pat.

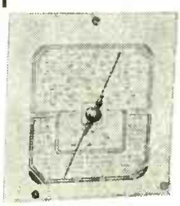
Type	Hole Size	Price
1	¼in.	6/6
2	⅜in.	7/6
3	½in.	8/9

Both types of cutters are of hardened steel and are for use on steel up to 18 s.w.g. Brass and Dural up to 16 s.w.g. Aluminium and Copper up to 14 s.w.g.

DIALS



Type A. GLASS DIAL ASSEMBLY (as illus.) measuring 7in. x 7in. (9¼in. x 9¼in. overall) mounts in any position on or above the chassis and works with any type of drive. Choice of two 3-colour scales—G1(L.M.S.) or G2(M.S.S.). Price complete, 24/6. Pulley assembly for right-angle drive if required 1/9 extra. P. & P. 1/6.



METAL DIALS

Overall size 5¾in. sq., as illustrated. Cream background, 3-colour. Type M1, L.M.S. waves. M2, L. & M. waves. M3, M. & 2/S. waves. Price 3/6 each. Pointer, 1/6.

Drum, Drive, Spring and Cord for use with both above types of dials, 3/2.

We keep stocks of many radio components for use in published circuits, including

"WIRELESS WORLD"

"NO COMPROMISE" TRF TUNER. (Osmor coils QA11 and QHF11 for M.W. and QA12 and QHF12 for L.W. are suitable price 4/- each.)

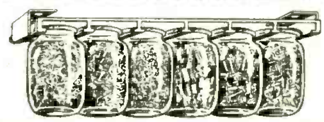
"MIDGET MAINS RECEIVER" (Osmor coils QA11 for M.W. and QA12 for L.W. are suitable, price 4/- each.)

"PRACTICAL WIRELESS"

3-speed Autogram. Modern 1-valver. A.C. Band-Pass 3. R1155 Converter. Attache case portable. Modern high power Amplifier—2.

Dear Reader,

We can't mention all our products here but shall be glad to receive your enquiries for Chassis, Tuning Condensers, Switches, Volume Controls and all other Radio Components. If it's top-quality components and a speedy, courteous service you are looking for—try Osmor. We really shall do our best for you.



Keep those small components—resistors, condensers, etc., neatly stored yet visible by using an

OSMOR "JAR-RACK"

(If you're a generous husband you'll buy one or two for your wife's larder, too—she will appreciate somewhere to store her preserves.) Holds any 1 lb. jam jars, with or without lids. Easily removed, cannot fall out. Just the thing for the tidy "HAM" or Radio Dealer.

Type 1 for wall-fixing, 6/9 each, holds 8 jars. (Jars are not supplied but are easily obtained).
Length 24in. enamelled olive green.

Type 2 (as illustrated) for screwing under a shelf, 5/9 each, holds 6 jars.
Length 18in., enamelled green.

Post and packing 1/- (either type).
(Trade supplied)

You won't believe it!

the first time you hear your own voice! Have fun and find endless pleasure in using an **inexpensive TAPE RECORDER** you can build yourself. We can supply all the parts to make a really efficient unit, utilising your gramophone turntable (which can still be used for its normal purpose). Send 2/6 only for easy-to-follow blueprints and instructions, or ask for details.

I.F.s. 465 k/c. Permeability-tuned, with flying leads. Standard size 1⅜in. x 1⅜in. x 3½in. For use with OSMOR coilpacks and others, 14/6 pair. PREALIGNED, 1/6 extra.

FREE! Send 5d. (stamps) for **FREE CIRCUITS** *and full lists of coils, coilpacks and radio components.*

OSMOR radio products ltd.

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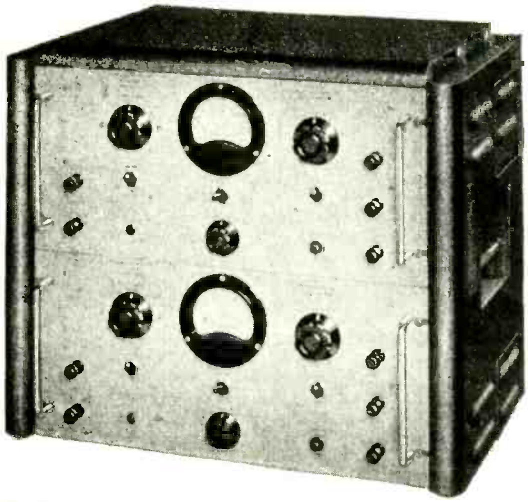
0–1000 VOLTS

WITH THE NEW SOLARTRON

Twin-Regulated Power Supply

*MODEL SRS.*152



THIS new power supply consists of two separate high stability units mounted in a two tier case with an internal switching mechanism and link so that the outputs may be interconnected. Careful design and choice of components ensures complete reliability of operation up to 1 KV with a maximum load of 150 m/a. Alternatively, when the units are switched to parallel operation, a supply of 0-500 volts is available at 300 m/a.

FEATURES:

Wide Range of positive and negative output voltages. High quality components including only paper type capacitors. Automatic overload protection. High Stability.

SPECIFICATION:

D.C. Output Series Condition:	0-1,000 volts +ve or −ve, 0-150 m/a. or 0-500 volts +ve and 0-500 volts −ve, 0-150 m/a.
Parallel Condition:	0-500 volts +ve or −ve, 0-300 m/a.
A.C. Output Unstabilised:	Two outputs 6.3 volts, 5 amps. each.
Stability:	0.2% for ±10% mains input change.

The units are available separately for bench or 19in. rack mounting.

SOLARTRON

● ORDER NOW FOR EARLY DELIVERY

Write for details to:

SOLARTRON LABORATORY INSTRUMENTS LTD.
22 HIGH STREET KINGSTON SURREY TEL: KINGSTON 8981 PBX

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QUALITY COMPONENTS

for the Electronic and Instrument Industries

Constanta High Stability Resistors
(Stability and tolerance from ± 0.5% to ± 10%)

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Winkler Precision Multiway Switches
(Up to 30-ways per bank and up to 16 banks, 1 to 3 poles)

Winkler Key Switches
(Up to 8 change-over switches in one unit of small dimensions)

Wire-wound Potentiometers
(½ watt to 250 watts)

Ganged Carbon Potentiometers

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Heavy Duty Multiway Switches

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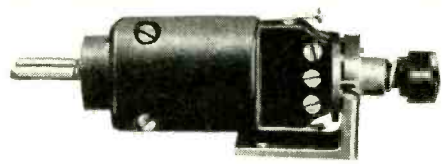
THE GOLDRING MAGNA CARTRIDGE



- A magnetic Turnover Cartridge with high output and cantilever styli.
- Entirely new principle. (Pat. applied for.)
- Output comparable to crystal pick-ups.
- Cantilever styli give minimum record wear and eliminate needle-talk.
- Styli easily replaceable.
- Smooth extended frequency response on both standard and L-P. records.
- The ideal replacement Cartridge for 3-speed record changers and units.

Of special interest to the designer of new equipment.

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The new

THE MASTER SOUND SYSTEM

MAGNETIC TAPE RECORDER

●

Type PMR/3

"from a pedigree line"

And its SPECIFICATION

The Tape Player itself is of unit construction which enables many special requirements and applications to be met without undue modification. The following features can be provided to special order:—

Tape speeds 7½" and 15" per second, or 3¾" and 1⅞" per second.

●

Synchronous drive motor.

●

Remote operation or foot control.

●

Automatic back spacing and reverse drive for dictation purposes.

●

Cassette tape loading.

●

Rack mounted assembly.

TAPE SPEEDS	7½" and 3¾" per second.
TRACKS	·1" wide. Number of tracks 2.
PLAYING TIME PER TRACK	30 minutes at 7½" per second. 60 minutes at 3¾" per second.
SPOOLS	Standard 7" and 5" plastic or metal.
SENSE OF SPOOLING	From left to right with tape coating inwards.
REWIND TIME	One minute for 1,200 ft. of tape (approx.).
HEADS	R.F. erase head. Record/playback head off-set for recording on upper track. Provision on player unit for additional monitoring head for special applications.
TAPE OPERATION	Single control provides:—Record, Playback, Fast Forward, Cueing, Rewind. To ensure additional safety against accidental erase, an additional record / playback switch is provided on the amplifier assembly. Power and brake operation is by means of a relay which will enable remote operation to be provided in special applications.
FREQUENCY RESPONSE	At 7½" per second 60-10,000 C.P.S. plus or minus 3 db. At 3¾" per second 70-7,000 C.P.S. plus or minus 3 db.
DISTORTION	Less than 2½% total harmonic distortion at normal operating level.
SIGNAL/NOISE RATIO	Approximately 50 db. using standard high output tape.
INPUTS	(1) Up to 50 ohms low level —110 db. microphone input. (2) High Z up to 100 K at 1v. unbalanced (radio input).
OUTPUTS	(1) 2½ ohms at 3 watts to internal loudspeaker. (2) 15 ohms at 3 watts for external speaker.
WOW AND FLUTTER	Total wow and flutter content less than ·2%.
MAINS SUPPLY	200/250 v. 50 cycles 230 V.A. Other voltages and frequencies supplied to special order.
DIMENSIONS	16" wide x 11" high x 18" deep approx.
WEIGHT	45 lbs.

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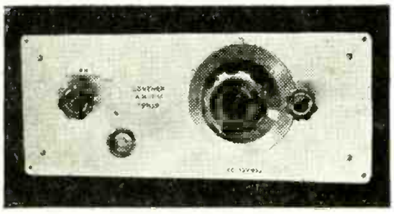

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Tunable 85-100 m.c.s on both A.M. and F.M. for experimental transmitter from Wrotham and other sites as erected.

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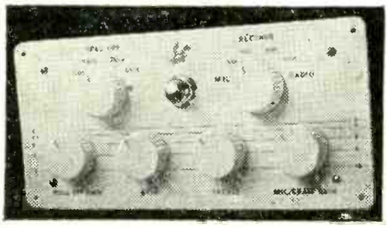

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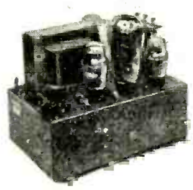

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The Lowther Master Control unit (see details last issue "W.W.") with Lowther B.5F., PX25 output, amplifier offers the finest start to quality reproduction or modification to your present equipment, where either greater control or degree of fidelity is required. Further details :

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THE MODEL 5D TAPE DESK (to take 10½in. NAB Reels)
Programme Time : 62 minutes at 7½ i.p.s.
124 minutes at 3¾ i.p.s.
Panel size : 20in. x 14½in.
Two speeds, 3¾ and 7½ i.p.s. Double track heads. Push button control. Fast wind and rewind. Three heavy duty motors. Three separately shielded heads. Complete with NAB reel adaptors
PRICE : (fitted with 6RP heads) **£50/-/-.**

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Programme Time : 55 mins. at 7½ i.p.s.
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Large Panel (20in. x 14½in.), **£47/10/-.**
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In rexine covered case, fitted with model 5B tape desk, type D.2. C.J.R. amplifier with monitoring. Provision for external loudspeaker.
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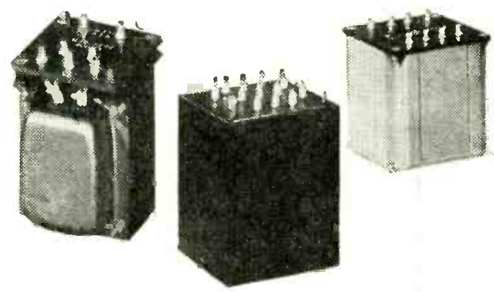

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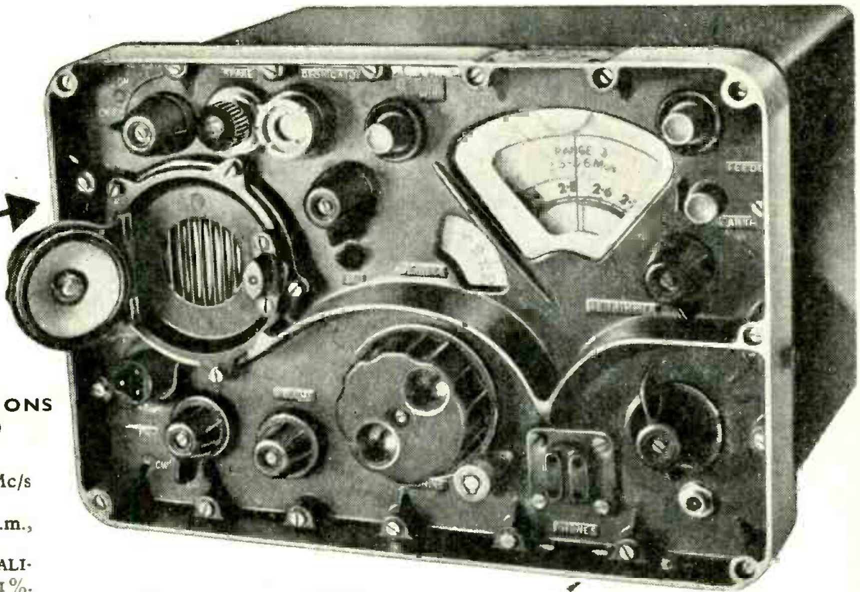

MOBILE COMMUNICATIONS RECEIVER R209(Mk2)

Technical Features

WAVE RANGE: 1.0-20.0 Mc/s in four ranges. RECEPTION: a.m., f.m., c.w., m.c.w., c.f.s. AERIAL: Rod or wire. CALIBRATION ACCURACY: 1%. FREQUENCY STABILITY: 100 c/s per Mc/s per hour. SIGNAL TO NOISE RATIO: At least 20dB with 5 micro volt signal applied to 80 ohm input. C.W. FILTER: 950 c/s. POWER SUPPLY: 12 volt d.c. at 1.6 amps. DIMENSIONS: width: 12.5 in.; depth: 9 in.; height: 8.5in. WEIGHT: 21 lb. (approx.).

Mullard

Compact and lightweight, this new Mullard mobile communications receiver, R209(Mk2), is designed to give reliable performance under the most arduous conditions of service. Maximum protection against the effects of shock and vibration is ensured through rugged construction and careful mounting of specially designed components, whilst hermetic sealing renders the equipment completely airtight and waterproof. Any moisture in the unit at the time of sealing is absorbed by a silica gel desiccator.

Other features of the R209(Mk2) include ease of operation, provision for either headphone or loudspeaker reception, and a high degree of frequency stability, even under extreme variations of temperature.

Abridged details of the R209(Mk2) are given above. More comprehensive information will be gladly supplied on request.

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HIGH GRADE SPECIALISED ELECTRONIC APPARATUS

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- ★ 3-VALVE 3-BAND SUPERHET. FEEDER.
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- ★ 5-VALVE 3-BAND A.C. SUPERHET.
- ★ 5-VALVE 3-BAND A.C./D.C. SUPERHET.
- ★ 6-VALVE 3-BAND A.C. SUPERHET.
- ★ 6-VALVE 3-BAND A.C./D.C. SUPERHET.
- ★ 3-VALVE 2 BAND "LOCAL STATION" T.R.F. SUPER QUALITY FEEDER.
- ★ FEEDER AMPLIFIER AND POWER PACK.
- ★ MAGIC EYE TUNING INDICATOR UNIT.
- ★ SIGNAL TRACER A.C.
- ★ 5-WATT AMPLIFIER A.C.
- ★ 10-WATT PUSH-PULL QUALITY AMPLIFIER, A.C.
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DETAILS for construction, **LARGE** *blueprint* circuits, **COMPLETE** parts lists, and technical descriptions, of these famous circuits are some of the good things in store for you in the **NEW 1953** HOME CONSTRUCTOR'S HANDBOOK! Also: Set Building Hints, Servicing Hints, Facts and Formulae, Resistance Colour Code, Symbols, Data, etc., etc., **AND** our current Catalogue, **ALL FOR HALF-A-CROWN ! !**

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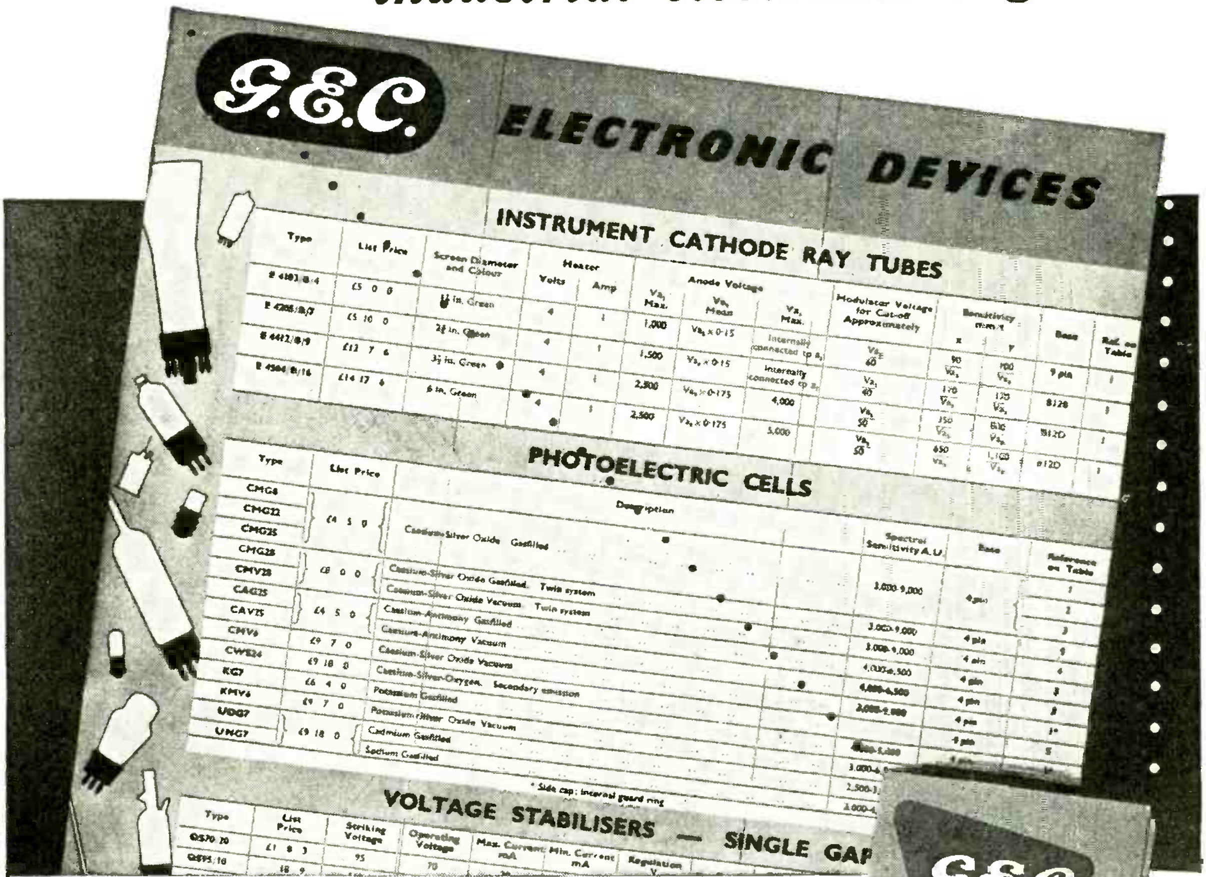

This G.E.C. folder forms an invaluable reference to the latest developments in the field of electronic devices. It contains brief specifications, screen characteristics, pin connection tables etc. and is available free on application. Fuller details of all the electronic devices described in this folder can also be supplied.

Write to the Osram Valve and Electronics Dept. for Folder OV1782

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

NEW ARCOLECTRIC SIGNAL LAMPS

For Low Voltage or Mains

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A new mains voltage lampholder, Cat. No. S.L.88/N, has been developed for use with the Arcolectric MES neon tube. Among the features of this design are easy lamp replacement, from front or rear of panel, and a built-in resistor.

The low voltage lampholders are designed for use with standard MES bulbs. Features are, easy single-hole fixing and pleasing appearance. Bulbs are accessible from front or back of panel. Insulation of all types will withstand a flash test in excess of 1,500 volts A.C.

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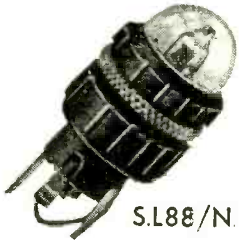
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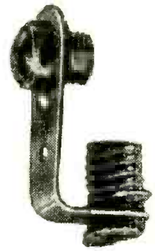
S.L.90.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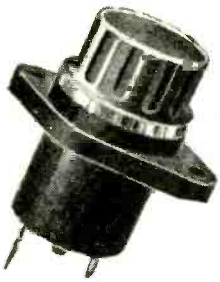
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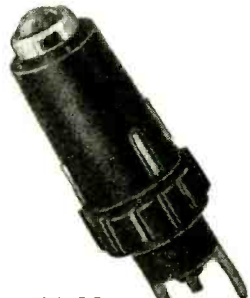
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Receiver R54/APR4 with tuning units TN16, 17, 18, 19, 54 (or bought separately) ...	£135
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LINCOLN SPOOL ADAPTORS	each	5	9
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is an ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil, mutual and stray inductances and both fixed and stray capacitances. Covers 1.5 to 300 Mc/s in eight ranges. PRICE: 12 Gns. Complete.

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5/8" or 3/4"	11/6
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Keys, small, 10d., medium, 1/3, large, 1/9.

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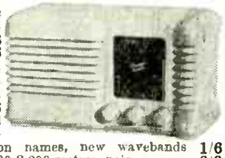

We can supply all the parts to help you.
Drum (2¾in. dia.), 1/6
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Punched chassis, 3-valve plus rectifier T.R.F. 3/9
Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut Finish 17/6
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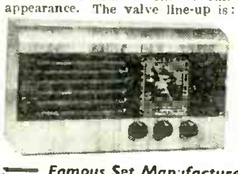
SEND 1/6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver Illustrated above.

THE COMPLETE KIT

to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at **119/6** plus 2/6 packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated, and the Receiver housed in its Cabinet size 12in. × 5in. × 6in. presents an attractive appearance. The valve line-up is: 717A—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier. Waveband coverage is for the medium and long bands. Choice of 3 Cabinets: Bakelite in Walnut or Ivory, or Wooden (Walnut finish).



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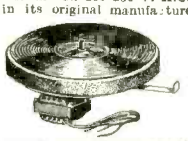
ELECTRIC 'GRAM UNITS

Two-speed, 33⅓ and 78 r.p.m. For playing standard and L.P. recordings. Complete with Turntable. For use on 200-250 v. A.C. mains. Each unit is in its original manufacturer's carton and is fully guaranteed. Limited quantity only available at approx. half list price.



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Plus 2/6 pkg., carr., ins.

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BRAND NEW

Induction motor, 100-250 volt, 50 cycles A.C. only. 78 r.p.m. The GARRARD Induction motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic Variable speed. With 12in. Turntable. Price **£4/19/6**. plus packing and carriage 5/-.

GARRARD Type 75. Latest 3-speed Autochange Unit complete with 2 Acos High Fidelity G.P.19 Pick-up Heads. 1 L.P. and 1 standard. **£14.19.6**

GARRARD Rim Drive 78 r.p.m., complete with magnetic pick-up and turntable ...... £5 . 19 . 6

COLLARO 3-speed single gram. unit, complete with head for L.P. and Standard recordings ...... £8 . 8 . 0

Packing and carriage on each of the above units 2/6.

B.S.R. "MONARCH" AUTO-CHANGER

This is a 3-speed automatic mixed record changer designed to play 12in., 10in., and 7in. records intermixed in any order. Capacity 10 records, operates on 100/125—200/250 volts 50 c/s. A.C.

New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self compensated for the L.P. lower frequencies with the Turnover fequency at the correct point. **PRICE £16.10.3** plus 5/- pkg., carr.

THE FAMOUS "CHANCERY" HIGH-FIDELITY MICROCELL PICK-UP—TYPE GPX for Standard and Long Playing

The Chancery Light Weight GP.X Pick-up embodies certain unique features achieving a standard of performance not possible with normal magnetic or crystal pick-ups. The secret of the high standard of performance is in the use of the special microcell crystal cartridge assembly which has an unusually wide frequency response. The sapphire stylus is precision ground and semi-permanent. With two cartridges 1 L.P. and 1 Standard. Price 52/6. *Additional L.P. or Standard Cartridges can be supplied from stock at £1/11/6 each.*

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Also ideal for fishing rods—ALL BRAND NEW

12ft.—3 4ft. sections of copper-plated steel highly flexible tapering ⅜in. to ⅛in. Brand new in container **6/9**. Packing and carriage 1/6. Insulated Base **3/-**. Webbing waterproof carrying case with shouldersling, **2/6**.

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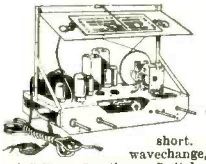
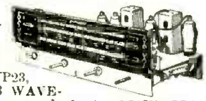


5 VALVE SUPERHET RADIO RECEIVER CHASSIS, built to high standards ensuring quality reception. SPECIFICATION :— VALVE LINE-UP: 7S7, 7B7, 7C6, 7C5, 7Y4. 3 WAVEBANDS Long, medium, and short. CONTROLS: Tuning, wavechange, volume tone control on/off Gram. Position on Switch. Pick-up and Extension Speaker Sockets incorporated. For use on 200/250 v. A.C. mains. DIMENSIONS: Length 14½in., height 11¾in., width 6½in. Distance between controls, left to right from edge of chassis: 1in., 3in., 6½in., 3in. Plus 5/- pkg./carr./ins. **£7.19.6**

The above Receiver is less Speaker and Output Transformer. A suitable 10in. Moving Coil Speaker and Output Transformer can be supplied at **29/-** extra.

A 4 Valve BATTERY SUPERHET RADIO RECEIVER CHASSIS



by the same manufacturer is also available.

SPECIFICATION: MAZDA VALVE LINE-UP: TP25, VP23, HL23DD, Pen. 25. 3 WAVEBANDS: Long medium and short. CONTROLS: Tone, Volume On/Off, Tuning, Wavechange, Gram. Position on Switch. Pick-up and Extension Speaker Sockets incorporated. Batteries required LT 2 volt, HT 120 volt. DIMENSIONS: Height 6in., length 15in., width 5¾in. Distance between controls, left to right from edge of chassis, 1¼in., 3¼in., 3¼in., 3¼in.

£5.15.0 (Less Batteries) plus 5/- pkg./carr./ins.

The above Receiver is less Speaker and Output Transformer. A suitable 8in. Moving Coil Speaker and Output Transformer can be supplied at **23/-** extra.

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ELAC—2½in. dia., Moving Coil, 15 ohms imped. 15/-
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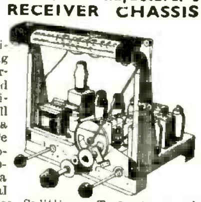
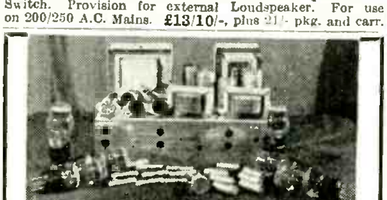
PLESSEY—8in. dia. Mains Energised, 3 ohms imped. (600 ohms field) 19/6
PLESSEY—10in. dia. Moving Coil, 3 ohms imped. 23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms £8/8
Plus 5/- packing and carriage.
VITAVOX—K12/20 12in. dia., Moving Coil, 15 ohms imped. £11/11
Plus 5/- packing and carriage.

A WORLD-FAMOUS *Manufacturer's Surplus of* RADIO RECEIVER CHASSIS 7-valve RECEIVER



Built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s., using Mazda VP41. **FOUR WAVEBANDS—14 M.-24 M., 24 M.-55 M., 190 M.-600 M., 900 M.-2,000 M.** DIRECT AND VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. **£13/10/-**, plus 21/- pkg. and carr.



WILLIAMSON AMPLIFIER KIT

A complete kit of parts for the construction of the latest version of this famous amplifier, complete with valves, output and mains transformers.

15 gns. *Plus 7/6 pkg., carr. and ins.*

WILLIAMSON AMPLIFIER TRANSFORMERS (To specification)

The Output Transformer 3.6 ohms sec., **£4/4/-**.
The Mains Transformer **PREMIER SP425A**, **£3/7/6**.

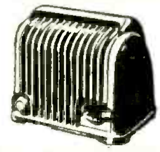
ACCUMULATORS

By world-famous maker, 2 volt 10 amp. 4/11

ONLY A FEW LEFT—*BUY NOW!*

THE FAMOUS 'SOBELL' 4 VALVE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS



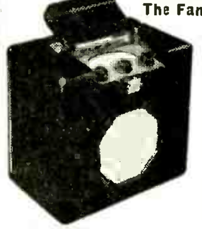
Valve Line-up 12J7, 35L6, 1487 35Z4.
Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.
Choice of 2 Colours—Ice Blue or Aero Green.

Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains. Plus 5/- Pkg./carr./Ins. **£8 . 19 . 6**

Covered fully by Manufacturer's Guarantee

LIMITED QUANTITY ONLY AVAILABLE AT GREATLY REDUCED PRICE

The Famous 'ROBERTS' M.4.D.



All Dry Battery Portable (Ex-R.A.F.)
This is a 4 valve superhet Receiver covering medium and long wavebands. Built in Aerial. Housed in a superbly finished rexine covered case. Brand new in manufacturers' original carton.

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1124 RECEIVER UNIT

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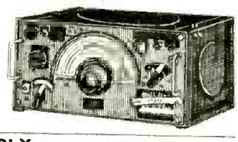
R1132A RECEIVER. Complete with valves **£3/19/6.** Plus pkg. and carr. 10/6.

1155 RECEIVER UNIT

BRAND NEW



In original case, complete with 10 valves. Frequency range 18.5 Mc/s-75 Kc/s. in 5 wave bands. **£11/19/6.** 10/6 packing and carriage.

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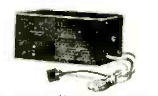

for above incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. Price **£5/5/-**, plus 5/- pkg. and carr.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6, Plus 15/- pkg. & carr.

★ *We now have available a small quantity of used R1155 Receivers. We can offer these at the ridiculously low price of £9/19/6, plus 10/- pkg., Carr., Ins. These Receivers have been reconditioned and Air Tested and are fully guaranteed to be in perfect working order.*

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with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's, 1—5U4, 1—VU120, 1—EA50, **£1/19/6.** Plus pkg. and carriage 10/-.

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Frequency covered 40-50 Mc/s (6-7.5 metres) switched tuning. 5 Pre-set positions complete with 3 VR65's **£1/5/-.** Plus pkg. and carr. 2/6.

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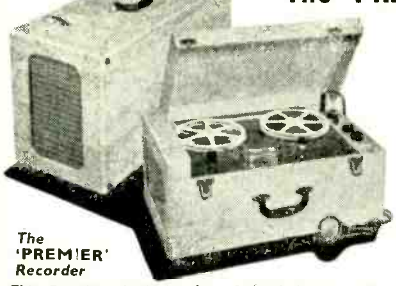

The 'PREMIER' Recorder

This Recording Outfit has been designed for use with M.C.-1-111 "SCOTCH BOY" Magnetic Tape. With this high-quality tape a frequency of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½in./sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-.

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OUTPUT: 4 Watts. **FREQUENCY RANGE:** 50 c.p.s. to 9,000 c.p.s. **CONTROLS:** Volume; Record/Playback Switch; Treble Boost; Bass Boost—on/off.

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INSTRUCTIONAL BOOKLET . . . 2/6
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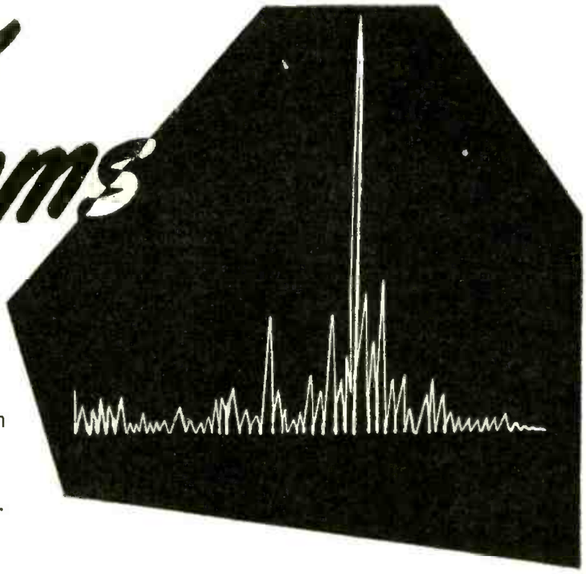

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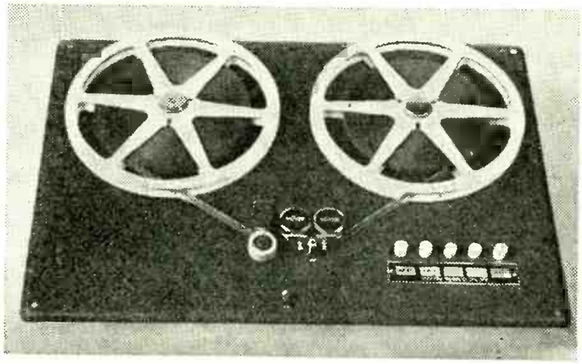

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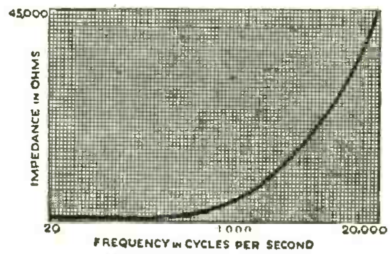

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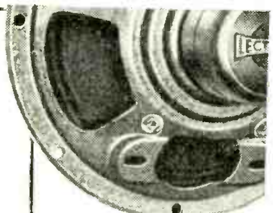

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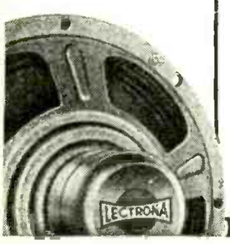

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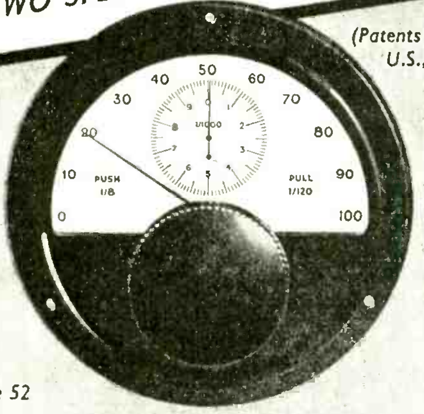

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH

JUNE 1953

In This Issue

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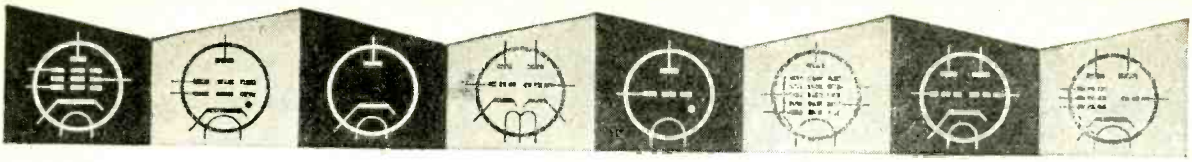

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6. DM70—SUBMINIATURE TUNING INDICATOR FOR BATTERY OR MAINS RECEIVERS (Contd.)

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A.B.C. Receivers In an A.B.C. receiver it is usually necessary to connect the filament of the DM70 in series with the filaments of the other valves. With a chain of valves having 50mA filament the 25mA filament of the DM70 should be shunted by a 56Ω resistor. The positioning of the DM70 in the filament chain needs careful consideration to ensure that the values of grid voltage at zero and at maximum signal give the optimum amount of indication on the DM70.

A.C. Mains Receivers The filament of the DM70 can usually be fed from a 6.3-volt transformer winding through a series resistor of 220Ω 5±%. Alternatively, a 3.15V centre-tap on the heater supply can be used, the value of the series resistor then being 82Ω ±10%.

It is not recommended that the filament of the DM70 be fed with a direct current from the cathode resistor of the output valve owing to the possibility of wide variations in this current resulting in reduced life of the indicator.

The recommended anode voltage for the DM70 in mains receivers is 60V, which can be obtained from the h.t. line by means of a series resistor. This results in a sliding anode voltage dependent upon the current of the valve and so extends the range of grid control to deal adequately with strong signals in a very sensitive receiver.

As the filament is supplied with an alternating voltage it is necessary to take precautions to prevent hum being introduced into the a.g.c. circuit from the grid of the DM70.

A.C./D.C. Receivers The filament of the DM70 shunted by a suitable resistor may be connected in series with the heaters of the other valves in an A.C./D.C. receiver provided a surge current limiting device is also included in the series circuit. For mains voltages above 160V the shunt resistor should be 18Ω ±10% when included in a 100mA heater chain.

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Wireless World

JUNE 1953 VOL. LIX No. 6

Exhibitions

IT would be ungracious—and indeed, foolish— to complain that too much limelight is thrown on our art. All the same, the very large number of exhibitions concerned with radio and electronics are something of an embarrassment to many people, including visitors and exhibitors as well. Although almost all the exhibitions with which we are concerned nowadays are in fact, if not in name, specialized, there is a good deal of overlapping between them. Manufacturers, naturally enough, want to show their products to the largest number of potential users, who, in their turn, want to see what is available to them. But is it possible to avoid the present duplication of effort and to reduce the expenditure of man-hours and money by both exhibitors and visitors?

An exhibition organized by the Radio Communication and Electronic Association, with collaboration of the Ministry of Supply, was held recently at Farnborough for the benefit of delegates from the European Defence Community, N.A.T.O. and the British Commonwealth. It was supported by firms in the components and valve sections of the radio industry, and though outwardly of a military character, did in fact cover a much wider field. With some justification this was claimed to be "the most comprehensive display of electronic equipment held anywhere in the world." The pity of it is that this impressive show, which presented the "professional" side of the industry as it has never been presented before, was seen by a mere handful of visitors.

The success of the Farnborough show gives rise to the thought that, for purposes of exhibitions, all radio could be divided into two sections, which might very roughly be described as professional and domestic. The first category would include all products for communication, industrial, commercial and military applications. The domestic show would, of course, deal predominantly with broadcast receiving equipment, but might also cover electronic equipment intended to some extent at least for the general public, including perhaps "business radio." The advantage would be that annual exhibitions organized in this way would provide a focal point of the year for developments in the main spheres of activity. Such a scheme might not entirely avoid the need for specialized exhibitions, but would at least allow them to be still more specialized, and thus obviate much of the wasteful overlapping that now occurs.

Television Conversion

A LETTER from a correspondent, printed elsewhere in this issue, expresses the view that the problems involved in designing converters for adapting existing television receivers for reception of the proposed alternative service are rather more difficult than is commonly believed. No doubt, certain types of set, operated in favourable conditions, could be fairly simply adapted, but it does seem most unlikely that a standardized design of converter, applicable to all sets in all conditions, could be produced at low cost.

The tunable receiver having channel selection under the control of the user will lend itself more readily to conversion to the new band, and so it is to be expected that this type of set will become increasingly popular when the start of the alternative service becomes imminent.

An allied problem that has not yet been touched upon at any length is that of aerials for two-band reception. That is one of the many matters connected with the proposed alternative television service that we hope to discuss in detail in the near future.

Local Conditions

THE task of the B.B.C. in providing an acceptable medium-wave signal for the whole country is not an enviable one, and becomes more difficult as time goes on. To an increasing extent, compromises are necessary. Critics of B.B.C. quality are inclined to overlook the fact that a transmitting technique that satisfies the listener who lives, figuratively speaking, on the doorstep of a station is quite unacceptable to those in the wilds. The only way out of this difficulty lies in the use of v.h.f.

Components and Techniques

Survey of the R.E.C.M.F. and Physical Society's Exhibitions

Since the above two exhibitions ran more or less concurrently in London this year and also overlapped to some extent in their types of exhibits, we have selected the most interesting items from both shows and combined them into this one report. No distinction is made between Physical Society exhibits and R.E.C.M.F. exhibits, but each section dealing with components is followed by a list of the exhibitors in that class.

RESEARCH AND MATERIALS

The problems of noise measurement in fractional-ohm resistors at temperatures of the order of 20 deg K (-253 deg C) are formidable and offer an interesting challenge to the amplifier designer. These have been successfully solved in an amplifier designed by P. J. Baxandall at the Telecommunications Research Establishment. Two input transformers are used, the first operating at low temperature and stepping up to 300 in order that the leads to the refrigerant container shall be thin enough to avoid too much loss by heat conduction; the second transformer provides an impedance of 1 MΩ at 4,000 c/s. In designing the first transformer it was found that at 20 deg K the permeability of Mumetal falls to a third of its normal value, but the shunt eddy-current losses are not appreciably effective. At the level of the noise to be measured microphony in the input transformers is a serious factor, and anti-vibration mounting is necessary. In order to reduce shot noise in the first stage, an ME1400 version of the EF37A was used under electrometer conditions with an anode current of 110 μA and grid current of $10^{-4}\mu$A. When used with a tuned circuit having a Q of 50 to 800 c/s, the noise factor was 2.7 db (a figure of 3 db was stipulated).

A compact selective amplifier for the analysis of fluctuation noise in germanium rectifiers has been developed by the Radio Research Station, Slough. The basis is the RC circuit due to Schneider (*Phil. Mag.* 1945, Vol. 36, p. 371) and five resonant frequencies are provided at 0.1, 0.04, 0.02, 0.01 and 0.005 c/s with an effective Q of 8.

The transparency to infra-red radiation of germanium is exploited in a demonstration, by T.R.E. of the modulation of a beam. The transmission of infra-red through the germanium is dependent on the number of current carriers present in the germanium and this can be varied by applying an audio signal to a contact fulfilling a similar function to the emitter in a transistor. It was shown that some plastics with high light transmission are relatively opaque at the frequency used, 1.5×10^8 Mc/s (2 microns).

Selenium in its amorphous form is also transparent to radiation from the infra-red to centimetre wavelengths, and "optical" components such as prisms and lenses have been made by a simple casting technique by the Services Electronics Research Laboratory, Baldock.

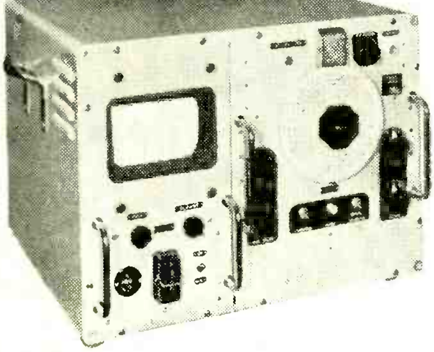
An infra-red image converter tube has been applied by Prof. B. K. Johnson (Imperial College) to the microscopy of opaque specimens, and is being used in the examination of minerals for the identification of uniaxial and biaxial crystals.

The detection of impurities in air by the change in emission and surface potential of a prepared plate at normal temperatures was demonstrated by the Signals Research and Development Establishment (Christchurch) using a vibrating capacitor in association with a selective phase-sensitive amplifier-detector. Potential changes of the order of 10 μV can be measured.

Exploration of the wavelengths and field patterns associated with different oscillation modes in a magnetron is effected in apparatus designed by S.E.R.L., Baldock, by means of a rotating pick-up probe extending from the surface of the cathode. The anode is excited by a tunable oscillator and mode "contamination" is readily visible on a c.r.t. display. By changing the axial positions of the excitation and pick-up probes, longitudinal distributions of r.f. voltage can be explored.

Some results of research into the effects of irradiation of insulants by radioactive emanations has been disclosed by the Ministry of Supply. Cross linking in long-chain polymers, such as polyethylene, affects not only the mechanical and chemical properties such as elasticity, melting (transition) point and solubility, but also the power factor which is increased at 65 c/s and 1 Mc/s, but appears to be unchanged at 9,000 Mc/s.

Although well past the "breadboard" stage a G.E.C. wide-band panoramic v.h.f. receiver developed by the Research Laboratories is conveniently included in this section, if only to show that there can be no hard dividing lines between research, development and production. It is of the double superheterodyne type and gives c.r.t. display of all signals in bands 10 Mc/s wide between 80 and 220 Mc/s. Sensitivity for twice peak noise level is 10 μV, and limitations usually set to bandwidth by considerations of image rejection have been overcome by sweeping the second oscillator through the converted signal frequency



G.E.C. wide-band panoramic v.h.f. receiver.

in the i.f. amplifier. Pulses on either side of zero beat for each signal are combined to give a single response in the display. Frequency markers are derived from a quartz crystal.

Materials

Some interesting developments are taking place in the field of magnetic materials which will upset many preconceived ideas on the subject. Having become more or less accustomed to the idea of ceramic (ferrite) permanent magnets such as Mullard "Magnadur," we must now accept *soft iron* permanent magnets. The prediction of Prof. Néel of the University of Grenoble, that pure iron should develop very high cœrcive force when the particle size is of the order of magnitude of a magnetic domain, has been experimentally confirmed and is found to be a maximum when the crystal size is between 0.1 and 0.01 micron. Above and below these limits the material exhibits its familiar "soft" characteristics. The problems of producing the right grade of power have been solved and G.E.C. in this country are now supplying "Gecalloy Micropowder" magnets in a variety of shapes. The powder has strong cohesive properties and can be cold pressed at normal temperatures without a binder, though a binder is an advantage in some applications. Like the ferrites, micropowder magnets are light, easily moulded and have low eddy current losses, but they have the added advantage of mechanical softness and ease of working. Their properties can also be controlled and in particular the ratio of remanence to coercivity can be varied over a wide range. Energy content ranges from 0.5 to 1.7×10^6 gauss-oersteds according to the grade of the material and coercive forces up to 700 oersteds are available.

Among conventional magnetic alloys the introduction by Telegraphic Construction and Maintenance of a new series of high-saturation alloys with properties comparable with Permendur, but with better machining qualities was noted; and Swift Levick are now producing columnar crystal anisotropic permanent magnets in simple shapes on a quantity basis. Made under the trade name of "Columax" this alloy has an average energy content of 6.8×10^6 gauss-oersteds compared with 5×10^6 for Alcomax III.

London Electric Wire (Lewcos) are now producing instrument wires with p.t.f.e. coatings from 0.0005 to 0.0015in thickness with adequate adherence and abrasion resistance to withstand normal hazards of winding. Synthetic enamel coatings with greater abrasion resistance than conventional oil-based enamels are now available, under the name "Diamel," on precision resistance wires made by Johnson, Matthey. A new range of wires introduced by B.I. Callenders and known as "Fifty Three" have a new strongly adherent and abrasion resistant enamel coating with mechanical and electrical properties intermediate between oil-base and vinyl acetal enamels. Non-stretching binding twines, treated with p.v.c., and designed to withstand tropical acceptance tests, are now available from Associated Techincal Manufacturers.

Although, for all practical purposes, modern activated rosin solder fluxes are non-corrosive, there is still prejudice against their use in some quarters, and ordinary rosin is used in spite of its slow and uncertain fluxing properties. Enthoven have discovered a method of increasing the activity of rosin-cored solder without the use of chemical additives and have marketed the product under the name of "Actol," with a characteristic stellate core, in all standard tin/lead alloys and gauges.

To increase still further the ratio of solder to flux in their three-cored solders "Multicore" have developed an improved activating agent "Pentacol" which will in future be incorporated in their Ersin fluxes which now form 2.2 instead of 3.4 per cent of the total weight. Fluxed solder in tape form is a new departure from Multicore. It can be wrapped round a pair of wires and makes an effective joint when heated by a match flame.

Aluminium soldering has always been regarded as difficult, but a new process developed by the Sheffield Smelting Co., shows more than usual promise and can be carried out with ordinary torch flames at a temperature of 450 deg C. The joints will withstand the accepted accelerated corrosion tests.

Makers*: Associated Technical Manufacturers (B, C, IM, IS, W); Bakelite (IM); Geo. Bray (CE); B.I. Callenders (C, CO, IS, W); British Moulded Plastics (IM); Bullers (CE); Clarke (CF, IM, IS); Connollys (IM, W); De La Rue (IM); Duratube and Wire (C, CO, IS, W); Enthoven (S); Fine Wires (W); Hellerman (IM, IS); Henley's (CO, IM, W); London Electric Wire (CO, W); Long & Hambley (IM, IS, RP); Magnetic and Electrical Alloys (L, M); Marrison and Catherall (M); Micanite and Insulators (CF, B, CO, IM, IS); Mullard (DC, M); Multicore (S); Murex (M); Mycalex (IM); James Neill (M); Reliance Wire (B, C, CO, IS, W); Rola-Celestion (D, L, M); Salford (DC, M); Geo. L. Scott (L); S.T.C. (M); Steatite (CE); Suflex (B, CO, IM, IS, W); Swift Levick (M); H. D. Symons (IM, IS); Taylor Tunnicliff (CE); Telcon (C, DC, L, M, W); Thermo Plastics (CF, IM); Transradio (C, IS, W); United Insulator (CF, CE, IM); Vactite Wire (W).

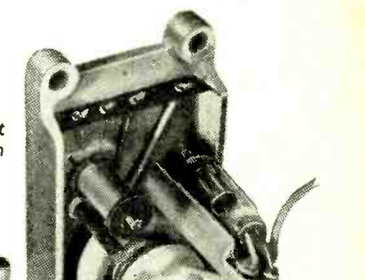
* *Abbreviations*: B, braiding; C, cables; CE, ceramics; CF, coil formers, bobbins; CO, cords; DC, dust cores; IM, insulating materials; IS, insulating sleeving; L, laminations; M, magnets and magnetic alloys; RP, rubber products; S, solder; W, bare or covered wires.

COMPONENTS AND ACCESSORIES

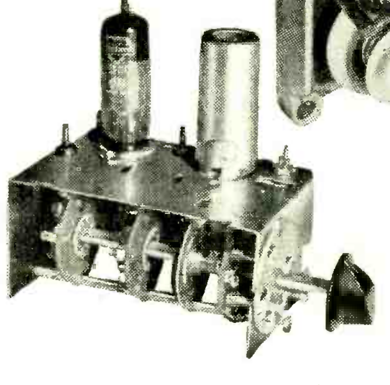
The fact that we now have five television channels all occupied is emphasized this year by the appearance of a five-channel tuner for receivers. Made by Cyldon it has an EF80 r.f. amplifier and an ECC81 frequency changer, and the channels are selected, not by a continuously variable control, but by switching in incremental inductances. The power gain of the unit is 24db and the i.f. output can be either in the band 9.5-14 Mc/s or the band 15.5-22 Mc/s according to the receiver manufacturer's requirements.

Another thing which is more of a sub-assembly than a component is the Igranic e.h.t. generator, for use with the new transformerless line scanning circuits. It contains an inductor for boosting the line flyback voltage, an EY51 e.h.t. rectifier and variable inductor for linearity control, the whole being mounted on a moulded base-plate. The unit supplies an e.h.t. voltage of 13.5kV.

For c.r.t. focusing, permanent magnets moulded from insulated metal powder are coming very much to the fore. Having the advantage of high resistivity, they can be placed close to deflector coils without affecting their performance. An example of their use is to be seen in the focus unit made by Elac, designed for wide-angle c.r.



Right: Igranic e.h.t. unit for direct-drive line-scan circuits.



Left: Five-channel television tuner by Cyldon.

tubes. This has two ring magnets mounted with their fields opposing, and focus is controlled by varying the spacing between them—the minimum field being when they are closest together. The unit contains two other rings, magnetized transversely, which can be adjusted to centre the picture.

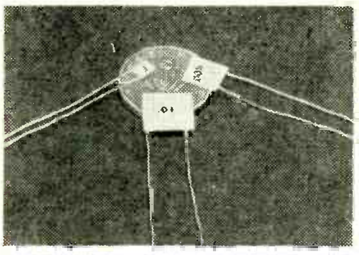
The problem of mounting the variable inductors used for width and linearity control has been solved in one way by Egen Electric, who have combined them into a twin unit, and in another by Plessey, who have stowed them in the mounting bracket of their new line scan transformers.

Makers : Advance, British Moulded Plastics, Cyldon, Egen, Electro Acoustic Industries, Igranic, Long & Hambly, Magnetic & Electrical Alloys, Mullard, Plessey, Thermo-Plastics, Weymouth, Whiteley.

Capacitors

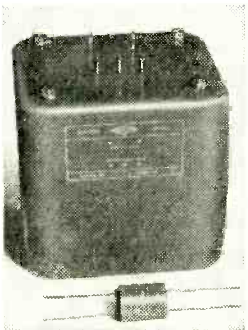
Metallized polystyrene film capacitors figure among the latest T.C.C. products. These are comparable in size to small paper types but have infinitely better characteristics. Capacitances up to 0.5 μF are available. Another plastic film capacitor, also made by this firm, has the exceptionally close tolerance of $\pm\frac{1}{8}$ per cent only and power factor of 0.0005.

The potentially high stability of silvered mica capacitors is not always possible to retain when stacked plates are used, but Johnson, Matthey have introduced a new manufacturing process in which the stack is bonded by firing at a controlled temperature. Reduction in size is claimed as a by-product of this process.



Left: Plessey "Casfilm" silvered ceramic capacitors.

Above: Zenith twin-brush Variac variable voltage transformer.



Below: Two of the Parmeko Jupiter range of resin potted transformers.

Wider temperature ranges are a feature of some of the latest Hunt's capacitors; for example, their "Thermetic Midget" can be used without derating from -100 deg C to $+120$ deg C.

A new technique is exemplified by the Plessey "Casfilm" silvered ceramic film capacitors. The smallest, measuring 0.2 in square only, provides a capacitance of 0.001 μF at 120 V d.c. working.

Some interesting miniature trimmers for television and v.h.f. applications have appeared this year. Cyldon has a chassis-mounting model with ceramic insulation of 0.5 to 3 pF or 3 to 9 pF, Wingrove & Rogers one of 0.5 to 3.5 pF with P.T.F.E. insulation and Mullard have a new version of their concentric air-dielectric trimmer with precision adjustment.

Makers*: Cyldon (T, V), Daly (E), Dubilier (C, E, M, P, T), Erie (C, T), Hunt (E, M, P), Jackson (T, V), Johnson, Matthey (M), London Electrical Mfg. (C, M), Mullard (T, V), Plessey (C, E, T, V), Stability (C, M), Static (P), Suflex (F), T.C.C. (C, E, F, M, P, T), T.M.C. (F, M, P), Walter (T), Wego (M, P), Welwyn (T), Wingrove & Rogers (T, V).

**Abbreviations:* C = ceramic, E = electrolytic, F = plastic film, M = mica, P = paper, T = trimmers, V = variable.

Resistors

To produce a standard resistance of 0.0001 ohm is in itself no mean achievement, but to guarantee its accuracy to 0.03 per cent demands such skill that few can emulate. Yet standards of this value, increasing in decade steps to 1,000 ohms, are now included in the Sullivan range of standard components. Salford have a new range of precision wirewound potentiometers intended primarily for use in desyn systems. They have tapped windings, single and double elements, twin wipers and provision for 360-deg rotation.

Miniaturization is extending into unusual fields; for example, Painton has introduced a range of miniature faders and attenuators of the type generally used in control consoles. Some are of the edgewise pattern and occupy very little space.

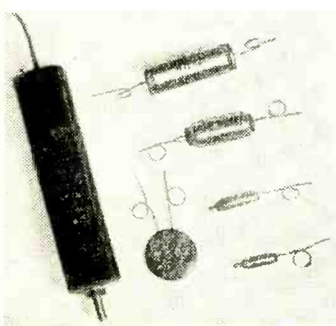
A glimpse into future development was vouchsafed by some unusual fixed resistors shown by the Ministry of Supply. In one case a form of conducting glass is applied to glass plates and rods and then fired to fuse the whole together. In another, microscopic films of one of the precious metals is applied to glass plates and glass fibres. The former is etched to produce long paths and various values of resistance, while the fibres are wound on rods to provide a high resistance in a compact form. High stability is the aim in these designs.

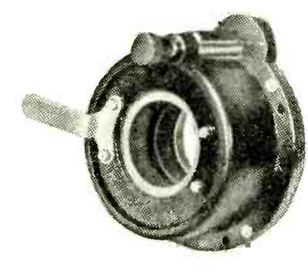
Makers*: Doran (S), Dubilier (C, Hs, W), Egen (C), Erg (Hs, W), Electrothermal (Hs), Electronic Components (C, W), Erie (C, Hs, W), Morganite (C), N.S.F. (C, W), Painton (Hs, W), Plessey (C, W), Pye (W), Salford (W), Sullivan (S), Welwyn (C, Hs, W), Whiteley (C).

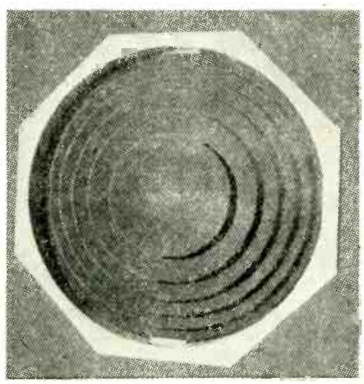
**Abbreviations:* C = carbon, Hs = high stability, S = standards, W = wirewound.

Transformers

The extension of the resin "potting" technique, as used for certain sub-miniature radio assemblies, to the







Left: Selection of T.C.C. latest type capacitors. Above: Elac focusing unit with device for picture centring. Right: Marconi 4-ft metal aerial lens for the 9-mm wavelength.

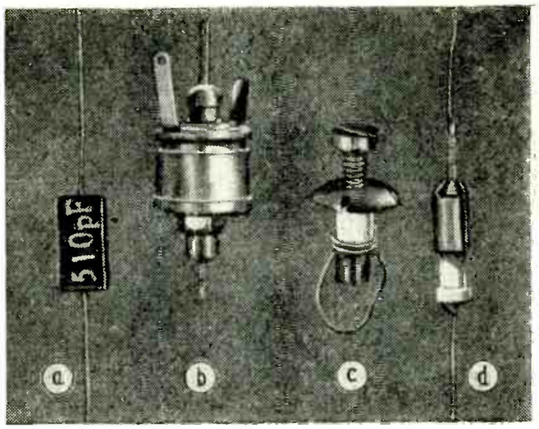
construction of mains transformers may prove an important advance in the design of this class of component. It results in a considerable saving in size and weight of the article and also in the materials used for clamping the core and generally providing either an attractive or functional finish according to the use to which the component is put.

The potting resin not only provides a seamless protective case, but before setting it penetrates all parts of the core and windings and gives internal as well as external sealing. Transformers and chokes constructed in this way are extremely robust and will withstand a considerable amount of rough handling.

Examples of the potting technique as applied to these components are the Jupiter range made by Parmeko and the Pentland series introduced recently by Ferranti.

To the Variac range of variable voltage transformers made by Zenith Electric has been added some new models in open and enclosed types fitted with twin brushes and providing two independently controlled output voltages.

Makers: Advance, Bulgin, Electro Acoustic, Ferranti, Goodmans, Gresham, Igranic, Parmeko, Partridge, Plessey, Rola-Celestion, T.M.C., Weymouth, Whiteley, Woden, Wearite, Zenith.



Some modern miniature trimmers; (b) Mullard air-dielectric with precision adjustment, (c) Cyldon television model, (d) Wingrove & Rogers with P.T.F.E., insulation compared in size with a Hunt's "Micromold" (a) measuring ½-in long.

Aerials

A few minor improvements and one or two new indoor television aerials seem to comprise this year's contribution to broadcast aerial design.

Belling and Lee have modified the reflector (and director) fitting of their television aerials to simplify assembly and also impart greater strength. A clamping device is used which by means of a single screw simultaneously locks the elements and secures the fitting to the cross-arm.

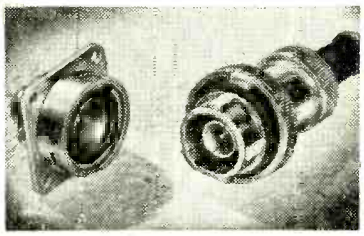
A square-section cross-arm is Wolsey's contribution to the general betterment of aerials. It is claimed to secure the elements more positively, prevent displacement by high wind and also enables the aerial to be part assembled in the factory, thus simplifying the erection on the site.

Antiference have a new indoor television aerial called a "Loftex" for either vertical or horizontal mounting and based on the Antex (X-type) principle. This firm has introduced also a new type of car aerial with a swivelling split-ball base for scuttle mounting at any desired angle of slope. It is telescopic, extends to 62 in and closes to 24 in.

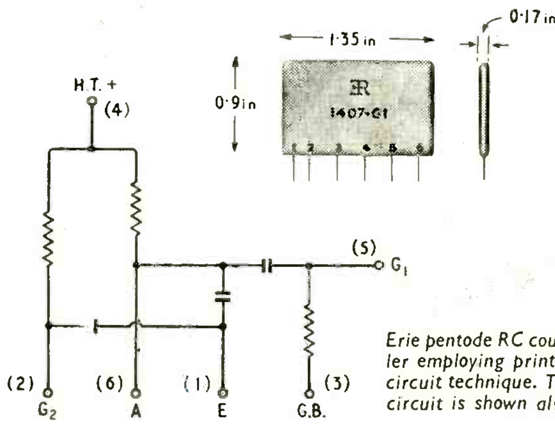
Aerial lenses for the 9-mm wavelength in metal and in plastic were used for an interesting demonstration staged by Marconi's to illustrate some of the characteristics of this type. They varied in size from 6 in to 4 ft in diameter. These lenses are now finding certain applications in relay systems.

Makers*: Antiference (B, C, T), B.I. Callender's (B, C), Belling-Lee (B, C, T), Henley's (C), Marconi's (S), Reliance Wire (C), Suflex (C), Telcon (C), Transradio (C), Wolsey (C, T).

**Abbreviations:* B = sound broadcast, including anti-interference, C = cables and feeders, S = special types, T = television.



Left: Belling-Lee double-screened coaxial plug and socket.



Erie pentode RC coupler employing printed circuit technique. The circuit is shown also.

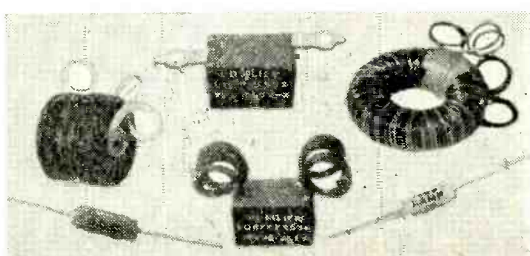
Sub-assemblies

The printed circuit technique is used by Eire in a range of compact resistance-capacitance units covering such requirements as diode filters, triode and pentode RC couplings and various other combinations.

A considerable saving in assembly time can be effected by the use of these units. In one particular case six joints replace some 16 or so if separate components are used.

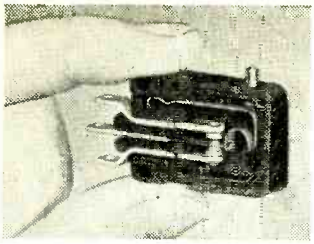
Interference suppressors form another convenient sub-assembly and as produced by Dubilier they comprise capacitors and chokes of one kind or another. A special range of television suppressors is now available for use on or in small domestic appliances such as electric sewing machine motors and hair dryers.

Below: Dubilier television interference suppressors and some of the special chokes now available.

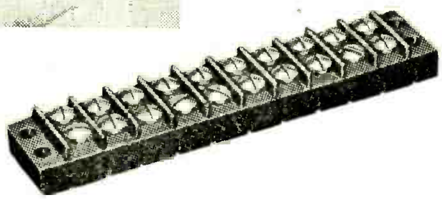


Chassis Fittings

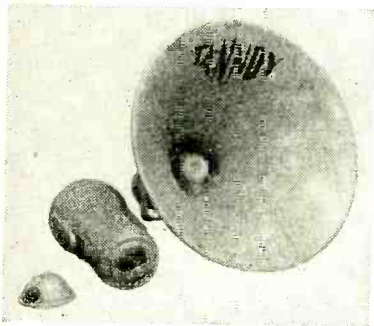
Careful insulation is the main feature of the latest valveholder from McMurdo. Intended for B9A e.h.t. rectifiers, it has a Nylon-loaded Bakelite socket moulded



Left: Bulgin micro-switch with side cover-plate removed.

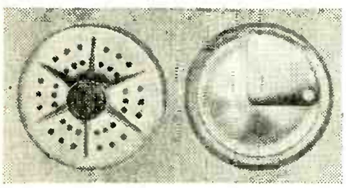


Right: Barrier terminal strip by Carr Fastener.

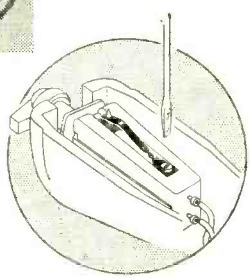


Left: Tannoy 100-watt loudspeaker for airfields, harbours, etc.

Right: Goldring No. 200 magnetic pickup.

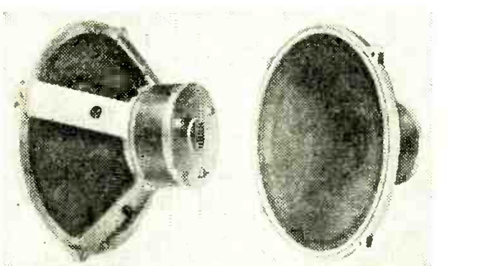


Left: Front and back plates of Acos Mic. 32 microphone capsule.



Right: Collaro "Studio" crystal pickup.

Below: Plessey 15-inch moving-coil loudspeaker.



into a Polythene shroud with an integral Polythene mounting plate, and the safe working voltage to chassis is 25kV. This firm is also producing a quartz crystal socket which will take two types of crystals, those with ¾-in pin spacing and those with ½-in spacing.

Belling-Lee have put on the market a very useful double-screened coaxial plug and socket. The contact assemblies are interchangeable in their housings to give either fixed-plug and free-socket or free-plug and fixed-socket, and the two parts are secured by a half-turn locking ring on the housing of the free part. Another improved connecting device is a moulded terminal strip, made by Carr Fastener, with screw terminals on the top face and small insulating barriers separating them. This is claimed to be more reliable than the usual strip containing metal inserts.

The range of cabinet components made by Widney-Dorlec now includes parts for miniature cabinets. These are made on a rather different principle from previous ones and are designed for spot welding. This firm also has a new telescopic mounting for draw-out chassis which locks in two places.

Makers: A.B. Metal Products, Aerialite, Antiference, Belling-Lee, Berco, British Mechanical Productions, British Moulded Plastics, Bulgin, Carr Fastener, Colvern, Cosmocord, Electronic Components, Electrothermal Engineering, G.K.N., Goldring, Hasset & Harper, Hellerman, Igranic, Imhof, Jackson Bros., Long & Hambly, McMurdo, Painton, Plessey, Reslosound, Simmonds Aerocessories, Steatite, Telcon, Thermo-Plastics, T.M.C., Transradio, Tucker Eyelet, United Insulator Co., Walter, Weymouth, Whiteley, Widney-Dorlec, Wimbledon, Wingrove & Rogers, Wireless Telephone Co., Wolsey.

Switches

There was nothing very outstanding in switches this year except that Bulgin have produced a new and smaller version of their well-known micro-switch. Broadly the mechanism is as before (see picture) but it has been made smaller by folding back on itself the spring leaf on which the operating stud presses. Also, the moulded Bakelite body has been made as a flat tablet only ¼in thick. The switch can be operated with a pressure of less than an ounce and a movement as small as 5 hundredths of an inch, and will break a current of up to 3 amps.

Makers: A.B. Metal Products, Belling-Lee, Berco, British Mechanical Productions, Bulgin, Diamond H Switches, Electronic Components, Electrothermal Engineering, Erie, N.S.F., Painton, Plessey, T.M.C., Walter, Whiteley, Wearite.

Sound Reproduction

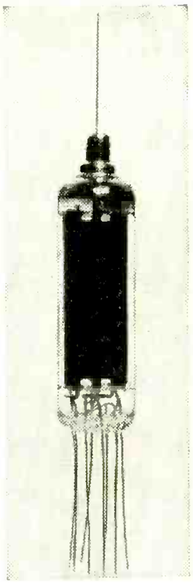
An interesting new p.a. loudspeaker has been developed by Tannoy for airfields, harbours, etc. The single driver unit is rated to handle 10 watts (120 watts peak) and is used in conjunction with a 200-c/s cut-off horn to give an electro-acoustic conversion efficiency of 50 per cent. The pressure unit is waterproof and incorporates a switched transformer for coupling to line impedances of 50, 100, 200 or 330 ohms; the coil impedance is 8 ohms.

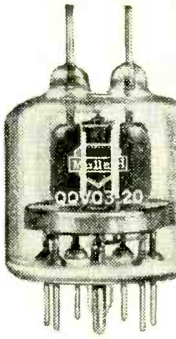
Plessey have developed a conventional cone loudspeaker with a power-handling capacity of 25 watts. It is 15 inches in nominal diameter and has applications both as a p.a. unit and as a bass unit in high-quality loudspeaker combinations. Elliptical-type loudspeakers have now been added to the range of "Elac" units made by Electro-Acoustic Industries.

In the new "53" series of Collaro gramophone motors and record changers a new speed-change mechanism with a large-diameter, concentric-ground rubber idler has been designed with a cam mechanism to minimize wear when changing speed. A new crystal turnover pickup head, the "Studio," has been added to the existing Collaro range and incorporates a simple screw fixing for the replaceable cantilever stylus arms.

A turnover pickup working on the moving-iron magnetic principle, giving an output of 0.5V at 3.16 cm/sec lateral velocity has been marketed by Erwin Scharf (Goldring No. 200) The armature is coupled to the stylus by a rubber block in which the cantilever arm is a push fit.

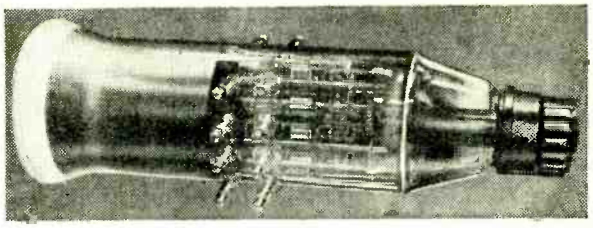
Garrard are now in production with a new transcription-





Above: *Mullard double tetrode for use at u.h.f.*

Left: *Brimar reliable valve with flying leads (equivalent to R18).*



Four-gun oscilloscope c.r. tube made by 20th Century Electronics.

type 3-speed turntable (Model 301) in which speed fluctuations are less than 0.2 per cent.

A new crystal microphone of interesting design, the Acos (Cosmocord) Model 32, is of the diaphragm-driven type, and has a flat response up to 6,000 c/s. Cavity resonance is controlled by a specially shaped back plate which reduces volume and compliance of the enclosed air, while the front plate carries a buttressed lug which performs the dual function of providing rigidity and improving the polar response of the microphone.

Makers (Components)*: Birmingham Sound Reproducers (GM, GU, RC, PU); Collaro (GM, GU, RC, PU); Cosmocord (E, M, PU); Ediswan (RC); Electro Acoustic Industries (LS); Garrard (GM, GU, RC, PU); Goodmans (LS, M); Plessey (GM, GU, RC, LS, PU); Reslosound (LS, M); Rola-Celestion (D, LS); Goldring (PU); Tannoy (LS, M); Truvox (LS); Vitavox (LS, M); Whiteley (LS, M).

* *Abbreviations*: D, diaphragms; E, earphones; GM, gramophone motors; GU, gramophone units; RC, record changers; LS, loudspeakers; M, microphones; PU, pickups.

Valves and Cathode Ray Tubes

Sub-miniature valves with indirectly-heated cathodes are quite a new thing in this country. Osram have produced two pentodes, a triode, a beam tetrode and a rectifier of this type, while Mullard have a triode which can be used at frequencies up to 500 Mc/s. In directly-heated sub-miniatures, Mullard are contributing two new hearing-aid pentodes, the DF64 and DL64, designed for 15-V h.t. batteries and with the very low filament consumption of 10mA. Also very economical to run are their new miniature valves for portable battery sets—the filament consumption being only 25mA. Another new miniature battery valve is the Brimar 1AC6 heptode frequency changer, which has an h.t. consumption of only 0.7mA and will operate up to 30 Mc/s. Brimar have also produced an e.h.t. rectifier, the R19, which has the high peak inverse voltage of 25kV, and is enclosed in a lead-glass bulb to prevent radiation of x-rays.

Production of reliable valves is continuing and this year a new range is available from Osram. The valves are mechanically-improved versions of existing Osram types and are known as the "Q" series. Brimar have extended their range of "Trustworthy" reliable valves with equivalents of the 6AM5, 6C4 and R18.

Two transistors of the point type are now available on the British market. These are the Osram GET1 and the S.T.C. LS737, both of which can be used to give a gain of about 20db. New germanium diodes are being made by S.T.C. and Mullard.

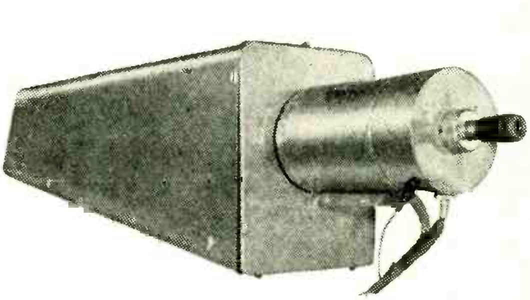
In cathode ray tubes much interest has been aroused by an oscilloscope tube containing four separate guns, made by 20th Century Electronics. It operates at 5kV on the final anode and the deflection sensitivity is just under $\frac{1}{2}$mm per volt. Each gun has independent deflecting plates and the makers claim there is no interaction between them.

Another tube with more electrodes than usual is the Mullard 17-in rectangular television tube MW43-64. This is basically a tetrode, but has an extra electrode between the accelerator and the final anode for improving the uniformity of focus over the whole screen. Like the new Ediswan 15-in tetrode CRM153, this tube has a tinted glass face. Two more tetrodes are being made by Brimar, a 14-in rectangular tube C14FM and a 17-in rectangular tube C17FM.

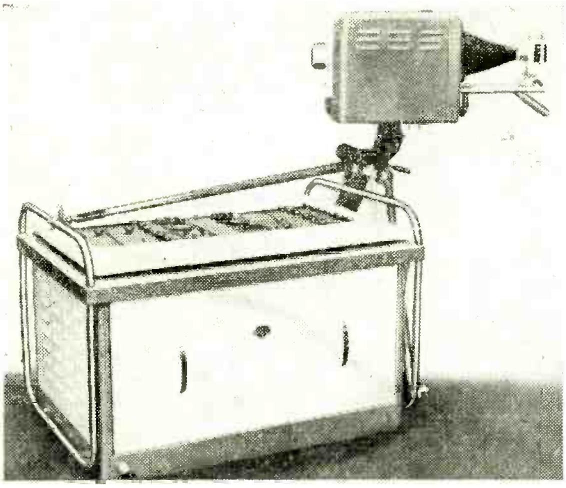
Remarkable for its extremely small size is the Ferranti KD10 voltage stabilizer, which stabilizes at 62 volts ± 0.15 volts with a running current of 1-1.2mA. It is made in a metal capsule measuring only $\frac{7}{8}$in $\times$ $\frac{3}{16}$in $\times$ $\frac{1}{4}$in. Miniaturization is also the main feature of the new Westinghouse tubular e.h.t. rectifiers, Type 39. They are $\frac{3}{16}$in in diameter, and with the selenium elements working at the high P.I.V. of 85 volts they are only 0.6in long per 1,000 volts. The current rating is 100μA and the upper frequency limit 50 kc/s.

ELECTRONIC APPARATUS

The definition of "electronics" concerned with the extension of man's senses was well illustrated this year by three interesting aids to visual observation. One, produced by Philips, is an instrument for intensifying x-ray images so that the radiologist can see them immediately. It works on the image converter principle. The x-ray image is formed on a fluorescent screen and this is in contact with a photo-cathode, which emits a corresponding pattern of electrons. The electrons are accelerated by an electrode carrying a high positive potential and focused on to a second fluorescent screen very much smaller than the first. As a result of this acceleration and reduction



Philips instrument for intensifying x-ray images.



Mullard image converter equipment for high-speed photography.

in size the final image (which is viewed through an eye-piece) is about 1,000 times brighter than the original one.

The second instrument, made by Mullard, uses an image converter tube as an electronic shutter for high-speed photography—the point being that the electron beam in the tube can be interrupted electronically much faster than a light beam can be by a mechanical shutter. In this way exposures can be made as short as 1/20th of a microsecond! The exposure is actually made by applying a positive pulse to a control electrode in the tube, which normally has a negative bias to cut off the electron beam. This produces a brief image on the fluorescent screen which is recorded photographically. Deflector coils enable the instrument to make a line of successive images across the screen so that a cinematographic effect can be obtained.

The third electronic aid to observation is a flying-spot microscope, produced by Cinema-Television. This uses a conventional flying-spot scanning system in conjunction with an optical microscope. The main feature of the instrument is that the image can be displayed on a number of c.r.t. monitors (magnified about 2,000 times) for demonstration purposes. Apart from this, the ability to alter contrast avoids the necessity for staining specimens, while the use of ultra-violet light for scanning gives greater resolving power than is possible with an ordinary microscope (because of the shorter wavelength).

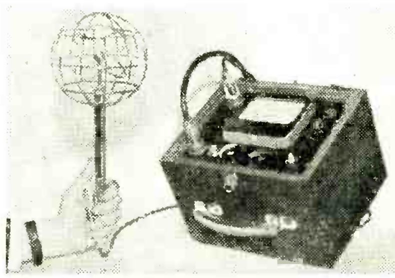
Probably the most original instrument that has appeared recently is the electronic anemometer made by Isotope Developments. It measures wind velocities as low as 10ft per minute. Basically a radiation detector, it uses a wire-cage ionization chamber in which is fixed a small piece of radioactive material. The wind simply blows away the ions which are formed in the chamber and the effect is registered on a meter in the detector.

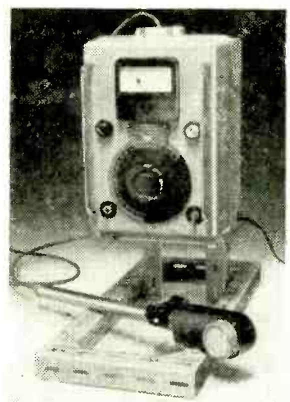
The servo or negative feedback principle is to be seen in a good many electronic instruments nowadays. In several d.c. amplifiers of the mirror-galvanometer type, for example, a portion of the output is fed back to stabilize the action of the galvo. Then in two a.c. voltage regulators a change in input voltage is amplified and applied to a motor, which drives a variable transformer to correct the change. A new pen recorder works on a similar principle with the fluctuations of the d.c. input, the movements of the "correcting" motor being used to drive the pen.

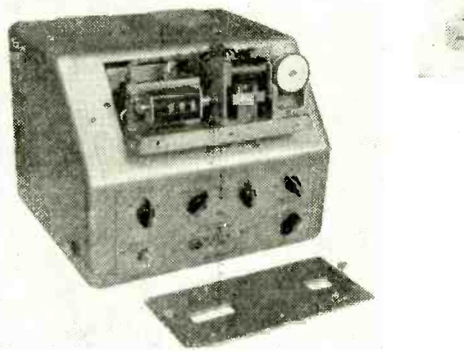
Industrial Electronics

Applications of electronic techniques in industry depend primarily on the measurement of physical constants and the subsequent derivation of signals for automatic control. Sometimes one parameter is obtained in terms of another as in radioactive thickness gauges where the fundamental quantity indicated is mass per unit area of sheet material. In the Baldwin rolling mill extension gauge, thickness is derived in terms of change in length (velocity) of steel strip as it passes through the mill, and the method of measurement is novel. Magnetic recording heads print an alternating pattern of magnetization on the strip before and after rolling, the tracks being offset to avoid interference. Pick-up heads follow the recording heads and their outputs are combined in a differential phase-indicating meter. If the distance between heads before and after the rolls is equal, and if there is no reduction in thickness, the meter reads zero—fluctuations in roll speed are eliminated by driving the recording generator from one of the roll spindles. When there is a reduction in thickness a corresponding increase in wavelength takes place after rolling, and to bring the meter back to zero the "pre-rolling" recording head can be moved relative to its pick-up by a micrometer, which can be calibrated in percentage reduction of thickness. The instrument will detect reductions of less than 0.1 per cent and can be applied to the production of thin steel strip running at speeds of the order of 1,000ft/sec.

B.T.H. have applied a high-speed multiple preselecting batch counter to the measurement of length, and have used it for cutting veneer wood to predetermined lengths. A perforated wheel is driven by the wood strip and interrupts a photo-cell light beam at intervals equivalent to 1/10th inch. Four Dekatron counters in cascade record the passage of the strip, and when the glow reaches the predetermined cathodes in all four tubes, the strip is stopped, cut and the counter reset. Up to ten different lengths can be selected by push-button and this enables the operator to avoid blemishes economically. In practice the measuring speed is limited to 12in/sec, though the counting speed would permit 200in/sec.







Top left: Electronic anemometer by Isotope Developments. Above: Baldwin "Quantex" light quantity meter. Left: Pye direct-reading (counter) pH meter.

Liquid level meters depending on electronic methods are widely used, and in one recent model introduced by Fielden, a self-balancing capacitance bridge technique is used which provides positive indication and control to less than 1 per cent. The principle of the Fielden "Servograph" recorder has been applied by Stanton Instruments to the continuous measurement of weight in a "thermobalance" designed to record the change of weight with time in specimens heated in a small furnace to temperatures up to 1,000 deg. C.

The metering of light quantity is of importance in many photographic and printing processes, and the Baldwin "Quantex" light quantity meter is based on the charging of a capacitor by a current derived from a photoelectric cell. Preset relays give exposures in two ranges covering 1 sec to 1 hour.

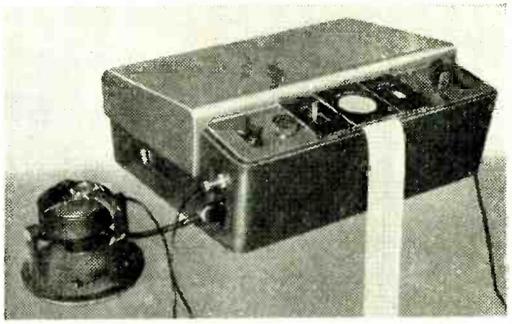
Process timers are widely used and depend usually on the time-constant of an RC circuit. As a demonstration, Allied Electronics show equipment designed to life-test an electronic d.c. voltage stabilizer through a regime of varying load and supply voltage.

Two watch timers are available from Furzehill Laboratories. Type 774V gives a bright spot on a circular c.r.t. trace. The time-base frequency can be varied over a small range to bring the spot to a stationary point, when the error can be read off a calibrated dial. An alternative display expands the watch pulse and provides useful information for the diagnosis of irregularities. In the Type 774E each watch beat is recorded on a strip of paper which records short-term irregularities as well as the average rate. Both instruments make provision for the testing of watches with all standard gear trains giving beats of 3½ to 6 per sec.

Developments in strain gauge technique include the production by Saunders Roe of foil elements by a process evolved by Technograph Printed Circuits, Ltd. Considerable simplification of the associated equipment results from the increased current-carrying capacity of these elements. Pressure gauges employing strain gauges are made by Langham Thompson for use in pipe lines and the technique is applied by C. N. Smyth to hypodermic needles for use in medical research.

Ultrasonic flaw detection is now well established and developments are mainly in detail. The latest equipment made by Glass Developments, Ltd., includes barium titanate probes, steerable beam over angles from 90 to 55 deg to the surface, miniature probes for small specimens and a single probe transmitting-receiving technique. C. N. Smyth has introduced an inexpensive flaw detector, with separate or combined transmitting and receiving probes, which can be used as an accessory to a Cossor oscilloscope.

The machining of brittle materials by an ultrasonic technique has been developed by Mullard. A magnetostriction transducer operating at 22 kc/s is coupled by a tapered metal "velocity step-up transformer" to a cutting tip, which, when applied with suitable abrasive, rapidly penetrates glass and other difficult materials. As the motion is translatory rather than rotary, holes and depressions of other than circular shape are easily formed.



Furzehill recording watch timer.

Measurement of pH (hydrogen ion concentration) is important in many industries and a correspondingly wide variety of instruments is available, as exemplified by the small battery-operated portable (Model 30) and the industrial, hermetically-sealed instrument (Model 28) made by Electronic Instruments, for which a wide range of electrode systems is available. The W. G. Pye No. 11082 pH meter gives direct readings on a 4-figure counter with an accuracy of 0.01pH. A self-balancing potentiometer is driven by a servo motor which is also coupled to the counter. Automatic zero correction is carried out continuously while the instrument is idle, so that it is always available for immediate use.

In the "Humicon" humidity detector Standard Telephones make use of glass silk between two perforated plates as a moisture-sensitive impedance. The voltage drop across this is used to control a series of thyratrons which operate appropriate ventilation or heating devices in, for example, a G.C.A. radar mobile van.

The measurement of moisture in coal dust presents difficulties due to variable conductivity from impurities, and the National Coal Board have found that these effects can be eliminated by measuring the effective dielectric constant at 30 Mc/s for which purpose a Fielden "Drimeter" has been adapted.

Dawe Instruments have developed a comprehensive warning system for inflammable gases in the ventilating systems of oil tankers. The principle involved is the rise in temperature and resistance of a catalytic platinum filament. A motor-driven commutator samples all the detectors in sequence and an alarm signal is given on the bridge indicator board by concentrations well below the explosive limit.

TEST AND MEASURING INSTRUMENTS

Under this heading are included instruments intended for laboratory use, for production testing, and for servicing. It is not possible to review any but new or substantially improved models, nor the numerous industrial instruments (many employing electronic techniques) such as material testers, that might conceivably be employed in the radio industry.

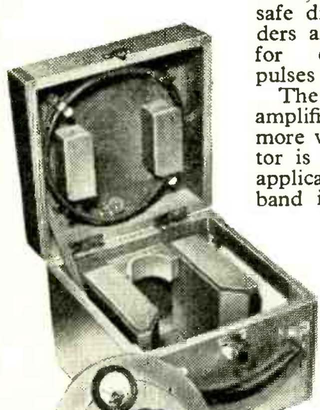
The first impression on surveying the instruments exhibited this year might have been one of disappointment at not finding outstanding new types or techniques. Closer examination would have shown, however, that behind many of the apparently similar front panels a vast amount of real progress has been made. Anyone experienced in the use of instruments knows that small refinements may add up to a more significant total than some striking departure from previous practice.

Even the old-established moving-coil meter has not reached the limit of improvement, and this year there seems to be more evidence of this than usual. To obtain a high sensitivity and speed of response, Everett Edgcumbe use four high-flux magnets in the magnetic circuit, which is shaped so as to allow a 270-degree scale instead of the usual 120 degrees. In the Metrovick meters an exceptionally robust result is achieved by skilful use of die castings and mouldings. Ballistic characteristics are especially important in signal level indicators, and the new Pullin VU meter, which is a rectifier m.c. voltmeter, claims to reach 99 per cent of steady value in about 0.3 sec, with an overswing not more than 1.5 per cent. Another specialized m.c. instrument is the Pye fluxmeter, full-scale reading 700,000 "line-turns" (7 milliweber-turns), in the well-known "Scalamp" for-mat; provision is included for rapidly restoring the deflection to zero. A portable silicon-crystal millivoltmeter developed by A.I.D. for testing signal-generator output calibration might well find wider applications on account of its frequency range of 1-300 Mc/s. An attenuator has been designed which extends its voltage range (0.05-0.15).

Among valve-aided meters the most noticeable trend is the use of pre-detector wide-band amplification to increase sensitivity, as in those by Dawe and Furzehill. The ranges of the latter (Type V.200) are now 1mV-1kV full-scale, and the frequency coverage—10 c/s-6 Mc/s—is adequate for high-definition v.f. work. The Philips 6010 battery-powered millivoltmeter, for zero frequency, employs the modulation principle so as to amplify stably over twelve ranges, 0.1mV-300V, with input resistance 0.67-100 MΩ; with the addition of a probe containing a germanium rectifier it can be used for measuring voltages from 5-1,000 mV over the wide frequency range 2-800 Mc/s. Very high input resistance is now becoming common in z.f. valve voltmeters; an instrument shown by B.T.-H. is exceptional in having an input current of only 0.1 micromicroamp at frequencies from zero to 100 kc/s.

Measurement of very high voltages is a problem. The latest Ernest Turner electrostatic voltmeters up to 20 kV are protected against brush discharge by the use of fixed vanes of graphite-loaded Bakelite. At still higher voltages, safety is a major consideration. A capacitive potential divider by Hivolt uses a concentrated field around the periphery to protect the divider proper (arranged axially) from proximity effects; the indicator, connected by a long cable, can be read at an amply safe distance. Capacitive dividers are also made by B.T.-H. for examining high-voltage pulses on a c.r. oscilloscope.

The facilities of wide-band amplification are perhaps even more valuable when the indicator is an oscilloscope. In this application, width of frequency band is usually appreciated as speed of response. Amplifiers are obtainable separately from Nagard and Cossor, working from z.f. or thereabouts upwards, but for examining high-speed transients there are obvious advantages in having the amplifier built into the oscilloscope. Several new models are well adapted for this type of work, notably the Nagard DG.103 with double-beam tube, the Philips GM.5660 with frequency band 15 c/s-10 Mc/s and pulse rise time 40 mμs, and the Airmec 830 (30 c/s-20 Mc/s and 25 mμs respectively). The notable sharpness and brightness of the trace on the screen of the last-named oscilloscope is maintained even at the extreme speed of 30 cm per μsec. Philips also have a new oscilloscope which, although a general-purpose model, takes into account the importance of pulse technique in television. It is notable for including two identical amplifiers covering 0.3 c/s-1 Mc/s and exceptional synchronization facilities. There are several other new general-purpose oscilloscopes. The Cossor 1052 also has two identical amplifiers and other improvements on the old 339, but does not include voltage-calibrated shifts like the 1049; a separate voltage calibrator (1433) is obtainable however. The Furzehill 1684D/2 continues and extends the association of this marque with direct-coupled amplification, the frequency range now being 0-4 Mc/s. The Industrial Electronics 2300, although a truly miniature $2\frac{1}{2}$in-tube instrument weighing only $6\frac{1}{4}$ pounds, includes features usually obtainable only in types many times its size—push-pull amplification from zero to 100 kc/s on both X and Y plates, and automatic synchronization.



U.h.f. absorption frequency meter, Type TF. 1026/1 (Marconi Instruments).

Field potential divider and remote indicator unit comprising 20-100 kV voltmeter (Hivolt).

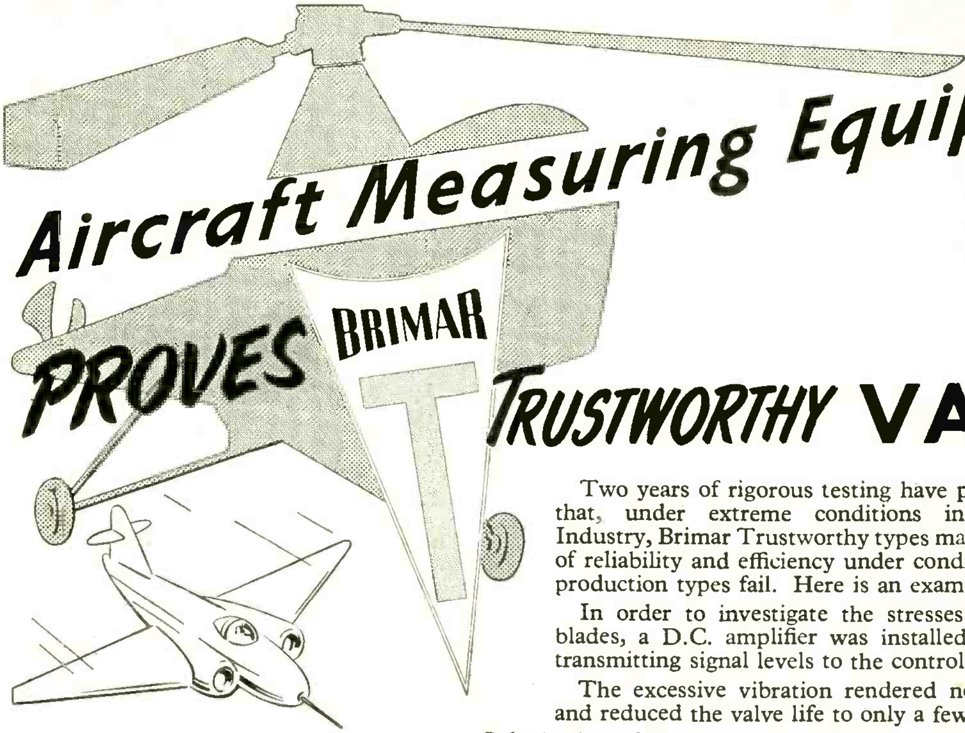
The Advance range of signal generators has been extended in the 15 c/s-50 kc/s band by Type J, which differs from the H.1 in having a calibrated power output up to 1 watt at a constant 600-Ω impedance, rather than a voltage output. Two varieties are obtainable, with and without output meter. There is now a smaller version of the Dawe a.f. source. The previous Muirhead decade oscillator has been superseded by an improved model having remarkable frequency accuracy.

All of these employ RC tuning, which has displaced the beat method for a.f. purposes, but where a very wide frequency is required without switching the beat method still applies, as exemplified in the interesting Philips GM.2889 a.m.-f.m. oscillator, covering 5-225 Mc/s in one sweep. It is particularly suitable for measuring bandpass response of television and other receivers; f.m. at mains frequency can be obtained with deviation up to 10 Mc/s by means of a "loudspeaker" movement. For testing discriminator characteristics, 400 c/s f.m. is available up to 250 kc/s deviation. A separate 15-30 Mc/s oscillator is incorporated for introducing frequency marker "pips."

The Marconi Instruments TF948 signal generator covers 20-80 Mc/s in two ranges, the effective scale length being over 14 feet, and is provided with sine wave f.m. and sine and square wave a.m., internally at three audio frequencies. The specification is elaborate and includes crystal frequency checking and modulation depth and deviation measurement. Another new instrument from the same firm is the v.h.f. test set TF.982, comprising a signal generator for 60-184 Mc/s and four i.f. ranges, a crystal calibrator, a r.f. field detector, an a.f. output power meter, and a multi-range test meter. A range of frequency hitherto not at all well provided for—300-1,000 Mc/s—is covered by the Advance L.1 signal generator in two ranges, using a 6F4 valve in a conventional series-tuned oscillator circuit. Output is controlled over a 130db range by a piston waveguide attenuator, and modulation can be either sine or pulse.

Instruments for frequency measurement are not so prominent as they have been in times past, but there are three new Furzehill crystal frequency standards: one providing 150 watts at 50 ± 10^{-5} c/s, and two portable units for general frequency checking, of which Type G.410 is provided with push-button control for selecting standard frequency signals at multiples of 0.1, 1, 10, 100, 1,000 and 5,000 kc/s. A vastly more elaborate equipment is the Plessey frequency synthesizer, which now appears with motor-driven operation by which any multiple of 1 kc/s up to 100 Mc/s can be automatically selected. An unusual

Aircraft Measuring Equipment PROVES BRIMAR TRUSTWORTHY VALVES



Two years of rigorous testing have proved beyond doubt, that, under extreme conditions in the Services and Industry, Brimar Trustworthy types maintain a high standard of reliability and efficiency under conditions where ordinary production types fail. Here is an example :

In order to investigate the stresses of helicopter motor blades, a D.C. amplifier was installed in the motor head, transmitting signal levels to the control cabin below.

The excessive vibration rendered normal valves useless, and reduced the valve life to only a few minutes.

Substitution of Brimar " Trustworthy " type 6067 freed the D.C. Signals of all noise, and measurements were able to proceed.

In another case, an Aircraft Company required instrumentation to measure stresses on jet aircraft when approaching the speed of sound. This equipment consisted of sensitive amplifiers located in the aircraft. Normal valves were too noisy under these conditions to give reliable results, but modification, to employ Trustworthy valves, has since solved the problem. Further, the equipment has stood up for a considerable number of hours service under these arduous conditions.

These are but two of many examples which prove that extra-rugged, extra-reliable Trustworthy valves are so often the perfect solution to an otherwise insoluble problem.

BRIMAR T

3 TRUSTWORTHY types are immediately available for commercial use

6064 the Trustworthy version of CV138 (6AM6/8D3)
6065 „ „ „ „ CV131 (9D6)
6058 „ „ „ „ CV140 (6AL5)

T for TRUSTWORTHY

BRITISH MADE

BRIMAR VALVES

Standard Telephones and Cables Limited FOOTSCRAY, SIDCUP, KENT

Tracking 2000g at 10 grammes maximum stylus pressure

acos REG'D **Hi-g SERIES**

PICK-UPS & CARTRIDGES

The listening public is inclined to take technical achievements for granted—to assume, for instance, that the increasingly exacting requirements of microgroove records can automatically be met by pick-up manufacturers. This is not the case. There is nothing automatic about it. The technical progress made by record manufacturers is, in effect, a challenge to pick-up manufacturers—a challenge which Cosmocord, whose slogan "Always well ahead" really does mean something, are always ready to take up. Sometimes the record manufacturers set us a problem, to which the solution is "impossible" and therefore takes quite a time to provide.

Such a problem is involved with regard to pick-up tracing capabilities which now have to be of a substantially higher order than those for 78 r.p.m. records, and are likely to become even more critical.

Cosmocord, with the very helpful co-operation of the Decca Record Company, have recently made a detailed examination into the optimum tracking requirements that *could* arise in modern types of microgroove records. This was done in order to establish a basis for the design of pick-ups that would not only satisfy the requirements of all records at present available to the public, but if possible anticipate future developments within the limits as set out in the recently published British Standard Specification (B.S.1928 : 1953).

THREE FACTORS

The three important factors that had to be considered by Cosmocord in designing such a pick-up were minimum groove width, maximum lateral displacement and maximum stylus tip acceleration.

The minimum groove width as laid down by the British Standard Specification is .002in. The conditions existing in a record giving up to 30 minutes playing time per 12in. side are well demonstrated in the accompanying scale drawings. For simplicity's sake, the groove angle has been shown as 90° and the radius at the bottom of the groove has been left out, as at .0003in. maximum it has no effect. Three pick-up stylus radii are shown, the nominal .001in. radius (Fig. 1) and its upper and lower limits of .0012in. and .0008in. (Figs. 2 and 3 respectively) according to British Standard Specification. It can be seen that the .001in. radius has .0004in. wall above its point of contact, whilst the .0012in. radius has no more than .0002in. This does not take into account the pinch effect which can reduce the margin by .0002in. at 5,000 c/s.

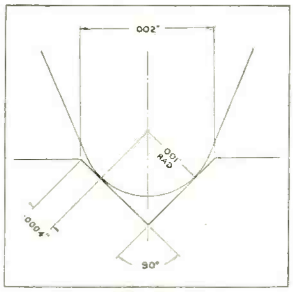


Fig. 1

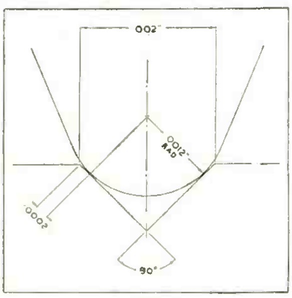


Fig. 2

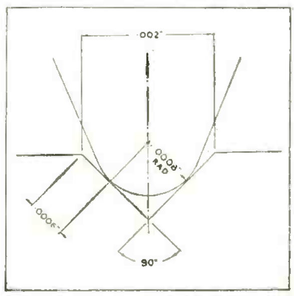


Fig. 3

PRACTICAL CONSIDERATIONS

In order to arrive at maximum possible displacement, some assumptions have to be made that are dictated by practical considerations. Working on the basis of 200 grooves per inch the maximum possible displacement (d) is .003in. At a frequency of 40 c/s. this displacement corresponds approximately to a maximum velocity of 2 cm/sec. ($v = 2\pi fd$).

Accepting the recording characteristics of the Decca Long Playing test record No. LXT 2695 as typical for commercially produced long playing records, the maximum velocity and corresponding acceleration at 10,000 c/s. can be calculated. According to the record specification the recording pre-emphasis at 10,000 c/s. relative to 40 c/s. is + 24.4 dbs. and this gives a velocity of 31.6 cm/sec. and a corresponding displacement of .0002in. $\left(e = \frac{v}{2\pi f}\right)$. It further follows that expressed in gravitational units the acceleration at 10,000 c/s. may be as high as 2000g $\left(g = \frac{ef^2}{10}\right.$, where e = displacement = .0002in. and f = 10,000 c/s.).

WHAT OF THE FUTURE?

The examination, as can be seen even from this simplified statement, has brought to light conditions that appear to be incredible at first sight. They are, however, far from being purely hypothetical and it may be only a question of time before they appear on commercially produced records. Even now there are a few odd records on the market which come very close to these limiting conditions.

It can be seen that the problem set by the record manufacturers in this matter was a formidable one. Cosmocord have answered it so completely with their Acos "Hi-g" series of pick-up cartridges that they already meet, here and now, any likely future development of gramophone records within the B.S. 1928 : 1953 specification.

acos *always well ahead*

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COSMOCORD LIMITED · ENFIELD : MIDDLESEX

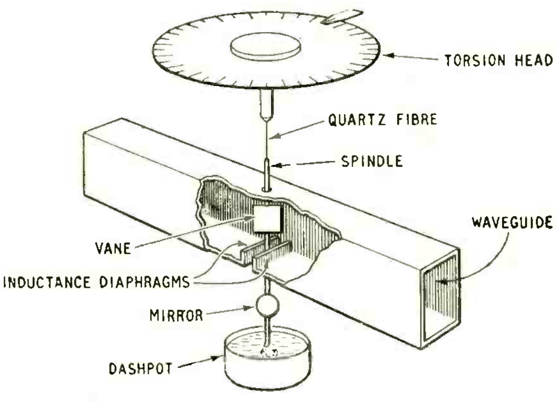
form of absorption frequency meter (TF.1026 series), illustrating an entirely different conception of frequency measurement, has been introduced by Marconi Instruments; each has a 2 : 1 frequency ratio, the whole series of five covering 125-4,000 Mc/s. The resonant system comprises a coaxial line closed at one end and tuned at the other by a variable capacitance.

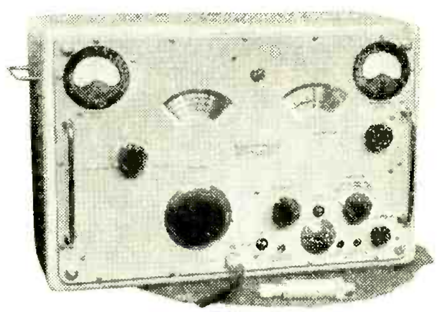
Nearly all new a.c. bridge designs, for all frequencies from power to v.h.f., are based on the use of transformer ratio arms for input or output or both. One of the chief advantages is that an admittance connected across part of a low-leakage transformer winding does not appreciably alter the ratio, as it would if connected across one of a pair of resistance ratio arms. As a result, the values of components can be measured *in situ*, notwithstanding that relatively low admittances exist between both terminals and earth. An example is the grid-to-anode capacitance of a screened valve, which is small absolutely and also relatively to the capacitances to cathode, etc. Wayne Kerr have for some time been exponents of this technique for high r.f., and now have several experimental models for a.f. In one, capacitances can be measured from 12,000 pF down to 0.0001 pF, at 10 kc/s. A 1-Mc/s transformer bridge devoted more particularly to inter-electrode capacitances and conductances and therefore less wide in range has been produced by Electronic Tubes. It is worth noting that in both these bridges, as well as in other high-performance modern equipment, the humble "magic eye" is adequate as the indicator. In another experimental Wayne Kerr bridge the Maxwell form is brought up to date with a transformer output, 10 kc/s source, and "magic eye," to such good effect that self and mutual inductance are measurable in ranges as low as 0.01μH full-scale. But perhaps the most interesting of the series is a 1-kc/s bridge for four-terminal network measurements, in which full use is made of transformer arms to cover all four quadrants of the complex plane.

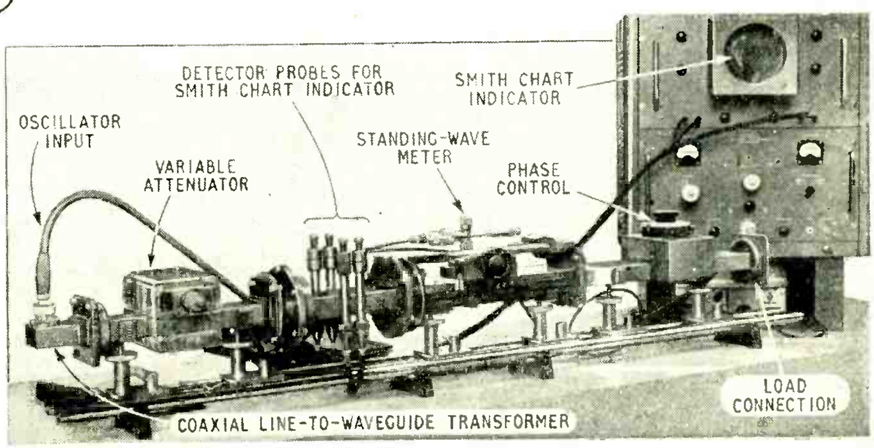
If one terminal of a bridge arm is joined to its screen, as in most of these obtainable separately, its use is thereby limited. For adaptability it is necessary to have two screens, the outer earthed and the inner joined to the arm; decade resistance boxes so arranged are produced by the Croydon Precision Instrument Company.

Apparatus for displaying valve characteristics on a c.r. tube screen now appears in a form adapted for germanium valves (transistors), by Marconi's W.T. Co. The development of equipment for testing the mechanical properties of valves has been stimulated by the requirement for valves to stand severe conditions, such as being shot from guns. The usual technique is to vibrate the valves by a modified loudspeaker drive and to examine them mechanically and electrically. In the set-up by Electronic Tubes the movements of the electrodes can be seen stroboscopically, and their resonance spectrum recorded photographically from electrical responses. The observing instrument in the Industrial Electronics vibrator equipment is the c.r. panoramic wave analyzer by the same firm.

Measuring apparatus for frequencies over 2,000 Mc/s centres on the waveguide "test bench" assembled from a wide variety of waveguide sections and components. Most of the work is based on observance of standing-wave ratio and node positions, and some recent devices have the object of facilitating this. In the Decca automatic s.w.r. indicator four crystal detectors mounted in the waveguide and spaced at eighth-wave intervals are connected to a c.r. unit which provides a display in Smith chart form from which the frequency variation of a match can be seen at once. A cylindrical chart enabling displacements measured at one frequency to be seen by inspection for any other frequency in the waveband has been devised by the Admiralty. Among the precision microwave instruments offered by Elliott Bros. is a torque vane wattmeter for absolute measurements of power in the X band. The vane is suspended by a fine quartz fibre at 45 degrees in the waveguide, and the power passing along the guide is measured in terms of the mechanical torque exerted on the vane. This can hardly fail to remind one of the Raleigh disc absolute method of measuring sound intensity.







Above: Torque vane wattmeter, for absolute measurements of power in the X (3-cm) band (Elliott Bros.).

Above, right: U.h.f. (300-1,000 Mc/s) standard signal generator, Type L.1 (Advance Components).

Right: Microwave test bench, fitted with spaced detectors for automatic Smith chart display on the indicator seen on the right (Decca Radar).

TRANSISTORS

By THOMAS RODDAM

5—*Applications in Trigger Circuits*

EARLIER articles in this series have dealt rather generally with the nature of the two common forms of transistor and with some of the more elementary linear circuit properties. Following the plan of the series, which is to hop from topic to topic in an effort to cover an enormous field sometime in the foreseeable future, we must now look at the applications of transistors to trigger or switching circuits. Here the future is wide open and, from some points of view, rather depressing. As an example of a transistor application here, I have two blocking oscillator circuits performing equivalent functions, one using a valve, power consumption 1 watt, and a transformer, as well as the few resistors and capacitors; the other uses a transistor, three resistors and one capacitor, and consumes only 50 mW. Apart from the difference in bulk and power consumption, the smaller unit should operate in the particular application for ever, while the valve must have its heater operating continuously, so we can expect to change valves at least once a year.

I say this is rather depressing, because it makes the fully automatic factory a much more immediate prospect. As Norbert Wiener has pointed out, we shall then have a community supported by slaves, a state of affairs which can be studied better in Gibbon than in the works of the economists. This may happen quite quickly, and our only hope is to make sure that the first computing machine can be solving the economic problems faster than the industrial machines are creating them. I do not think we shall get much guidance from either the Georgics or from "Das Kapital." But make no mistake, within 10 years or so we shall see the development of two economies, transistorized and non-transistorized, and if we are to belong to the second class we might as well start planting cabbages now.

The trigger circuit is the key item of any digital device. It produces pulses, re-shapes pulses, accepts them, rejects them. In most existing computer systems a twin-triode circuit has been used, but now the single or double transistor circuits are sweeping the board. Let us consider the general properties of these trigger circuits.

The equations given earlier in parts 2 and 3 of this series showed that the impedances presented at the input or output terminals of a transistor-resistor circuit could be negative, provided that the current gain, α, of the transistor was greater than unity. At the present time we can take this to mean that a point transistor must be used. This negative resistance is the first requirement for obtaining the type of

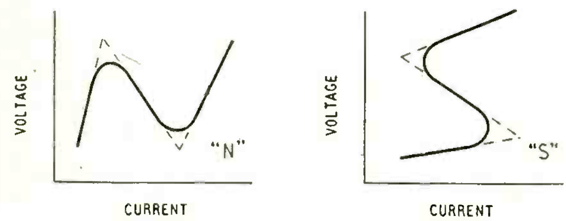


Fig. 1. Characteristics of the two main types of negative resistance.

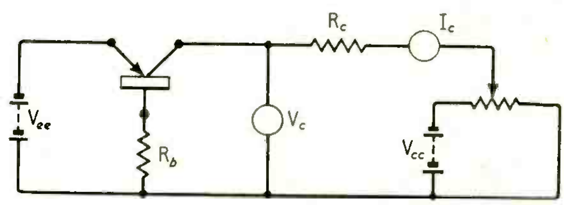
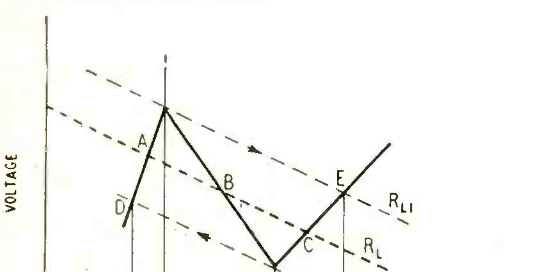


Fig. 2. N-type negative resistance with load lines. Intersections like B are unstable.



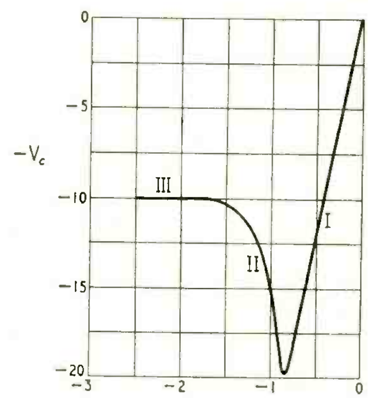
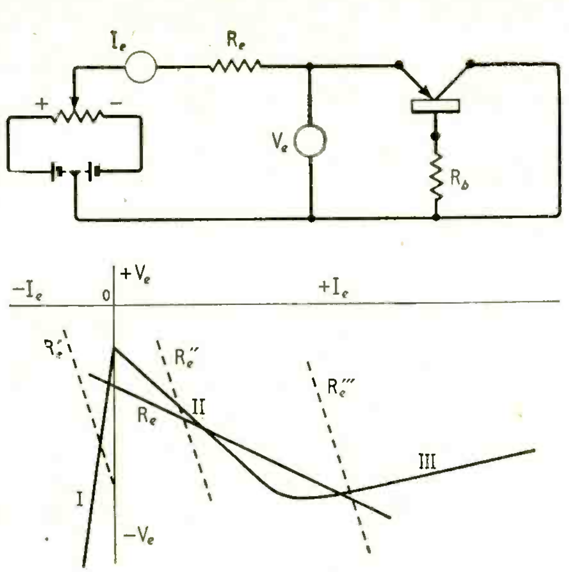
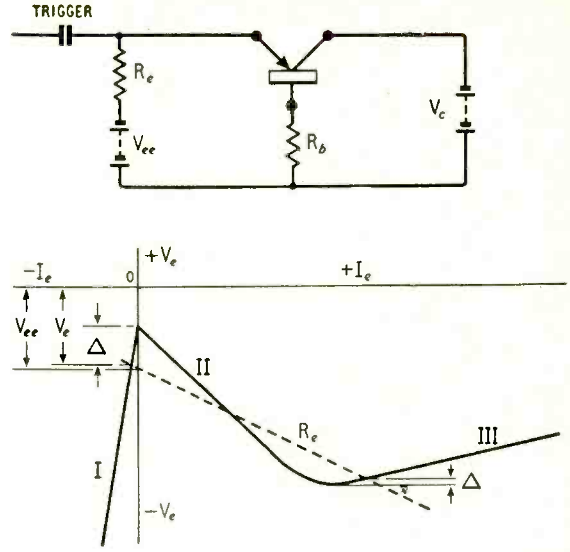


Fig. 3. Collector large-signal negative-resistance characteristic.





Left : Fig. 4. Idealized emitter large-signal negative-resistance characteristic. Right : Fig. 5. Bistable transistor circuit.

non-linear operation which is nowadays called a "switching function." A general investigation of these "switching functions" leads to the view that the most rational method of analysis is obtained by splitting the action into three regions : on, off, and transition. The classic example of such a system is the famous Duke of York, who had 10,000 men (when they were up, they were up . . .). All the important switching functions used in engineering contain some sort of energy storage which drives the circuit through the transition region. A very simple example is the ordinary press type of electric light switch. As you press the button you store energy in a spring until a triggering threshold is reached, when the spring drives the mechanism from one position to the other.

There are two types of negative-resistance characteristic, and it is necessary to be clear which type we are using in any particular circuit. The reason why there are two types is only understood when the full impedance diagram is plotted, because it depends on the way the impedance behaves at the extremes of high and low frequency. This is a topic for an article in itself. Here we can content ourselves with the voltage-current diagrams of what are called, for obvious reasons, the N and S types of negative resistance. Fig. 1 shows the simplified forms of these diagrams. The N type of negative resistance is stable when open-circuited, but is not stable when short-circuited : the S type is short-circuit stable, but unstable when open-circuited. A rough picture of the difference between the two is obtained by considering some conventional oscillator circuits, in which the tuned circuit may be either resonant, if the negative resistance is short-circuit unstable, or anti-resonant, if the negative resistance is open-circuit unstable.

Let us consider what happens if we have an N-type negative resistance and we connect a positive load resistance R to the terminals. Since the N characteristic is the characteristic of an active network we must put a bias battery in the circuit, too. The load line can then be moved parallel to itself, and three possible positions are shown in Fig. 2. The middle position, marked R_L is the most interesting. It intersects the N at three points, of which A and C correspond simply to two positive resistances in series and are thus stable. At B we have a loop consisting of a negative resistance in series with a numerically smaller positive resistance. This is unstable, and if the system is moved to B by some means it will snap (as fast as the reactances in the circuit will allow) to either A or C.

Now suppose that the system is stable at A and we alter the bias to move the load line up to R_{L1}. The only stable point is E, and the current through the loop jumps smartly from I_{D1} to I_E. Now we change the bias in the opposite direction, to bring the load line down to R_{L2}. The current falls slightly to I'_E and then as the load line leaves the right-hand corner the current drops to I_D as the only stable point becomes D. This sort of snap action will be familiar to anyone who has ever used the Schmitt double-triode trigger circuit.

It does not require much imagination to see that a load line can be imposed on the S-type characteristic in Fig. 1 to give three-point intersection. All the discussion in the last paragraph can be rewritten with the word current replacing voltage and vice-versa and it will then apply to the S-type characteristic. These two characteristics are, in fact, duals. The subject of duality has been explored by "Cathode Ray," and will be discussed in detail later.

Switching Circuits

Now, perhaps, we can turn our attention to transistor circuits. In Fig. 3 and 4, we have two very simple test circuits and the voltage-current characteristics obtained with them. In Fig. 3, the circuit is held under control by using a large value of R_c so that the tests can be carried out even in the negative resistance region II. The same stabilizing function for the emitter characteristic of Fig. 4 is performed by R_e. Both these curves belong to the N-type, although region III has got flattened out a bit : but regions I and III are positive resistance regions, linked by the negative resistance region II.

Fig. 5 shows the simple transistor bistable circuit.

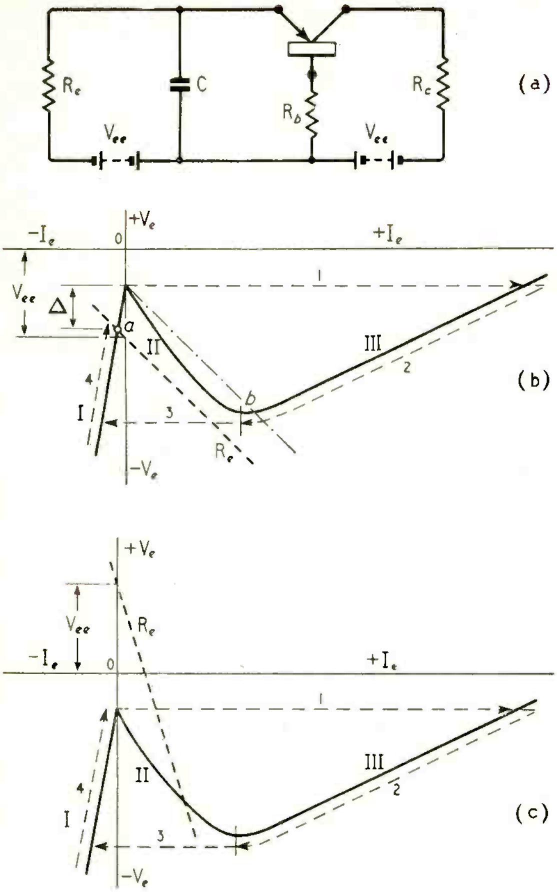


Fig. 6. Monostable and astable characteristics resulting from the addition of capacitor C.

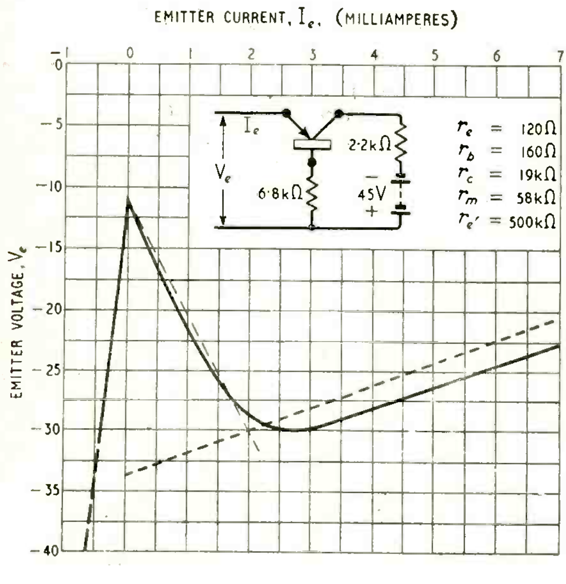


Fig. 7. Basic circuit values and calculated (dotted) and measured emitter negative resistance characteristics, for a Type 1698 point transistor.

If you compare the characteristic with that of Fig. 2, you will see that there are two stable positions, and the system can be triggered from one to the other by applying a pulse of the right polarity at the " trigger " input. This circuit is equivalent in properties to the resistance-coupled multivibrator using two triodes.

Having this idea of the multivibrator in our heads, let us see how we can introduce capacitors into the transistor circuit to convert it to either an oscillator or a " single-shot " multivibrator. A single capacitor has been introduced in the circuit shown at the top of Fig. 6. The extra resistance R_c is fairly small, and is introduced to provide a convenient way of getting a low impedance output from the circuit. In the case shown in Fig. 6(b), the controlling resistance R_e is low enough for the three-point intersection to be possible. The value of V_{ee} is such that the circuit is normally stable at *a*. Suppose now we put in a trigger voltage $\triangle$. The load line is lifted up to the apex of the N-curve, and can then " see " the single stable point *b*. As soon as the system starts to re-set itself to *b*, however, the capacitor C presents a short-circuit to the emitter, and the operating point jumps along the line 1 to a high emitter current. When the intersection with the N-curve is reached, however, R_e takes control again, and the capacitor starts to discharge along the path 2. By this time, however, the trigger pulse has ended, and when the discharge brings the emitter voltage to the trough, the working point jumps along the short-circuit line 3 to meet region I again. Finally, the emitter voltage runs up along 4 to the point *a*, where the system waits for a new trigger.

With a higher value of R_e and positive bias applied to the emitter we have the conditions shown in Fig. 6(c). This arrangement is astable, as the only intersection is in region II. The circuit oscillates steadily round the path 1, 2, 3, 4.

Pulse Length and Spacing

Practical values for a circuit of this kind are shown in Fig. 7 for a 1698 point transistor. With the values given in the inset diagram and an emitter load resistance of 15,600 ohms returned to the earth line, frequencies of 2,000-10,000 pulses/second and pulse lengths of 20-2,000 microseconds can be obtained with capacitors in the region 0.01-0.5μF. Both experimentally and theoretically it can be shown that pulse length and spacing are proportional to capacitance. Experimentally I have found that pulse repetition rate is fairly linear with emitter bias. The characteristic in Fig. 7 is not extended far enough to enable the peak emitter current to be determined, but a rough estimate is about 12 mA. The pulse available at the collector will be about 40 volts. When very short pulses at repetition rates of the order of 1,000 pulses/second are needed, the most satisfactory arrangement seems to be to use an emitter load resistance of the order of one megohm, and a correspondingly smaller capacitance. The 40-volt output pulse can then be obtained with collector current of about 1-2 mA, but for reliable operation a positive bias voltage on the emitter is needed to lift the intersection clear of the corner.

More elaborate circuits of this basic kind for bistable operation incorporate diodes in the base or emitter circuit. I hope we shall be able to consider these in more detail later, but for the moment we may note that one form of this arrangement converts the R_e line into a " dog leg," and provides a more certain three-point intersection condition.

A very similar discussion will apply to the arrangements shown in Fig. 8. The N-type collector characteristic enables us to arrange for bistable, monostable or astable working. There is nothing of special interest here, unless it is the danger of excessive currents with the low emitter impedance.

The base connection is rather more interesting. The voltage-current plot shown in Fig. 9(a) on the following page is of the S-type and it can be seen that one condition for the three-point intersection load line is that the external base load resistance must be numerically larger than the negative input impedance. By inserting inductance in the base lead we get the instantaneous open-circuit effect, corresponding to the capacitance short-circuit, needed to give the snap action in monostable and astable action. The circuits and conditions are shown in Figs. 9(b) and 9(c), and in any practical circuit a resistance in the collector lead would be added to provide an output. The main disadvantage, of course, is the rather limited range of time constants available using inductances.

This treatment is obviously of great value in considering sinusoidal oscillators. If the capacitor in the emitter or collector astable circuit is replaced by a resonant circuit, the system will act as a sinusoidal generator, limited by overloading. Similarly, the inductance in the base circuit can be replaced by an anti-resonant circuit. The design problem is quite easy now. Looking at Fig. 7 we see that the emitter circuit resistance can be just over 9,000 ohms and the emitter bias −10 volts to give a barely astable condition with the other values as shown. The net negative resistance is then very small, so that oscillations will be limited without much overloading.

Refinements of the simple emitter circuit, the most commonly used form, are directed towards improving the pulse shape. With the simple capacitor circuit the collector current pulse has a drooping top caused by the run down path 2 (see Fig. 6). The capacitor can be replaced by an open-circuited delay network, of the ordinary pulse-forming type. This has two results: the pulse top becomes flat, and the pulse duration no longer depends on the time constant (C × emitter resistance), but is fixed by the line. Different samples of transistor give identical pulses. The second refinement is to use diodes in the monostable circuit, so that it takes the form shown in Fig. 10. This circuit is triggered by a negative pulse applied to the base. Once the trigger action starts, the diode CD2 cuts off the input terminal so that it has no further control over the action. As a result, the output pulse is practically independent, both in width and amplitude, of the input trigger. The other diode, CD1, is provided to reduce the time constant of the capacitor discharge in section 4 of the path. This means that the circuit returns very quickly to its quiescent position after producing a pulse, and very high repetition rates are possible. This circuit is used in computers to reform the pulses after they have passed through the various gates. Obviously it could also be used as a repeater in a pulse code modulation system.

Another application of diodes is in stabilizing the position of the junction between regions I and II. In the characteristic shown in Fig. 7 this junction is at 11.5 volts. The value can be calculated, and is approximately $V_cR_b/(R_b + r_c)$, where V_c is the collector voltage, R_b the total base resistance and r_c the collector resistance. The weak point is r_c, which varies with temperature. Typical figures suggest that the junction

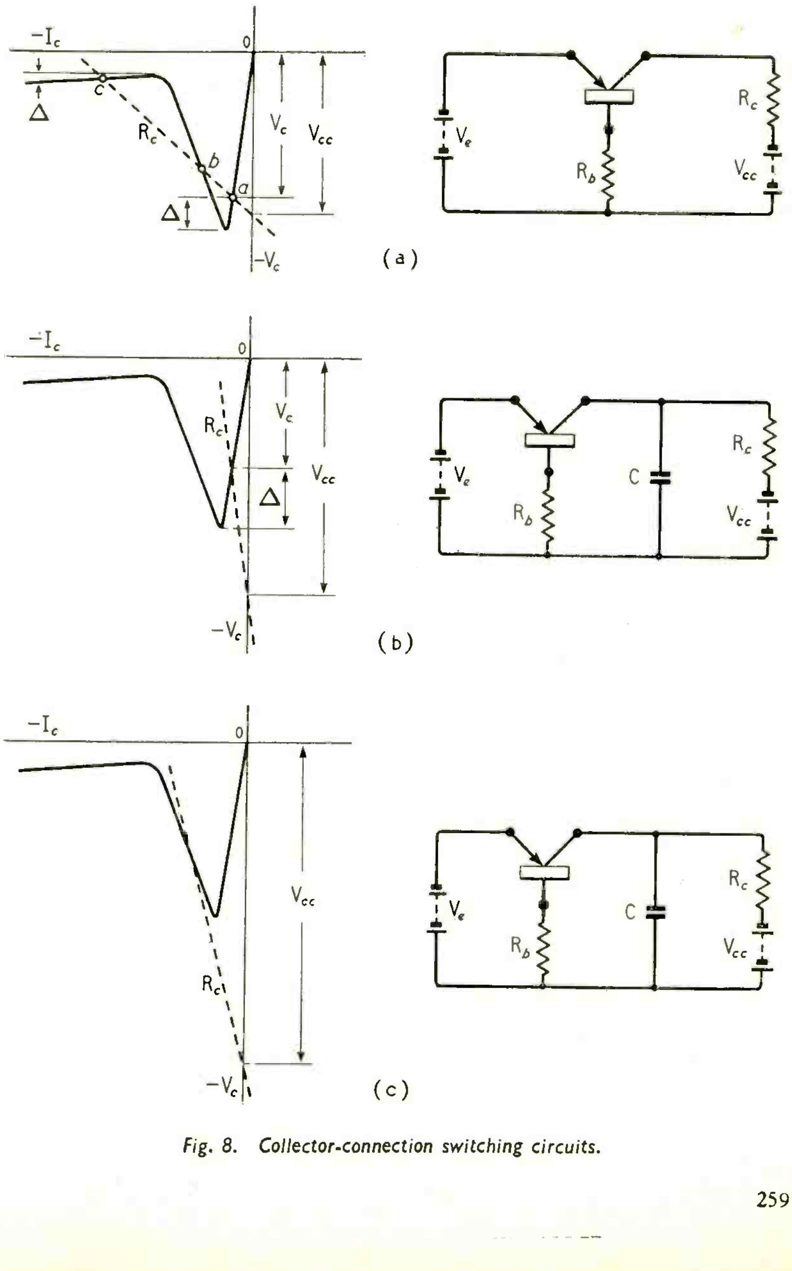


Fig. 8. Collector-connection switching circuits.

may move about 5 per cent, or, say, 0.5 volts. For circuits adjusted to maximum sensitivity this is rather important, especially if the transistor moves into the bistable condition and locks on.

I do not propose to discuss the actual circuits used to prevent this until some later date. A word of warning is perhaps the best conclusion: in using these circuits, always make sure that they will fail safe and that if an oscillator or monostable circuit does lock on it will not allow a destructive current to flow. Inductive loads are especially dangerous in trigger circuit working because they slow down the passage through the region in which the transistor has a large dissipation.

Acknowledgment.—Figs 3 to 9 are based on Figs. 3, 4, 6, 7, 20, 9 and 11 respectively of " Transistors in Switching Circuits " by A. E. Anderson and Fig. 10 on Fig. 16(a) of " Transistor Trigger Circuits " by A. W. Lo. Both papers appeared in *Proc. I.R.E.*, Vol. 40, No. 11, Nov. 1952.

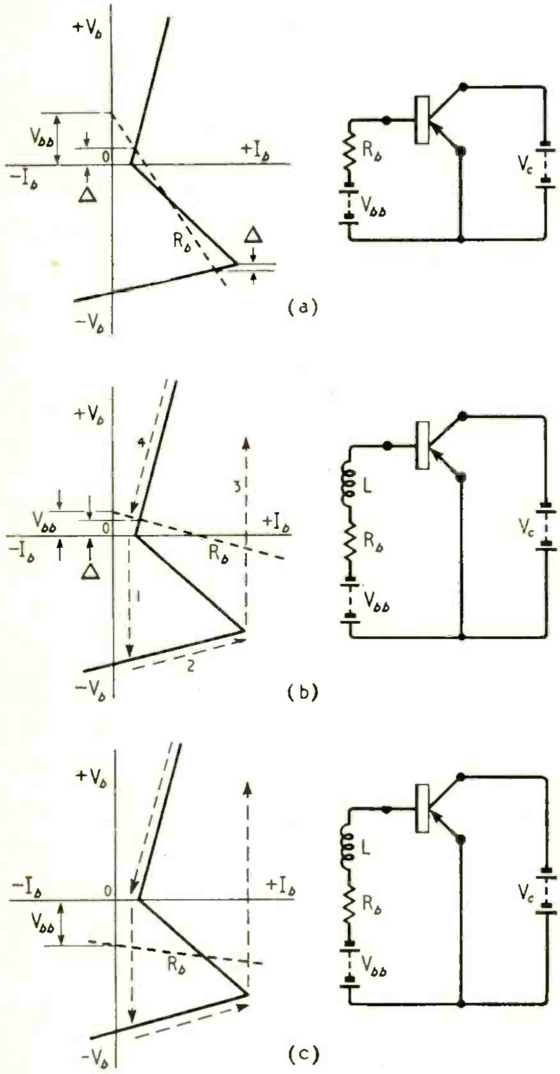


Fig. 9. Base connection switching circuits.

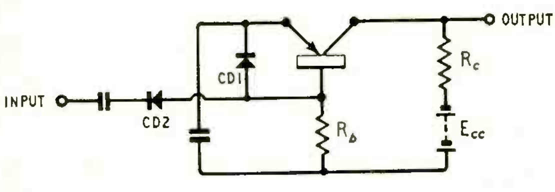


Fig. 10. Addition of diodes to stabilize pulse width and amplitude.

Manufacturers' Literature

Metal Rectifiers; a brochure giving dimensions and weights of selenium spindle-mounted stacks, with an explanation of the coding system used to identify them. From Standard Telephones and Cables, Rectifier Division, Warwick Road, Boreham Wood, Herts.

Solder, in wire, pellet and fluid form; a leaflet giving a summary of the products of Multicore Solders, Hemel Hempstead, Herts.

Television Receiver, type TUG36; console with a 17-in tube giving a picture 14in × 10½in and with five controls on the front panel, described in a leaflet from Bush Radio, Power Road, Chiswick, London, W.4

Radio-gramophone, H.M.V. model 1617A, with ten waveband ranges, three-speed record changer and 8-watt output from a 13½-in speaker. Circuit description and specification in a leaflet from the Gramophone Company, Blyth Road, Hayes, Middlesex.

Universal Television Servicing Unit (" Klempt " Type FW0200), comprising a versatile a.m./f.m. signal generator and oscilloscope. Technical specification leaflet from Otto Gruoner, Winterbach bei Stuttgart, Germany.

High-energy Permanent Magnets using " Columax," an improved grade of " Alcomax III," and claimed to have the highest magnetic energy per unit of volume yet achieved (8.63×10^6 gauss-oersteds max.). Specification and curves in a leaflet from Swift Levick & Sons, Clarence Steel Works, Sheffield, 4.

Electro-mechanical Devices, including a.c. and d.c. relays, mercury relays, time-delay relays, solenoids, thermostats and low-inertia motors for instruments. Specifications and operating characteristics in a catalogue from Electro Methods, Caxton Way, Stevenage, Herts.

Anti-vibration Instrument Mountings, in stud form, made of rubber with projecting metal pins. A leaflet giving shapes and sizes available from Howard Clayton-Wright, Wellesbourne, Warwickshire.

Television Converters; alignment instructions for Type AC/4 units in a leaflet from Spencer-West, Quay Works, Great Yarmouth, Norfolk.

Surplus Equipment, Government and manufacturers', listed in a catalogue from Clydesdale Supply Co., 2, Bridge Street, Glasgow, C.5. Also a supplementary list of **Components and Accessories.**

Microwave Test Equipment, for waveguide sizes 10 and 11, including standing-wave meters, adjustable short circuits, matched loads, waveguide-to-coaxial line transformers, variable attenuators, waveguide bench rails and supports, and a Heil-tube test oscillator. Loose-leaf book containing specifications from Decca Radar, 1-3, Brixton Road, London, S.W.9.

Toggle Switches and Signal Lamps, also a number of special-purpose switches, described in an illustrated catalogue with blue-print drawings from Arcolectric Switches, Central Avenue, West Molesey, Surrey.

" **Permanent Magnets**," a well-produced illustrated book of 58 pages covering the theory of magnetism, design of magnets, materials used, properties of various alloys (with curves and tables), effects of heat, shock and alternating fields, magnetizing and demagnetizing, testing, storage and handling; with a glossary of technical terms. From the Permanent Magnet Association, 301, Glossop Road, Sheffield, 10, price 10s.

Waveform Analyser; description and specification (with curves) of the Muirhead-Pametrada instrument and associated equipment, with notes on its use for vibration measurement and waveform analysis in various industries. An illustrated booklet from Muirhead & Co., Beckenham, Kent. Also a leaflet on their amplifier-maintained tuning forks for frequencies of 480-2,000c/s.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference.

Gold Plated Components

Considerable interest was aroused by the gold plated contacts on several of our components on view at the recent R.E.C.M.F. exhibition.

This finish came about as a result of stringent tests to which many components under development for the Ministry of Supply and Admiralty are subjected.

These tests, particularly those of R.C.S.11, to which components of the H.1 grading have to be submitted, include subjection to temperatures of 100°C dry heat, where hitherto the top temperature in many cases was only 70°C. In addition, there are tests in which the components are exposed to exacting and prolonged conditions of damp heat.

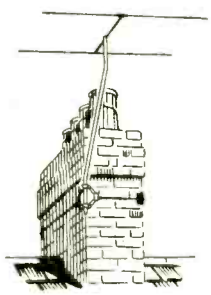
To maintain a low contact resistance under the exhaustive tests described above, considerable attention had to be given to the contact surfaces. After intensive investigation it was found that a gold flash on an appropriate underfinish gave the required durability, together with low contact resistance.

It will be obvious that once the process had been introduced, its benefits would be applied wherever desirable.

It may be asked why not keep to silver ? Silver discolours badly as silver sulphide has an awful appearance, and makes it very difficult for soldering.

Birds on the Aerial

When speaking to an audience in a district where horizontal aerials are necessary, one question certain to be asked is, " What



happens if a row of seagulls decide to perch on the elements ? " Web-footed birds **don't** perch in the accepted meaning of the term. They will sit in rows on the comparatively rounded apex of a roof, or on the flat " bun finial " of a flag pole, but they cannot grasp a half-inch rod or tube. Starlings might, but they only weigh a few ounces. We have seen rooks that have developed a technique of grasping the top of an " H " aerial, and sitting apparently in comfort, but even a rook has little weight. Birds are built for lightness, even their bones are hollow and contain air.

Suppression of Household Appliances

A few days ago we were testing out a new flex lead suppressor on a number of appliances, hair-dryers of various makes, fans, sewing machine motors, etc. The tests were carried out at home. When tried with T.V. on an outdoor aerial, suppression was quite good, making all the difference between intolerable nuisance and entertainment value. On an indoor aerial in the same room as the receiver however, interference was still troublesome. That is why, as we have so often written before, the authorities will have scant sympathy for a complaining viewer who has not done his best for himself by the erection of an aerial suitable for his location.

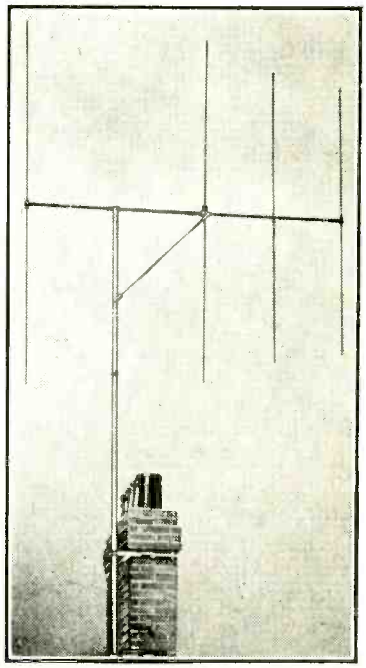
A Lightning Tip

A few peals of thunder at Easter reminds us to issue the annual soother regarding lightning. The chance of a strike on your house is very remote, and the presence of an aerial does not increase the risk. If anything, it is bound to reduce the chance, as the presence of the aerial connected to a receiver is constantly discharging that little pocket of air in the immediate vicinity, thereby reducing the voltage gradient.

We can pass on a useful tip for those who feel they should do something to satisfy a qualm. Theoretically, the top element should be connected to the centre conductor of a co-axial feeder and the lower to the screen. We doubt if the average user would notice the difference, therefore reverse the arrangement and take the upper element to the screen, and before it enters the house, remove the P.V.C. outer covering exposing the screen, twist round it a length of heavy copper wire and take to a good earth by the most direct route. Care should be taken to waterproof the join with adhesive tape, otherwise water might syphon into the house via the screening mesh.

"Non-Directional" "Multirod"

We had a report from a useful source, that a " Multirod," carefully installed, was apparently " all round looking." The case was sufficiently interesting to warrant sending the mobile research laboratory to examine the situation. We found that the answer was due to the fact that the site was surrounded by hills, there was



" Belling-Lee " " Multirod " 4-element array.

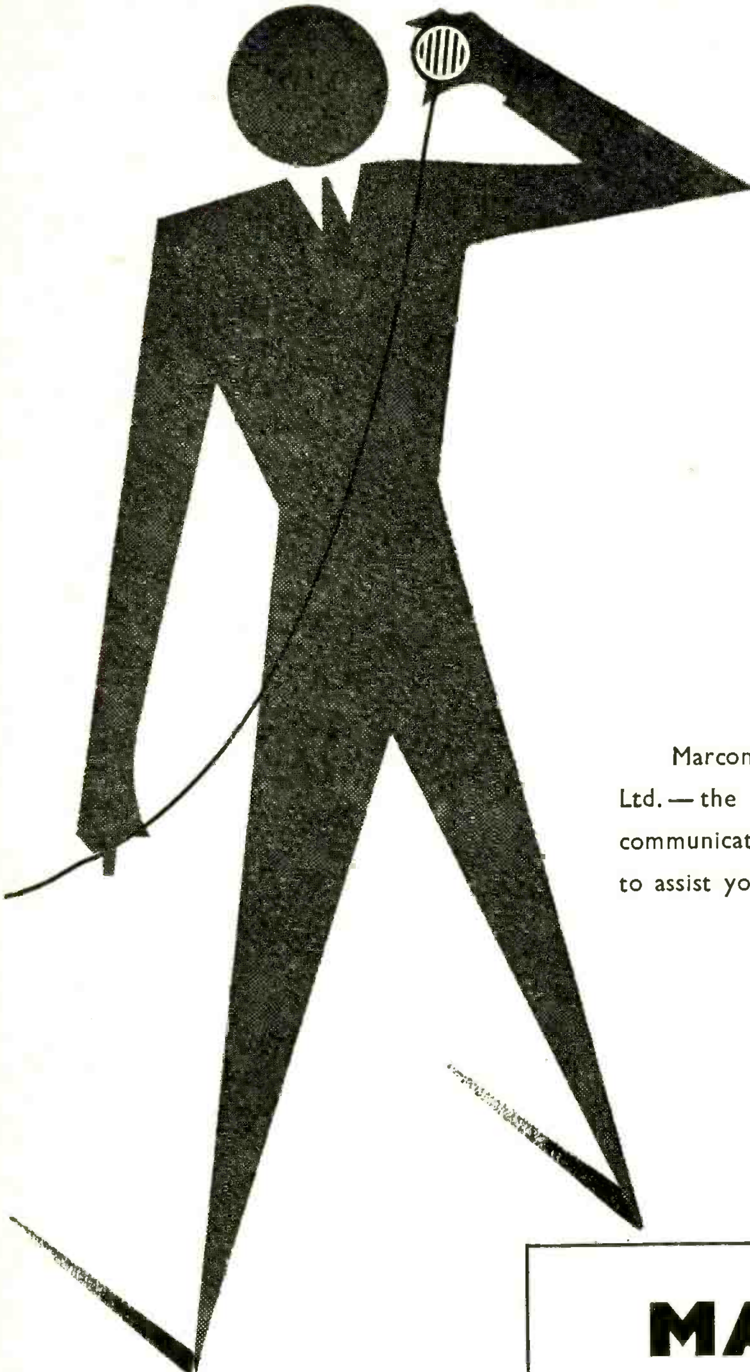
apparently no direct signal, all that the aerial received was reflections and diffusions from the high ground.

Aluminium Corrosion

Most forms of corrosion are very serious to the engineer, and we would prefer to think that there was no such thing associated with our aerials. We ask users to paint aerials on erection and at intervals, but we know that few are so treated. The form that aluminium alloy corrosion takes, is that parts tend to " grow " together, with a reduction of electrical resistance.

Written 27th April, 1953

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND



Diagnosis of Distortion

By E. R. WIGAN*
B.Sc.(Eng.), A.M.I.E.E.

The "Difference Diagram" and Its Interpretation

AT the outset it should be emphasized that this article is not concerned with the *measurement* of distortion; it deals with a method of *diagnosis* aimed at recognizing, locating and removing the source of any distortion which is found.

The diagnosis is made by examining an oscilloscope trace which represents all the defects of the apparatus which is being tested. By comparing the outline of this picture with certain standard shapes, examples of which are given here, the various sources of distortion can be recognized. For example, typical overload conditions can be recognized at a glance (Figs. 10 and 11). In other photographs the distortion conditions have been artificially exaggerated to bring out the characteristic features.

The technique adopted to generate these pictures can be summarized briefly as follows:—

A pure sine wave signal is applied to the test object (an amplifier, for example) and also to the X-plates (horizontal axis) of an oscilloscope.

The distorted output signal is applied to the Y-plates after passing through a network which subtracts the pure fundamental wave and leaves only the distortion terms, together with any hum, hum-modulation or circuit "noise." Before being applied to the Y-plates this "difference" signal is amplified, generally 30 to 100 times.

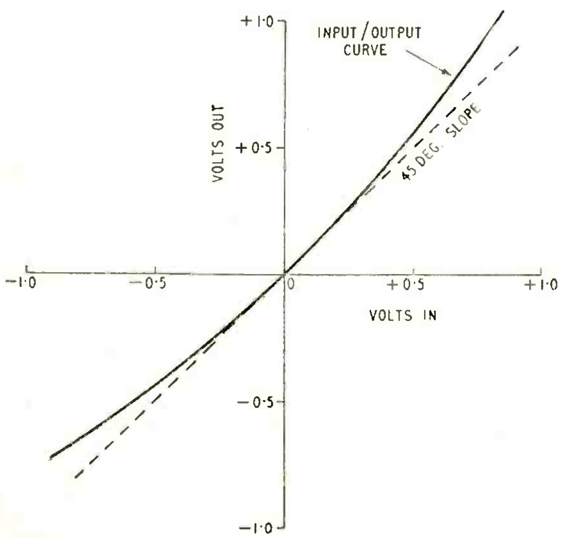
When the phase of the X-signal is suitably adjusted the trace shown on the oscilloscope closes into a curved line which is a representation of the transfer characteristic of the circuit tested with all its defects enormously magnified (see Figs. 1 and 2). Because this display is produced by a subtraction process the term "difference diagram" has been chosen for it.

The technique has the special merit that transient or slowly changing distortion conditions can be observed. Moreover, although it is not put forward as a measuring technique, it is possible to read off from the difference diagram the magnitude of the primary distortion terms with useful accuracy, a procedure which is necessary when correlation with standard harmonic analyses is required.

Since distortion components as small as 0.1 per cent can be recognized under good conditions, this method of diagnosis is applicable to amplifiers, oscillators, and the like, which have to meet even the most stringent performance specifications.

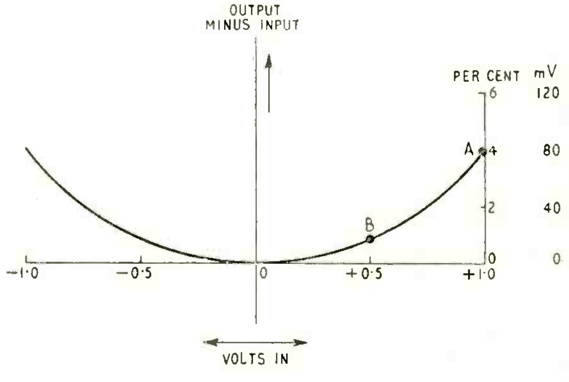
The equipment required is relatively simple and can be assembled from apparatus generally available in an audio-frequency laboratory.

Details of Apparatus. To understand the difference diagram, consider first the typical input/output transfer characteristic of a single-valve amplifier shown in Fig. 1. The curve for an ideal amplifier is represented by the dotted line with a slope of 45 degrees, and the difference (i.e., vertical intercept) between these two curves represents the departure of the system from the ideal conditions. In Fig. 2 this difference is shown, plotted in the form which has been called the difference diagram.



Left: Fig. 1. Ideal (dotted) and actual transfer characteristic of an amplifier.

Below: Fig. 2. "Difference diagram" corresponding to Fig. 1.



* B.B.C. Research Department.

The block schematic of the apparatus to produce this diagram electronically is shown in Fig. 3. The two upper branches carry out, at (9), the subtraction process illustrated in Figs. 1 and 2. The fourth branch is used only when a large distortion term has to be cancelled to prevent confusion of the fine detail.

The circuits shown are arranged for a test frequency of 1,000c/s. The filter (8) in Fig. 3 is necessary only if the phase shifter (7) contains valves which may introduce distortion. The ganged attenuators (4) and (6) are used to alter the input level to the test object (5) without changing the output level delivered by (6).

If it is desired to cancel any selected component in the difference signal, the oscillator (15), which can be set to multiples of 1,000c/s, is locked to the input signal by a "spike" generated by clipping and differentiation at (14). Element (12) is used to adjust the phase of the harmonic frequency generated by (15) relative to the phase of the test signal.

The arrangement shown in Fig. 3 is used when both the pure input signal and the distorted output signal from the test object are available, but if this is not so, and only the output can be obtained, the arrangement of Fig. 4 is employed.

Since the signal equivalent to the missing input signal is necessary for the "subtraction" process, a filter (8) is employed to abstract a pure sine wave from the output signal. Tests of this kind are called here 2-terminal tests, to distinguish them from the 4-terminal test made when both input and output terminals can be used.

Typical Diagrams. Essentially the difference diagram is a Lissajous figure, the configuration of which will change with the setting of the phase control of the X-amplifier. In some circumstances it follows the shape of the transfer characteristics and it may also be used, with caution, to estimate the harmonic content. To introduce the reader to the kind of information which a difference diagram yields the following examples have been chosen: Fig. 5(a) is the difference diagram generated by a single-valve output stage. The input/output curve of such a stage is similar to Fig. 1, so the diagram of Fig. 5(a) resembles Fig. 2. When the input voltage is increased the diagram changes to Fig. 5(b) The downward "spike" on the right is due to grid-current which sets in fairly sharply and reduces the output voltage. (The reason for the curve being looped is dealt with in the Appendix.)

The input/output curve of a push-pull stage is like Fig. 1 in the upper part, but in the lower part lies below the dotted line. As a result the difference diagram (see Fig. 6) droops downwards on the left-hand side and tips up on the right.

The distortion component present in Figs. 2 and 5(a) is almost pure second harmonic, shown by the two positive maxima in the difference signal. Fig. 6, however, shows nearly pure third harmonic because there are three positive maxima in the trace on the tube; one on the extreme right, one as the fundamental approaches negative maximum, and one as it returns to the centre again. In this photograph the "go" and "return" traces are, of course, superimposed. The vertical width of the diagram is due to hum in the amplifier. In spite of this the upper and lower edges retain their characteristic S-shape.

The flattened parabola of Fig. 7 indicates a heavily driven triode stage and contains both second and third harmonics. It consists of a parabola (characteristic of second harmonic) to which has been added an S-shaped curve which steepens one end and flattens the other. The relative proportions of the two components can be deduced from this. Here again, in spite of a very large proportion of hum, the upper and lower edges of the diagram retain the shape characteristic of the non-linearity of the system. To get this photograph the earlier stages of the amplifier were heavily driven while the gain control at the input to the final stage was turned down.

Fig. 8 shows the presence of hum-modulation in a push-pull output stage in which there was a strong 100-c/s ripple in the h.t. supply. The test-frequency was set to be exactly ten times the ripple frequency so that ten individual stationary traces could be seen, each corresponding to a different h.t. voltage. Each trace, Fig. 8(a), is a distorted S-shape and oscillates 100 times per second about the centre point of the

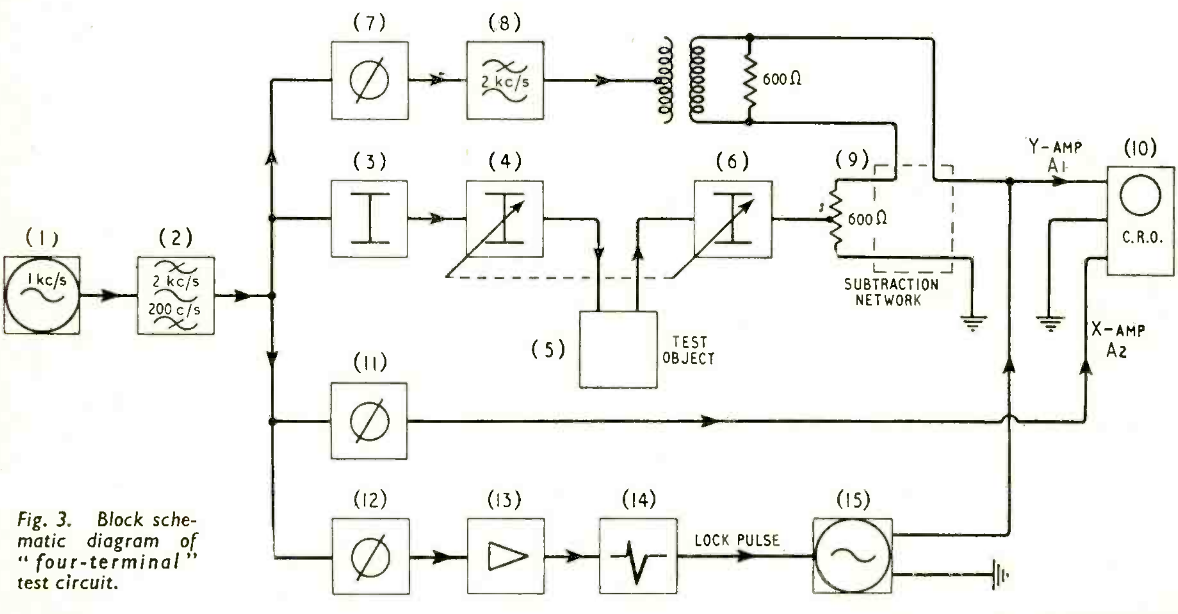
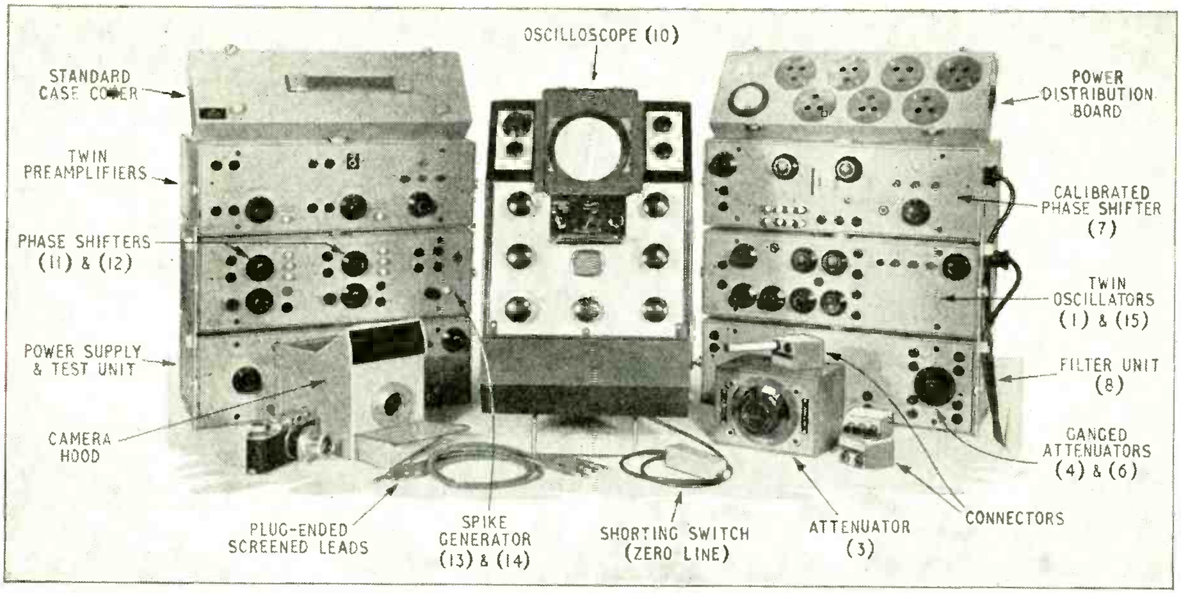


Fig. 3. Block schematic diagram of "four-terminal" test circuit.



Portable test equipment and accessories. Numbering corresponds to that used in Figs. 3 and 4. The twin pre-amplifiers on the left are used to provide either high-level test signals (up to 20 dbm) or to act as a buffer between the output from the test object and the input to the test gear. All units are housed in the standard ventilated boxes used by the B.B.C. Research Dept. for portable test apparatus.

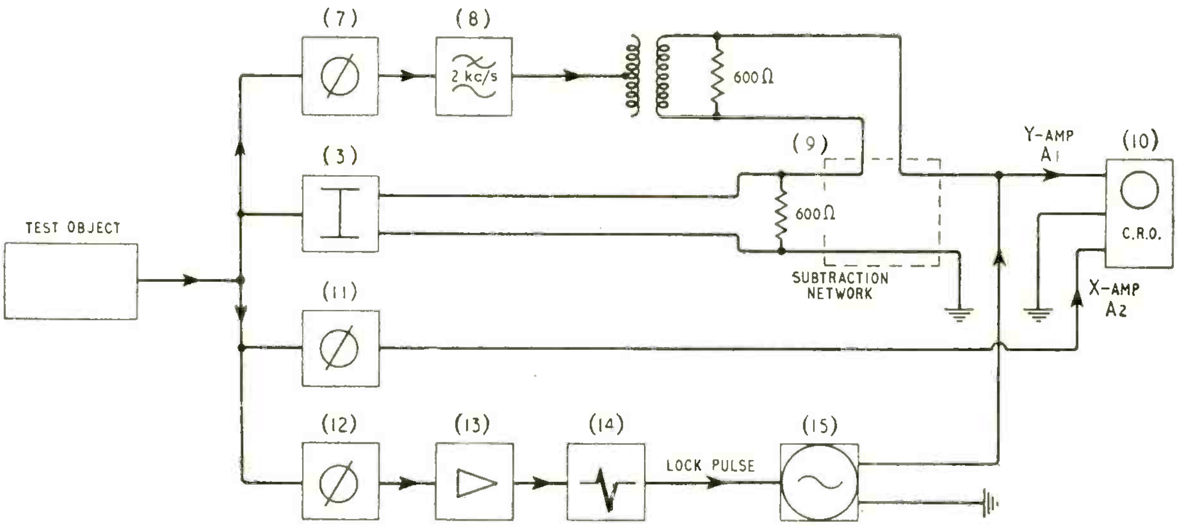


Fig. 4. " Two-terminal " circuit for use when the input to the apparatus under test is inaccessible.

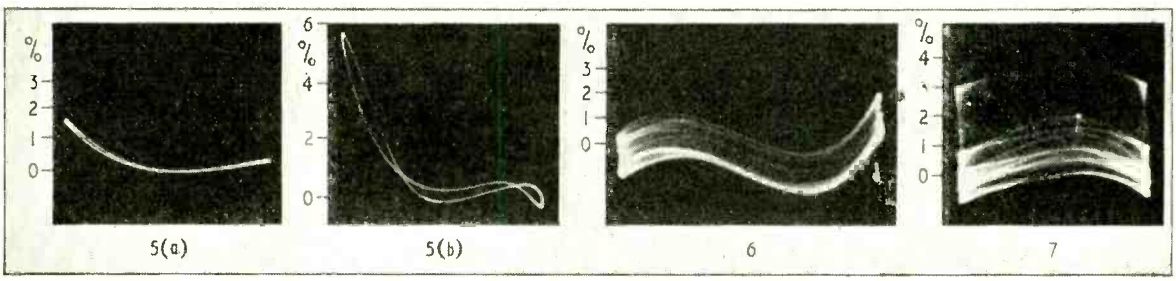


Fig. 5. Single-valve output stage working (a) just below and (b) just above the overload point. Fig. 6. Hum and third harmonic in a push-pull output stage. Fig. 7. Hum at greater level than second and third harmonics (single-valve output stage).

diagram. When the driver stage was balanced the second harmonic term disappeared, yielding Fig. 8(b). Finally the third harmonic was removed by "injection" (see Appendix). The resulting diagram, Fig. 8(c), has nearly straight edges which shows that higher distortion terms were negligible, evidence that the system was operating well within its capacity.

The previous example illustrates very well how effective a picture of the distortion can be, for the amplifier in question had earlier been tested with a wave analyser. The 100-c/s modulation had not then been noted, whereas the diagram showed at a glance that the modulation term was several times larger than the second or third harmonic.

Figs. 9(a), (b) and (c) show gross distortion in an amplifier of the electro-mechanical type in which a moving-iron loudspeaker movement drives a pair of push-pull carbon buttons. There are some novel features. Fig. 9(a) shows the stepwise response of the carbon granules. Fig. 9(b) shows a double line at bottom centre due to an alternative transient condition. Figs. 9(c) and (d) show an unsuspected phenomenon, the reversal of the phase of the distortion terms when the d.c. voltage fed to the carbon button was increased slowly through a critical value. The distortion, Fig. 9(c), momentarily disappeared and reappeared in reversed phase, as shown in Fig. 9(d). It will be noted that the "go" and "return" traces are different, owing to friction or other forces between the carbon granules.

The remaining diagrams were obtained with the circuit of Fig. 4. Figs. 10 and 11 show the "spike" characteristic of a system driven beyond its designed limits. Figs. 12(a) and (b) show very clearly the sharp origin distortion produced by a diode. The loop in Fig. 12(b) generally appears when severe overload is associated with a large transient phase shift.

The distortion illustrated in Figs. 11 and 12 is the result of two processes, and neither diagram alone gives any clue to the true cause. Both the recording and the playback equipment combine to produce Fig. 11, and transmitter and receiver combine to produce Figs. 12(a) and (b). From a series of diagrams representing different carrier levels and degrees of modulation it is, however, possible to separate the influence of the receiver from that of the transmitter, but it is difficult to find an equivalent method of dealing with recording distortion.

Fig. 11 is a good example of a difference diagram containing "noise" which has blurred the edges of the trace. Variation of the speed of the turntable caused slight oscillations of this diagram about its centre point. This has slightly lengthened the extremes of the trace and confused details which could be clearly distinguished when the diagram was directly viewed on the tube face.

Scale of the Diagram. The Y co-ordinate (i.e., the height) of any difference diagram will depend directly upon the gain chosen for the Y-amplifier of the oscilloscope. This gain must be known and included in any photograph of the diagram either for record purposes or to allow one picture to be compared with another. If the procedure set out below is followed the photograph is like Fig. 12(b). The necessary information is given by the scale.

The percentages represent the deviation from linearity of the transfer characteristic; the scale must be used with caution, however, for it can be applied directly only to the extremities of the diagram (e.g., the point A in Fig. 2). At that point the percentage scale reads 4 per cent while the input voltage is 2.0 V peak-to-peak. It follows that the 4 per cent ordinate corresponds to 80 mV. That is to say that if the conventional transfer characteristic were drawn, the instantaneous output voltage would exceed the instantaneous input voltage by 80 mV where the latter was +1.0 volt. Observe, however, that the corresponding ordinate at −1.0 volt input indicates that at this point on the diagram the output voltage will be less than the input voltage by 80 mV. This follows from the simultaneous change of sign of input and output voltage as the left-hand side of the diagram is entered.

This apparent anomaly should be carefully noted, and in practice a test always has to be made to establish whether positive or negative ordinates on the tube face represent gains or losses. A simple test is to apply a biased-off diode to the test-circuit; where the signal voltage exceeds the bias a sharp kink or spike appears in the diagram. The direction of this spike indicates the loss ordinate.

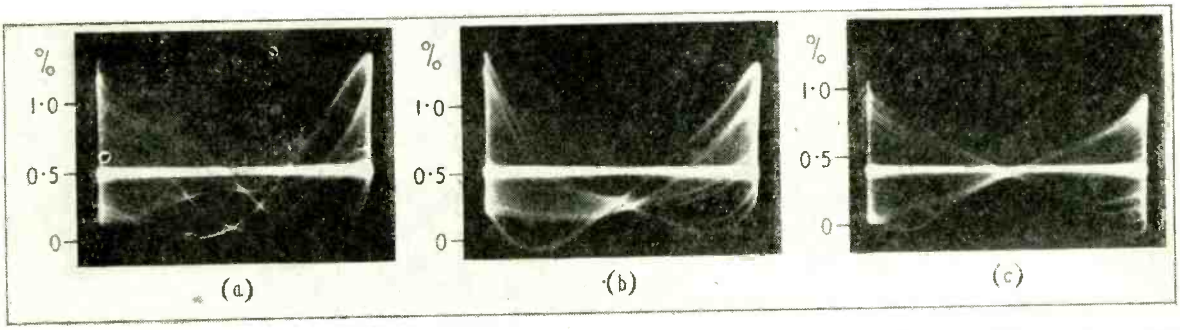
Suppose now that the diagram of Fig. 2 were used to predict what the distortion would be if the signal input were reduced from 2 volts to 1 volt peak-to-peak. The diagram of Fig. 2 would then terminate at B. The mV scale shows that the error voltages would be 20 mV; i.e., 2 per cent of the input signal. The percentage scale reads 1 per cent.

At first sight it appears that this kind of difficulty could be avoided by scaling each diagram in mV instead of percentages. This, however, would involve a new scale for every photograph, which would be impracticable.

On the other hand, if a percentage scale is used, three scales will serve for all purposes. In practice the percentage scale is determined as follows:—

(a) The cancellation circuit (7), (8) in Figs. 3 or 4

Fig. 8. Push-pull output stage with 100-c/s ripple in h.t. supply. (a) modulation with second and third harmonics. (b) driver stage balanced to remove second harmonic. (c) both second and third harmonics removed.



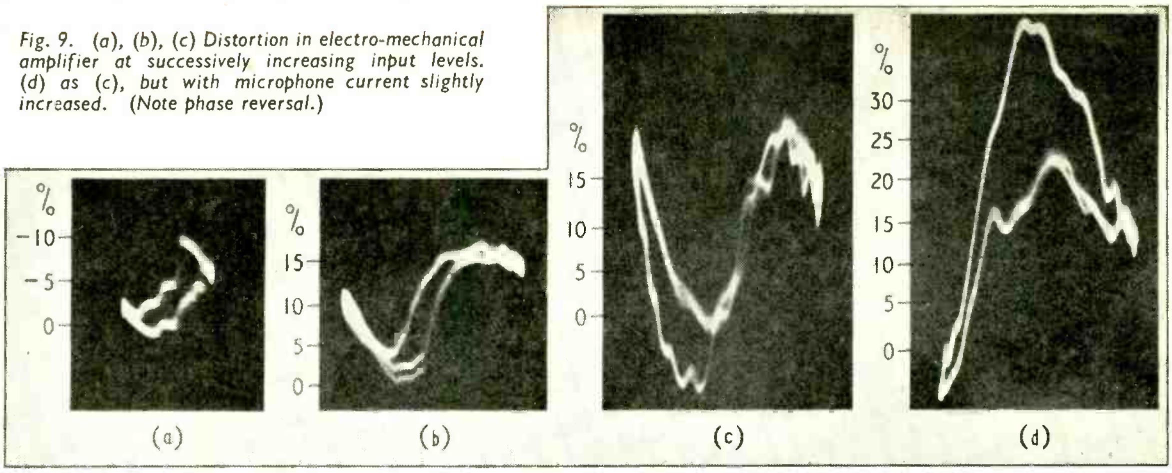


Fig. 9. (a), (b), (c) Distortion in electro-mechanical amplifier at successively increasing input levels. (d) as (c), but with microphone current slightly increased. (Note phase reversal.)

is interrupted, the X-signal removed, and the gain of the Y-amplifier adjusted to bring the resulting vertical line to a chosen height on the oscilloscope graticule. Let this height be D units.

(b) Having restored the cancellation circuit (7), (8) and the X-signal, the gain of the Y-amplifier is increased by a known amount (usually not more than 30 times) so as to make the details of the diagram clearly visible. Let the gain increase by N times.

(c) The percentage scale to be associated with this diagram must have an interval of DN/100 between the 1 per cent marks on the scale.

It is convenient to arrange that the Y-amplifier (A1) has several fixed steps of gain which are exactly known (say N = 10, 30, 100), and to prepare in advance the corresponding percentage scales, which can be fixed to the face of the tube and photographed together with the diagram.

Simplifications. The somewhat elaborate networks of Figs. 3 and 4 can be simplified if no more than a general impression of the distortion is required. If changes of régime are considered unimportant, and only the larger distortion terms are of interest, the ganged attenuators and the "slave" oscillator chain (12) to (15) may be omitted.

Bridge-type circuits are a common feature of apparatus designed to measure total harmonic distortion, but although they provide an output which contains only the distortion terms, they cannot be used to generate a difference diagram, because the various distortion products are "dispersed," i.e., shifted in relative phase, by passing through the bridge network.

The essential components of a 2-terminal circuit are the phase-shifter and filter, (7) and (8). A 4-terminal circuit requires, in addition, a bandpass or possibly a low-pass filter at (2). The performance of these filters need not be superlative, for many commercial oscillators generate no more than 1 per cent or 2 per cent of second or third harmonics, which can be reduced to 0.1 or 0.2 per cent by 20db attenuation at (2). If a valve stage, which may generate distortion, is incorporated in (7), filter (8) should have a slightly better performance.

Photographing the Diagram. For the illustrations a Cossor oscilloscope, Type 1035, with a green tube, Type 89D, was used.

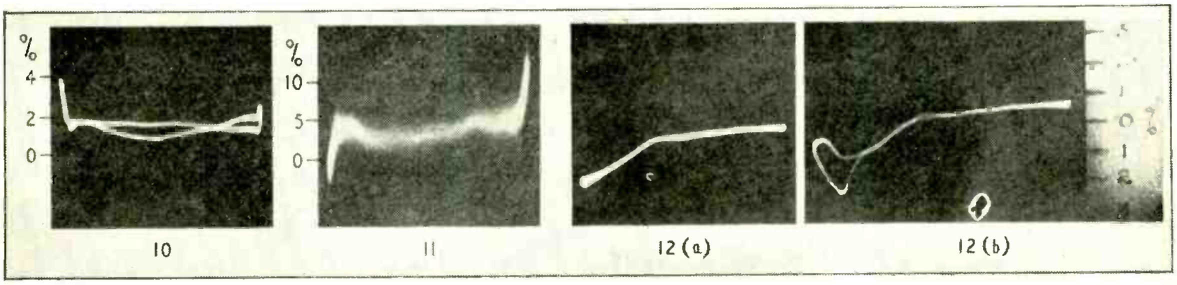
The photographs were obtained with a Leica II camera on Kodak 35mm orthochromatic film R55, with an exposure of 1½sec at F/6.3. The brightness of the trace was adjusted for each exposure by the following procedure. The trace was dimmed until only just visible in its weakest part while being traversed to and fro by the X-shift control. The brightness control was then advanced by a fixed amount predetermined by trial exposures.

This procedure makes allowance for the influence of mains-voltage variations upon the brilliance of the spot, and also for the large variations in writing speed which are caused by changes of test frequency or size and degree of detail of the diagram.

The percentage scale will appear in the photograph if it has been attached to the face of the tube and is given local illumination.

Conclusion. It is not easy to bring out in a short survey the full merits of this technique; the informa-

Fig. 10. Oscillator running into grid current. Fig. 11. Disc recording grossly over-modulated. Fig. 12. Radio receiver with "delayed" a.v.c.; modulation (a) just below and (b) just above 100 per cent.



tion given should, however, be sufficient to guide those who wish to explore its possibilities. The method has been in use in the Research Department of the B.B.C. in the course of the last 2-3 years, its development being part of a general investigation into distortion in a.f. systems.

The illustrations in this article are taken from a stock of several hundreds collected over this period. It should be noted that, in order to simplify discussion, the most elementary examples have been chosen, whereas in practice much more complex forms may occur. Fig. 9 has therefore been included to demonstrate the application of this new technique to a more complex problem.

For the investigation of distortion in recording systems the difference diagram has unique value, for unless the speed of the medium (disc or tape) is practically constant only the simplest of the conventional distortion measuring systems can be applied in such work. It is justifiable in such cases to attempt to deduce the harmonic content from a geometrical analysis of the diagram, should a numerical expression of the distortion be required. In general, the diagram serves its most useful purpose in bringing to light the nature of the distortion and its relationship to hum and circuit noise. The history of Fig. 8 is a striking example of this.

It is not unreasonable to suppose that there is a relationship between the shape of the diagram and the aural assessment of the resulting distortion. Indications of such relationship have been found, but cannot be discussed here.

APPENDIX

Operational Procedure. The circuits of Figs. 3 and 4 are used for 4-terminal and 2-terminal tests respectively. Their operation will be described for a 1,000 c/s test tone. For tests at any other frequency the filters must be changed. The figures marked against the filters refer to the attenuation peaks adjacent to the cut-off points.

In setting up the difference diagram of an amplifier the first operation is to put 20 db at (4) and zero at (6) (see Fig. 3). Add attenuation at (3) to bring the overall attenuation from (3)-(6) to about overload point. Vary (7) and slightly adjust (3) until the difference signal contains no fundamental tone. This will be shown by minimum vertical deflection of the oscilloscope trace. Turn up the gain of the X-amplifier of the oscilloscope to get a nearly horizontal line.

Now transfer attenuation from (4) to (6) thus driving (5) harder. The Y-deflection will grow and a loop will form. Adjust (11) until this loop closes to a line. When the input to (5) is small this line will resemble Fig. 2 if the output stage is a single valve. As the input increases a difference diagram like Fig. 5(a) will appear. The centre should be tangential to the X-axis of the tube. If not, adjust (3) very slightly to tilt the diagram correctly. If a loop appears as in Fig. 5(b) first adjust (7) and then (11) to remove it. The final curve is a representative difference diagram.

The phase shifter (7) should be designed to shift the phase without changing the amplitude of the 1,000-c/s signal, otherwise any adjustment will cause the diagram to tilt about its centre point and this has then to be corrected by readjusting (3).

The 2-terminal network is adjusted in much the same way, except that (3) is adjusted initially to equal the loss in (7) and (8).

In some amplifiers a change of operating regime occurs as the drive increases. This is shown up by a 4-terminal test but not by a 2-terminal test. The gain at 1,000 c/s alters and the diagram tilts about its centre point. The change in gain can be measured by introducing a slight compensating loss in the (7) (8) chain to restore the diagram to its original position.

The most difficult adjustment is the setting of phase shifter (11). If there are "overload spikes" as in Figs. 10 and 11 there is no difficulty, for it is clear that these must be located at the extremities of the X-axis. Sometimes artificial "spikes" have to be introduced (by a biased-off diode or rectifier) before the correct setting of (11) can be found.

When, as in Figs. 9(c) and (d), the "go" and "return" traces are different and have to be displayed separately for examination, the diagram is opened into a loop by a slight readjustment of (7).

If oscillator (15) uses a 2-valve zero-phase-shift RC circuit, it can be locked by injecting the "spike" from (14) into the common anode lead. No frequency calibration is needed, since the harmonic number can be read from the trace which appears when the output of (15) is made large enough. The magnitude of the spike signal must be adjustable so that it locks the oscillator without introducing visible distortion.

Cancellation of the unwanted distortion term can be observed on headphones connected temporarily to the output of the Y-amplifier of the oscilloscope. Phase-shifter (12) can be of a simple type in which the output voltage is not strictly independent of the phase adjustment, for the size of the locking "spike" will not seriously affect the output of the oscillator (15).

EARL'S COURT

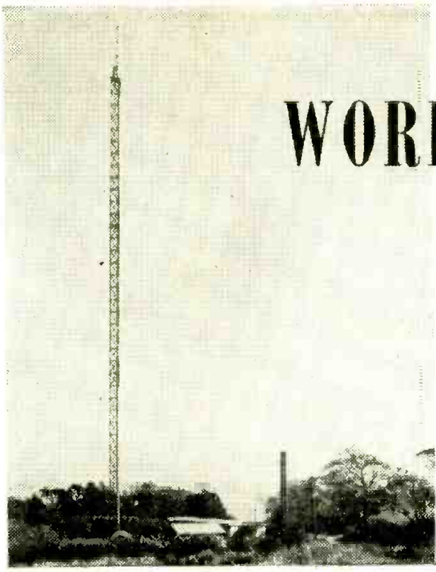
Preliminary List of Exhibitors

AS a result of the recent ballot for space at the 20th National Radio Show to be held at Earl's Court from September 1st to the 12th, the Radio Industry Council has issued a preliminary list of exhibitors. In addition to the 80 manufacturers, traders and journals, etc., listed below, four banks, British Railways, the Electrical Trades Union, and the Association of Radio Battery Manufacturers have also taken space.

Aerialite, Ambassador, Antiference, Argosy, Automatic Coil Winder.
B.B.C., Baird, Balcombe, Belling & Lee, Bernards, Boosey & Hawkes, Bowmaker, Brown Brothers, Bulgin, Bush.
C.W.S., Cole, Collaro, Cosmocord, Cossor.
Decca, Dubilier, Dynatron.
Econasign, Edison Swan, English Electric, Ever Ready, *Electrical & Radio Trading*.
Ferguson, Ferranti.
G.E.C., Garrard, Goodmans, Gramophone Co.
Hobday, Hunt.
Invicta.
J.B. Manufacturing.
Keith Prowse, Kerry's, Kolster-Brandes.
Linguaphone, Lugton.
McMichael, Marconiphone, Masteradio, Mullard, Multicore, Murphy.
Peto Scott, Philco, Philips, Pilot, Plessey, Portogram, *Practical Wireless*, Pye.
R.G.D., Regentone, Reproducers, Roberts, Rola-Celestion.
S.T.C., Simon Sound Service, Sobell, Stella.
T.C.C., Taylor Electrical Instruments, Telerection, Thompson, Diamond & Butcher, Truvox.
Ultra.
Valradio, Vidor.
Westinghouse, Whiteley, *Wireless World* and *Wireless Engineer*, *Wireless Trader*, Wolsey, Wright & Weaire.

Plans for the exhibition, which will be open to the public from September 2nd, include considerable space for displays of radio and electronic equipment to be provided by the Services and manufacturers. It is also planned to have an educational and training exhibit on the lines of that introduced last year. Technical training colleges will be represented by Norwood T.C. and the Borough Polytechnic and industrial training establishments by E.M.I. Institutes and Marconi College. The B.B.C. Engineering Training Department will be participating and the universities will also be represented.

Many of the exhibitors will be equipping demonstration rooms and there will be the usual Television Avenue in which manufacturers have the opportunity of demonstrating their receivers.



WORLD OF WIRELESS

Mobile Television Transmitters ◆ Standard Frequencies ◆ New Amateur Band

New TV Stations

THE temporary low-power mobile stations at Glencairn (Belfast) and Pontop Pike (Newcastle) were brought into regular service by the B.B.C. on May 1st. Pontop Pike is linked with the main radio network, but Glencairn relies on its direct reception of the Kirk o' Shotts transmitter for rebroadcasting. Initially, the Newcastle station used a temporary aerial, but the main radiator, which will eventually be employed by the permanent medium-power transmitter, is now in use.

Both stations use horizontal polarization and their sound and vision carriers are slightly offset from those of the main high-power transmitters using the same channel to reduce interference. Glencairn, shown with its Marconi aerial in the above photograph, operates in Channel 1 (41.5 and 45 Mc/s), and Pontop Pike in Channel 5 (63.25 and 66.75 Mc/s).

The low-power booster station near Brighton started a regular service on May 9th. It uses vertical polarization, operates in Channel 3 (53.25 and 56.75 Mc/s) and relies on its direct reception of Alexandra Palace for rebroadcasting. As in the case of the other two low-power stations, Brighton's carriers are slightly offset.

MSF Schedules

STANDARD FREQUENCY transmissions from the Rugby station MSF are now being radiated continuously for 24 hours a day. In accordance with the Atlantic City Convention (1947), the carrier frequencies will be 2.5, 5, 10, 15 and 20 Mc/s, but only three of these will be used simultaneously. Initially the transmissions are being radiated on 2.5, 5 and 10 Mc/s with a power of 0.5 kW.

These frequencies are not the most suitable for reception within the United Kingdom and it has, therefore, been decided to continue the transmissions on 60 kc/s for a short period each day. A power of 10 kW will be used for this transmission which will be radiated from 1429 to 1530 G.M.T.

The carriers will be modulated in accordance with the following cycle (repeated each quarter of an hour): 0-5 mins, 1,000 c/s tone; 5-10 mins, 1 c/s pulses (59th pulse in each minute being omitted); 10-14 mins, unmodulated; and 14-15 mins, speech announcement. The carrier and modulating frequencies are derived from the same 100-kc/s standard and are maintained to within ± two parts in 10^8 of their nominal values.

Results of N.P.L. measurements of these transmissions are given each month in our sister journal *Wireless Engineer*.

Coronation Radio

BIGGEST-EVER radio hook-up has been planned by the B.B.C. for the Coronation Day broadcasts. In addition to the television arrangements (which include the relay to Europe detailed on pages 274 and 275) and those for home listeners, the entire transmitting equipment of the External Services of the Corporation will be employed. This includes thirty-six high-power and two medium-power short-wave transmitters in this country, six in Malaya, two in Canada and two in Ceylon as well as m.w. transmitters in this country, Germany and Austria.

The B.B.C. has also been asked to provide land lines for a large number of overseas broadcasting authorities, while many other countries are retransmitting the received programme. It is estimated that in all some 1,000 stations throughout the world will be broadcasting some part of the day's proceedings. Eighty-four microphone positions for commentaries in 44 foreign languages have been provided by the B.B.C.

Amateur 2-Mc/s Band

SINCE MAY 1ST amateurs in the U.K. have not been permitted to use the band 1715-1800 kc/s, but instead have been granted the 200-kc/s band above 1800 kc/s. This change was necessitated by the enforcement of part of the Atlantic City allocation table and the Geneva frequency plan covering that band.

It will be recalled that in the Atlantic City Radio Regulations there was no 2-Mc/s allocation in Region I (Europe and Africa) for amateurs. A footnote to the frequency allocation table, however, reads "In the band 1715-2000 kc/s, Austria, Ireland, the Netherlands, Northern Rhodesia, Southern Rhodesia, Switzerland, the Union of South Africa and the United Kingdom may assign up to 200 kc/s for the amateur service provided that the mean power of any amateur station does not exceed 10 watts and that no harmful interference is caused to the authorized services of other countries."

The Radio Society of Great Britain in giving details of the change lists the maritime stations (see p. 214 of our last issue) in the band which are likely to be particularly vulnerable to interference.

"Trader Year Book"

THE "Wireless and Electrical Trader Year Book, 1953," to give it its full title, is a veritable mine of information—technical, legal and general—for the radio and electrical trader. This 24th edition includes thumbnail specifications of current broadcast and television receivers, i.f. values of broadcast receivers marketed between 1947 and 1951, valve base connections and mains voltages in the principal towns in Great Britain. It also includes in its 264 pages directories of trade organizations, manufacturers, wholesalers and proprietary names. It is published by the Trader Publishing Co., Dorset House, Stamford Street, London, S.E.1, price 10s 6d.

Modern Navigational Aids

AN EXHIBITION "Navigation Today" has been arranged from now until September at the Science Museum, South Kensington, to show the basic principles of navigation and the changes which have taken place in navigational methods under the impact of high-speed flying and the developments of radio and radar.

There are demonstrations of such radio aids as Consol, Gee, Decca Navigator, v.h.f. omni-range, ground controlled approach and, of course, radar. The latter includes an interesting supersonic simulator by Kelvin and Hughes of the Thames approaches in which model craft in motion on water are reproduced on a standard p.p.i. display.

Firms contributing to the exhibition include S. G. Brown, Cossor, Decca, G.E.C., Kelvin and Hughes, Kolster-Brandes, Marconi, Siemens, Sperry and Ultra.

PERSONALITIES

Wing Commander R. Stanford-Tuck, D.S.O., D.F.C., who joined Marconi's W.T. Co. in 1949, and earlier this year was appointed sales manager of the Aeronautical Division, has been released by the company to join the Aircraft Division of the English Electric Co. Marconi's is a member of the group of which English Electric is the parent company.

H. R. L. Lamont, Ph.D., M.A., B.Sc., A.M.I.E.E., has recently joined the scientific staff of the European Technical Representative of the Radio Corporation of America whose office is in London. Dr. Lamont, who is well known for his book on waveguides, will be principally concerned with technical liaison. Until his present appointment he was senior lecturer in electronics at the Royal Technical College, Glasgow, and was formerly at the G.E.C. Research Laboratories, Wembley.

C. L. G. Fairfield, M.A., M.I.E.E., A.M.I.Mech.E., who has joined the Telegraph Construction and Maintenance Co., Ltd., as manager of the overseas division, had been with Mullard, Ltd., since 1947, latterly as manager of the valve division. He has been a director of Mullard Equipment, Ltd., for the past two years, and was a Mullard representative on the board of Telcon Telecommunications, Ltd.

Wilfred Sampson, B.A., A.M.I.E.E., has been appointed commercial manager of Telcon Telecommunications, Ltd. (owned jointly by Mullard, Ltd., and the Telegraph Construction and Maintenance Co., Ltd.). A graduate of Queen's, Cambridge, Mr. Sampson joined the transmission systems division of Standard Telephones and Cables, Ltd., in 1929, where he gained wide experience in the field of telecommunications both in this country and abroad, particularly in South Africa.

J. Foster Veevers, M.I.E.E., has resigned his recent appointment as general manager of the Swindon factory of the Plessey Company to become managing director of Peto Scott Electrical Instruments, Ltd. Before joining Plessey's he was for many years manager of the Stockport factory of Salford Electrical Instruments, Ltd.

Until his recent appointment as senior liaison engineer of the Components Division of the Plessey Co., **E. Morgan,** B.Sc., A.M.I.E.E., had been in the Engineering Division of the B.B.C. since 1950. He had held the positions of superintendent engineer (transmitters) and assistant head of the Valve Section. Before joining the Corporation he was a member of the technical sales staff in the Osram Valve Department of the General Electric Co.

OUR AUTHORS

Ralph W. Hallows, who has been a frequent contributor to *Wireless World* for the past 21 years, writes in this issue on the efficiency of the dry cell and suggests ways in which its design and construction might be improved. He has been European Consultant to the Burgess Battery Co. Inc. since 1925. During the war he was a major in the Royal Artillery and became chief instructor (radar) at the 6th A.A. Group School. Major Hallows, who was an open exhibitioner at Magdalene College and an honours M.A. (Cantab.), is author of a number of books including " Radar Simply Explained " which has been translated into six European languages.

E. R. Wigan, who writes in this issue on the diagnosis of distortion, spent some 14 years in industry (graduating from d.c. and 50 c/s on the test beds of the G.E.C., Witton, in 1924 to audio and carrier frequencies in the laboratories of Siemens Bros., Woolwich, before joining the Signals Research and Development Establishment, Ministry of Supply, in 1938. At S.R.D.E. he was primarily concerned with the design of acoustic and a.f. field equipment and the associated test gear. Since 1949 Mr. Wigan has been in the B.B.C. Research Department, Kingswood Warren, Surrey, dealing with problems associated with distortion.

Eric Griffiths, contributor of the article on the design and construction of portable equipment in our last issue, is in the Lines Department of the B.B.C. Since joining the Corporation in 1941 he has worked at both transmitter and studio centres, and was for some time an instructor in the Engineering Training Department. Before joining the B.B.C. he was in the Research Laboratory of Callender's Cables (1936-39) and with the Ministry of Supply (1939-41).

OBITUARY

It is with regret that we record the sudden death of **Simon Orde,** manager of the B.B.C. Engineering Information Department, on April 23rd at the age of 59. Mr. Orde joined the Corporation in 1942 as a censor and in 1943 transferred to the Engineering Division.

We record with regret that **Charles Walter Eve,** a former director of Standard Telephones and Cables, Ltd., and a director of Kolster-Brandes, Ltd., died on April 19th aged 66. He joined S.T.C. in 1906 and retired in 1947. Mr. Eve was closely associated with the formation of the Radio Industry Council, the Radio Communication and Electronic Engineering Association and the Telecommunication Engineering and Manufacturing Association, and was at one time vice-chairman of the British Radio Valve Manufacturers' Association.

IN BRIEF

Broadcast Receiving Licences totalled 12,892,231, including 2,142,452 for television sets and 183,996 for car radio at the end of March. The month's increase in television licences totalled 69,472.

Stand-by Equipment has now been installed at the Sutton Coldfield television station and the switching arrangements permit it to be used with either the main or stand-by aerials. The powers are vision 5 kW, sound 2 kW. The last of the main stations to be equipped with stand-by gear is Alexandra Palace, where similar Marconi transmitters are now being installed.

Radio Exports.—Of the £2.2M worth of radio equipment exported in March, £855,084 was for capital goods—transmitting gear, etc. According to Customs and Excise figures, components and test gear accounted for £454,580, domestic receivers £442,072, sound reproducing equipment £253,128, and valves £216,531.

Plastics Exhibition.—Among the 90 exhibitors at the British Plastics Exhibition, which will be held at Olympia from June 8th to 18th (10 a.m. to 6 p.m. daily) are the following radio and electronic manufacturers:—E. K. Cole, G.E.C., Radio Heaters, Rediffon and T.C.M. Admission to the exhibition costs 2s 6d, but free tickets for the convention which runs concurrently with the show are available from *British Plastics* (the organizers), Dorset House, Stamford Street, London, S.E.1.

Instruments.—The second British Instrument Industries Exhibition opens in the National Hall at Olympia on June 30th for 12 days. The Scientific Instrument Manufacturers' Association is among the five supporting organizations. The exhibition will be open daily, except Sunday, from 10 to 6.30.

Canadian Trade Fair.—Eight British publishers are combining to present a display of 55 technical, trade and specialized journals at the sixth Canadian International Trade Fair, to be held in Toronto from June 1st to 12th. Our own publishers will be exhibiting 24 journals including *Wireless World* and *Wireless Engineer.* Among the British companies participating in the fair is the G.E.C., who will be exhibiting the BRT400E communication receiver and v.h.f. gear.

Communications in the widest sense will be featured at the German Communication and Transport Exhibition which opens in the 670,000-sq yd Munich Exhibition Park on June 20th. The exhibition, which will remain open until October 11th, will include sections devoted to broadcasting, radio-telegraphy and telephony and navigation.

German Radio Show, which was to have been held last August and has twice been postponed, will open in Dusseldorf on August 29th for nine days.

A.P.A.E. Officers.—At the annual general meeting of the Association of Public Address Engineers, L. W. Murkham was re-elected president. The vice-presidents are A. V. Sharp, J. F. Doust, C. Clarabut (who is also chairman of the Council), A. H. Middleton and Alex J. Walker, who is also honorary general secretary. The Council consists of G. F. Baker, A. B. Hulme, W. O. Mannerings, A. E. Buchan, F. Hedges, A. E. Ward, R. Jackson and S. W. Lewis (trade members), and R. E. Owen, J. F. Doust, F. Poperwell, S. Norley, A. V. Sharp, S. Kelly, C. T. Wright and P. Whiteley (manufacturing members).

"Solid-State Electronics," which is at the foundation of such practical applications as germanium diodes, transitors and other semi-conducting devices, will be dealt with by Dr. Karl K. Darrow of Bell Telephone Laboratories, in a series of four lectures at King's College, Strand, London, W.C.2, at 5.30 on June 22nd, 23rd, 25th and 26th. Although the lectures are addressed to students of London University, admission is free to others interested in the subject.

Transistor circuitry and applications will be dealt with by G. C. Sziklai of the R.C.A. Research Laboratories, Princeton, U.S.A., at a meeting at the Royal Society of Arts, John Adam Street, London, W.C.2, at 5.30 on July 1st. Dr. R. L. Smith-Rose will be in the chair. Tickets are available from the R.C.A. European Technical Representative, The Tower, Brook Green Road, London, W.6.

Electro-Acoustics.—A series of 10 lectures covering the nature, generation, propagation, measurement, recording and reproduction of sound has been planned by the Department of Radio and Musical Instrument Technology at the Northern Polytechnic, Holloway, London, N.7. The lectures by E. H. Jones, B.Sc., A.M.Brit.I.R.E., will be given on Tuesdays and Thursdays, commencing on June 4th. The fee is two guineas.

Fringe-area Reception.—A series of papers on this subject will be given at the summer meeting of the Television Society, which will be held at Bedford on June 27th.

Photographing TV Pictures.—Readers interested in the photographing of television pictures from the cathode-ray tube may like to know that in the Coronation number of *Amateur Photographer* (May 27th) there is an article dealing with the subject.

"Designing a Tape Recorder."—In the complete circuit diagram (Fig. 7, p.231, May issue) the cathode resistor R_{26} of V_6 should be 470 ohms and in Fig. 4 (p. 165, April issue) C_{27} should be 0.5μF.

SIR NOEL ASHBRIDGE. The Radio Industry Council is to present him with this portrait by Frank O. Salisbury. Sir Noel was recently elected an honorary member of the Brit.I.R.E. "in recognition of his services to the radio engineering profession of Great Britain and as a tribute to his outstanding work in developing the technical services of the B.B.C."

LITERATURE

Engineering Education.—A booklet setting out the full-time and part-time courses in technical education available at colleges and institutes in London and the Home Counties has been issued by the Regional Advisory Council for Higher Technological Education. It includes a list of courses in radio and television servicing, in telecommunications for the C. & G. certificates and in electrical engineering for the Higher National certificate. It is available from Tavistock House South, Tavistock Square, London, W.C.1, price 1s.

Metric Edition of the British Standard for enamelled round copper wire (oleo-resinous enamel) has recently been published as B.S.1961:1953. It differs from the 1951 edition of B.S.156 only in that all quantities are expressed in metric units. Copies may be obtained from the British Standards Institution, 24, Victoria Street, London, S.W.1, price 4s.

Technical Papers issued by all departments of the Department of Scientific and Industrial Research, including the National Physical Laboratory and the Radio Research Station, are listed in the 31-page catalogue "Government Publications, Sectional List No. 3 D.S.I.R.", revised to March 1st. It is obtainable free from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

Scientific Literature published by and for the Institute of Physics is listed in a catalogue which is obtainable gratis from the Institute, 47, Belgrave Square, London, S.W.1. A summary is given of some 30 books, monographs and pamphlets including "Physics as a Career" by N. Clarke, which deals with the fields of work open to physicists and the training necessary.

BUSINESS NOTES

Emitron Television, Ltd., are to supply two flying-spot film channels for the new television station being built by the Italian broadcasting organization (Radio Audizioni Italiano) at Turin. They will operate on 625 lines and are fitted with magnetic heads for reproduction of sound tape recordings. Either married or single picture and sound films can be used.

Mullard is to transfer the manufacture of cathode-ray tubes from its factory at Mitcham, London, to a new Government-financed factory of approximately 250,000 sq ft to be built in the North-East Lancashire Development Area. The vacated space at the Mitcham factory will be utilized for the production of other electronic devices.

B.I. Callender's Cables, Ltd., have formed a new company in Australia to co-ordinate the activities of agents in the Commonwealth and to establish a technical service organization. The registered office of British Insulated Callender's Cables (Australia), Pty., Ltd., is 84/88, William Street, Melbourne, C.I., Victoria, Australia. B.I.C.C. has also formed a Canadian company. It has acquired the business of Phillips Electrical Works, Ltd., of Montreal and Ontario, which will now be known as Phillips Electrical Company (1953), Ltd.

Modern Acoustics, Ltd., of Manor Way, Boreham Wood, Herts, (Tel.: Elstree 3636), has been formed to manufacture "Lectrona" loudspeakers which were previously produced and marketed by Acoustic Products, Ltd. E. L. Edwards, late of Edstone, Ltd., is managing director of the new company.

Mattis Industries, Ltd., of 4, John Adam Street, London, W.C.2, (Tel.: Trafalgar 5502), inform us that they have been appointed sales representatives for London and the Home Counties for the "Milaflex" range of insulating silks, tapes and cloths manufactured by Miller & Ferguson, Ltd., of Glasgow.

Decca's Glasgow office, which deals with both radar and navigation business, is now at 67, Blythswood Street, Glasgow, C.2, (Tel.: City 6457/8). The manager is R. E. G. Simmons.

London Docks servicing depot of Rees Mace Marine, Ltd., is now at Yabsley Street, Poplar, E.14, (Tel.: East 4216). It is under the management of R. Aveyard.

Exporting Computers.—The second electronic digital computer to be produced by Ferranti, Ltd., for export has been ordered by the Royal Dutch/Shell Group for installation in their research establishment in Amsterdam.

B.T.H. has received an order from the European Headquarters Command of the U.S. Army for \$4M worth of mobile fire-control radar equipment for supply to N.A.T.O. countries.

Marconi Marine radio and navigational equipment is being supplied by Marconi's associates Deutsche Betriebsgesellschaft für Drahtlose Telegrafie M.B.H., for four motor vessels being built at Rendsburg on the Kiel Canal.

TRANSISTOR AMPLIFIER

PROBABLY the first piece of commercial apparatus on the British market to make use of a transistor is a small pocket amplifier for boosting the outputs of hearing-aids.

Designed by Multitone, it is intended for hearing-aid users who get adequate output from close-range sounds but not enough from sounds at a distance. The G.E.C. Type GET1 point transistor used gives a power gain of about 15 db, and it has to be used with a high-impedance earpiece which is supplied with the instrument. The cylindrical housing has a plug at one end to fit into a standard hearing-aid battery ($22\frac{1}{2}$ V or 15 V), and two sockets at the other for the input and output plugs and cords. Multitone have also produced a hearing-aid with a transistor output stage, the main object being to reduce l.t. consumption.

No More "Reliable" Valves

VALVE manufacturers in this country deplore the use of the term "reliable valves" because it implies that all other valves are not reliable. Their trade association, the B.V.A., now announces that it intends to describe these valves as "Special Quality" in future. A "Special Quality" valve is defined as "a valve which has certain design and manufacturing features making it suitable for use under conditions different from or in excess of those experienced in normal radio or television receivers and when operated under stated or agreed electrical or mechanical conditions it has an acceptable statistically determined expectation of life."

This definition covers several classes of valves, for example, those which will withstand severe mechanical shock but do not necessarily have long lives; those which have particularly long lives or high electrical stability but not so much ability to withstand shock; and those giving normal lives under moderate conditions of shock and vibration. Thus the term "Special Quality" has quite a wide meaning, and does not really distinguish the particular class of valves hitherto known as "reliable" from valves with other special qualities such as long life or stability.

Books Received

Television Picture Faults. By John Cura and Leonard Stanley. Contains 150 photographs of television pictures illustrating various faults together with explanations of their cause. These explanations are printed in contrasting types for readers with and without technical knowledge. The faults mainly comprise those resulting from incorrect adjustment of the controls, but various forms of interference are also illustrated. Pp. 68. Television Times, Ltd., 39a, Bartholomew Close, London, E.C.1. Price 3s 6d.

Radio Engineering (Second Edition). By E. K. Sandeman, Ph.D., A.C.G.I., M.I.E.E. Method of approach is fundamental and general, though specifically related to practical ends. The book grew from an instruction manual written primarily for maintenance engineers at B.B.C. stations. Pp. 613+xxi; Figs. 204. Chapman and Hall, 37, Essex St., London, W.C.2. Price 55s.

Télévision Dépannage. By A. V. J. Martin. A practical book on the installation, adjustment, fault-tracing and repair of television receivers. Pp. 176; Figs. 197. Société des Editions Radio, 9, Rue Jacob, Paris, 6. Price 600 francs.

Modulators and Frequency-changers. By D. G. Tucker, D.Sc. An analytical and largely mathematical approach to the subject as applicable to amplitude-modulated radio and line systems. The book is intended for design and maintenance engineers. Pp. 218+xiv; Figs. 115. Macdonald and Company, 16, Maddox St., London, W.1. Price 28s.

The Living Brain. By W. Grey Walter, M.A., Sc.D. (Cantab). Basically a book about research into the mechanics of the brain by means of electro-encephalography (and intended for general reading), but contains technical information on EEG apparatus developed by the author with appendices describing his electronic analogues of physiological mechanisms. Pp. 216+xii; Figs. 23. Gerald Duckworth & Co., 3, Henrietta Street, Covent Garden, London, W.C.2. Price 15s.

"Radio Designer's Handbook"

MANY thousands of copies of earlier editions of "Radio Designer's Handbook" have been sold throughout the world. The fourth edition of this popular work, just issued by our Publishers (price 42s; by post 43s 6d) is more than four times as large as its predecessors. The book deals in detail with basic principles and the practical design of all types of modern radio receivers, audio amplifiers and record-reproducing equipment. It is the work of 10 authors and 23 collaborating engineers, under the editorship of F. Langford-Smith.

CLUB NEWS

Birmingham.—The June programme of the Slade Radio Society includes two direction-finding contests. On the 12th there is to be an evening contest and on the 13th-14th the second event for the Harcourt Trophy. There will be a technical discussion evening on the 26th at 7.45 at Church House, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Coventry Amateur Radio Society's "night on the air" has been suspended for the summer months, but meetings continue to be held on alternate Mondays at the Y.W.C.A., Queens Road, at 7.30. On June 8th G2BVW will talk about 70-centimetre operation. There will be a v.h.f. field-day on Sunday, June 21st. Sec.: K. G. Lines (G3FOH), 142, Shorncliffe Road, Coventry.

Hastings and District Amateur Radio Club, of which L. H. Thomas, M.B.E. (G6QB), assistant editor of *Short Wave Magazine*, is president, is participating in the Hobbies Exhibition to be held in the town during Carnival Week, July 4th-11th. Membership of the club, which during the summer meets only once a month, is now over 30. Sec.: W. E. Thompson, 8, Coventry Road, St. Leonards-on-Sea.

Manchester.—The South Manchester Radio Club (G3FVA) meets on alternate Fridays at 7.30 at Ladybarn House, Mauldeth Road, Fallowfield, Manchester, 14, and is planning a course of instruction for the Radio Amateur Examination. Sec.: M. Barnsley (G3HZM), 17, Cross Street, Bradford, Manchester, 11.

Reading.—Meetings of the Reading Radio Society, of which W. A. Smallcombe, B.Sc., was recently elected president, are held on the second and last Saturdays of each month at 7.0 at the Abbey Gateway, Reading. The programme for the coming session includes lectures, debates and demonstrations. Sec.: L. A. Hensford (G2BHS), 30, Boston Avenue, Reading.

Southend.—At the meeting of the Southend and District Radio Society on June 12th S. W. F. Asquith, A.M.I.E.E., will talk on frequency measurement. The winners of the recently awarded Pocock and Hudson Cups for home-built gear—J. Wallace and D. Whitworth, respectively—will demonstrate their equipment at the meeting on June 26th. Meetings are held on alternate Fridays at 7.30 in the Queen's Road Annexe of the Municipal College, Victoria Circus. Temp. Sec.: J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Two-band Television Reception

WHEN alternative television programmes are provided, whether by the B.B.C. or by sponsoring or by both, it is plain that the new stations must operate on frequencies higher than the present 40-70 Mc/s band. New television sets will be designed to cover the new band as well as the old and must obviously include some station-selection mechanism.

The problems of design are technically straightforward ones, but what about the several million existing sets? Has anyone yet thought seriously about the problem of making them suitable? The usual glib answer is that cheap, mass-produced converters will be produced which will enable the frequency of the new station to be changed to that for which the receiver is designed.

That is a satisfactory solution provided that the converter does what it is supposed to do, but will it? It seems to me that there are a great many technical snags.

It so happens that most existing television sets are not readily tunable from one channel to another and some cannot be changed at all without a major operation. In order that normal reception of the station in the 40-70 Mc/s band may be retained, therefore, the receiver must be left tuned to this station and the converter must operate to change the frequency of a signal in the higher band to this lower frequency. There is then a possibility of interference due to the direct pick-up of signals from the 40-70 Mc/s station by the early circuits of the receiver. For the avoidance of interference a disparity of some 50 db between the two signals is required. In some areas and with some receivers this may be easily obtainable, but when the receiver is used near a 40-70 Mc/s station and remote from one of the new ones, the interference may well be intolerable. This is especially likely to be so with some of the earlier receivers which were not very well screened.

The solution would seem to lie in having the television set permanently tuned to a channel other than the local one—say to Sutton Coldfield in the London area—and to include in the converter provision for changing the frequency of the local 40-70 Mc/s station to this chosen channel. The converter then becomes necessary for all reception. This will increase its cost and the changing of the tuning of the set itself may be an expensive matter with some sets, although negligible with others.

In addition to this, where the television set is a superheterodyne, as most now are, the set plus converter will be a double superheterodyne having two oscillators. The almost limitless possibilities of self-generated interference by beats between their harmonics are well known and it seems likely that satisfactory operation would be largely a matter of chance and would depend on the precise frequencies of the signal, the input of the set (1st i.f.), the i.f. of the set (2nd i.f.) and upon whether the oscillator of the television receiver is above or below the signal. The converter oscillator will have to be always below the signal to prevent inversion of the sound and vision channels.

The development and rapid growth of competitive television services will depend very much on the finding of satisfactory solutions to all these problems.

London, N.14. W. T. COCKING.

Broadcast Transmitter Distortion

THE letters of Ian Leslie in your April issue and A. Yates in your May issue both deal with the overall performance of the broadcasting chain, and a few notes on B.B.C. practice may be of value.

There is, of course, no such thing as completely distortionless transmission, and the problem facing any authority engaged in broadcasting is to what extent shall distortion be permitted. If no restriction of volume range is used between microphone and transmitter, and the modulation is adjusted to such a level that 100 per cent modulation is never reached, then distortion may be very slight, but the average level of modulation will be extremely low, and listeners will rightly complain of excessive background noise due to interference and receiver noise in the quiet passages. For these reasons it is the practice in this and every other country to adjust levels manually so as to bring up the quiet passages and to keep down somewhat the level of the loud passages. This is done at the originating point in the programme chain. Sharp transients will, however, always occur, probably of such short duration as to be unobserved at the manual control position, and in any case so short as to make it impossible to take any human steps to limit their amplitude. In order to deal with this situation automatic means of amplitude limitation are incorporated at the transmitter input. These ensure that such transients cannot cause the transmitter to be modulated more than 100 per cent. Admittedly while so doing a certain amount of distortion is necessarily introduced by a very short period of time, but this distortion is very much less than that which would be heard by listeners if the transmitter were modulated more than 100 per cent. In that case the carrier amplitude would be reduced to zero for short periods of time and a very noticeable distortion radiated. Also, of course, heavy over-modulation can be very dangerous for the transmitting equipment.

The extent to which the average programme level is raised, and the extent to which limitation is used, is, of course, very much dependent on judgment of the degree to which distortion is acceptable, and on a balance being made between the amount of such distortion and the improvement in signal-to-noise ratio for the general listener. This improvement in signal-to-noise ratio is particularly important at times like the present, when on certain wavelengths there is appreciable interference from continental broadcasting stations.

The B.B.C. has arrived at its present standards after very careful listening tests, and believes that in the existing circumstances these represent the best compromise between distortion and interference.

Within the restricted band of frequencies available for medium-wave broadcasting there seems to be no prospect whatsoever of any appreciable reduction in interference from stations in other parts of Europe, and in fact a probability that this may increase. To increase the power of the medium-wave stations is not permitted by the Copenhagen Plan, and in any case to increase by an adequate amount would in most cases be impracticable. The hope for future improvements in transmitting conditions lies therefore in the development of a v.h.f. broadcasting service. The B.B.C. has published the results of its experimental transmissions from Wrotham, and the development of a regular service is now under consideration by the Advisory Committee set up by the Postmaster General under the terms of the Government White Paper on Broadcasting.

Mr. Yates is in error in stating that we rarely give live transmissions. Of the programmes radiated after 6 p.m. in the week ending May 2nd, recorded programmes represented 25 per cent of the Home Service, 40 per cent of the Light Programme, and 62 per cent of the Third Programme. In any case, for the vast majority of recorded programmes the quality of reproduction is indistinguishable from that of a live programme. The continued introduction of new recording and reproducing equipment should in time eliminate all unsatisfactory recorded items.

The quality of transmissions over the land lines from the studio to the various transmitters is subject to continual careful check. Only very occasionally does the quality of transmission deteriorate, and in such cases it is rectified at the earliest possible moment.

Consideration has been given to the use of the sound channels of the television service for the transmission of a sound programme, but the continued development of the television service and the fact that the equipment is in use for television purposes at times when the greater part of the public would wish to listen precludes such use.

The conclusion drawn by Mr. Yates that the general average of performance has deteriorated in the last twenty years is, I think, not justified, as the improvements in the design of the equipment in the transmitting chain over the last twenty years have been very appreciable, while every care in the operation and maintenance of the equipment continues to be taken.

London, W.1. F. C. McLEAN,
Deputy Chief Engineer, B.B.C.

I WAS interested to see A. Yates' letter, supporting my plea for better B.B.C. transmission quality, in your May issue.

As regards the use of recordings, I wrote to the Director of the Third Programme last autumn deploring the trend towards the development of a "transcribed service" and pointing out that, apart from questions of optimum signal quality, those shortcomings which identify the medium used—rumble, regular clicks due to a scratch, the change in quality as between the end of one disc and the start of the next—produce a mental image of the revolving turntable and destroy the illusion of reality, that psychological factor so important in a live service.

In reply I was informed that the extensive use of recordings is both necessary and expedient in a comprehensive service. Further, I was invited to Broadcasting House and shown that on direct playback (pickup tracking the groove freshly made by the cutter, with monitor switched instantaneously to input line or replay amplifier at will) the reproduced signal is almost indistinguishable from the input signal and total background noise imperceptible. I was told, and it was evident, that deterioration in the signal finally radiated is due to deterioration in the equipment of the playback channels, and in the recorded discs, due to careless handling by staff other than that of the recording department. There can be no excuse for this.

That improvement is possible in landline quality is indicated by the fact that excellent quality is in fact obtained from landline relays—sometimes. It is doubtful whether the use of television transmitters for sound services would serve any useful purpose in view of the fact that they would only be available at odd, "off-peak" hours. As regards the development of a comprehensive f.m. service, clearly the B.B.C.'s hands are tied by the financial powers-that-be.

Regarding automatic volume compression, the B.B.C.'s Parthian shot was a suggestion that I should see the matter in perspective; that "there is nothing more annoying than a strong carrier with low average modulation." I strongly disagree. Average level means nothing; minimum level matters but can be maintained by manual monitoring. Various measures can be undertaken by the listener to improve signal pick-up and/or mitigate interference of all types, but nothing can be done to correct a signal that contains non-linearity distortion. Many aspects of the interference problem are out of the B.B.C.'s control, but radiated signal quality is entirely their responsibility; in this at least let them set their house in order.

London, N.10, IAN LESLIE.

Flywheel Sync

THE observation made in the opening paragraph of K. G. Beauchamp's letter in the April issue on the flywheel synchronizing circuit, described by B. T. Gilling in your March issue, we consider to be incorrect when it is stated without reservation that neutralization of impulsive interference is effected across the common load resistance of the diodes. This is true during the sync period; i.e., when the fly-back has been initiated and point B (B. T. Gilling's Fig. 2) is neutral, but prior to the sync pulse the circuit does not appear to be immune to noise. For example, during the period between the middle and end of the scan, point B is negative and thus noise spikes appearing 180 degrees out of phase at V2 (a) and V2 (b), anode and cathode respectively, will result in the greater conduction by V2 (a), and hence a positive signal voltage developed across the common load.

The operation of the d.c. amplifier, as shown in Fig. 5, is obscure, since the valve is without cathode bias and will be driven by positive excursions during the sync period into grid current which can find no d.c. path to cathode.

We support your correspondent in identifying the circuit as a phase discriminator, and it is to be hoped that the discriminator as used in frequency modulation applications, which for so long has assumed a similar identity, will be regarded more correctly as a frequency discriminator. W. J. CROSSLEY, S. L. FIFE.

English Electric Company, Liverpool.

Lamp Interference

THE problem of lamp interference, raised by K. Robinson in your May issue, is quite well known, though it does seem extraordinary that a lamp with a continuous filament can give trouble.

Whilst the complete mechanism is, so far as I know, not fully understood, it is quite normal for vacuum lamps to act as quite powerful energy generators, and interference from them can cover a range of at least ¼-mile.

The functioning of a lamp as a r.f. generator, and the frequency, depends on instantaneous voltage, and thus when a.c. is used the interference only occurs on certain parts of the voltage cycle, and the frequency also varies, this accounting for "herringbone" and similar effects.

Luckily, this phenomenon is restricted to vacuum lamps normally of 25 watts or more, and these lamps are only used in special installations, such as traffic signs and "keep left" bollards, and are not on sale to the general public. The "gasfilled" lamp is quite innocent.

Enfield, Middx. A. P. HALE.

"Designing a Tape Recorder"

REFERRING to the above article in your April issue, I should like to make two further suggestions for a level monitor. Both incorporate the refinement, particularly desirable in home-built equipment, of monitoring bias oscillator and audio output voltages simultaneously.

The first uses the two meters from an aircraft direction indicator (see *Wireless World* article of September, 1951, and remember the warning about beta radiation—January, 1952). Each meter is put in a bridge rectifier circuit which is fed through a high resistance from either the erase oscillator or the anode of the audio output valve. Because of the high sensitivity of these meters, there is no trouble concerning the load they will put on the two outputs.

The second method is very suitable if a 500-volt h.t. line is available. A 1CP1 type cathode ray tube is used as the indicating device, the oscillator volts being fed across one set of plates whilst the audio output is fed across the other. This gives a rectangular fluorescent area the width of which is proportional to oscillator output and the depth to audio output.

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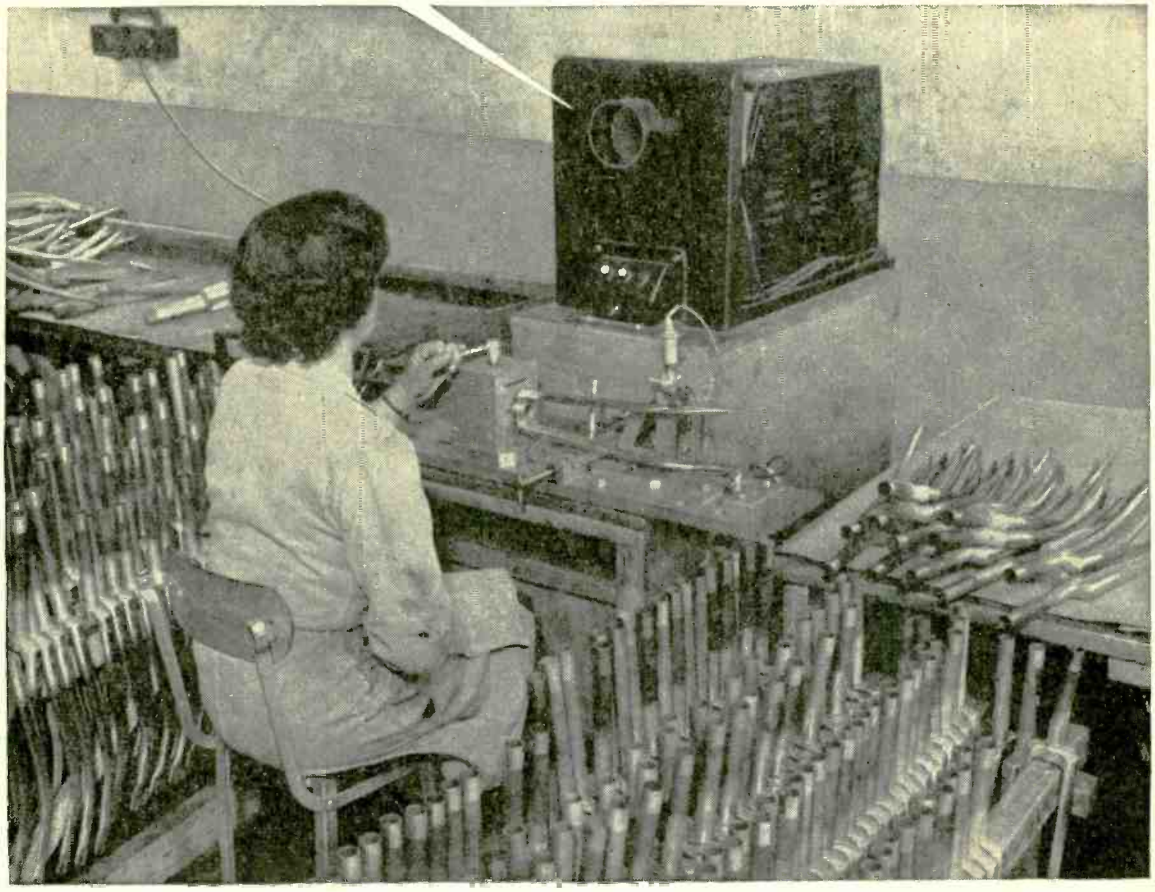

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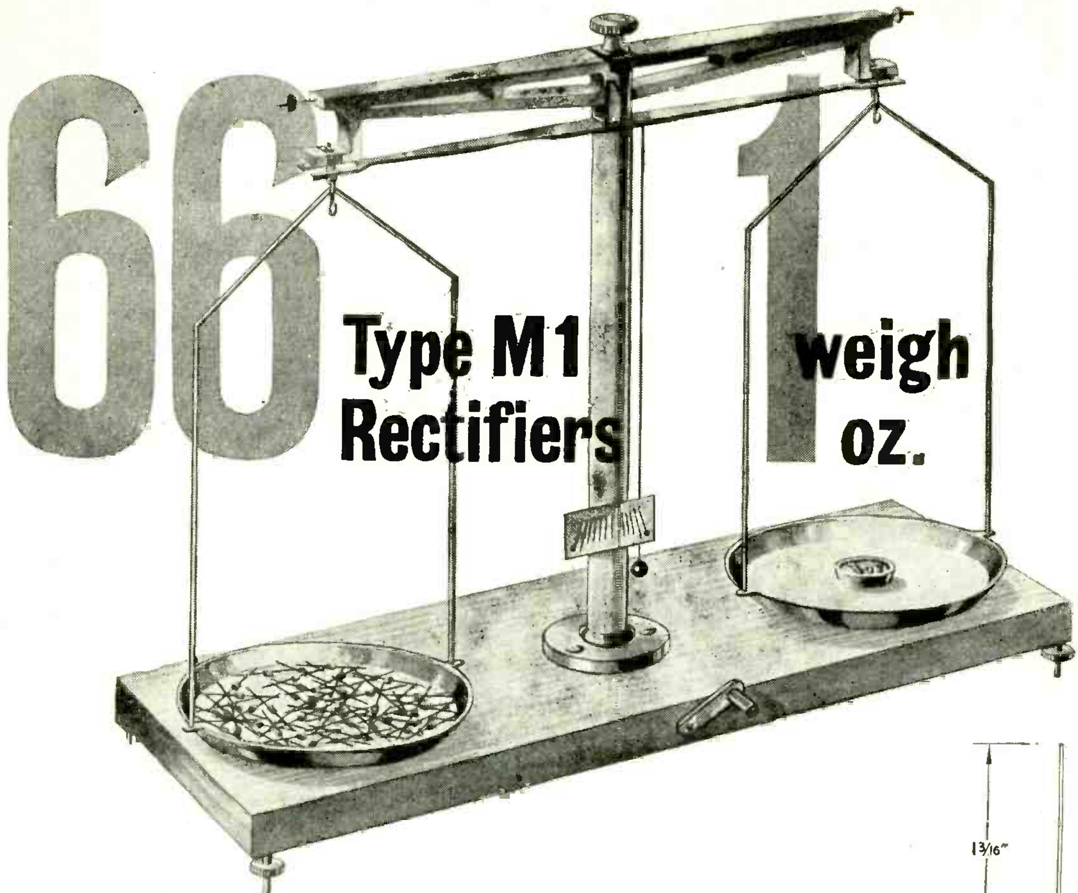

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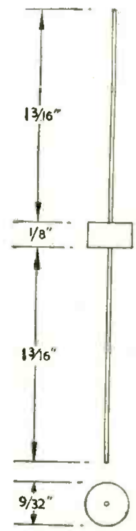

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Self Capacitance	22 pF
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Reverse resistance at 5 V D.C.	1000 M Ω
Maximum peak inverse voltage	68 V
Minimum A.C. input	0·5 V

TYPE M-3

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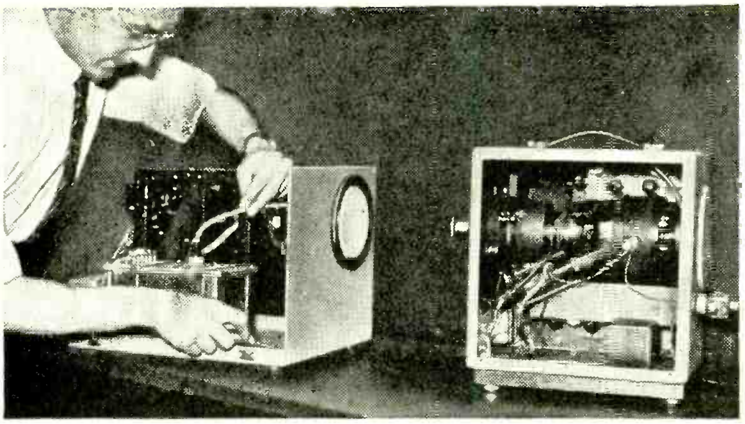


Television Standards Converter

Mobile Equipment in Holland for the Coronation Relay

READERS will see from our route map of the Coronation relay to Europe (following page) that the British 405-line signals are converted to the continental 625-line standard at Breda in Holland. The converter equipment, designed by the Philips Research Laboratories at Eindhoven, is basically the same as that used by the B.B.C. at Cassel last year for changing from French to British standards—a c.r.t. monitor displays the incoming picture and this is viewed by a camera working on the new standards. The situation is rather different at Breda, however, in that the pictures are going in the opposite direction and are being converted from a low number of lines to a higher number of lines. Moreover, the equipment is a good deal smaller than the B.B.C.'s, and is actually installed in a trailer—which also contains a reserve converter (in case of breakdowns) and a quantity of monitoring and test gear. This trailer is stationed outside a church known as the Grote Kerk in Breda, and from it cables run up the side of the building to the centimetre-wave transmitting and receiving equipments which are mounted on the steeple.

The smallness of the converter has been achieved mainly by the use of a c.r. tube with a screen diameter of only 5in to display the incoming picture. Normally, with a screen of this diameter, the definition would not be very good because of the relatively large size of the spot; but the tube is actually a flying-spot scanner with a very small spot and has a definition of 1,000 lines. The camera has an image iconoscope pick-up tube, and this is fitted with a mask at the edge of its viewing window to provide a black reference for the 625-line signal.

As in previous converter equipments, the monitor c.r. tube uses a long-persistence screen as a means of light storage. Without this, the camera pick-up tube would tend to act as a simple photo-cell and would respond to the instantaneous variations of intensity of the light spot. Thus it would produce a spurious waveform corresponding to the 405-line vision signal, and this would beat with the normal 625-line signal to give a completely meaningless output. With the long-persistence screen, however, a large component of unmodulated light is introduced, so that the intensity variations of the spot are made negligible in comparison and have little or no effect on the pick-up tube.

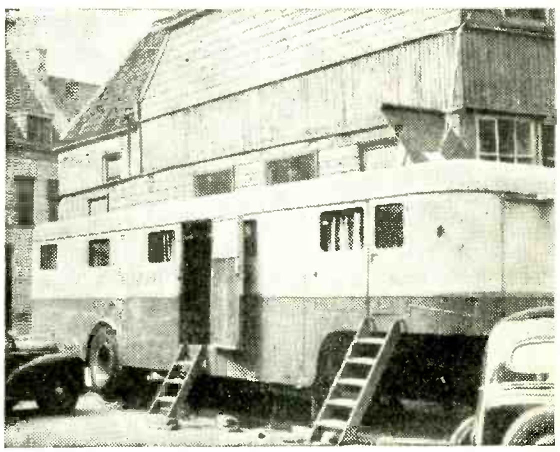
At the same time, of course, the persistence must not be made long enough to preserve one picture into the next picture period, otherwise blurring would occur with moving images. Actually the decay characteristic of the phosphor is such that the brightness of a point on the screen falls to about $\frac{3}{8}$ths of its original value by the end of one frame period.

Another important point is that the scanning beam of the camera is arranged to "read" the picture at a more-or-less constant time interval behind the "writing" spot of the c.r. tube. (This is possible because, although the line periods of the two systems are different, the frame periods are the same.) If this were not done there would be a phase drift between the two scanning systems, and sometimes the camera would be "reading" the picture while it was still bright from the spot and sometimes while it was fading out a long way behind the spot, and the result would be that the outgoing picture would fluctuate in brightness. The two scanning systems are actually locked together by synchronizing the camera waveform generators with the frame sync pulses of the incoming 405-line signal.

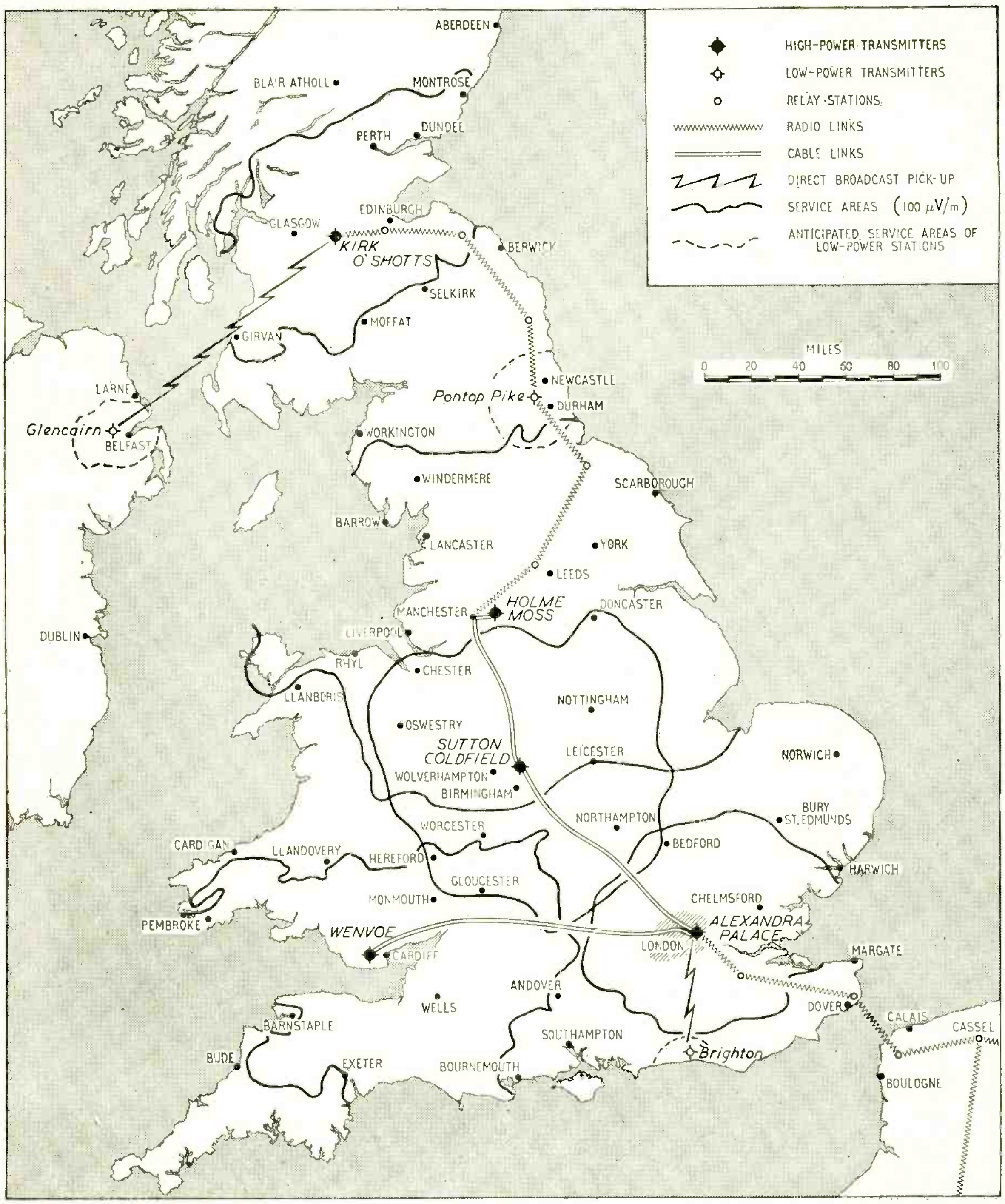
Since the conversion is from a low number of lines to a higher number, it has been necessary to "fill in the gaps" in the 405-line picture by spot-wobbling. Without this device, the scanning lines of the camera would sometimes coincide with those of the 405-line picture and sometimes fall between them, and an interference pattern would appear on the outgoing picture.

Recently *Wireless World* had an opportunity of seeing the converted pictures at Amsterdam, after they had been transmitted from Lopik, and we were agreeably surprised by their quality. Inevitably there was some degradation, but not enough to worry the average viewer, and we have seen worse on receivers in this country.

The converter equipment, with the monitor unit on the left and the camera on the right, is shown above, and below is the trailer in which the equipment is installed.



International Television: *Radio and*



With the recent opening of the temporary, mobile, low-power television stations at Glencairn (Belfast) and Pontop Pike (Newcastle) and the booster station near Brighton, approximately 80% of the population are now within the B.B.C. television service area, indicated on this map by the 100µV m contours. The estimated coverage of the Glencairn transmitter, which relies on its direct reception of Kirk o'Shotts, is Belfast and its immediate surroundings. Using the permanent aerial, Pontop Pike serves an area within a radius of approximately 20 miles of the transmitter. The Brighton booster station, which re-transmits the Alexandra Palace transmission, is intended to serve the town and district.

Cable 2,000-*mile Network for the Coronation Transmissions*

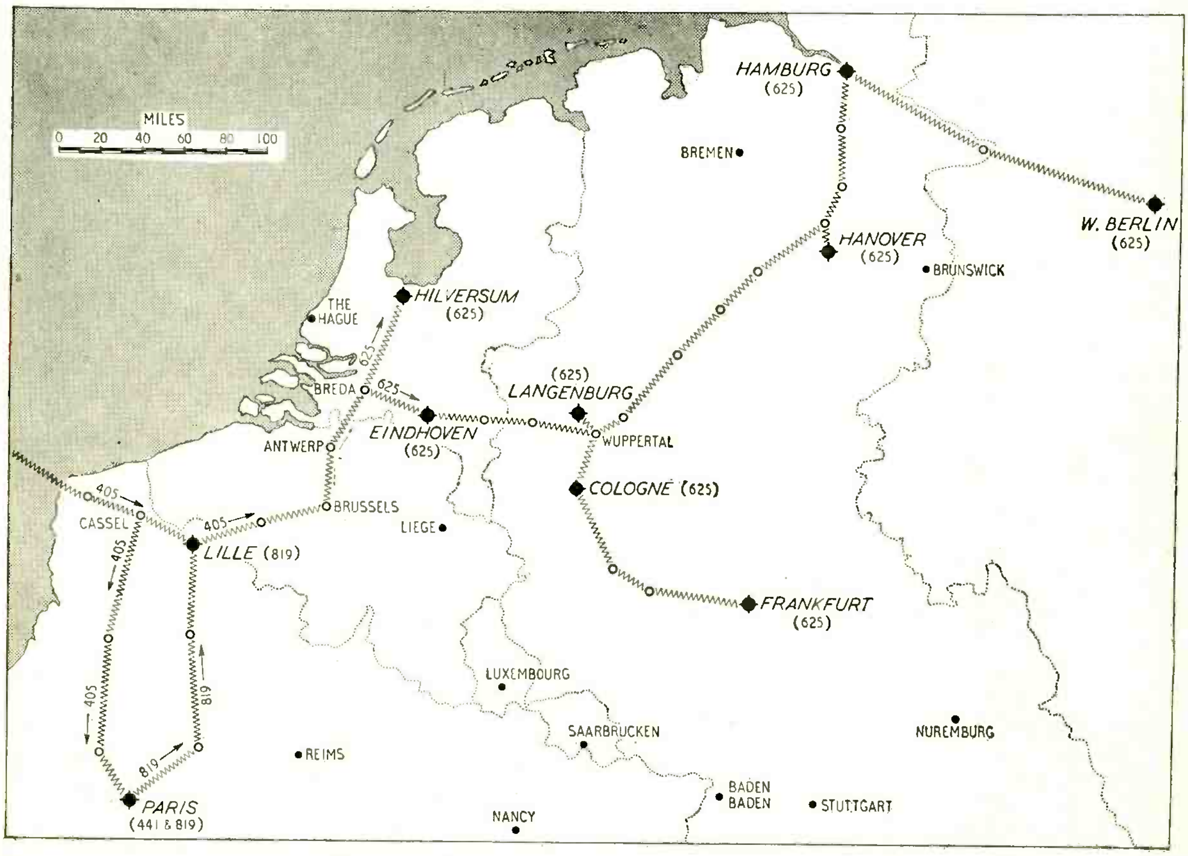
THE international exchange of television programmes has been brought a stage nearer by the unqualified success of the recent tests conducted on the Continent, preparatory to the re-radiation of the B.B.C. Coronation day transmissions by stations in France, Holland and Western Germany. On these two pages we reproduce sketch maps of the British Isles and northern Europe showing the 2,000-mile radio and cable network which will convey the B.B.C. television transmissions on June 2nd to viewers in four countries. On the opposite page is shown the complete chain of British television stations, the methods of linking and the service areas of each of the five high-power and three low-power transmitters now in use.

For the continental relay the vision signal will be transmitted from London to France by relay stations provided by Standard Telephones & Cables, Ltd. It will be picked up at a point near Cap Blanc Nez, Calais, and re-transmitted to Cassel. It will be seen from the map that the 405-line signal is carried by the French P.T.T. and Radiodiffusion et Télévision Françaises south from Cassel to Paris for conversion to 441 and 819 lines for re-transmission by Paris and Lille. The 405-line signal is also carried east from Cassel to Lille where it is conveyed over a chain of centimetre-wave links across Belgium, which has not yet a television service. It is, however, planned to monitor the transmission in Brussels where a limited number of people will see the 405-line picture probably on large-screen equipment.

The key point for the 625-line transmissions by the Dutch and West German stations is Breda, where, as described on page 273, the Philips organization has set up a conversion unit. The 625-line signal will be taken by direct links to Hilversum and Eindhoven and via four centimetre-wave relays to Wuppertal to be fed into the permanent network recently inaugurated by the Nordwestdeutsche Runfunk to link the five N.W.D.R. television stations. The longest hop in this chain of relay stations is that linking the Berlin transmitter with the last station in Western Germany—a distance of nearly 100 miles. The frequency used for this hop is 196.25 Mc/s. In addition to the five N.W.D.R. stations the Frankfurt transmitter in the American Zone and possibly the Weinbiet station near Baden Baden (French Zone) will be radiating the 625-line transmission.

The complementary sound transmissions will be carried by cable to the Continent, where broadcasting organizations will have the choice of two of the following three circuits: 1, background sound free from any commentary; 2, English commentary; and 3, French commentary. It will, therefore, be possible for Dutch and German commentators to hear the English or French commentary which they can then translate for superimposition on the background sound.

Centimetre-wave links covering some 1,200 miles form the chain for the re-transmission of the B.B.C.'s Coronation day broadcasts by Continental television stations. Against each transmitter is indicated the standard employed.



Improving the Dry Cell

Making Better Use of the Raw Materials

By R. W. HALLOWS, M.A.(Cantab), M.I.E.E.

WHEN zinc was plentiful and little accounted, a run-down dry battery, whose cell-cans might still contain from two-thirds to four-fifths of their original weight of the metal, could be thrown light-heartedly into the dustbin. To-day, there is a world shortage of zinc, and it is a matter of some importance that it should not be used wastefully. The dry Leclanché cell, which has proved itself to be the most convenient, the least messy and the most foolproof source of what the late Dr. C. F. Burgess aptly termed portable power, is nowadays one of the major callers on the world's zinc supplies, for the number of such cells in use at any moment runs into astronomical figures. Apart from the fact that most of the world's homes are now within range of some source of broadcast entertainment, and that the majority are still without mains supplies of electricity, portable wireless receivers of various kinds enjoy wide popularity; much of any army's wireless equipment must be battery-operated; hearing-aid appliances, developed from the a.f. side of the wireless receiver, are being used in larger and larger numbers. If one thinks, too, of the flashlamps, the cycle lamps and other small electrical appliances used now by millions of people in all parts of the world, it is quickly realized that the term astronomical is no exaggeration when applied to the number of dry cells in use the world over at any time.

The purpose of the present article is to investigate the efficiency, or otherwise, of the dry cell as we know it and to suggest ways in which its design, composition and construction might be improved. A second article will deal with the possibilities of using relatively cheap power from the supply mains to bring dry cells after discharge back to something like their original condition.

As almost everyone knows, the Leclanché cell "generates a current of electricity by consuming zinc as a fuel." Or, to put it a little less unscientifically, such a cell maintains a flow of electrons through an external closed circuit by converting into electrical energy the chemical energy involved in the recombination of ammonuim-chloride and zinc into zinc-chloride, ammonia and hydrogen. As the textbooks have it,

$$2NH_4Cl + Zn = ZnCl_2 + 2NH_3 + H_2.$$

That is a considerable over-simplification, for every manufacturer has his own pet electrolyte, which may contain calcium, lithium, magnesium, zinc and possibly other metals in the form of chlorides. This, however, is not the place to discuss such a complex matter, and we may accept for working purposes that the primary reaction is on these lines.

Depolarizing Process

The word "primary" is used because the cell is really a two-part affair. Part 1 consists of the electrolyte and the zinc, between which (on open circuit) there is a potential difference of about 1.1 volt. This portion is very efficient, in so far as it does not suffer from polarization: it gets rid of its surplus hydrogen in the form of positive ions. In Part II we have a p.d. of 0.4 V between the carbon and manganese-dioxide element and the electrolyte; hence the overall open circuit p.d. between the terminals of the cell is about 1.1 V + 0.4 V = 1.5 V. But in this second part of the cell we run into considerable trouble when the external circuit is closed.

Each positive hydrogen ion, on reaching the carbon element, exerts an attraction which causes one electron to leave the negative pole, to travel through the external circuit and to turn the positive ion in question into a neutral hydrogen atom. Were nothing done about it, the carbon would soon be surrounded by a blanket of inert hydrogen molecules. Part II of the cell would be clogged and the action of Part I would also be brought to a standstill, for it would no longer be able to discard its surplus hydrogen ions.

Many textbooks lightly show the action of the man-

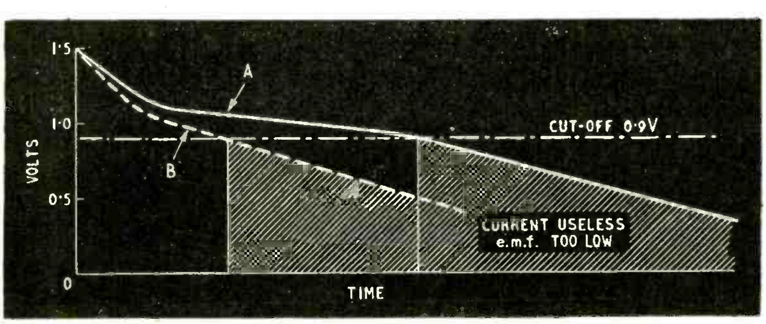


Fig. 1. Curve A shows typical end voltages during intermittent discharge of high-grade cells under ideal conditions of load, temperature and rest periods. A considerable proportion of the ampere-hours potentially available from the zinc in the can is useless, since the e.m.f. is too low. B is the discharge curve of moderately good cells under similar conditions.

ganese-dioxide depolarizer usually employed as:

$$2H + 2MnO_2 = Mn_2O_3 + H_2O$$

If that were a complete statement of the case polarization would be eliminated; or, in any event, complete depolarization, with a return to its original e.m.f., would occur in a cell "rested" for a short time. That this does not happen is common knowledge. The reactions involved are far more complicated. It would be nearer the truth to write: "In time, a certain amount of the hydrogen molecules become dissociated into ions and some of these react with some of the manganese dioxide to form another oxide of manganese and water. Other slow and complex reactions are involved, and this process of depolarization is never sufficiently rapid to keep pace with the clogging that takes place during discharge, or complete enough to restore the original load e.m.f., no matter how long the cell is rested."

Now let us see how effectively the zinc is used. My experiments were made with cells of the $1\frac{1}{4} \times 2\frac{1}{4}$-inch size. Each maker has his own designation for these. The Ever Ready "U2" will be familiar to most readers and will be used as a general term, though cells of a number of different makes, British and American, were subjected to the series of tests on which the present articles are based. The cans of such cells vary somewhat in weight from make to make; nor is it always easy to determine the exact weight of zinc, for seamed cans contain a certain amount of solder. Some cans are thicker than others and there are slight variations in dimensions. On the whole, though, we shall not be far out if we put the average weight of zinc in cans of this size at 19 grams.

There is no difficulty about discovering the number of ampere-hours of current which 19 grams of zinc would furnish, could it be used with complete efficiency. An ampere is a flow of one coulomb a second, and a coulomb consists of 6.3×10^{18} electrons. Zinc is bivalent; each atom passing into the electrolyte is a doubly positive ion, Zn^{++}. This means that for every zinc atom removed from the can two electrons are available at the negative terminal of the cell. To maintain a current of one ampere, then, 3.15×10^{18} atoms must leave the can every second. The atomic weight of zinc is 65.38 ($O = 16$), and from Avogadro's Number we know that 65.38 grams of zinc contain 6.0234×10^{23} atoms. Hence the weight of 3.15×10^{18} zinc atoms is 0.000338 gram; and that is the electrochemical equivalent of zinc. Multiplying by 60×60, we have, in round figures, 1.2 grams of zinc per ampere-hour.

In other words, the current obtainable if 19 grams of zinc were used a hundred per cent efficiently, would be 15.8 Ah. Discharged under ideal conditions of load, temperature and time allowed for recuperation, average cells of "U2" size give 3-4 Ah, and those of the highest quality from 5.5 to a little over 6 Ah. In other words, cells in common use may turn only from 19 to 24 per cent of their zinc to good account, while for the very best the figure does not exceed 40 per cent.

Many factors contribute to this low efficiency. One of the most important of these is that most apparatus intended to be operated by dry cells is designed to work satisfactorily down to, but not below, an e.m.f. of 0.9V per cell. Curve A of Fig. 1 shows typical lumped end voltages (that is, the average e.m.f.s at the end of each day's run) of a group of first-rate cells, discharged under the ideal conditions mentioned. It will be seen that much of the current potentially available from the zinc is useless, since the e.m.f. has fallen below cut-off as a result of progressive polarization. The first requirement, then, if cells of high quality are to be made more efficient, is to speed up the depolarizing process and to make it more thorough. Possible means to this end will be considered later. Curve B of Fig. 1 shows the curve for moderately good cells, discharged under similar conditions.

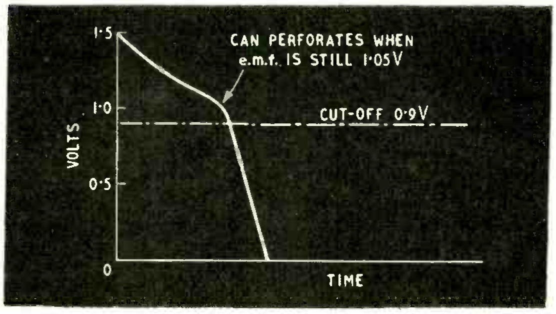


Fig. 2. Discharge curve showing the effects of perforation of the can at a moment when the e.m.f. is still 1.05V.

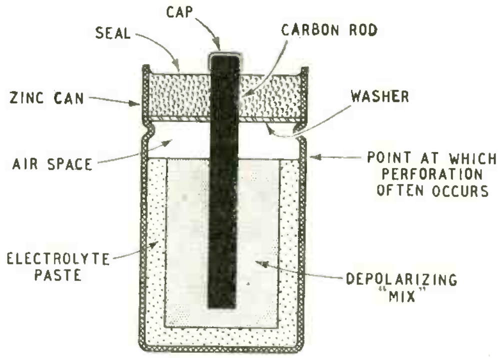


Fig. 3. Construction of modern dry cell. It will be seen that no sac is used. Perforation often occurs in line with the top of the electrolyte paste.

Though their overall performance is poor, the cells are classed as moderately good because they do not show one shocking and all-too-common fault; perforation of the can when the e.m.f. is still above (sometimes well above) cut-off. Fig. 2 indicates what happens in such cases. The e.m.f. begins to fluctuate and then falls almost like the proverbial stone. The electrolyte paste oozes from the hole in the can and may do serious damage. Perforation of one or more cans is in my experience one of the commonest causes of the breakdown of h.t. batteries. I have many times known it occur in batteries which had till then been giving readings of from 0.95V to 1.15V per cell. A curious point is that the cans perforated are nearly always near the middle of the battery; that is, in an 80-cell (120-volt) battery untimely perforation is most liable to occur between the 20th and 60th cells from the negative end.

Causes of Perforation

Premature perforation is in most instances due to poor design or construction. Fig. 3 (which may come as a surprise to any who have not examined the inside of a dry cell for some time) shows how most of these cells are made to-day. There is no sac, the depolarizing "mix" being in direct contact with the

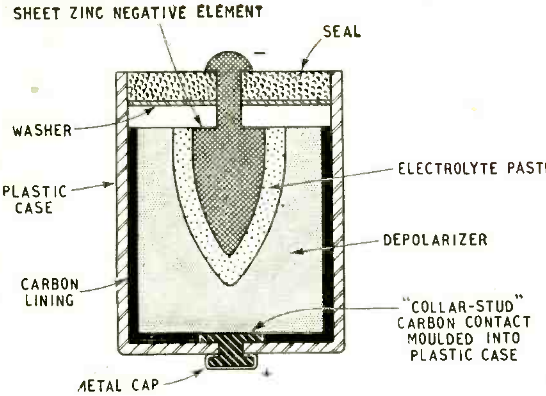


Fig. 4. Suggested "inside-out" cell. Only a small part of the zinc used is now unemployed. By designing the cell so that the carbon forms a lining to the plastic container, the depolarizer is given a much larger surface area on which to act.

paste electrolyte. As Fig. 3 indicates, a position at which the first signs of perforation very often occur is in the part of the can on a level with the top of the electrolyte. When a cell which has failed in this way is opened one frequently finds evidence of a considerable amount of "creeping" of salts from the electrolyte in the vicinity of the puncture. Small differences in the concentrations of such salts may give rise to undesirable local action.

Creeping does not occur to any marked extent inside really good dry cells. It may be due to one of two causes, or to both together. The first of these is the use of too strong a concentration of sal-ammoniac in the electrolyte; the second is failure to make the seal perfectly air-tight. These two causes are probably inter-connected. When a cell is not air-tight, evaporation takes place from the electrolyte, with the result that the ratio of sal-ammoniac to water increases. Another cause of the perforation of cans before cut-off e.m.f. is reached, is the use of zinc of too light a gauge.

There is another important reason why a considerable amount of the zinc in the can is not available for the production of current. A glance at Fig. 3 will show that all that part of the can which surrounds the air-space, the washer and the seal is out of the running: it is merely acting as part of a container and has no electrical role. Again, there is very little electro-chemical action at or near the bottom of the can; and here again zinc *as* zinc is mainly wasted.

New Design of Cell

Could not the dry cell be entirely redesigned on lines more in keeping with the present availability of raw materials? I think I am right in saying that, when the first dry cells were made, suitable carbon was most readily obtainable in the form of rods or plates. Zinc being then plentiful and cheap, the line of least resistance led to the familiar design of the dry cell. Great changes have occurred in the sixty-odd years that have passed since these cells began to come into anything like general use—changes, that is, in everything except their general make-up. High-density carbon, for example, is now readily shaped—or deposited—in any required way.

It is some time now since it occurred to me that a good many advantages might accrue, were the dry cell turned, so to speak, inside out. I have not the facilities for making up the dry cell illustrated in Fig. 4—or, for that matter, any kind of dry cell. But experiments made with wet Leclanché cells using carbon elements of large area have given very promising results. The main purpose of these has been (a) to put the zinc element where the greatest possible proportion of it plays a useful part; (b) to provide the depolarizer with the largest possible surface of carbon on which to act; (c) to make the greatest use of cheap and easily obtainable materials; (d) to evolve a cell which cannot play havoc by perforating; and (e) to produce a cell of exactly the same dimensions as the zinc-cased cell and fitting into any apparatus designed to be operated by it.

Fig. 4 illustrates more or less diagrammatically the suggested new look for the dry cell. The case is of plastic and into the bottom is moulded a "collar-stud" carbon (or metal) contact, with a metal cap on its external end. Immediately inside the case is a thin carbon lining; it need not be more than a few hundredths of an inch in thickness, for in the cell the carbon is chemically inert.

The zinc element is hollow and made of sheet metal, possibly perforated. Or again, it may be a finned die-casting. Its exact shape and mass must be the subject of experiments. The zinc is "pasted" with electrolyte in the ordinary way. The parts between the electrolyte and the button forming the negative contact are protected from chemical and electro-chemical action by a plastic coating.

. . . And its Advantages

A cell made on the proposed lines cannot perforate; by far the greater part of the zinc is usefully employed; polarization must be much slower and depolarization quicker and more complete owing to the far larger area of carbon over which the hydrogen ions are distributed and on which the depolarizer is free to act. The surface area of the carbon walls is actually more than four times greater than that provided by the rod element now used. It will be seen that the proposed cell appears to be also inside-out, or perhaps one should say upside-down, as regards the polarity of its terminals. That protruding from the seal is the negative, while the cap at the bottom is the positive. This, however, is not a matter of importance, so long as the terminals are plainly marked + and −.

Though the idea of designing a dry cell on the lines described was original, in so far as it was based on my own line of thinking and on nothing that I had read, seen or heard, I cannot claim to be first in the field in trying to make the dry cell more efficient by turning it inside-out. Somebody always seems to have thought a little sooner than oneself of any new conception that occurs!

Explaining my scheme recently to an American friend, I learnt that an "inside-out" dry cell had made its appearance in the United States. I have not been able to acquire American cells of this type, or to find out anything more about them. Whether or not they bear any resemblance to the design suggested in Fig. 4 I do not know. What I venture to hope is that this article may stimulate British designers of dry cells to break away from tradition and to give us (and the all-important export market) something far more efficient and more economical than the familiar dry cells of to-day.

MODERNIZING THE

Wireless World Television Receiver

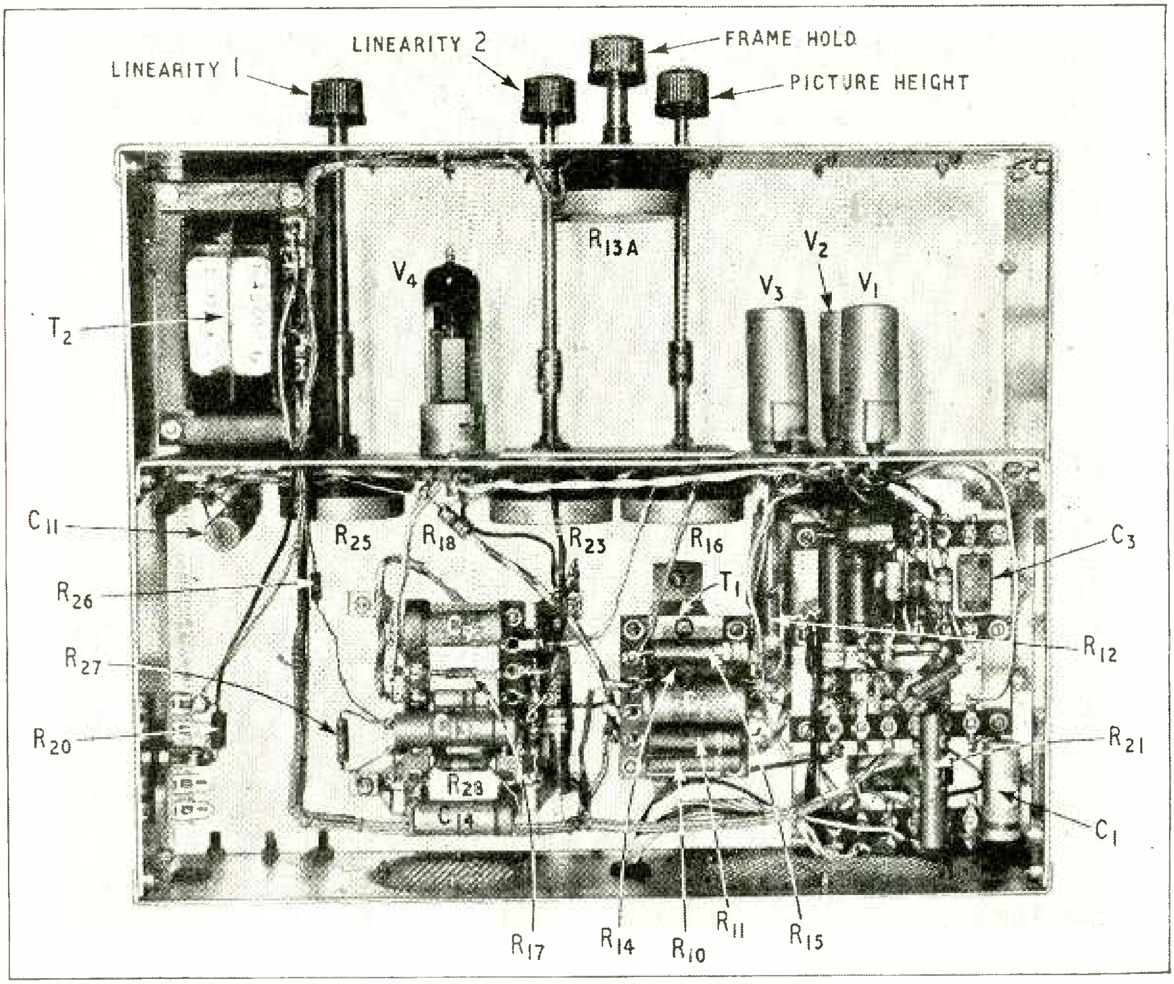
Part 2.—Time-Base Circuits

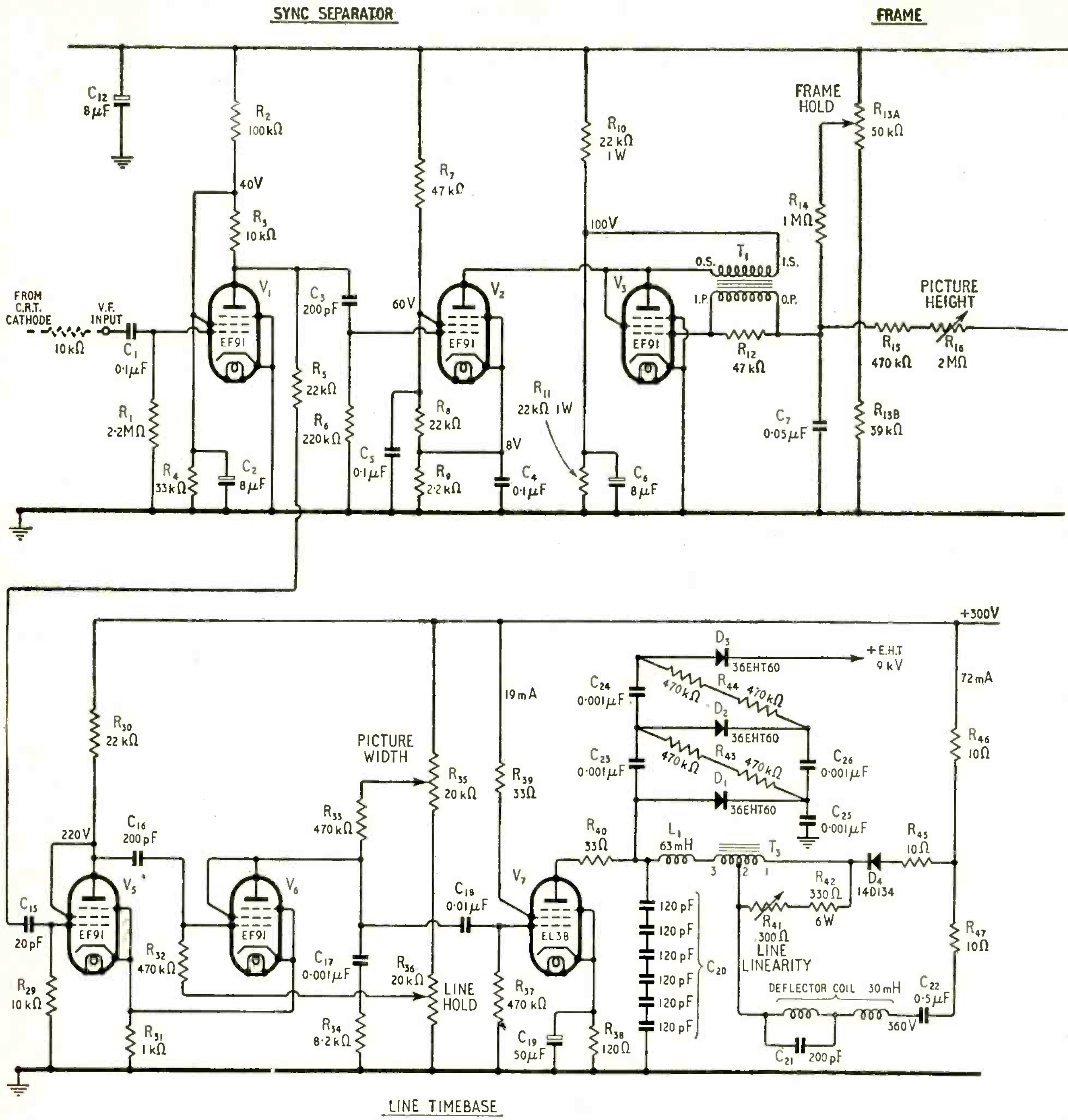
IN the original *Wireless World* Television Receiver the frame and line time-bases were built on two separate chassis and the sync-separator circuits were included with the frame time-base. A similar arrangement is adopted for these new time-bases and the sync-separator is included with them.

The circuit diagram is shown in Fig. 1. V_1 is the sync-separator and is fed with the combined sync and picture signal from the cathode of the tube. It is actually fed through a 10-kΩ $\frac{1}{2}$-W resistor suspended in the lead from the tube cathode to the sync-input connector on the time-base. This resistor is shown dotted in the diagrams to indicate that it is external to the chassis. In the original time-bases, C_1 was so mounted and can be still if desired, but it is normally convenient to include it in the chassis. It must be so mounted that it has a low stray capacitance to earth.

D.C. restoration is effected in the grid circuit in the usual way and the separated negative-going sync pulses appear in the anode circuit. They are applied

Internal view of the frame time-base unit with some of the chief components indicated. The sync-separator components are on the extreme right.





through a differentiator and attenuator R_5, C_{15}, R_{29}, to V_5 of the line saw-tooth generator. They are also applied through a semi-differentiator C_3, R_6, to the limiter V_2 which produces sharp output pulses from the trailing edges of the frame pulses. These are negative-going and are applied to the anode of the frame saw-tooth generator V_3.

This generator is a blocking oscillator using a transformer T_1. This transformer is identical with the one used in the original receiver. The saw-tooth appears across C_7. Instead of using a variable charging resistance for the Hold control, the charging resistance R_{14} is now fixed and is taken to a variable voltage point provided by R_{13A}. The main reason for this is that a lower value variable component can be used and therefore one which can be wire-wound.

The saw-tooth voltage across C_7 is fed to the grid of V_4, the frame output valve, through R_{15} and R_{16}, the latter of which is variable as a Height control. The deflector coil is transformer-coupled to the valve by T_2 and the 150-Ω resistance R_{20} across the deflector coil is for the purpose of reducing the line-frequency voltages set up in the deflector coil by unavoidable coupling to the line deflector coil.

Since it is not possible to make the inductance of the transformer anything like high enough to avoid

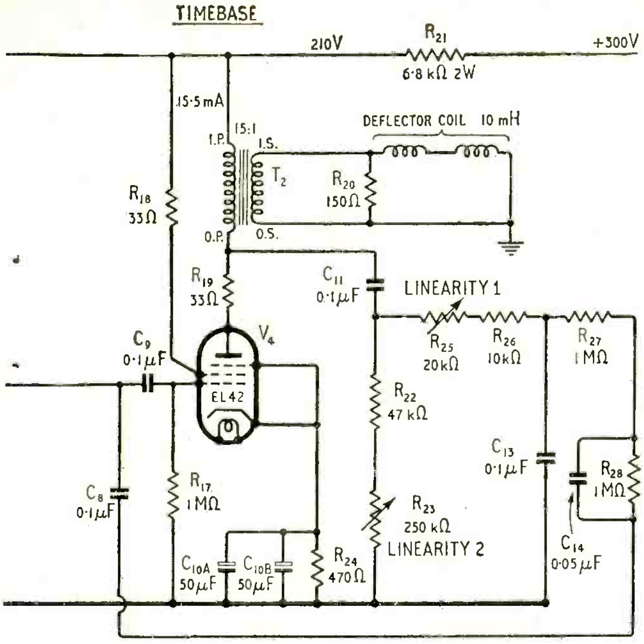


Fig. 1. Complete circuit diagram of the new time-bases. The resistor shown dotted is mounted in the wiring between the tube cathode and the input to the sync separator. C_{21} is mounted on the deflector-coil assembly. R_{45}, R_{46} and R_{47} have no circuit function but are included merely so that the current waveforms can be checked easily with an oscilloscope.

severe waveform distortion, very heavy correction is needed to obtain linearity. This is obtained by a feedback circuit of the Blumlein type. There are in all four circuits introducing distortion of the same form ; the initial charging circuit R_{11}, C_7, the coupling R_{17}, C_9, the cathode-bias circuit R_{24}, C_{10}, and the transformer coupling. The transformer is the major source of distortion and the bias circuit the next in importance.

The correction circuit comprises C_{11} with R_{22} and R_{23}, the latter being variable as a linearity control. It is the main such control and affects the linearity generally over the picture. The next elements R_{25} and R_{26} with C_{13} affect the linearity at the extreme top of the picture only. In practice, R_{25} opens or closes the top half-inch of the picture. The remaining components R_{27}, R_{28}, C_{14} and C_8, are unusual ones, but were found experimentally to improve the linearity at the extreme bottom of the picture.

The linearity is affected by valve curvature, and so the settings of the linearity controls are slightly affected by the Height control. The dependence is small, however, and causes no practical inconvenience. In initial setting up the Height control should be adjusted for a picture of about three-quarters normal height and the two linearity controls roughly adjusted. Height should then be increased until the picture is just a little smaller than the mask and the linearity controls finally adjusted. Linearity 1 can easily be adjusted at any time for uniform line spacing at the top of the picture. Linearity 2 should be adjusted on Test Card C if possible. Height can then be increased to the proper value

A very hard frame lock is usually obtained, with the result that over a large part of its range a variation of Hold only affects the picture Height. Usually it is sufficient to set Hold at about the middle of the hold range and leave it there.

In the line time-base the saw-tooth generator is a cathode-coupled multivibrator V_5, V_6. The charging capacitance is C_{17} and the charging resistance is R_{33}. The applied voltage is varied by R_{35} as a width control. This varies the amplitude of the generated saw-tooth and hence the drive on the output valve V_7.

The valve V_6 is normally held beyond cut-off by the charge on C_{16}, thus enabling C_{17} to charge. V_5 is conductive. A negative-going sync pulse on the grid of V_5 reduces its anode current and causes a rise of voltage on its anode which is passed to V_6 by C_{16}. This makes V_6 conductive and its anode current is drawn from C_{17} to discharge it. Grid current also flows to charge C_{16}. These currents flow through R_{31} and raise the cathode potential of both valves. which still further reduces the current in V_5. The action is regenerative. When C_{17} is discharged, the current in V_6 drops and so the cathode potential falls and the current in V_5 rises. The action is again regenerative and V_6 is cut off. It is held cut off by the charge on C_{16} until the next sync pulse comes along or until C_{16} has discharged sufficiently to let V_6 conduct again. The grid-return potential of V_6 is adjustable by R_{36} as a hold control.

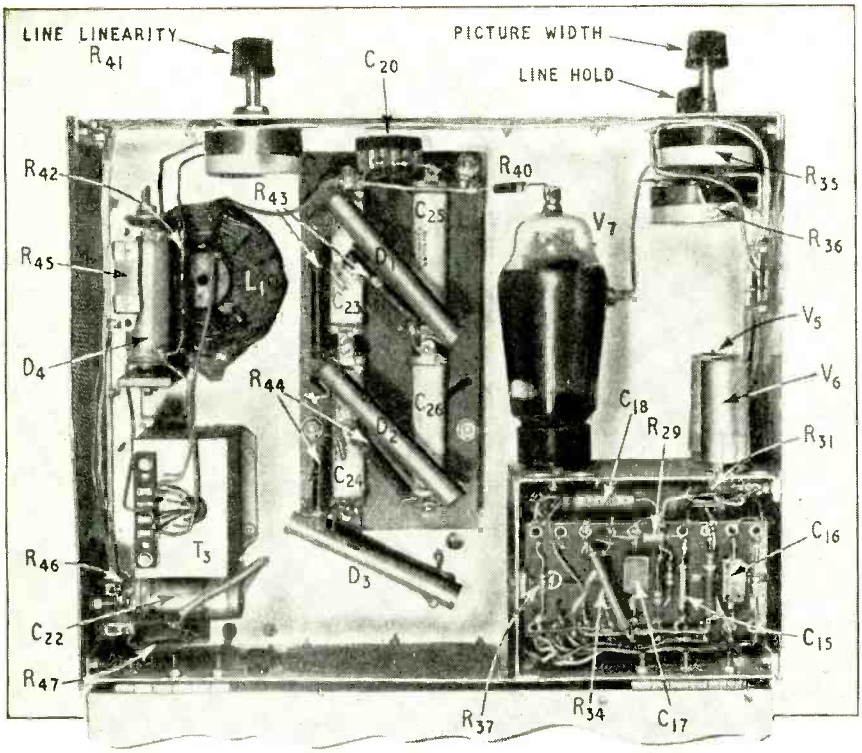
A resistance R_{34} is included in series with C_{17} in order to produce a large negative-going pulse on flyback. This is necessary in order to cut off the output valve rapidly and hold it cut off during flyback. The value of this resistance has an appreciable effect on the e.h.t. voltage produced and some effect on the linearity at the start of the scan.

No coupling transformer is used between the valve and the deflector coil and the circuit is one using a resonant flyback with an energy-recovery diode. Because of losses, the natural overshoot is less than 100%, and to obtain h.t. boost either a step-down transformer must be used or energy must be fed into the deflector-coil circuit during flyback so that the overshoot does become 100%. This energy is derived from a second circuit comprising L_1 and stray capacitances which is coupled to the deflector coil by C_{20}.

For a detailed explanation reference should be made to a previous article, but, briefly, L_1 and the deflector coil form two tuned circuits with their self- and stray-capacitances and they are coupled together by C_{20}, which acts as a "top-end" coupling capacitance. When V_7 is cut off during flyback, energy is stored in the magnetic fields of both coils. In the case of the deflector coil, it is required that the energy in its field be turned into electric form in the capacitance and then back again into magnetic form ready for the next scan. A loss of energy inevitably occurs, and this is made good by a transference of energy from L_1 through C_{20}.

The capacitance needed for this coupling is formed partly by the anode-cathode capacitance of V_7 and partly by a 20-pF capacitor C_{20}. This capacitor actually comprises six 120-pF capacitors in series, each of 750-V rating, in order to obtain the required voltage rating of 4 kV total.

A metal rectifier is used as a diode for energy recovery and avoids any difficulty over heater supply. It recovers about 50–60 V at the mean anode current of V_7 and this appears across C_{22}. With the 300-V h.t.



The line time-base unit. The e.h.t. voltage-tripler components are mounted near the centre on a sub-panel of Paxolin: slots are cut around the fixing holes to lengthen the leakage paths.

line the anode supply for the output stage is thus 350–360 V.

Linearity is controlled by the variable resistor R_{41}, which varies the magnitude of a control voltage injected by T_3 in series with the diode and derived from the anode current of V_7. This transformer is a simple scramble-wound component which needs no special insulation in itself and is, therefore, easy to make. As a whole it needs insulating for up to 2 kV from the chassis, because the peak voltage of the deflector coil appears on it. Magnetostriction in the core produces a whistle and the two are remedied together by enclosing it in sponge rubber to provide both electrical and acoustical insulation.

The resistors R_{45}, R_{46} and R_{47} have no circuit function. They are included merely to enable the current waveforms to be checked with an oscilloscope. If an oscilloscope is not used they need not be included. If they are employed they should be wire-wound resistors of 1% accuracy so that they can be used for actual measurement purposes. The mean anode current can be measured, for instance, by measuring the voltage drop across R_{45} or R_{46}. The reading in volts multiplied by 100 gives the current in milliamperes.

E.h.t. is obtained through a voltage-tripler rectifier system from the peak voltage which appears on flyback across L_1 and the deflector coil. The tripler gives a multiplication of about 2.5 times and produces some 8.5 kV from the 3.4-kV peak. The magnitude of the e.h.t. voltage is governed by the rate of cut-off of the output valve and by the value of C_{20}. Increasing the first by increasing R_{34}, and/or reducing C_{20}, will increase e.h.t. and, under some conditions, up to 11 kV has been obtained with full picture width. Generally speaking, if C_{20} is reduced, R_{34} must be increased to maintain linearity.

It is not recommended that these changes should be made, for the picture width becomes rather bare at voltages much over 9 kV and the full width may not always be obtainable. Also, difficulty from corona is likely.

Under the normal conditions of the circuit diagram, ample width is available with very good linearity and a complete absence of fold-over or visible ringing, and the adjustments are not critical. Normally the linearity control R_{41} should be set at about half-way and Width increased until the picture nearly fills the mask. Hold should be adjusted for a good lock, which will narrow the picture considerably. Then turn up Width again and re-adjust Hold. Adjust linearity on Test Card C. It is not a critical control. When R_{41} is too small the picture tends to be gradually compressed towards the right. As R_{41} is increased the linearity is improved and, if it is too high, it may expand towards the right. Adjust Width to the proper value and lastly, Hold.

A large range of width is available without losing synchronization but, after adjusting it, Hold should be readjusted because, even if synchronizing has not been lost, it may be nearly lost, and a slight change of mains voltage may send it over.

Some adjustment to C_{21} may be required. If this component is omitted, a series of grey and white bars will appear over the left-hand side of the picture. They are produced by ringing in the deflector coil itself and are quite independent of the time-base. They can only be avoided, in the absence of heavy coil losses, by equalizing the capacitances on the two coils of the line assembly. Ideally, C_{21} would be an adjustable component and would be adjusted to the critical value at which the bars disappear from the picture. In practice a suitable component is difficult to obtain, for it must be stable and withstand 1-kV peak. An approximate balance using a fixed capacitor has been adopted, therefore, with the result that the bars may not be completely absent.

The balance is normally good enough if the bars are just visible on a blank raster, for they are then unnoticeable on a picture. Precise adjustment of C_{21} will make them disappear even on a blank raster, but sufficient precision for this is hard to obtain without using an adjustable component.

This capacitor is not mounted in the chassis but directly on the deflector-coil assembly and across the "unearthy" coil of the line pair. If the deflector-coil connections as a whole have to be reversed, C_{21} must be changed over to the other coil.

Adjustment of C_{21} is best carried out on a blank raster, which need not be synchronized. Without it, a series of vertical grey and white bars on the left-hand side of the picture will be seen gradually decreasing in intensity towards the right and ceasing about the middle. As C_{21} is increased in value up to the optimum they decrease in intensity, but reappear again when it is too large.

In practice, if the bars are more than just detectable with a blank raster and a 200-pF capacitor, one should try different values for C_{21}. The first step is obviously to try an extra 20–30 pF capacitor in shunt with it, and to note whether this increases or reduces them. If it reduces them try a bit more, but if it increases them reduce the main capacitor to 150 pF and then start adding more capacitance.

The precise value for the complete elimination of the bars is quite critical. However, a value which renders them undetectable on anything but a blank raster is far from critical, and no difficulty should be experienced in finding one. If, by any mischance, the proper value cannot be found, it is a good plan to replace C_{21} temporarily by a variable air capacitor of 500 pF or so. This can be smoothly adjusted while watching the picture, and if a sharp balance point cannot be found, something is wrong somewhere.

Before turning to the constructional side it may be as well to say something about what parts of the original time-bases can be retained in making a change to the new one. The original sync-separator V_1 and V_2 can be retained unaltered with the original circuit values; but R_5, C_{15} and R_{29} of Fig. 1 must be included and have their new values. It may be found desirable in this case to reduce R_{29} to 4.7 kΩ, for the original sync separator gives a larger output than the new one.

In the frame time-base the EF37 can be retained for V_3 and the EL33 for V_4, but using all the new circuit values of Fig. 1. In the line time-base the EL38 is the only thing that can be retained. Although this has not been tried, it is probable that the EF50 can be used in place of the EF91 without change of values. A 6SN7 double-triode has been employed successfully in place of V_5 and V_6 without changing component values.

The use of an 807 in place of the EL38 has not been tried and can hardly be recommended. It has a screen dissipation rating of 3 W only, compared with the 6 W of the EL38, and its rating is therefore exceeded in this circuit. Apart from this, it would probably work satisfactorily but it might well have a short life.

The time-bases give ample scan for a tube operating at 8–9 kV, and this is an adequate voltage for a 12-in tube. Many will consider it enough for larger tubes, although the trend is to operate such tubes at higher voltages. The use of higher voltages is not recommended to the inexperienced, however, on account of the difficulty of avoiding corona troubles. These are

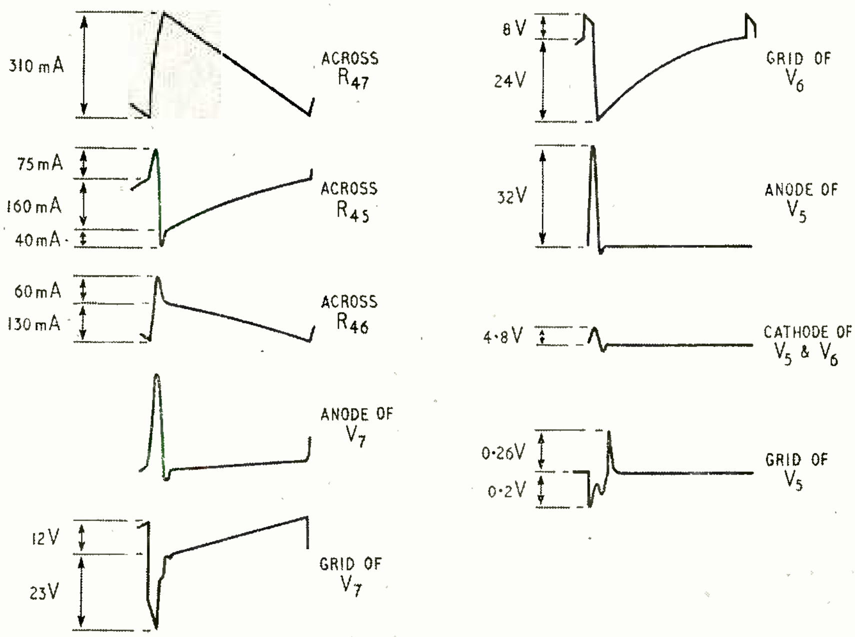
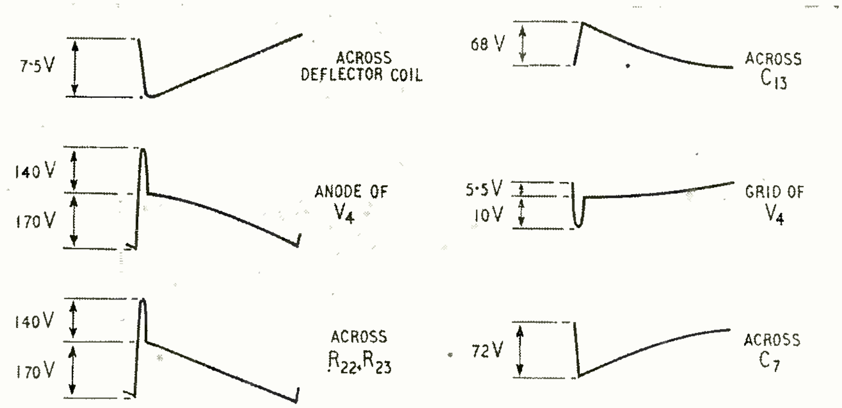


Fig. 2. Waveforms at important points in the line time-base. The current waveforms were measured as voltages across 10-Ω resistors.

Fig. 3. Waveforms in the frame time-base. A 10-MΩ resistor was connected to the oscilloscope cable to reduce small superimposed line-frequency voltages.



small for voltages below 8 kV, but become very considerable above 10 kV. In the region 9–10 kV corona can be troublesome, but is not unduly so. To minimize these troubles the voltage is limited to 9 kV in the present design and, allowing for the inevitable variations, may be 8 kV in some models.

It may be remarked in passing that a major effect of slight corona, which may be otherwise unsuspected, is poor line synchronizing. The discharge produces pulses which fire the time-base erratically. The visible effect is a ragged edge to the picture.

The waveforms in various parts of the circuit are shown in Figs. 2 and 3 for the line and frame time-bases respectively. These were all taken using the "Television Oscilloscope*." In the case of the frame time-base, most were taken using a 10-MΩ resistor as a probe to minimize the effect of the oscilloscope on the time-base. In conjunction with the capacitance of the cable, this acts as a filter and removes the small content of line pulses which appear on some of the waveforms. If such a filter is not used, several of the frame waveforms will not appear as traces with clean lines but rather as fuzzy outlines.

In the line time-base the oscilloscope was connected across R_{45}, R_{46} and R_{47}, so that its case was live to h.t. If this is not done, the small ripple on the h.t. line appears also on the trace to distort it. Since this makes the case of the oscilloscope live, care must be taken in handling it.

* "Television Oscilloscope", by W. Tusting, *Wireless World*, June and July 1952.

LIST OF PARTS

Resistors

R_1	2.2MΩ	½W	Erie
R_2	100kΩ	½W	Erie
R_3, R_{26}, R_{29}	10kΩ	½W	Erie
R_4	33kΩ	½W	Erie
R_5, R_8, R_{30}	22kΩ	½W	Erie
R_6	220kΩ	½W	Erie
R_7, R_{12}, R_{22}	47kΩ	½W	Erie
R_9	2.2kΩ	½W	Erie
R_{10}, R_{11}	22kΩ	1W	Erie
R_{13A}	50kΩ	potentiometer, wire-wound, linear, 5W	Reliance Type T.W./1
R_{13B}	39kΩ	1W	Erie
R_{14}, R_{17}, R_{27}, R_{28}	1MΩ	½W	Erie
R_{15}, R_{32}, R_{33}, R_{37}	470kΩ	½W	Erie
R_{16}	2MΩ	variable, linear	Reliance Type S.G./1
R_{18}, R_{19}, R_{39}, R_{40}	33Ω	½W	Erie
R_{20}	150Ω	½W	Erie
R_{21}	6.8kΩ	2W	Erie
R_{23}	250kΩ	variable, log-law	Reliance Type S.G./1
R_{24}	470Ω	½w	Erie
R_{25}, R_{35}, R_{36}	20kΩ	variable, wire-wound, linear, 5W	Reliance Type T.W./1
R_{31}	1kΩ	½W	Erie
R_{34}	8.2kΩ	½W	Erie
R_{38}	120Ω	2W	Erie
R_{41}	300Ω	variable, wire-wound, linear, 5W	Reliance Type T.W./1
R_{42}	330Ω	6W	Welwyn
R_{43}, R_{44} each 2×	470kΩ	1W	Erie

Capacitors

C_1, C_4, C_5, C_8, C_9, C_{11}, C_{13}	0.1μF, tubular paper, 350 V, Dubilier Type 460
C_2, C_6, C_{12}	8μF, electrolytic, 500 V, Dubilier Drilitic BR850
C_3, C_{16}	200pF, silvered mica, 350 V, Dubilier Type 635
C_7, C_{14}	0.05μF, tubular paper, 350 V, Dubilier Type 450
C_{10A}, C_{10B}, C_{19}	50μF, electrolytic, 50 V, Dubilier Drilitic BR505
C_{15}	20pF, ceramic, Dubilier Type CTD316
C_{17}	0.001μF, moulded mica, 350 V, Dubilier Type 635
C_{18}	0.01μF, tubular paper, 350 V, Dubilier Type 460
C_{20}	6× 120pF, silvered mica, 750 V, Dubilier Type 635
C_{21}	200pF, mica (see text), Dubilier Type 680
C_{22}	0.5μF, tubular paper, Dubilier Type 4706B
C_{23}, C_{24}, C_{25}, C_{26}	0.001μF, 10 kV, Dubilier Type 411

Valves

V_1, V_2, V_3, V_5, V_6	EF91 Mullard
V_4	EL42 Mullard
V_7	EL38 Mullard
D_1, D_2, D_3	Westinghouse 36 EHT60
D_4	Westinghouse 14 D134

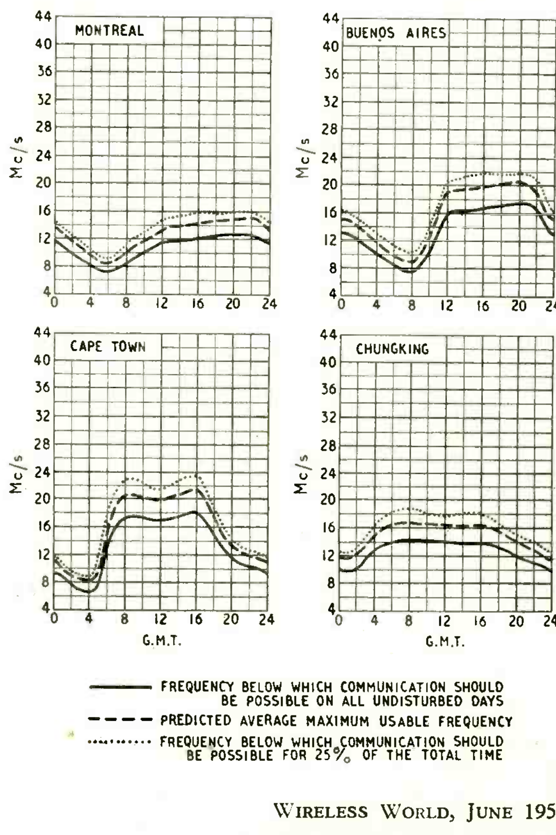
(*to be concluded*)

Short-wave Conditions

Predictions for June

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during June.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



Radio Waves

How the Magnetic and Electric Fields Support Each Other

By "CATHODE RAY"

DURING the war, when thousands of people had to be trained in the shortest possible time to look after radar equipment, it surprised everybody, I think, how in a few months any reasonably intelligent lad, starting right from scratch, seemed to be quite at home among unprecedentedly complicated circuitry. Some of them, not noticeably bright in other respects, could quite readily reproduce diagrams of such circuits from memory. We, who were called upon to do our spot of instructing, sometimes wondered what we could have been doing during our years of study! But when questions were asked that required the application of basic principles to a new situation some of the most outstanding memorizers failed the most dismally. It was not that they couldn't recite all the necessary principles from memory. The difficulty was—and is—first to know which to pull out of the bag, and secondly, how to use it. A, who relies entirely on memory and practical experience can go far astray when he comes up against something unfamiliar; B, who works things out from principles may be hopelessly slow at routine stuff but can find his own way over new ground.

Exactly what happens between radio sender and receiver doesn't concern most of us very deeply most of the time; we are taken up with what happens before and after, and may not have to dig out our basic principles often enough to prevent them from getting rusty. So a little practice here and now may be all to the good.

Two months ago, you may remember, I mentioned that radio waves—electromagnetic waves, to be precise—consist of equal electric and magnetic fields. People sometimes ask, "Which part produces the signal in the receiving aerial; the magnetic, the electric, or both?" If the receiving aerial were close enough to the source to be affected by *induction* fields, this would be quite a sensible question, because the induction fields are those parts of the total electric and magnetic fields that depend directly on the source, so it is possible for them to be mainly electric or mainly magnetic, depending on whether the source is energized mainly by voltage or current. That is why G. Bramslev was able to show (in the Nov. 1952 issue) how to use a frame aerial to discriminate against noise interference from sources producing mainly electric fields. When no clear distinction is made between induction fields, tied to their mother's apron strings, and radiation or wave-motion fields, making their own independent way through the world, it is not surprising that there are confused ideas about wave reception, such as a belief that an open-wire aerial responds to the electric part of a radiated wave and a frame aerial to the magnetic part, so that one can choose whichever one wants. Actually, asking which part of the wave causes the signal in either kind of aerial is rather like asking whether things blown over by the wind are affected by the movement or the pressure of the wind. Without movement there would be no one-way pressure, and without pressure there would be no movement. The two are inseparable, so you can please yourself which you say is the cause.

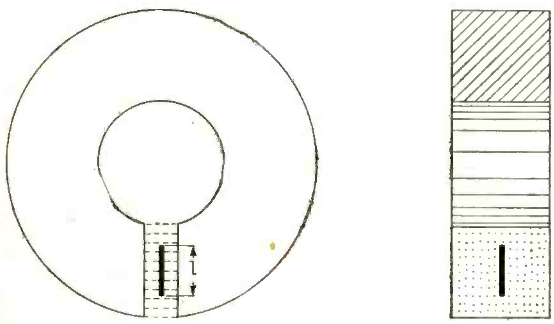
If you still feel puzzled about this, even after the difference between induction and radiation has been made clear, I am not surprised. It does seem contradictory. Fact One is that an open-wire aerial responds to an induction electric field and a frame aerial or coil to an induction magnetic field, but not vice versa. Fact Two is that there is no difference between induction and radiation fields themselves but only in the way they are organized. And yet one is asked to believe that with radiation fields the type of aerial cannot be used to distinguish between the electric and magnetic parts, and that this is not simply because the electric and magnetic fields happen to be present in equal proportions. The only possible explanation must lie in the difference in organization between induction and radiation fields.

That is quite so, but to see it one needs to fall back on first principles. And it is just as well to remember that these principles are not mere armchair theory but are the results of actual experiments. One of the greatest of all experimenters was Faraday. He it was who discovered how to generate electricity by magnetism. (The generation of magnetism by electricity had already been discovered.) He found there were two ways of generating an e.m.f. in a coil of wire. One was to push a magnet in or pull it out. He found the e.m.f. lasted only while the magnet was moving relative to the coil. Of course the same result was obtainable with a fixed magnet and moving coil. The principle of the thing was summed up by saying that whenever any part of a circuit is cut by the flux of a magnetic field the circuit receives an e.m.f. proportional to the rate of cutting. If you were to get a large magnet and a small piece of wire as in Fig. 1, and move the magnet at right angles to the wire (i.e., towards or away from you in (a), and to left or right in (b)) the magnetic field extending between the poles of the magnet would cut across the wire and generate in it an e.m.f. The rate of cutting, and hence the e.m.f., would obviously be proportional to (i) the strength of the field, or flux density, (ii) the speed of movement, and (iii) the length of the wire.

The other epoch-making experiment of Faraday was to generate an e.m.f. in a coil *without any movement*, by varying the strength of the magnet. He did this, of course, by using a coil of wire as the magnet, switching the current on and off. Again, the e.m.f. lasted only while the magnetism was varying. This result was generalized by saying that if the amount of magnetic flux linked with any circuit is varied the circuit will receive an e.m.f. proportional to the rate of variation.

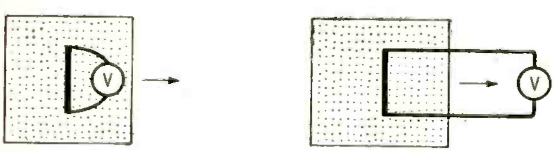
On the first experiment is based the generation of nearly all the world's electricity supplies, and on the second the transformers needed to make those supplies economically available; so no wonder Faraday is the "patron saint" of electrical engineers.

As sometimes taught, the flux-cutting idea (Fig. 1) is given as the basic principle, and the flux-varying idea is brought into line with it by supposing that when a current is switched on the resulting flux springs out from it and cuts across any close-up circuits, and when it is switched off it returns inwards and cuts them again in the opposite direction. This mental picture is none too clear when it is called upon to explain the e.m.f. of *self*-inductance. How does the flux springing out from a wire cut that wire itself? And this is not the only dubious aspect of the flux-cutting idea. The "experiment" purporting to demonstrate it (Fig. 1) is quite phoney. Unlike those of Faraday, it is not an experiment that can be performed. To demonstrate the existence of the e.m.f. it is necessary to connect a voltmeter between the ends of the wire; then what about the voltmeter leads? If they are kept within the field as in Fig. 2(a) they too are cut by the flux so they receive an e.m.f. which (assuming the field is uniform) exactly counterbalances the e.m.f. in the wire and one is none the wiser. If the leads are taken horizontally as in Fig. 2(b) so that they are not cut, the e.m.f. now shown by the voltmeter can be explained equally well by the fact that moving the magnet in the direction of the arrow increases the flux linking the circuit. The absence of result in Fig. 2 can likewise be explained on the same basis; the assumption that the field is uniform means that moving the magnet does not alter the flux linked with the circuit. So both of Faraday's methods of inducing an e.m.f. can be visualized and calculated as flux-linkage variation, without any need to bring in the rather shaky and experimentally undemonstrable flux-cutting picture.



(a) (b)

Fig. 1. The basic principle of how electricity is generated in a power station is often expressed something like this, by saying that if a magnetic field is moved across a length of circuit l an e.m.f. is generated in it, proportional to l and to the rate at which the field is moved across. Here the field is shown as due to a permanent magnet, moved towards or away in (a) and to right or left in (b), which is a cross-section of (a).



(a) (b)

Fig. 2. When an attempt is made to verify Fig. 1, it is necessary to take account of the voltmeter leads. Moving the magnet causes no reading in (a); the arrangement shown in (b) is successful, but the action can at least equally well be explained as change of magnetic field passing through the whole circuit.

Example of Flux Linkage

Just to consolidate the matter, let us take a simple example; say the Fig. 2(b) situation, making the assumption that the flux density is uniform between the pole-pieces and zero elsewhere—no "edge effect." Wire, flux, and motion are all mutually at right angles. Field calculations are easiest if one uses the m.k.s. system of units, as most modern books do. The voltage generated is equal to the rate of flux cutting or linkage if that is in webers per second (1 weber = 10^8 "lines"). Suppose the flux density (B) is 1.2 webers per sq metre (12 kilogauss in the old units), the wire is 0.02 metre long, and the magnet is moved at 0.5 metre per sec. Then the cross-section area of flux passing through the circuit increases at the rate of $0.5 \times 0.02 = 0.01$ sq metre per sec, so the rate of flux linkage, and hence the induced voltage, is $0.01 \times 1.2 = 0.012$. If the process is pictured as flux cutting the original vertical wire, the figures are of course the same, but the result (0.012) must not be taken as the measurable voltage until one has made sure that no other parts of the circuit are being cut by any flux. Because of this the flux-linkage way of looking at it is both safer and (in less absurdly simple examples) may be easier.

So far we have supposed this moving magnetic field to be produced by a permanent magnet. But of course it could be an electromagnet. Fig. 3(a) shows a single-turn coil of wire carrying d.c. Its magnetic field is at right angles to the paper, and with an anti-clockwise current as shown it is towards us, as suggested by the dots. Next (b) imagine the loop to be whisked rapidly to the right. The effect of this is that paths such as those shown dotted experience an e.m.f. tending to drive current in the directions shown. But because no circuits are provided there, it is only a tendency. One can say that within the area covered by the loop at any instant there is an upward e.m.f.

Electric-Field Current

At this stage a little digression may be necessary to recall what happens when an e.m.f. is applied across a space. This is done in Fig. 4 by connecting a battery to a pair of parallel plates. The e.m.f. of the battery sets up a potential difference between the plates, which is another way of saying that there is an electric field between them, indicated conventionally by the lines in Fig. 4. This field is reckoned in volts per metre. But before it can exist the battery must have driven a current from the lower to the upper plate in order to charge it positively. (Actually what happens, of course, is that electrons are driven downwards on to the lower plate to charge it negatively, but that is just another way of saying the same thing.) To anybody who thinks in terms of circuits and current electricity rather than charges and static electricity, this charging current is something of an anomaly. How can a current flow in a circuit that is not complete? Maxwell, the genius who brought his mathematics to bear on Faraday's experimental results and predicted electromagnetic waves, argued that what happened in the space occupied by the field was equivalent to a current; it flowed only so long as the field strength was varying, so could not continue indefinitely in the same direction, and to distinguish it from conduction or circuit current he called it displacement current. It is like the limited movement in a fixed block of rubber while pressure is being increased across it. So we think of the temporary current that flows upward through the battery in Fig. 4 when it is connected as being continued back to the start by a downward displacement current in the space between the plates.

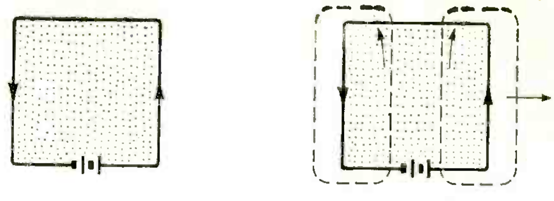
To fit this Fig. 4 picture into Fig. 3 it is necessary to imagine that the battery fills the whole of the space covered by the loop, because it is all occupied by upward e.m.f. So the downward displacement current must all flow outside the loop area. Finally, since the e.m.f. is not produced by a battery at all but by a moving magnetic field, the upward current too must be a displacement current. Since space at the top of the loop is positively charged, an upward displacement current must have just occurred in order to make it so; in fact, at the extreme right-hand side of the loop the space is actually in the process of becoming positive at the top, and so a displacement current must still be occurring here. *Note that it is in the same direction as the magnetizing current produced by the loop battery.* At the left-hand side the positive charge must disperse as the edge of the loop passes by, so here there is a downward displacement current—again in the same direction as the magnetizing current.

Now any current causes a magnetic field; no questions are asked as to whether it is a conduction current or a displacement current. So when the loop is moved there is no need to supply quite so much current from the battery; the difference is made good by the displacement current caused by the motion. The faster the loop is moved the greater the electric field developed by a given magnetic field and the greater the displacement current. If the loop were moved fast enough, could it be dispensed with altogether, the moving magnetic field being sustained entirely by displacement currents?

That is the question that Maxwell answered and expressed in the celebrated Maxwell equations. These don't mean a thing to anybody who is not rather unusually bright at mathematics, so I shall try to arrive at the answer by an easier route, even if it may not altogether satisfy the stricter mathematicians.

What we know already is that the electric field (denoted by ϵ) is equal to the voltage per metre p.d. set up by the movement of the magnetic field. (If an air capacitor with plates 1 mm apart is charged to 50V, the electric field in the space between is 50,000 V/m.) And we know that the voltage is equal to the rate at which the flux is changing in the space concerned. The flux (Φ) is equal to the flux density (B) multiplied by the area of its cross-section. And B is equal to the magnetic field strength (H) multiplied by the permeability (μ). And in m.k.s. units H is equal to the ampere-turns per metre of field length. We can greatly simplify the putting of all this together if we make our chunk of space a one-metre cube. The original magnetizing loop would appear in Fig. 3 as a one-metre square, but this would be an edge-on view of a turn made of strip one metre wide. Suppose that at the instant considered it exactly contains our stationary cube of space. And let the current round the loop be I amps. Then H is equal to I, and B (and therefore Φ in this case) is equal to μI. The rate at which Φ is changing in this space depends on the speed with which the loop is moved across the space. By the time it has been shifted one metre the whole of the flux Φ has been taken away, so if the speed is v metres per second the rate of change of Φ is $v\Phi$, and we know this is equal to ϵ. So the final upshot is

$$\epsilon = v\mu I$$



(a) (b)

Fig. 3. If a simple loop electromagnet as shown, producing a magnetic field pointing towards the reader, is moved to the right it causes an upward e.m.f.

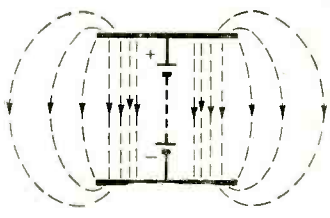


Fig. 4. In order to set up a potential difference between two plates it is first necessary for a temporary charging current to flow, and this is supposed to be continued as a displacement current along the directions of the electric field, shown here.

Doing Without the Loop

Now to render the magnetizing loop entirely unnecessary, I has to be the displacement current generated by the charging of the space. A current is the rate at which electric charges are being moved. If a charge amounting to one coulomb is transferred at a steady rate in one second the current is one amp. The amount needed to charge C farads to V volts is CV coulombs. Our chunk of space can be regarded as a capacitor with plates one metre in area spaced one metre apart. Its capacitance in m.k.s. units is equal to the permittivity (κ) of space. The movement of the magnetic field at v m/s causes it to be charged to ϵ volts v times per second, so the rate at which charging takes place (which is I) is $\kappa\epsilon v$ coulombs per second. So now we know that $I = \kappa\epsilon v$. But our previous result told us that $I = \epsilon/v\mu$. So putting these together we get

$$\kappa\epsilon v = \frac{\epsilon}{v\mu}$$

$$\therefore\ \kappa v = \frac{1}{v\mu}$$

$$\text{and } v^2 = \frac{1}{\mu\kappa}$$

$$\text{so } v = \frac{1}{\sqrt{\mu\kappa}}$$

For reasons that are too involved to explain in passing, the m.k.s. electrical units are based on the μ of empty space—air is practically the same—being equal to $4\pi/10^7$. Measured in the same units, κ is found to be almost exactly $1/(36\pi \times 10^9)$, so

$$v = \sqrt{\left(\frac{10^7}{4\pi} \times 36\pi \times 10^9\right)}$$
$$= \sqrt{(9 \times 10^{16}}$$
$= 300{,}000{,}000$ metres per second approximately*.

That is the speed at which fields have to move through space in order to be self-supporting. This apparently formidable requirement is in fact quite easily met, for any change in the magnitude of any current or voltage anywhere starts the process and launches an electromagnetic wave. But as we have seen in recent issues, it is only when the originating circuit is large and the rate of change rapid that the resulting wave is likely to be substantial.

If we did the above calculation more thoroughly, using a chunk of *any* dimensions, these would cancel out, giving the same result. I suggest you try it, just to convince yourself. Maxwell, being the bright boy he was, arrived at it by strict mathematical processes, before anybody knew definitely that electromagnetic waves were possible. It was Hertz who came along later and proved Maxwell right by demonstrating such waves produced by electrical means.

In case anyone thinks I have been trying to pull a fast one by quietly forgetting about the current in the top and bottom of the magnetizing loop that was necessary to produce the magnetic field, I would hasten on to Fig. 5, which shows what happens when 1-metre " bricks " are put together as a start towards unrestricted open space. The currents in adjacent parts cancel out, so the dimensions of the bricks don't matter at all.

Another thing: the result does not depend on using m.k.s. units. Any system of units, recognized or unrecognized, will do, provided it *is* a system.

* The latest estimate is 299,792,000.

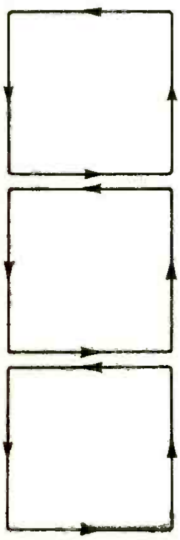
Procession of Fields

Before finally knocking away the visible scaffolding that has helped us to build a picture of electromagnetic radiation, let us multiply it a little as in Fig. 6, showing three links in a whole chain of loops all moving to the right, with currents alternately clockwise and anticlock. The middle one, S, is just our old Fig. 3 friend, now escorted fore and aft by R and T. Between R and S the space which a moment ago, while R was passing, was positive below is becoming positive above, so an upward displacement current is necessary. Between S and T it must clearly be downward. Now accelerate the procession to the speed at which battery magnetization is unnecessary, and what remains is a sequence of moving fields, alternately positive and negative; each bunch of magnetic field pointing towards us being accompanied by an upward-pointing electric field, and followed by an away-pointing magnetic field accompanied by a downward electric field. Since there is now no apparatus to maintain either field, each relies entirely on the other for its existence. It is the perfect marriage; they cannot be parted even by death.

So there is really not very much point in arguing about which partner causes the signal in a receiving aerial. Radiation can only exist as a combination—an electromagnetic wave. The logical view is that the electric field is primarily responsible, because that is what the free electrons in the aerial respond to. But since the radiated electric field is generated by the magnetic field the same answer is obtained if one supposed the e.m.f. in the aerial to be generated by the magnetic field as in ordinary Faraday induction. In practice the strength of a radio wave is usually given in terms of its electric field, in microvolts per metre, because this gives the aerial e.m.f. directly.

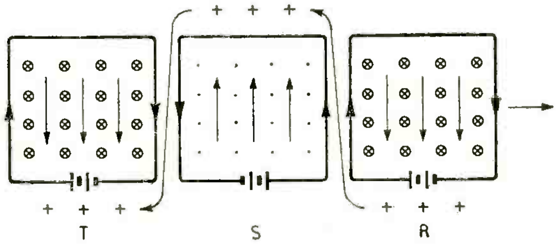
Fig. 6, you remember, was a sample of what we imagined to be a long chain of "links." A pair of them, say S and R, makes up one complete wave, with positive and negative half-cycles. So wavelength is represented by twice the width of one link.

All the way through we have, for simplicity, been assuming that the fields are uniform over a whole link, loop, chunk, or brick. So Fig. 6 represents square waves. In practice one is more often concerned with sinusoidal patterns of field strength, and the calculations are usually made on that basis, which does not alter the main conclusions.



Left: Fig. 5. Showing how any number of current loops can be put together to form a larger one, because the currents along internal frontiers cancel out.

Below: Fig. 6. Elaboration of Fig. 3 to show a procession of magnetic fields on the move, with the resulting displacement currents that help to maintain the magnetic fields and therefore themselves.



Voltmeter Loading

Use of Potentiometer Method

IT is very well known that the measurement of voltage in high-resistance circuits is liable to be inaccurate because of the load imposed by the voltmeter. It is surprising, therefore, that more use is not made of a method which is described in all text-books of electricity—the potentiometer method.

A voltmeter requires some power to operate it and this power is normally supplied by the circuit under test. If this circuit is of high resistance it cannot supply the necessary power without a drop in voltage. In the potentiometer method, a separate source of power is used to operate the voltmeter and the circuit under test has to supply no power at all. It is, therefore, quite unaffected by the connection of the measuring circuit.

The arrangement is shown in Fig. 1, where M_1 is any ordinary voltmeter. The associated apparatus comprises a second meter M_2, which is preferably a centre-zero galvanometer, a potentiometer R and a battery V of voltage greater than that to be measured. The circuit under test is represented by a box with two terminals AB. The measuring circuit is connected to AB, R is adjusted so that M_2 indicates zero and the voltage is read from the voltmeter M_1.

If R is adjusted so that there is no current in M_2, then AB neither supplies current to nor draws current from the measuring circuit. The voltage between A and B is thus the same as if the measuring circuit were not connected. If there is no current in M_2 the voltage across M_2 must be zero and so the voltage between C and D must be the same as that between A and B. The voltmeter M_1, however, indicates the voltage between C and D; therefore, it gives a true indication of the voltage between A and B. The power for operating the voltmeter is drawn entirely from the battery V.

In practice, it is not very convenient to have to use a separate power supply in this way. In most radio apparatus, however, the voltages appearing at high-resistance points are derived by voltage-dropping from a common higher-voltage supply of relatively low resistance. Screen-grids, for example, are fed from the main h.t. line through dropping resistors or potential dividers. In most cases, therefore, the main h.t. line of the apparatus can be used for the voltmeter supply and the battery of Fig. 1 becomes unnecessary.

The basic circuit of Fig. 1 can be simplified by the omission of the battery but in other ways it requires some elaboration. It is necessary to have something to protect the meter M_1 in case R is a long way from the proper adjustment when the circuit is connected. Let the voltage under test be V_{AB} with a source resistance R_{AB}. If the slider of R is at the bottom, the current in M_2 will be $V_{AB}/(R_{AB} + R_m)$, while if it is at the top it will be $(V_{AB} - V)/(R_{AB} + R_m)$, where R_m is the resistance of the meter.

It is necessary to make R_m large enough so that under these extreme conditions the current will not exceed the full-scale value of M_2. The worst conditions are when V_{AB} is much less than V or nearly equal to V and, for complete safety under all conditions, it is desirable to have V/R_m no greater than the full-scale current of M_2. In effect, this means that M_2 must be a voltmeter having V within its range.

The resistance of M_2 will then be high and this will make the meter an insensitive indicator of the balance condition and it will be difficult to determine the proper setting of R. To overcome this, the resistance can be short-circuited by a switch as balance is approached.

A second defect of the arrangement of Fig. 1 is that a potentiometer of ordinary quality does not give a fine enough control of voltage, particularly at low-voltage settings. It is often desirable to supplement it by a variable resistance. The circuit then takes the form shown in Fig. 2. R_1 and R_2 should be of about the same value and 20 kΩ is suitable in most cases. With a 300-V h.t. supply they will draw up to 15 mA and the power will be up to 4.5 W, so components of at least 6-W rating should be used. If M_2 is a centre-zero instrument reading 1 mA f.s.d., R_m should be 300 kΩ to avoid any possibility of overloading it.

In use, terminals 1 and 3 are connected to positive and negative h.t. of the apparatus under test and 2 is joined to the point at which it is desired to measure the voltage. With R_1 about mid-way on its travel, R_2 is adjusted for zero reading on M_2 (if this comes at the top of R_2, R_1 is reduced). Then S_1 is closed and R_2 (and R_1 if necessary) is re-adjusted more precisely.

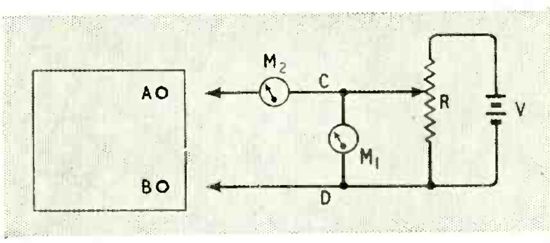
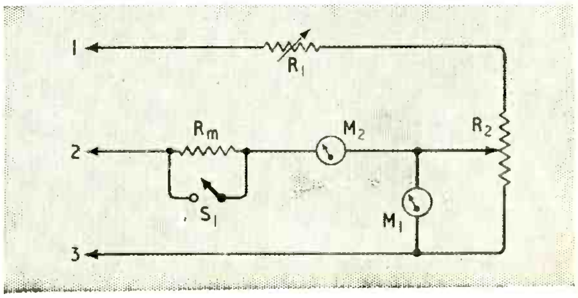


Fig. 1. Basic potentiometer circuit for voltage measurement.

Fig. 2. Practical circuit. M_2 is a centre-zero milliammeter.



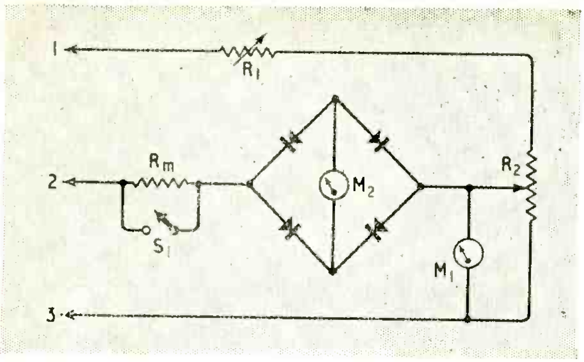


Fig. 3. Circuit for use with a left-hand zero meter for M_2. The metal rectifiers ensure that the meter deflects one way only irrespective of the direction of the current.

When a centre-zero meter is not available, the ordinary left-hand zero type can be used in conjunction with a bridge-type metal rectifier of the kind used in a.c. instruments, as shown in Fig. 3. This makes the meter reading independent of polarity and so the adjustment for zero current becomes one for minimum deflection of the pointer. The sensitivity obtainable is not quite so great because the resistance of the rectifier elements increases as the balance point is approached, but the adjustment of R is easier to carry out for a minimum reading than for zero.

It is, of course, possible to elaborate the scheme. By introducing switching, for instance, one meter can be used for both purposes. The voltmeter M_1, for instance, is only a milliammeter with series resistors. The meter itself can, therefore, be switched to do duty for M_2 if its voltage-range resistors are left in place to keep the proper load on R_2.

NEW BOOKS

Television Receiver Design : Monograph 1 ; I.F. Stages. By A. G. W. Uitjens. Pp. 177 + xii ; Figs. 123. Philips Technical Library : distributors ; Cleaver Hume Press, Ltd., 42a, South Audley St., London, W.1. Price 21s.

THE Philips organization (Holland) have already published English translations of a series of books on broadcast receivers by members of their staff, and they are now embarking on a similar series on television receivers. This, the first, deals with the i.f. stages ; the translation is, on the whole quite satisfactory ; printer's errors are few and, except in one instance, of minor importance. At the end is a list of symbols, some of which will be unfamiliar to the English reader. It is a pity that the opportunity was not taken to bring all the symbols into line with English usage, as this would greatly enhance the value of the book to a student reader. There are seven chapters on single and coupled tuned i.f. circuits with staggered tuning ; gain-bandwidth, distortion, noise and valve inter-electrode feedback problems are thoroughly explored. The text is illustrated by numerical examples and the last chapter details a particular design of staggered tuning with five single circuits as well as indicates the response to a modulation envelope step function ; a circuit diagram of the complete amplifier would have been helpful. The effect of trap circuits protecting from adjacent channels is considered, and reasons are given for the choice of the circuit to which they are connected. To preserve continuity proofs of many expressions used in the text are relegated to appendices. In Appendix 1, the attenuation and phrase responses of a single tuned circuit are derived, and input, output and transfer impedances, and admittance locus diagrams are developed for dissimilar as well as similar tuned circuits coupled by mutual inductance. Constant reference must be made to the list of symbols if the derivations are to be followed. In section 1*g* it is not immediately clear that the primary is the coupling circuit and the secondary an absorber circuit when discussing trap circuits in terms of tuned coupled circuits. A diagram including values, such as Fig. 74 with suitable captions, would have made this clear. Appendix 2 develops the expression for determining the response of staggered tuned circuits as used in Chapter 2 where the principle of "flat" staggered tuning is clearly set out.

In television receiver design it is important to know how the pulse shapes of the input signal are modified in their passage through the i.f. stages, and Appendix 3 shows how the modifications can be determined from the attenuation and phase response characteristics. A misprint makes Appendix 4 on noise factor calculations difficult to follow ; Fig. 31 should read Fig. 56. Appendix 5 develops expressions used in Chapter 6, where feedback effects due to valves are considered. Table 1 provides information on the characteristics (gain-bandwidth, etc.) of Philips valves suitable for use in wideband amplifier stages. The remaining three tables are concerned with factors of importance in staggered tuned circuits. There is no index.

The inexperienced designer will find much of value in this book but the expert will discover little that he does not already know. K. R. S.

Sound Reproduction (Third Edition) by G. A. Briggs. Pp. 368; Figs. 315. Wharfedale Wireless Works, Bradford Road, Idle, Bradford, Yorks. Price 17s 6d.

WRITTEN professedly in non-technical language and addressed primarily to the layman, this book contains, nevertheless, much material of interest to the knowledgeable enthusiast, and the terms non-technical and semi-technical, often used by the author, should be liberally interpreted. The field covered is wide—literally *all* aspects of sound reproduction not dealt with in greater detail in the author's other books on "Loudspeakers" and "Amplifiers"—and this third edition has been brought up to date by extensive revision of the original text and by the addition of eight new chapters.

Mr. Briggs has been fortunate in his collaborators and the chapter on vented (reflex) cabinets by R. E. Cooke is probably the best exposition of the underlying principles so far published. This is backed by tables giving specific recommendations for cabinet dimensions to suit typical sizes of loudspeaker and cone resonances. R. L. West and S. Kelly contribute new material on the design of pickups, and the practical aspects of successful magnetic tape recording are ably dealt with by C. H. Banks and L. J. Bradley. The chapter on cross-over networks is detailed and contains much useful coil-winding data, together with some concrete facts about phase shifts near the cross-over frequency—hitherto a somewhat nebulous bogy.

Mr. Briggs is an indefatigable experimenter and he has photographed countless cathode-ray oscillograms to verify the axiomatic as well as to illuminate the controversial in his search for better quality of reproduction. His conclusions are generally sound, but occasionally hasty as when he states (p. 37) that there is no "vibration" at the mouth of a quarter-wave pipe. A "velocity" instead of a "pressure" microphone would have given quite a different picture. There is also some confusion of thought on the role of density, Young's modulus and viscosity *sic* of materials involved in the production and transmission of sounds. Weight rather than density (p. 102) is the criterion for confining low-frequency sounds, and a high Young's modulus is not a necessity for producing high frequencies as his "odd man out" example of hand clapping (p. 183) seems to prove.

Whether one is learning from or disagreeing with the author—and no one interested in sound reproduction can fail to do both—there is little fear of falling asleep while reading this book. F. L. D.

Proposed Television Stations

Plans for British Two-programme Service

ON July 1st the Stockholm Plans for broadcasting in bands 41-68, 87.5-100 and 174-216 Mc/s, which were signed on June 30th last year, officially come into force. So far as this country (which was among the 21 signatories) is concerned, the signature is effective only for Band I. The British delegation would not commit this country to the plans for Bands II and III until it had been finally decided by the Government whether a.m. or f.m. was to be used for the sound service in Band II and also precisely how Band III was to be used. The Atlantic City Convention (1947), which allocated frequencies *en bloc* to the various services, contains a footnote permitting the U.K. to use Band III for other than broadcasting; actually for point-to-point communication (174-200 Mc/s) and air navigational aids (200-216 Mc/s).

Provision is made in the Stockholm Plans for 40 television stations in this country—12 in Band I (including the existing and projected 10 stations) and 28 in Band III. In view of the recent statement by Sir Ian Jacob, director-general of the B.B.C., that the Corporation hopes to erect 10 low-power stations when the present scheme is completed, we give below a list of the 30 additional British stations provided for in the Stockholm Plans.

It must, of course, be pointed out that this list, which provides for a dual service for the whole country, was drawn up before any decision had been reached regarding sponsored television.

Vision (Mc/s)	Sound (Mc/s)	Station	E.R.P.* (kW)		Polarization
			Vision	Sound	
BAND I					
61.75	58.25	Isle of Man	25	6	H
		Channel Islands	5	1.25	H
BAND III					
179.75	176.25	Channel Islands	5	1.25	V
		London	200	50	V
		Pontop Pike	50	12	H
184.75	181.25	Aberdeen	50	12	H
		Holme Moss	200	50	V
		South Devon	50	12	H
189.75	186.25	Kirk o' Shotts	200	50	V
		Norfolk	50	12	V
		North Wales	50	12	H
194.75	191.25	Northern Ireland	50	12	H
		South East Kent	50	12	V
		Sutton Coldfield	200	50	V
		West Cornwall	50	12	V
199.75	196.25	Cumberland	50	12	H
		Wenvoe	200	50	V
204.75	201.25	Isle of Man	50	12	V
		Isle of Wight	50	12	V
		Londonderry	50	12	H
		North Scotland	50	12	V
		West Wales	50	12	H
209.75	206.25	Cumberland	50	12	H
		South East Kent	5	1.25	V
		West Wales	50	12	H
214.75	211.25	Londonderry	50	12	H
		Norfolk	50	12	V
		North Scotland	50	12	H
		North Wales	50	12	H
		West Cornwall	50	12	V

* Effective radiated power. H, Horizontal. V, Vertical.

RANDOM RADIATIONS

By "DIALLIST"

The Components Show

THAT SUCH NUMBERS of visitors should have made special journeys to the Components Show from twenty-one countries is an outsize feather in the cap of the R.E.C.M.F. This year there were more of them than ever. How important the exhibition has become in the eyes of the world may be gathered from the fact that not a few technical journals in other countries didn't just send reporters: their editors came themselves. Two whom I was delighted to meet (and who expressed unbounded admiration for what they had seen) were the editor of *Audio Engineering* from America and the editor of *Toute la Radio* from France. There were buyers, manufacturers, journalists and others from all over the Empire, and from many countries in Western Europe, Asia, America and Africa. It is indeed a tribute to British components that so many people should find it well worth while to make long journeys to attend this small, private, three-day exhibition. The R.E.C.M.F. has been wise in adopting and adhering to the world's strictest and most rigid standards in materials, design and workmanship. Quality pays—and goes on paying.

Striving for Inefficiency

SO POWERFUL are the a.m. and f.m. signals that I receive from the 20-kW Wrotham transmitter at a range of 50 miles with a pukka dipole mounted on a chimney stack, that I've been trying out aerials of lower and lower electrical efficiency with a view to discovering how far one can go before any marked falling off occurs. The arrangement I'm using at the moment cost 1s 8d, including the feeder. It consists of four yards of PVC-covered flex, the last 2½ft of which were untwisted and straightened out, the single wires being stapled to right and left along a picture rail 8ft above the floor of a ground-floor room. Signal strength is still so ample that I shall have to work out something a good deal less effective before the answer is found. Metre-wave broadcasting when it comes (and may that be soon!) looks like having very great advantages over medium- and long-wave transmission. Among these, if f.m. is selected, are: (1) coverage of the same service area with about a quarter of the transmitter output power; (2) excellent reception (except in fringe areas) with the simplest and cheapest of indoor aerials; (3) far greater freedom from background hiss and impulsive interference; and (4) much better quality.

A Nice Point

SETTLE A COUPLE of wireless enthusiasts into comfortable armchairs of an evening and it won't be long before they start an argument on one of the finer points of their pet subject. Man has probably been an argumentative animal ever since he found out how to use speech to convey his thoughts and ideas to others. Our discussions and debates to-day carry on his age-old attempt to arrive at the truth about this or that. On a recent chilly evening a friend and I got on to the subject of valves as we basked in the warmth of a welcome fire. He's a bit of an authority on matters wireless; but I had to take him up when he described the thermionic valve as basically a voltage amplifier. His thesis was that voltage changes applied to the grid give rise to similar but much larger changes at the anode when a load is provided. By choosing the kind of anode load suitable for the work in hand you can pass these voltages on to another valve; or, you can use them as e.m.f.'s to drive current through a power-operated device such as a loudspeaker. I hold that the valve is essentially a power amplifier. There must be some resistance in the grid circuit and you can't get away from the fact that $V^2/R=W$, however small the figures may be. An amplified copy of these small applied powers appears in the anode circuit and you can use it as suits your purpose by selecting the right kind of anode load. I firmly believe that that is the best way of picturing the working of an amplifying valve. What are your views?

Room for Improvement

SORRY THOUGH I AM to have to say it, there cannot be much doubt that too many of the h.t. batteries available nowadays are pretty poor things. I am thinking particularly of those made up of ¾in × 2⅛in cells, for they are by far the most widely used; but my criticisms apply equally to those with larger and smaller cells. If you care to work it out from the electrochemical equivalent of zinc, you'll find that a ¾in × 2⅛in can, weighing about 12 grams, has, in theory, a possible current output of 10Ah. Of course, you cannot expect to get anything like that from it since the cell is usually discarded when the e.m.f. has fallen from 1.5V to 0.9V. Still, with a load of 8-10 mA you should justifiably hope for a good bit more than the 0.7Ah to 1.1Ah that is all that I've been able to obtain of late from h.t. batteries with cells of this size. Again and again the overall e.m.f. of a battery has become unsteady after far too short a period of intermittent use. Once that happens, the set becomes increasingly noisy for an hour or two, and then packs up altogether. Test the battery with a high-resistance voltmeter and you'll find only tiny fractions of their stated e.m.f.s between certain tappings—usually near the middle. I have conducted post-mortems on scores of such batteries and have found in each case one or more perforated cells. Cell-perforation after a short period of intermittent use under a moderate load is something which, in my opinion, should not occur in a well-designed and well-made dry battery.

Full Speed Ahead

Towards the end of March an American friend asked me in one of his letters whether the imminence of the Coronation was producing record sales of television receivers. I replied that sales weren't too bad, except in Scotland, where comparatively few sets were being sold. "Possibly," I added, "the hard-headed Scots are holding their hands in the hope that the Budget will bring a reduction in purchase tax. If so, they are likely to be disappointed." My prediction could not have been more erroneous and I'm very glad of that. The reduced tax will mean bigger sales everywhere and, therefore, more money for research and development. It isn't always realized that television has had a hard battle to fight in this country. Our television service, the first in the world, was just getting nicely into its stride when the outbreak of war closed it down in the autumn of 1939. The TV research men were mobilized as the "back-room boys" of radar and had, so to speak, to beat their viewing screens into p.p.i. displays. Then when the war was over shortages of men, money and materials prevented the rapid development of our national television system. The heavy purchase tax imposed on receiving sets led inevitably to restricted sales and meant that with us television had to amble, instead of galloping, into its rightful position as the best of all sources of domestic entertainment. With the lowering of the tax, this Coronation year may well see a boom in television comparable with that which occurred in the early nineteen-twenties in "sound" radio.

UNBIASED

By FREE GRID

Forestalling the Future?

WHEN our descendants celebrate the Queen's Golden Jubilee forty-nine years hence, the newspapers will doubtless publish many articles dealing with various aspects of life in England during the early years of her reign. Our descendants are bound to be struck forcibly by the amazingly primitive and comfortless

Primitive and comfortless.

condition in which we were content to live having regard to the degree of scientific knowledge attained.

I think that one of the things at which the people of the year 2002 will marvel most will be that we early Elizabethans of 1952 could make an atom bomb but failed to use the resources of radio to enable us to maintain communications with the rest of the world when journeying by land. The provision of radio-telephonic facilities on trains and other public vehicles, although technically possible is, I suppose, banned by bureaucrats. This is, however, equally true of private cars, for the P.M.G. has never bothered to equip each telephone exchange with v.h.f. radio apparatus so that car owners, who installed the necessary equipment, could be linked with the national telephone system while travelling.

It is, however, a strange thing that if you own a boat and take your pleasure in it anywhere in the Thames Estuary the P.M.G. *does* provide a specially equipped telephone exchange for you so that you are as much "on the phone" as if you were at home. Recently I was visiting a friend who, like others of his kind, enjoys himself by spending his week-ends on a small but well-equipped sailing craft.

I congratulated him on being "on the phone" in this special manner and said I wondered that he and others like him were not tempted, when temporarily abandoning ship on Monday mornings, to transfer the radio gear to their cars.

No reply was made to my observation but I did receive from my friend rather a queer look which might have been meant for silent reproof at my harbouring such subversive ideas; on the contrary, it might have been meant for withering contempt at my lack of sophistication. I just don't know. I merely record the facts and leave you to draw your own conclusions.

Silent TV

I WAS greatly interested in "Diallist's" prediction in the May issue that sets of the future may be provided with a three-position switch: sound and vision; vision only; sound only. But I certainly do not agree with him that more often than not the switch will be turned to the "sound-only" position. On the contrary, I think that if such a switch be provided it will almost invariably be turned to "vision only," and eventually the B.B.C. will radiate only silent TV.

I am led to this conclusion by the fact that owing to the development of a fault (which I have not yet found time to trace) in the "sound" side of my television set I have lately been looking at silent TV. As a result I have become quite expert at lip reading. I can, in fact, follow the dialogue by this means far more easily than I could when I had to rely on my ears, as the sound was so often rendered unintelligible by the ceaseless chatter of Mrs. Free Grid and her fellow females discussing the shortcomings of their respective husbands.

Even when I have the house to myself the peace and enjoyment of watching this silent TV has to be experienced to be believed. It does mean, of course, that I have to give the programme full concentration if it is to be intelligible, but this is as it should be. I have no more patience with people who use sound broadcasting as a sort of soporific background to their other activities than I have with those who go to the cinema and divide their attention between the screen and their own amateurish imitations of the amatory activities displayed on it. In common fairness, however, I must add that there is some excuse for their use of the cinema as an osculatorium as the proprietors fail to provide what used to be known in the U.S.A. as "necking niches" for those who don't want to see the film.

Inter-departmental Quiz

ANYTHING that smacks of the Totalitarian Police State is anathema to me. I must, therefore, register a very strong protest at the P.M.G.'s attempt to get the myrmidons of the Ministry of Transport to act as his Gestapo.

The current form which we all have to fill up when we want to renew our car licence asks bluntly "Is the vehicle fitted with a radio set?" If the answer is "Yes" we have to answer a further question which asks us if the set is separately licensed. These questions are, in my opinion, wholly irrelevant to the licensing of a car.

I presume that if the wretched motorist answers "No" to the question which asks him if the set is licensed, the information will be passed on to the P.M.G. Supposing the motorist declines to answer this question on the grounds that no man is compelled to answer a question which might incriminate him, I wonder if the authorities would refuse to issue him a Road Fund licence? I wonder, too, whether the police have instructions and the necessary authority to ask about the licensing of any set they may see

Decibelless dialogue.

installed in the car when taking particulars for some misdemenour?

This sort of inter-departmental quiz is probably reciprocal and there is a danger that before long, when buying a radio licence at the local Post Office we may be asked if we have a clean driving licence. When applying for a marriage licence the bridegroom may, one day, be asked offensive questions about his income—at present the prerogative of the intended bride's father.

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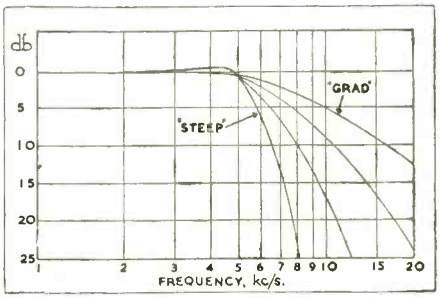
The VARI-SLOPE



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7kc/s and 9kc/s ("—2" and "—1" positions).

The filters consist essentially of twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

(b) Extremely low harmonic and inter-modulation distortion due to negative voltage feedback action.

(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control, altering the terminating impedance and the insertion loss.)

(d) No chokes to cause magnetic hum pick-up.

(e) Smaller size, lighter weight, greater uniformity in production.

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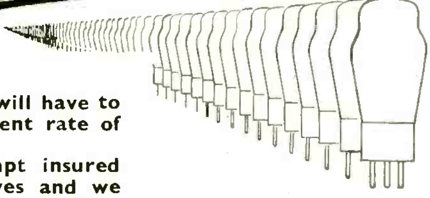

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OX5G
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O1A
1A4E
1A4
1A5G
1A6
1A6E
1BC1
1B4E
1B5
1C1
1C5
1C7
1D6
1D5
1D7
1FW4A
1F3
1F5
1F6
1F7
1G4
1G6
1H4
1H20
1J6
1LA6E
1LA4
1L4
1P10
1P11
1RF120
1R5
1S5
1T4
1T5
1V
2A6
2A7
2A8
2D2
2D4A
2D4B
2D13
2D13A
2D13C
2P
2YR215
2Z3
3V4
3Y4
4D1
4THA
4TPB
5
5U4
5X4G
5Y3
5Y4
5Z3
6AB7
6AC7
6AE5
6AG5
6AG6
6AM6
6AT6
6A3
6A6
6A7
6A8
6BA6
6BG6
6B4
6B6
6B7
6B7G
6B8EG
6B8G
6C4
6C5
6C6
6C8
6C9
6C10
6D1
6D2
6D3
6D6

6F1
6F5
6F6
6F7
6F8
6F13
6F14
6F15
6G6
6H6
6H7
6J5
6J7
6J8
6K5
6K6
6K7
6LD20
6L1
6L5
6L6
6L7
6L18
6L19
6M1
6N7
6P25
6Q7
6R7
6SA7
6SG7
6SH7
6SK7
6SL7
6SN7
6SQ7
6SS7
6S7
6T7
6U5
6U7
6W5
6ZY5
6Z5
7A2
7A3
7A7E
7B5
7B6
7C7E
7D3
7D5
7D8
7H7
7K7
7Q7
7R7
7S7
8
8A1
8D2
8D3
9D2
10C1
10D1
10D2
10F1
10F9
10LD11
10P13
10P14
11D3
11D5
12AL5
12AT7
12AU6
12AU7
12AX7
12A5
12A6
12A8
12B8
12J5
12J7
12K8
12Q7
12SA7
12SF5
12SG7
12SH7
12SJ7

12SK7
12SQ7
12SR7
12SW7
13D1
13SPA
13VPA
14
15
15A2
15D1
15D2
15E
17
18
19
19BG6
20C
20D1
20D2
20F2
20LPT
21A
22N41
24
24A
24E
25A6
25B5
25L6
25Z5
26
27
28D7
30
31
32E
33
34
35
35C5
35Z3
35Z4
36
37
38
39
39/44
41MDG
41MH
41MHL
41MLF
41MP
41MRC
41MTA
41MTL
42
41STH
41MXP
42A
42E
42MPT
43IU
43
45IU
46
47E
48
49A
50C5
50L6
58
61BT
62BT
62DDT
62TH
62VP
66KU
67PT
71A
75
76
78
77
80
81
83
84
101
104V
112A

117Z6
120
124
150
150A
150B
185BT
202DDT
202MPG
202STH
202VPB
202VP
210DDT
210HF
210LF
210PG
210VPT
215SG
2201PT
220P
220PA
220PT
220VPB
225du
230PEN
240QP
290L4
244V
301
302
307A
329
340
369BX
408BU
410HF
415PO
415XP
424
425XP
442BU
607G
625
635
807
904V
1215
1904
1912
1915
1920
1924
1927
1928
2102
6153T
9004
AC/HL
AC/HP5
AC/P
ACP4
AC/VP1
AC/VHPZ
AC/044
AC2/HL
AC6/PEN
ASL125
AS4120
AS4125
AZ1
A20B
A50A
BR202
BTH8G
BVA42
BVA43
BVA44
BVA45
BVA47
BVA43
BVA56
BVA142
BVA267
B2
CBL1
CBL31
CCH2
CCH35
CL4

CL33
CY31
C1
C1C
C2
C9
C10
C20C
C23B
C30B
C36A
C36C
C50B
C50N
DAC1
DAF91
DC/HL
DC/P
DD/PEN
DDL4
DDTR13
DDT16
DD13
DD14
DD40
DD41
DD101
DD207
DD620
DD818
DD2530
DER
DE3
DE5A
DE5B
DF51
DF91
DF92
DF495
DH2
DH63
DH76
DH77
DH149
DH150
DK91
DLS1
DLS10
DL2
DL24M
DL33
DL35
DL63
DL74
DL93
DL94
DL145
DN41
DN143
DP495
DU10
DVSG
DW2
DW3
DW8
DO20
DO24
DO28
D1
D3
D41
D42
D43
D63
D77
D92
D152
D400
EAF41
EAF42
EA50
EBC3
EBC41
EBF11
EBF32
EBF80
EBL21
EB4
EB34
EB41

ECC31
ECC32
ECC91
ECH21
ECH42
ECL80
EC5
EC91
EE50
EFM1
EF5
EF6
EF8
EF12
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EF54
EF80
EF92
EK2
EK3
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EK91
EL2
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EL33
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EL42
EL50
EL82
EL3
EM1
EM4
EM35
EY91
EZ35
EZ40
EZ41
FC2A
FC2
FC13
GR2
GU1
G24
HD13
HD14
HD24
HL/DD1320
HL4
HL13
HL13C
HL21DD
HL23
HL41
HL41DD
HL42DD
HL45DD
HL133DD
HL1320
HPB13
HP210
HP211C
HP215
HP1118
HP2018
HP4101
HP4101C
HP4103
HP4106
HP4106C
HP4108
HP4115
HR210
HVU1
H20
H21
H30
H63
H141D
H607
J240
KBC32

KCF30
KF35
KF32
KLL32
KL32
KL35
KTW61M
KTW61
KTW63
KTW73
KTW74
KTW81M
KTZ41
KTZ63
KT4
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KT33C
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KT81
K23B
K30G
K30K
K33A
K40N
K50M
K50N
K52
K80A
K183
K535
LD210
LG210
LL2
LL4
LP2
LP220
L1
L2
L2DD
L13
L21DD
L38
L63
L77
L410
L610
ME17
ME41
ME91
ME920
MDH4
MHL13
MH4
MH41
MH206
MH1118
MH4103
MH4105
MH4106
MKT4
ML4
MP PEN
MR1
MS/PEN
MS/PENB
MSP4
MSP41
MS4
MVSPEN
NHL13
NH4105
N14
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N18
N37
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N145
N150
N152

OC13L
OD3
OM4
OM6
OM9
O202
PA1
PD220
PD3521
PENB4
PENDD1360
PENDD2530
PENDD4020
PEN4VA
PEN4DD
PEN23
PEN25
PEN30C
PEN40DD
PEN45DD
PEN220
PEN383
PEN428
PEN453DD
PL33
PL38
PL82
PL83
PM2A
PM2B
PM2HL
PM3
PM4
PM4DX
PM12
PM12M
PM14
PM20
PM22A
PM25
PM202
PPL4
PP3/250
PP5/400
PP6C
PP6E
PP24
PP35
PP225
PP411C
PP4118
PT/DD35DA
PT10
PT24A
PT24/DAL
PT230
PVO6-25
PV230
PX230
PY30
PY82
P2
P8
P41
P14ON
P215
P220
P61
P220A
P610
QP22B
QP25
QP21
QP42
QP230
RB41
RB120
RP120
RG250/1000
RX210
R8
SD20
SG410
SP2
SP2D
SP4
SP4B.SP13
SP13

SP13C
SP22
SP41
SP42
SP61
SP210
SP220
SP1320
SP2220
SS210
SS220PA
SU25
SU61
SU2150A
SW1
S3DD
S8
S23
S130
S215VM
S217
S435N
TBC14
TBL14
TB9920
TCH24
TDD2A
TDD13C
TDD25
TE564
TF44
TH4
TH4A
TH4B
TH13C
TH21C
TH30
TH29
TH30C
TH233
TM1
TM14
TP22
TP23
TP25
TP26
TP220
TP230
TP1340
TP2620
TSP4
TT4
TT4
TT4A
TX21
T2
T20
T31
T32
UAF41
UAF42
UBC41
UBF80
UB41
UCH21
UCH42
UP41
UF42
UL41
UL44
UL46
UM34
UR2
UR3C
UU7
UU9
UU30/250
UU41
UX6
UX22
UY21
UY41
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U18/20
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U403
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U920
VMP4G
VMP4K
VM4K
VPT4
VP2B
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VP4A
VP4C
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VP13A
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VP28
VP41
VP41E
VP133
VP1320
VW48
V9
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V960
WD142
W17
W21
W76
W77
W81M
W101M
W142
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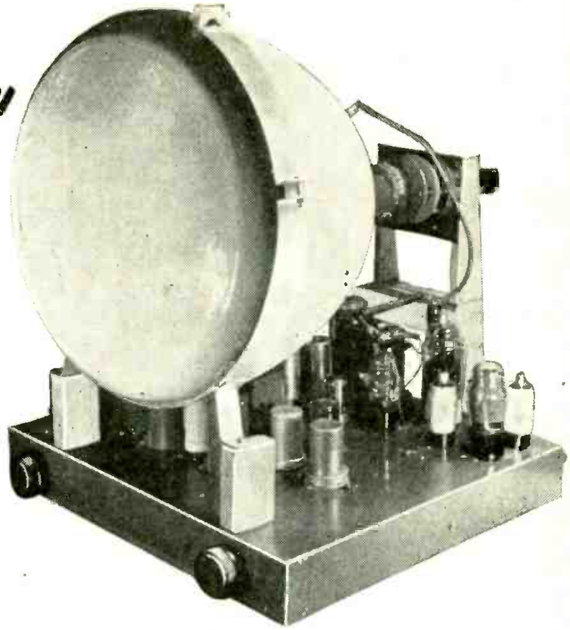
W145
W147
W148
XXL
X7
X17
X22
X24
X63
X64
X65
X71
X76
X73M
X78
X79
X81M
X101
X138
X142
X143
X145
X148
X150
X410
Y63
ZD17
Z14
Z21
Z22
Z26
Z66
Z77
Z152

ELECTRONIC PRECISION EQUIPMENT LTD

THE SUPERIOR 15"



- 15in. up to the minute Television for only £35, including Cossor Tube.
- H.P. Terms if required, i.e., send only £11/14/- deposit (carriage and insurance £1 extra).
- Working models demonstrated at both our Fleet Street or Ruislip branches.

You will have noticed that the modern trend is towards larger pictures, in fact the 12in. tube is fast going the way of the 9in. and 10in. tubes for few manufacturers are using them in their latest models. However, you can be right up to date for we are now commencing delivery of a new constructor set using the Cossor 15in. tube type 85K. All parts to build the set (as illustrated) will cost you only £35, including tube, and contrary to what might be expected, to get down to this very low price we have not sacrificed quality in any way, in fact, interlace, sensitivity and definition, are equal to the best commercial standards. The chassis provided is of generous proportions and will allow the inclusion of a Radio unit if one is wanted.

The whole has been so arranged as to be particularly suitable for our popular Coronation Console cabinet, but there is no reason whatever why it cannot be fitted into any well made T.V. cabinet.

Technical features :

A. Superhet circuit fed by a R.F. amplifier.

B. Particularly carefully dimensioned Video stage.

C. Diode damped interlace network.

D. Line and frame blocking oscillators.

E. Fly back EHT.

F. Optional voltage doubler for aluminisation effect.

DATA. Full constructional data price 7/6, post free, are available on approval (if you decide not to make the set and return the data within 7 days 7/- will be refunded).

DEMONSTRATION. A made up chassis can be seen at Fleet Street, or Ruislip, and if you arrange to call during BBC transmission times, we will gladly demonstrate the excellent interlace and other qualities of which we are particularly proud.

HOW TO ORDER. All parts are available and total cost is £35, which includes 15in. tube, 20 valves, prepared metal chassis, in fact everything needed except cabinet and mask. Order form and parts list are included with the 7/6 data. H.P. Terms: £11.14.0 deposit then 12 monthly repayments of £2.7.0.

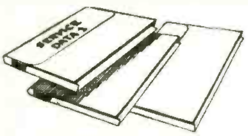
OPPORTUNITY FOR ADVANCED CONSTRUCTORS

We continually need designs for novel radio and television test sets, servicing instruments, tuning units, pattern generators, etc., particularly those which can be made cheaply from Government surplus and other low priced valves and parts.

If you have made up any such equipment and would care to send us details we will willingly pay a fair price for the right to reproduce the data and/or equipment for our customers.

ELECTRONIC PRECISION EQUIPMENT LTD

BOOKS & PUBLICATIONS



SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this Country. Names include Sparton, Emmerson Admiral, Crossley, R.C.A. Victor etc. Each sheet gives circuit diagrams and component values alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.

FREE T.V. SERVICE SHEETS

The supplement to a new publication "Television Faults" contains complete circuit diagrams, component values, technical descriptions etc., of 6 popular T.V. receivers as follows: Baird Everyman, T.29; Murphy, V.120C; English Electric, 1150M; Philips projection model 704A and 1800; Marconi, VT.53DA; Ultra V.711.

The book itself in the introductory chapter tabulates over 60 common faults from complete failures to such troubles as shadows in the corner. Against each fault symptom is given probable causes and a reference to the part of the book where more detailed information can be found. Following the quick fault finding guide are 10 chapters, each giving typical circuits and data indicating the actual components likely to be at fault. The book is invaluable to novice and experienced T.V. serviceman alike because it contains a wealth of practical experience and priced at only 5/- it will undoubtedly save its cost the first time you have to refer to it. Order now to ensure getting the free supplement.

THE ELPREQER

This describes a completely effective but most inexpensive Signal Tracer that can be built in one hour at a total cost of 12/6. Price 1/6.

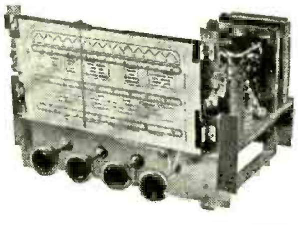
A VIBRATOR UNIT FOR 2 VOLT BATTERY RECEIVERS

Describes how an inexpensive unit, which will save its cost many times over, can be built and operated. Price 2/6. With Blueprint.

A VIBRATOR UNIT FOR 1.4 VOLT BATTERY RECEIVERS

Shows how to make a unit which will permit you to dispense with expensive dry batteries. You can work your little set from a 2 volt accumulator which can be recharged. Price 2/6 with blueprint.

FOR OUTSTANDING PERFORMANCE



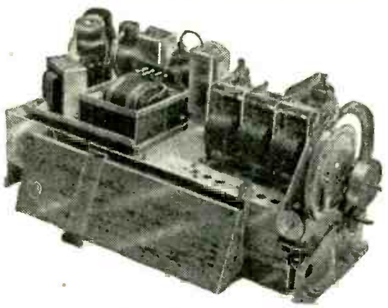
Model B. Six Wavebands, 11-15 metres continuous in 5 ranges (4 Bandspread) and M.W. 185-550 metres. Six position Tone Switch (3 Radio —3 Gram). Price £15/15/-, plus 7/6 carr. and insurance, or H.P. terms £5/9/- deposit.

Model B3. Three waveband, Long, Medium, Short, Gram switching on wave change switch. 3 position Tone. Price £12/12/-, plus 7/6 carr. and insurance, or H.P. terms £4/6/- deposit.

Both chassis 11½in. × 7in. × 8in. high. Latest type valves: 6BE6, 6BA6, 6AT7, 6BW6, 6X4. A.C. mains operated, flywheel tuning, negative feedback over entire audio section, engraved knobs, fully guaranteed.

BUILT TO HIGHEST PERFORMANCE STANDARD AND SPECIFICATION

7 VALVE 5 WAVEBAND RADIO CHASSIS



GIVE AWAY PRICE

only 47/- deposit.

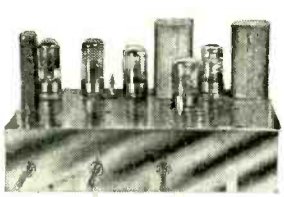
Less valves and power pack.

A famous set by a famous manufacturer. Undoubtedly a serious listener's receiver. Among many special features are an H.F. stage and tuning indicator. Tunes up to 11 metre band. Price complete with valves but less speaker, £14/19/6. H.P. terms £5/10/- deposit and 12 monthly payments of £1/10/-.

We have a few left, less valves and power pack, otherwise in good condition; they definitely have never been used. Price £6/19/6, or £2/7/- deposit and 11 monthly payments of 10/9, plus 15/- carriage.

5-VALVE I.F./A.F. AMPLIFIER

(For A.C./D.C. working)



This is on an aluminium chassis, size 11½in. × 7in. × 3in. deep. The layout is neat and simple and provision is made and in fact holes are drilled so that tuning condenser and coil pack may be easily fitted if same are required. Alternatively this vacant space can be used for mounting a control panel to which various points of the circuit can be brought to plugs, thus making a signal tracer which is invaluable for radio and T.V. servicing. It uses one of the latest valve line-ups, as follows: 14S7 Triode Hexode, 7B7 I.F. Amplifier, 7C6 D.D.T., 35A5 output, 35Z3 Rectifier. The I.F.s are present at 465 kc/s., but are variable over a fairly wide range. Price £6/10/- complete with valves and 8in. speaker. H.P. is 63/- deposit.

R1155 COMMUNICATION RECEIVER FOR ONLY £2/14/- DEPOSIT

This set, as most will know, is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F., so obviously a robust receiver which will give years of service. Slightly used but completely overhauled and guaranteed in perfect working order. PRICE £7/19/6 or will be sent against a deposit of £2/14/-, balance of 12 monthly payments of 11/6. If you cannot call to collect please include an additional 10/- to cover cost of transit and carriage. This partly returnable to you if and when you return the transit case.

MAINS POWER PACK FOR R.1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price £5/10/- complete with 5in. speaker ready to work, carriage 3/6.

BOOKS & PUBLICATIONS

"DEMOBBED VALVES." Gives the commercial equivalents of many thousands of service valves, and conversely gives the service equivalent of many thousands of commercial type valves, an invaluable publication recently revised. Price 2/3.

"AN ELECTRONIC TIMER." Shows how to build a device for controlling timed operations. The timer can be set to any timing up to 3 minutes. Price 2/3. **"THE ELECTRONIC SWITCH."** Shows how to make a device for switching without mechanical contact. Price 2/3. **"THE IMPULSE RELAY."** Explains the working of an ingenious relay, and gives several circuits including radio control. Price 1/9. **"THE OCCASIONAL T.R.F."** Shows how to build a T.R.F. Receiver for medium and long wave reception, of looks and quality output comparable with sets priced between £10 and £14. This costs less than £6 to build including cabinet. Price 1/6. **"VALVE EQUIVALENTS."** These are the best equivalents charts available today. Also the booklet can be used for keeping records of valve stocks. Price 2/6. **VISUAL ALIGNMENT SIGNAL GENERATOR.** Reprint from "Radio Constructor" describes a very useful combined signal generator and oscilloscope. 9d.

RADIO HEARING AIDER

The world for a deaf person must be particularly blank and monotonous, and a hearing aid which will function as a radio when not needed for hearing should help considerably. Constructional data and technical notes dealing with this are available. Price 2/6. Only standard parts are incorporated therefore the constructor will have no difficulty in making this up.

I.F. ALIGNMENT PEAKS

This book gives the I.F. frequencies of more than 4,700 receivers including British, American and Continental types. Every popular British set is covered, and in addition hints on finding the frequencies of unknown British sets are also given. Sale price 3/9.

EX-GOVT. CIRCUITS

These give circuit diagrams and details of Ex-Government receivers and equipment. In practically all cases the information has been extracted from official publications.

AR.88D	Ind.62	R.1355
A.1134	Ind.6K	R.F.24
A.1368	Ind.62A	R.F.25
A.3611	R.76	R.F.26
AN/APA1	R.78	R.F.27
A.S.B.3	R.103	R28/
BC.221	R.107	ARC5
BC.312	R.109	SCR269A
BC342	R.208	SCR522
BC.348	R.1082	T.1154
BC.453	R.1116	TR.1196
BC.454	R.1116/A	TR.18
BC.455	R.1124/25	
BC.624	R.1147	All 1/6
BC.625A	R.1132/	each or
BC.433G	1481	assorted
BC.1206	R.1155	dozen
I.F.F.	R.1224A	12/-.

ELECTRONIC PRECISION EQUIPMENT LTD

ELECTRICAL BARGAINS

In addition to our large range of radio accessories we also carry a good stock of electrical wiring accessories; details of a few of these can be found below:—

T.R.S. CABLES. 250 v. CLASS

1/.044 Twin flat	9d.
3/.029 Twin flat	1/-
3/.029 Twin with earth	1/3
3/.020 3 Core flat	1/6
3/.036 Twin flat	1/4
3/.036 Twin with earth	1/7
3/.0363 core flat	2/-
7/.029 Twin flat	1/6
7/.029 Twin with earth	1/11
7/.036 Twin flat	2/9
7/.036 Twin with earth:	3/3
7/.064 Twin flat	4/9

LEAD COVERED CABLES 250 v. CLASS

	yard
3/.029 3 core	2/3
3/.036 3 core	2/8
7/.044 twin	3/3
3/.036 twin	2/-
7/.029 twin	2/9
7/.064 twin	5/-

WAR EMERGENCY TYPE CABLES 250 v. CLASS

These are P.V.C. or rubber insulated, laid flat then braided with cotton and compounded:

	yard
7/.029 3-core flat	2/-
7/.044 twin flat	2/-
7/.064 twin flat	3/3

MULTICORED FLEXIBLES

All are suitable for mains work as the separate conductors are very well insulated, then they covered overall either with hard rubber, plastic or waterproof braiding:—

	yard
10 core	2/6
7 core	2/-
5 core	1/-

5 AMP SURFACE SWITCHES —HICRAFT

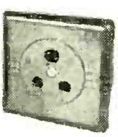
Oblong Brown Plastic 1-way 1/3 each.
Oblong White Plastic 1-way, 1/3 each.

Oblong Brown 2-way	1/6
Oblong White 2-way	1/6 ,,
Round Brown 1-way	1/3 ,,
Round White 1-way	1/3 ,,
Round Brown 2-way	1/6 ,,
Round White 2-way	1/6 ,,

SPECIAL THIS MONTH

Customers ordering quantities of bakelite accessories can take discounts as follows: 1 dozen of one item 25%. 1 gross mixed or one item 33⅓%.

SOCKETS HICRAFT



Flush type for skirtings, 5 amp. 3-pin shuttered, 1/3 each; ditto with switch, 2/3 each.

CEILING SWITCHES—HICRAFT

With cord and acorn. Brown or White, 1-way, 3/9 each; 2-way, 4/3 each.

LAMP HOLDERS

Bakelite, 1/- each or 10/6 doz.
Bakelite skirted Batten holder, 1/6 or 15/- doz.
Bakelite type threaded for ⅝in. with HO skirt, 1/6.
10 per cent. discount if bought in dozens.

BARGAIN FOR CONSTRUCTORS

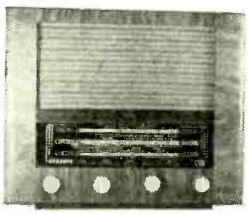
Special this month is the Portable illustrated alongside. We offer a bakelite cabinet with carrying handle, metal chassis, battery housing and two waveband dial, all for 27/6, plus 5/- carr. and insurance. This cabinet and set of parts is ideal for making up either an all dry battery receiver for holidays, picnics, etc., or a battery mains set for everyday use. Constructional details of two suitable circuits using 1.5 v. valves 1R5, etc., will be given free with cabinet assembly, or is available separately price 1/6 post free.

SPECIAL RADIOGRAM OFFER

To those who want an auto radiogram at a low price, we offer the cabinet illustrated alongside complete with Collaro three speed record changer with dual purpose crystal pick up, at a special bargain price of **£17/16/8,** plus 12/6 carriage and insurance or H.P. terms £6/7/- deposit.

3 colour scale, scale pan, chassis, pulley, driving head, springs, etc., etc., to suit the radiogram and two radio cabinets are available as a parcel at 15/-, plus 1/6 post.

Cabinet separately £7/10/- (or £2/10/- deposit), plus 10/- carriage and insurance.



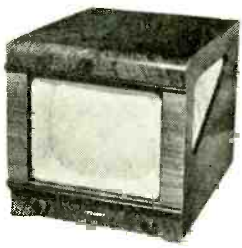
A Superhet Chassis to fit these two cabinets is now available. L.M. and S. waves, 3 colour scale, A.V.C. Tone control etc., complete with 8in. P.M. Speaker. Price **£9/19/6** or H.P. **£3/7/-** deposit. Carriage 7/6 extra.

TABLE MODEL RADIO

This very nice-looking cabinet will take the same scale and chassis as the radiogram above, and we are able to offer this at the bargain price of 37/6, plus 3/6 post and insurance.

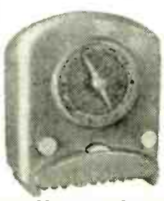
THE REGINA

T.V. Console Cabinet, undrilled, but cut for 12in. tube, with adjustable platform. This cabinet looks really superior and is ideal for all popular sets—Viewmaster, Tele-King, etc. Price **£7/17/6.** Carriage 10/- extra.



The table model illustrated is available in fair quantity at **£3/17/6,** plus 7/6 carriage and insurance, which price includes the armour plate glass and surround.

Mechanical details for this Table Model are available as a parcel: Punched and prepared metal chassis, punched outrigger valve plate with spacers, 12in. Tube Clamping ring, tube rear support brackets, etc. Price 25/-, plus 2/6 post.

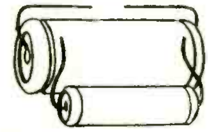


"MIDGETRONIC" Radio Cabinet

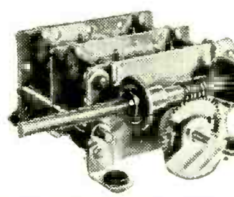
This pleasing small cabinet is in bakelite and is supplied complete with dial ring, pointer as illustrated but less knobs, also included is metal chassis and hardboard back. Price 15/-, plus 2/6 postage and packing.

To ensure receiving prompt reply, please enclose stamped addressed envelope, when writing for additional details.

ELECTROLYTIC CONDENSERS

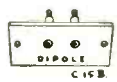


1 mfd. 150 v.	1/-
1 mfd. 250 v.	1/-
1 mfd. 450 v.	1/3
2 mfd. 350 v.	1/3
2 mfd. 450 v.	1/6
4 mfd. 350 v.	1/8
4 mfd. 450 v.	1/10
8 mfd. 150 v.	1/6
8 mfd. 350 v.	2/-
8 mfd. 450 v.	2/6
8 mfd. 500 v.	3/3
8 mfd. 500 v. centre-screw fixing	1/6
8 mfd. 600 v. centre-screw fixing	1/9
16 mfd. 350 v.	2/9
16 mfd. 450 v.	3/6
16 mfd. 500 v.	4/9
32 mfd. 150 v.	2 3
32 mfd. 250 v	2/3
32 mfd. 350 v.	2/9
8 mfd. × 8 mfd. 350 v.	3/-
8 mfd. × 8 mfd. 450 v.	3/9
8 mfd. × 8 mfd. 500 v.	3/9
8 mfd. × 16 mfd. 450 v.	4/9
8 mfd. × 16 mfd. 500 v.	6/-
16 mfd. × 16 mfd. 450 v.	6/-
16 mfd. × 16 mfd. 500 v.	7/-
20 mfd. × 20 mfd. 200 v.	4/-
24 mfd. × 24 mfd. 200 v.	4/6
25 mfd. × 25 mfd. 200 v.	4/9
32 mfd. × 32 mfd. 150 v.	4/9
32 mfd. × 32 mfd. 450 v.	6/9
100 mfd. × 100 mfd. 150 v.	5/6
10 mfd. 25 v.	1/-
12 mfd. 50 v.	1/4
20 mfd. 50 v.	1/6
25 mfd. 25 v.	1/6
25 mfd. 50 v.	2/-
50 mfd. 12 v.	9d.
50 mfd. 50 v.	2/3
250 mfd. 12 v.	2/3
250 mfd. 25 v.	2/6
8 mfd. × 8 mfd. × 8 mfd. 450 v.	3/9



.0005 2-GANG CONDENSER

Ceramic insulation with "no back lash" gear drive. Drive easily removed if required, when condenser becomes a standard type with long spindle. Price 8/6 each.



Two socket engraved L.S., 6d. each. Bin. C16B.

Two socket engraved A.E., 6d. each. Bin. C18A.

Two socket engraved P.U., 6d. each. Bin. C19B.

Two socket engraved Dipole 6d. each. Bin. C19B.

Two socket plain, 5d. each. Bin. C18B.

Three socket engraved DIP and E, 9d. each. Bin. C16D.

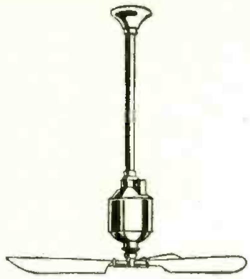
Three socket engraved A1, A2 and E, 9d. each. Bin. C19D.

Four socket engraved A.E. Pick-up, 9d. each, Bin. C19E.

Four socket engraved P.U. Ext. L.S., 9d. each. Bin. C16E.

Five socket plain, 9d. each. Bin. C16C.

ELECTRONIC PRECISION EQUIPMENT LTD.



CEILING FAN

This model, made by Revo, incorporates a series-wound totally enclosed ball bearing motor of robust construction and noiseless operation. The fan has a blade diameter of 36in. and is supplied with 20in. suspension tube and ceiling canopy. All finished white cellulose enamel. The voltage working is 230-250 v. D.C. Revo catalogue number D12288. Price £7/10/-.

TWO ITEMS FOR V.C.R.97 USERS

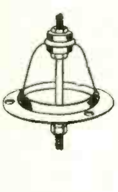
(1) RF. E.H.T. UNIT

To take the place of the mains E.H.T. transformer, has the following advantages:
(a) Is more reliable.
(b) Is cheaper.
(c) Can be repaired.
Complete kit comprises 2 valves, smoothing condenser, filament transformer and all necessary parts. Price 20/-, plus 1/6 post. Constructional and operational data free with kit or available separately, price 2/6.

(2) INTERNAL MAGNIFIER KIT

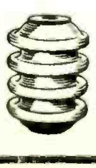
The kit comprises a veneered and polished wooden surround, special mask, oil filled enlarger and four chrome-head fixing screws.
Has these advantages:—
(a) It gives the impression of being a standard 9in. tube.
(b) Saves the cost of a 6in. mask.
(c) Protects magnifier from accidental damage.
(d) Is equally suitable for use with a 9in. tube.
Price of kit 39/6, plus 2/6 post and insurance.

PYREX AERIAL INSULATORS



Ideal for aerial connections through cabin walls or through panels. Consists of glass dome with threaded rod and terminal ends, and metal fixing flange Price 2/- each.

STAND OFF INSULATOR

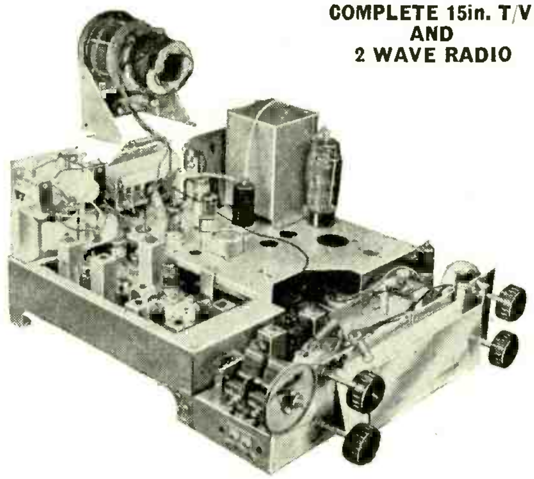


Vitreous porcelain. Price 1/- each or 10/- doz.

READY MADE T.V. and RADIO

Combined 15in. Television and 2-wave Radio chassis. Brand New—Ready to work—Fully guaranteed. Complete with Tube, Mask, knobs and speaker, Adjustable to any channel. Price £55, carriage and ins. £2.

COMPLETE 15in. T/V AND 2 WAVE RADIO



TECHNICAL DESCRIPTION

TELEVISION. This is an A.C. chassis of Superhet Design employing 14 valves, viz.: 7 6F1 Mazda, 1 CP25 Mazda, 2 6D2 Mazda, 1 6L18 Mazda, 1 EY51 Mullard, 1 EL38 Mullard, 1 6SN7 Brimar. Tube is Cossor 85K.
Special features: Focus, PM with pre-set centring and tilting facilities, and continuously adjustable focus control, accessible to the user.
Picture Tone Control: 3-position Gradation Control which adjusts the level of vision interference suppression.
Aerial Attenuation: A screen Aerial Attenuator Box is provided on the chassis for use in the vicinity of transmitters.
Sensitivity: 50 micro volts for peak white on the screen giving extremely good results in fringe areas.
Picture Centring: 2 slider controls accessible from the back enable the picture to be moved horizontally or vertically to the centre of the screen.

RADIO. This is a 4-valve A.C./D.C. chassis employing superhet principle. A two wave band tunable dial for the long and medium waves.

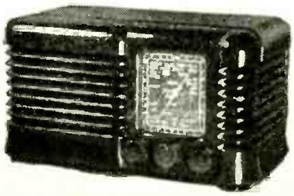
VIEW MASTER OWNERS

You probably know that a 15in. tube gives approximately three times as many square inches of actual picture as does a 9in. tube. You may not know, however, that without any modification at all your View Master will scan the 15in. Cossor type 85K which we offer for cash or on H.P. If you would like to go over to the big 15in. picture, the easy way is to send for "View Master Big Picture Parcel" as follows:
1. 15in tube, type 85K.
2. Moulded rubber mask.
3. Tube clamping ring.
4. Special ion trap.
5. Sundries, plugs, etc.
6. Blue print showing connections and method of fixing tube, ion trap, etc.

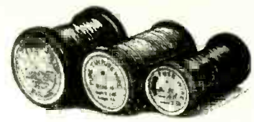
We offer the above six items at less than what a new 9in. or 12in. tube alone would cost, namely, £14/10/- cash with order or £5 deposit and balance over 12 months, carriage 12/6. Limited quantity only at this price due to fortunate purchase of set manufacturer's surplus C.R.T. stocks, so order by return.

LONG & MEDIUM WAVE OCCASIONAL RADIO

Yours for £2 . 1 . 6 (Deposit)



You will find that the building of our all-mains radio receivers is simplicity itself, and the more you make the less time each takes, everything down to the last nut and bolt is supplied, and everything fits together in a professional manner. When finished the receiver looks and plays as well as those being offered in radio shops at anything between £10 and £14. The one illustrated above we call the "Occasional," in a choice of colours, Ivory or Walnut and the T.R.F. costs £6/1/6 to make, H.P. terms being £2/1/6 deposit and 10 monthly payments of 10/6.



ENAMELLED WIRE
(On wooden reels)

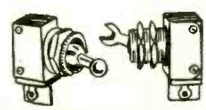
S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	2/-
20	1/4	2/2
22	1/5	2/4
24	1/6	2/6
26	1/7	2/8
27	1/8	2/9
28	1/8	2/10
30	1/9	3/-
31	1/10	3/1
32	1/10	3/2
33	1/11	3/3
34	1/11	3/4
36	2/-	3/6
38	2/2	3/10
40	2/4	4/2

TINNED COPPER WIRE

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/5	2/-
20	1/4	2/2
22	1/5	2/5

DOUBLE SILK COVERED WIRE

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	1/11
19	1/5	2/3
20	1/6	2/6
22	1/8	2/10
23	1/9	3/-
24	1/9	3/-
26	1/11	3/4
27	2/-	3/6
28	2/1	3/8
29	2/2	3/10
30	2/3	4/-
31	2/4	4/2
32	2/6	4/6
33	2/9	5/-
34	2/10	5/2
35	3/-	5/6
36	3/2	5/10
38	3/6	6/6
39	3/9	—
40	4/-	7/6
41	2/3	—
42	2/6	—



TOGGLE SWITCHES

Metal body standard size, made by a leading maker. Available with round dolly or with special V cut dolly. State which type when ordering. Price while stocks last only 2/3.

GERMANIUM DIODES
Wire Ended

Several alternative types available at bargain prices.

Types	Equivalents	Price
Red	CG4 GEX55, WG7A	10/-
Green	CG5, GEX45, WG7B, GEX33, WG4A	7/6
Orange	CG6, GEX45, WG5A	7/6
Green/Orange	For super detectors	5/6
Yellow	For Crystal Receivers	4/6
Blue	For General Experimental purposes ..	2/3

Parcel containing one each of the above, price 30/-.

For brilliant, high-fidelity sound recording the GRUNDIG *2-speed tape recorder*

PUSH button controls and magic-eye tuning give you complete mastery over the Grundig's superb recording and reproducing qualities. The 1,200 feet of tape give you ONE HOUR of high-fidelity music recording and play back, High speed rewind mechanism enables you to reproduce from (or record on) any part of the tape in a few seconds. The same tape can be used repeatedly, each new recording automatically erasing the previous one, or recordings can be kept indefinitely. Sound frequency range : 7½in. per second, 50-10,000 c/s. 3¾in. per second, 50-6,000 c/s.

Price 80 gns.
including condenser mike. H.P. Terms available.

- ★ Condenser microphone — as sensitive as the human ear.
- ★ Mixer unit—to mix up to 4 different recordings at once.
- ★ Remote controls—hand or foot operated.
- ★ Two-way telephone recorder—without alteration to G.P.O. handset.
- ★ As compact and *portable* as a suitcase.

THE GRUNDIG "Reporter"
700L TWO-SPEED TAPE RECORDER

Not only a revelation but a revolution in tape recording!

GRUNDIG (GT. BRITAIN) LIMITED, KIDBROOKE PARK ROAD, LONDON, S.E.3.

PHILIPS *present...*

GM6005 — a sensitive mains operated valve voltmeter for the measurement of voltages in the range 20 c/s to 1 Mc/s

Features :-

1. 0-10 mV—0-300 V F.S.D. in 10 ranges.
2. Covers the frequency range 20 c/s to 1 Mc/s
3. Overall accuracy error < 5%
4. Input impedance
   10 mV to 1 V at 20 Kcs = 1.5 M.ohm, < 15 pf
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Specially recommended for A.F. work and vibration investigations.

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E.M.I. H.65 1,200ft.	£1 15 0
E.M.I. H.50 1,200ft.	£2 8 0
SCOTCH BOY	
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600ft.	£1 1 0
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As advertised	£1 15 0

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ALL NEW TAYLOR TEST GEAR IN STOCK AND AVAILABLE ON H.P. Send S.A.E. for Catalogue and Terms.

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ACOS	
G.P.20 (Std. or L.P.)	£3 6 1
Spare heads for above	£2 0 0
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Super Lightweight, L.P./Std.	£9 8 6
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We are one of London's Largest stockists — Please write for requirements.

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New Model Pre-amp.	£22 10 0

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WEARITE 2A (limited stock), with complete instructions for Associated Amplifier, **£35 0 0,** carriage extra.

WHOLESALE, MANUFACTURERS' *AND EXPORT ENQUIRIES ONLY*

RADIO TRADERS LTD.

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Note Phone No. GERrard 3977/8 *Grams : "Radiotrade"*

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A Large Consignment of Television Components

Electrolytics, Ceramicons, Moulded and Silver-Mica, Tubular Waxed, Metal, Oil-filled, etc.

Vitreous Resistances, Valve Holders and Volume Controls, etc., etc.

Brand New Goods at Much Below Cost.

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VITREOUS WIREWOUND. Large selection from 2 to 200 watts.
CARBON. ¼ watt to 5 watt. All popular values. Standard Car Suppressors, 15,000 ohms.

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"BELLING & LEE" PANEL MOUNTING FUSE HOLDERS.

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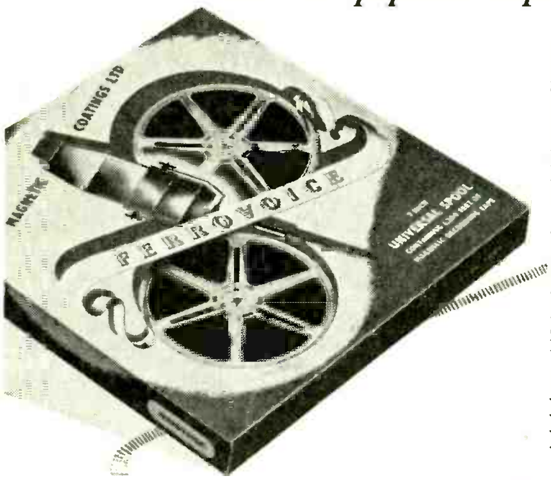
All enquiries dealt with individually, but regret no lists are issued.

The LATEST and IMPROVED TAPE

For all popular tape recording machines



Specially wound on transparent perfectly balanced plastic spools which fit easily to all popular types of tape recorders. The advantages of FERROVOICE are now available to all.

FERROVOICE improves the performance of all recorders. It provides twin-track recording of the highest standards of quality and faithfulness. Tape wear and rotation noises are reduced to the minimum.

FERROVOICE is the most modern and most efficient tape available.

It brings to all tape recorders the highest standards of recording and reproduction.

Technical features: Super Calendered Kraft Paper—breaking strain approximately 4 lb.—Tape width 0.247″ ± 0.001″. Medium coercivity—ease of erasure—frequency response 50 c/s to 10 Kc/s at 7½″ per second. Length of tape 1,200 ft. Spool 7″ diameter.

NOTE THESE OUTSTANDING FEATURES

★ TWIN-TRACK RECORDING WITH UNIFORM RESPONSE.
★ HIGH PLAY-BACK LEVEL AND LOW NOISE COMPONENT.
★ LIGHTWEIGHT PRECISION BALANCED SPOOL.
★ FERROVOICE SPOOLS KEEP WEAR, TEAR AND ROTATION NOISE TO A MINIMUM.

FERROVOICE REGD

The Tape YOU will ultimately use

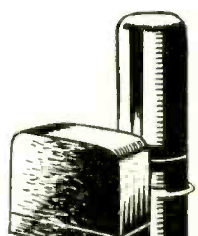
PRICE 22/6 RETAIL

Trade Enquiries Invited.

MAGNETIC COATINGS LTD., 38 GROSVENOR GARDENS LONDON SW1 **'phone: SLOane 9129**

Communication assured with G.E.C.

QUARTZ CRYSTAL UNITS



From take-off to touch-down, the safety of the aircraft is dependent on trouble-free radio contact being maintained. The components used in the radio equipment must be the best obtainable.

For reliable communications under all conditions, use G.E.C. Quartz Crystal Units.

Write to-day for list Q.C. 5012(R)

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CRYSTAL DIODES. Germanium Vacuum sealed glass type with wire ends, **2/8** each or **30/-** per dozen. **(P)**

WHANDA WIRE AND CABLE STRIPPERS, to take all size flexes and cables up to $\frac{3}{8}$in. diameter, with 3 alternative heads and triple screw adjustment. These are brand new and boxed, and the original price was 15/- each. Our Price **4/3** each or **48/-** per doz. **(P)**

CARBON RESISTORS. $\frac{1}{4}$-$\frac{1}{2}$ watt, **3d.** each. Virtually all standard values in stock. Nearest value supplied, unless otherwise stated. **(P or G)**

SILVER MICA OR CERAMIC CONDENSERS (pFs). 2, 4, 10, 15, 27, 30, 50, 75, 100, 160, 200, 220, 300, 330, 350, 500, 1,000, 2,000, 4,500, 4,700. All at **5d.** each, or **4/-** per doz. **(P or G)**

WAX TUBULAR CONDENSERS. .1 mfd. 350 v. **4d.** each or **3/-** per doz. **(G)**

MOULDED MICA CONDENSERS. .01 mfd. 500 v., **6d.** each or **5/-** per doz. **(G)**

EHT CONDENSERS. .001 mfd., 5kV. A.C. Test, **1/6** each or **15/-** per doz. .02 mfd., 5kV, D.C. working, **1/6** each or **15/-** per doz. **(G)**

SPEAKER FRET. Expanded Metal, finished Silver 6 x 6, **1/3**; 9x9, **2/6**; 12 x 12, **3/9**; 18 x 18, **8/6. (P)**

SPEAKER FRET. Expanded metal, finished gold 6 x 6, **1/6**; 12 x 12, **4/-. (P)**

SPEAKER FABRIC. Fawn or brown, 12 x 12, **2/-**; 18 x 18, **4/6. (P)**

HEADPHONES. 4,000 ohms, per pair, **11/-. (G)**

METAL RECTIFIERS. RM1, 125 v. @ 80 mA, **3/11.** RM2, 125 v. @ 100 mA, **4/3.** RM4, 250 v. @ 250 mA, **17/-.** 14D/972, 250 v. @ 25 mA, **6/6.** 12 v. $\frac{3}{4}$ A., **6/-.** 6 v. 1 A., **4/6.** 12 v. 2 A., **12/6.** 12 v. $2\frac{1}{2}$ A., **16/6.** 12 v. 4 A., **21/-. (P)**

SWITCH SOCKETS. Flush mounting 250 volt, 3 pin, 5 amp., bakelite. Price **3/6. (M)**

LINE CORD. 3-way, 0.3 amp., 60 ohms per foot, **1/9** per yard. **(P)**

ELECTROLYTIC CONDENSERS. These are current production, not surplus stocks. 32 mfd., 450 volts, 250 mA ripple, can., **4/6**; 8 mfd., 450 v., **1/9**; 8 + 8 mfd., 450 v., **3/3**; 8 + 16 mfd., 450 v., **4/-**; 8 + 32 mfd., 450 v., **4/6**; 16 + 16 mfd., 450 v., **5/-**; 32 + 32 mfd., 350 v., **3/6**; 25 mfd., 25 v., **1/9**; 50 mfd., 12 v., **1/9. (P)**

MAINS DROPPERS. Standard 0.2 and 0.3 amp. Price **3/9** each. **(P)**

AERIAL AND OSCILLATOR COILS. For medium and short waves. Price **5/-** per set of 4 coils. **(M)**

HEATER TRANSFORMERS. 230 v. input, 6.3 v., 1.5 amp. output, **5/6** each. **(P)**

MOULDED BAKELITE ESCUTCHEONS. $8\frac{3}{8}$in. x $2\frac{3}{8}$in. with opening $6\frac{3}{8}$in. x $1\frac{1}{8}$in., **1/-** each. **(M)**

GENERAL PURPOSE TRIODES. Type 7193, 6.3 v. heater. Similar to 6J5G. Price **2/6** each. **(G)**

ROTARY TOGGLE SWITCHES. 4-pole bunching. Price **1/6** each. **(G)**

OUTPUT TRANSFORMERS. Standard pentode matching to 2/4 ohms. Price **4/6** each. **(M)**

L.F. CHOKES. 10 Henry, 70 mA. Price **4/9** each. **(P)**

ENGRAVING TOOL. For 200-240 v. A.C. mains. Suitable for use on metals or plastics. Price **10/-** each. **(P)**

COAXIAL CABLE. Stranded centre conductor, $\frac{1}{4}$in. diameter, 80 ohms, **9d.** per yard. **(P)**

CONDENSER CLIPS. Vertical mounting 1in., **4d.**; $1\frac{3}{8}$in., **4$\frac{1}{2}$d.**; Horizontal mounting, $1\frac{3}{8}$in., **4d.**; Double, $\frac{3}{4}$in., clips, **4d. (G)**

TAPE RECORDER OSCILLATOR COILS. 6.3 mH, 45 kc/s, for high impedance heads only. Price **6/9** each. **(P)**

TELEVISION MAGNIFYING LENSES. 6in. clear, **19/6**; 9in. clear or filter, **50/-**; 12in., clear or filter, **70/-.** Please state which and add 5/- for carriage and packing. **(P)**

DIAL BULBS. 6-8 v. 0.3 amp., M.E.S. fitting Price 3 for **1/9. (P)**

PAPER CONDENSERS 0.01 mfd., 500 v., **6d**; 0.01 mfd., 750 v., **6d.**; 0.25 mfd., 500 v., **6d.**; 1 mfd. 400 v., **6d.**; 1 mfd. 500 v., **9d.**; 1 mfd. 600 v., **1/-**; 1 mfd. 800 v., **1/3** (all G); 3 μfd., 750 v., **1/9. (U)**

OIL FILLED CONDENSERS. 1mfd. 600 v., **3/-. (G)**

AERIAL FILTER UNIT. No. 112. 10P/13089 **2/-** each. **(G)**

ALADDIN $\frac{3}{8}$**in. COIL FORMERS.** Ex-Govt.; wound. No slugs or cores. **2/-** per doz. Iron dust cores for above **3/6** doz. **(G)**

ADMIRALTY TRANSFORMERS. 36 vA. 500/1,000 c. Pri. 0-80-180 v. Sec. 0-900-2,400 v. Can be used in reverse on 50 c., **3/9. (G)**

DIMMER SWITCHES. 5C/725. Wire-wound, approx. 300 ohms, with off position. **1/3** each. **(G)**

ELECTRON COPPER AERIALS. 50ft., **2/-**; 100ft., **3/9. (PZ)**

Garland Bros

BELLING AND LEE PLUGS AND SOCKETS. 5 way, **2/-**, 7 way, **2/3** complete. **(G)**

JONES PLUGS AND SOCKETS. 6 way, **1/9**; 8 way **2/-** complete. **(G)**

E.H.T. PLUGS AND SOCKETS. **1/-** complete. **(G)**

PYE $\frac{3}{8}$ **COAXIAL PLUGS AND SOCKETS.** **1/-** per pair, complete. **(G)**

4-WAY MOULDED PLUGS AND SOCKETS **2/6** per pair. **(G)**

ZINC PLATED CHASSIS. $13\frac{1}{2}$ x 6 x $2\frac{1}{2}$in. drilled for five valves, **2/6. (M)**

DUMMY AERIAL LOADS. Tapped at 20, 10 and 5 ohms, 100 watts. British 5-pin base. Callers only, **1/6** each. **(G)**

PLASTIC SPEAKER CABINETS. Louvred for 5in. speaker. Callers only. Price **10/-** each. **(P)**

IGNITION SWITCHES. Low voltage, high current, in bakelite case. Price **9d.** each. **(G)**

S.W. TUNING CONDENSERS. 160 pF, with fixing feet. Price **2/3** each. **(G)**

CATHODE-RAY TUBES. Type 5CP1. 5in. green screen, electrostatic focussing and deflection. Callers only. Price **17/6** each. **(G)**

FLEX CONNECTORS. $2\frac{1}{4}$ x $\frac{1}{2}$in., for 250 v., **1/-** complete. **(G)**

TWO GANG TUNING CONDENSERS. 0.0005 mfd., with fixing feet. Price **7/9** each. **(P)**

THYRATRONS. Type NGT1 (CV1141), 4 volt heater. Price **5/6** each. **(G)**

TRIMMERS. 50 + 50 pF, 100 + 100 pF, 100 + 500 pF, 500 + 500 pF, ceramic mica, **9d.** each; 250 pF, 1,000 pF, **9d.** each; 50 pF, 75 pF, airspaced pre-set, **1/3** each; 75 pF, air-spaced, 2in. spindle, **2/-** each. **(G)**

MAINS TRANSFORMERS. All at **19/6** each. **(P)**

- MT1. 250-0-250 v., 80 mA, 0-4-5 v., 2 A., 0-4-6.3 v. 3 A.
- MT2. 350-0-350 v., 80 mA, 0-4-5 v., 2 A., 0-4-6.3 v., 3 A.
- MT3. 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v. 24 v., 30 v., all at 2 amp.
- MT4. 4 v., 4 amp.; 10 v. 4 amp.; 20 v. 3 amp., for battery chargers.
- MT5. Auto; 0-10-120-200-230-250 v., at 100 watt.

P.O. TYPE 3-WAY TELEPHONE PLUGS. Ex-equipment. Price **6d.** each. **(U)**

MINIATURE LIGHT WEIGHT RELAYS. 270 ohm, 18 v. Single pole on-off. Ex-American equipment. Price **2/9** each. **(U)**

COMMERCIAL POTENTIOMETERS. All usual values. Less switch, **2/3**; with single pole switch, **3/6**; with double pole switch, **4/-. (P)**

VALVE HOLDERS. B3G, pax, **4d.**; Do., with spring retainers, **1/-**; B5, pax, **4d.**; B5, bakelite, **6d.**; B5, baseboard, **6d.**; B7, pax, **6d.**; B7, amphenol **1/-**; B7G, amphenol, **6d.**; Int. Octal, amphenol, **6d.**; B8A, amphenol, **9d.**; B8G (loctal), amphenol, **6d.**; B9, pax, **6d.**; B9A, amph., **9d.**; B9G, pax, **6d.**; B9G, ceramic or siliconised polystyrene, **6d.**; B12A, pax, **9d.**; UX4, pax, **6d.**; UX4, amphenol, **9d.**; UX5, pax, **6d.**; UX5, amphenol, **9d.**; UX5, ceramic, **1/-**; UX6, pax, **4d.**; UX7, pax, **4d.**; UX7, medium (for 1625, RK34, etc.) ceramic, **1/-. (P)**

NEON LAMPS. 85 volt striking, S.B.C. centre contact base. Price **2/6. (G)**

SLEEVING. Approx. 2 mm. Price **1/6** per doz. yard lengths. **(M)**

CARTRIDGE FUSES. All usual values in $1\frac{1}{4}$in., **5d.** each. Other sizes **6d.** each. **(P)**

SWITCHBOARD METERS. $6\frac{1}{2}$in. scale, 0-5 v. A.C./D.C. full scale. Price **30/-. (G)**

HIGH FREQUENCY PENTODES. Type 6SH7, high slope, octal based. 6.3 v. heaters. Price **6/-. (G)**

GARLAND TAPE RECORDER OSCILLATOR UNITS. With valve, for use with high impedance heads only. Price **35/-. (PZ)**

MINIATURE MUMETAL TRANSFORMERS. Auto-wound, giving approx. 2/1 ratio. Ideal rewind as head lift transformer, or lams can be used for recording heads. **2/6** each. **(G)**

DECALS. 500 $\frac{1}{8}$in. high white transfer letters and words for marking electronic equipment. Price **4/9** per book. The new Decals book for the amateur now available. 29 words per page, 4 pages radio and audio, 4 pages T/V and Scope, 2 pages misc. incl. Tx. and Tape Recording. **3/6** per book. **(PZ)**

INSTRUMENT WIRES. Enamelled, silk and cotton covered, available in upwards of 2 oz. reels. Send S.A.E. for list of lowest prices. **(P)**

ROTARY TRANSFORMERS. Type 31, input 18 v. 12 A.; output 7.2 v. 13 A. and 225 v. 0.11 A. Price **22/6. (U)**

VOLTAGE STABILISERS. Type VS110 (S130). With loose bases but otherwise sound. Price **3/6. (U)**

GOODMANS OUTPUT TRANSFORMERS. 10 watts push-pull to match into 10,000 ohm., with two 3.75 ohm. secondaries for 3 or 15 ohm. speaker. Price **14/9. (P)**

SMALL PAPER CONDENSERS. In tubular metal cases with wire ends. 0.25 mfd., 250 v., $\frac{1}{2}$in. diam. x $\frac{7}{8}$in., **1/-** each **(M)**; 1 mfd. 150 v., $\frac{5}{8}$in. diam. x $1\frac{1}{2}$in., **1/3** each **(M)**; 2 mfd. 250 v., $\frac{3}{4}$in. diam. x $2\frac{1}{2}$in., in Neoprene sleeve, **1/9** each. **(M)**

TYANA SOLDER GUNS. Weight 30 oz., for 220-250 v. A.C. mains only; consumption 100 watts. The low voltage bit can be easily bent to reach into corners and is insulated from the earthed case. Price **3 guineas. (PY)**

CONNECTION BLOCKS. 3-way on porcelain base, **6d.** each. **(P)**

WINDSOR SAPPHIRE NEEDLES. Available in the following three patterns: trailer type for magnetic or heavyweight pick-up; straight type for crystal pick-up; midget type for lightweight or high fidelity pick-up. Price **2/9** each. **(P)**

MIDGET 2-GANG CONDENSERS. American manufacture, 500 pF., **7/6** each. **(M)**

VARIABLE RESISTORS. 50 ohm, 1 amp., with calibrated very fine worm drive. Price **7/6. (U)**

IDENTIFICATION CODE
G = Government unused ; U = Ex-equipment, used ; P = Current production, unused ; M = Manufacturers surplus, unused ; X, Y, Z = Varying trade discounts available. Particulars on request by bona-fide traders.

Post and packing extra on all items (minimum parcel post 1/-). Post orders to our Deptford address. Kindly print name and address. Early closing Thursday, open all day Saturday.

GARLAND UE7B RECORD PLAYBACK AMPLIFIER. A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Formica control panel. Supplied complete with 8in. P.M. loudspeaker. Price £13/2/6 plus 7/6 carriage, etc. Trade supplied. **(PX)**

UNDRILLED CHASSIS. In 20 s.w.g., bright mild steel : Four-sided size 13in. x 7in. x 2½in., 5/- each ; two-sided with two straps, 12in. x 4in. x 2½in., price 3/- each. Two-sided with two straps, size 6 x 5 x 2in., price 2/- each. Add one-third to above prices if chassis required in aluminium. **(P)**

HIGH CAPACITY PRECISION MICA CONDENSERS. We have still a few thousand of these left, but as we can no longer offer our original comprehensive range, we are clearing the balance, in the values shown hereunder, at 1/- each, or 9/- per dozen. Accuracy in all cases is plus or minus point five (0.5) per cent. Ruby mica and copper foil or silver. (a) 0.017970μF, (b1) 0.027400μF, (d) 0.040710μF, (e) 0.055820μF, (g) 0.087460μF, (h) 0.108435μF. **(G)**

ENGRAVED KNOBS. 1¼in. diameter, fluted in Walnut or Ivory, with the following markings : Volume, Vol-On-Off, Treble, Bass, Tone, Tuning, Wavechange. S-M-L-Gram, On-Off, Brilliance, Brilliance-On-Off, Contrast, Focus, R1-R2-PB. Price 1/6 each. Plain knobs to match, 1/3 each. **(PZ)**

VALVE TYPE 954. 6.3 volt Acorn pentodes. Brand new Westinghouse, boxed in 25's. Special offer per box of 25, 30/-. Supplied separately at 2/- each. **(G)**

CONNECTION BLOCKS. Moulded plastic with brass inserts. 3-way, 10d. ; 4-way, 1/-. **(P)**

ELECTRO-MAGNETIC CONTACTORS. Energised at 9-14 volt, ½ Amp ; maximum switched current 40 Amps. In bakelite case. Price 2/9. **(G)**

PAXOLIN PANELS. 3½in. x 1½in. x 3/32in., 1/- per doz., 5/- per 100. 2½in. x 2in. x 1/16in., 1/3 per doz., 6/- per 100. Many thousands available. **(M)**

CABINETS in handsome two-tone Walnut veneer to house 6½in. extension speaker. Price 16/6 each. **(P)**

VALVE OFFER. Type 1625. These are the 12 volt heater equivalent of the 807. Price complete with Ceramic holder 5/9 each. **(G)**

...cut your Costs

T.R.F. COILS. Medium and long wave, aerial and H.F., 6/- per pair ; with reaction winding, 6/9 per pair. **(P)**

POTENTIOMETERS. 20k, 10w, 10% by famous maker, 1¼in. spindle, price 3/6. **(G)**

RADAR REFLECTORS. Type MX138/-A. These consist of 6—2ft. x ¼in. dural tubes covered with fine wire mesh. The whole assembly can be used as an omni-directional aerial, and the mesh has many horticultural applications. Price 3/9 each. **(G)**

BRENETTE MICROPHONES. We are sole distributors in Great Britain and Ireland of these new cell microphones. The following range is now available. **Type D7.** Directional in black and chromed case. Price £4/13/6. **Type 9ND.** Multi-directional ball type in black and chrome. Price £2/6/6. **Type 11A.** Wide frequency response, in brown and chrome. Price £6/17/-. **Type 13U.** Highly sensitive with wide frequency response, in black and chrome. Price £7/17/6. **(PZ)**

ELECTROLYTIC CONDENSER OFFER. Tubular cardboard cased, with wire ends, 8 mfd., 4/5 v. wkg., 525 v. surge, 2/- each. **(P)**

RECTANGULAR KNOBS. Size 1¼in. x ¾in., with gold indicating spot ; to fit standard ¼in. spindles. Price 6d. each. **(G)**

BOOKS FOR RADIO ENGINEERS

Mullard Valve and Service Reference Manual	5/-
Mullard Amateurs Guide to Valve Selection	1/6
Osram Valve Manual, Part I	5/-
Brimar Radio Valve and Teletube Manual...	5/-
Wireless World Radio Valve Data, 3rd edition	3/6
Radio Valve Guide. By W. J. May	5/-
The Williamson Amplifier Manual, latest edition	3/6
Wireless World High Quality Amplifier Manual	2/6
T.V. Fault Finding	5/-
Television Faults	5/-
Television Explained (Miller)	5/-
Viewmaster Envelope (state transmitter for which required)	7/6
Tele-King Envelope	6/-
The Oscilloscope Book	5/-
Magnetic Recording (Quartermaine)	4/6

(Add 3d. to price in all cases for postage.)

TYANA SOLDERING IRONS. Lightweight, 40 watt irons with easily interchangeable elements and 3/16in. diameter bits. Voltage ranges, 6v., 100/110 v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure." **(PY)**

WIRE WOUND RESISTORS. Open, cement coated or vitreous enamelled. **4 watt**, 50, 90, Price 1/- each. **6 watt**, 30, 145, 270 10 k., 15 k. Price 1/6 each. **10-15 watt**, 5, 90, 100, 120, 170, 175, 200, 400, 700, 950, 1 k., 3.5 k., 4.5 k., 4.7 k., 11 k., 15 k., 25 k.. 1/9 each. **15 watt**, 650 ohm. Price 2/-. **(M or G)**

CERAMIC SWITCHES. Single pole, eight-way, 3/6 each. **(G)**

VARLEY MAINS TRANSFORMERS. Primary 10-0-200-220-240 volts. Secondary 300-0-300 volt at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volt at 1 amp. Open type construction. Price 45/-. **(P)**

TOROIDAL CERAMIC POTENTIOMETERS. 260 Ω 50 w., 6/6. 17k. 100 watt, 8/6. **(G)**

MAGNETIC TAPE. Scotch Boy MC1-111 : 1,200ft., 35/- ; 600ft., 21/- ; 300ft., 12/3. Spare 7in. spools, 4/3. Ferrovoice, the new kraft-based medium coercivity tape : 1,200ft., 22/6. Spare 7in. spools, 4/6. **(P)**

BRIMISTORS. Non-linear resistors to protect valves from current surges : CZ1, 0.3A, 3/6; CZ2, 0.3A, 2/6 ; CZ3, 0.2A, 1/6; CZ4, 1.25 A, 5/- ; CZ6, 0.45A, 3/6. **(P)**

MOULDED BROWN BAKELITE CABINETS. Suitable for fitting Decca 3-speed gram. motor, amplifier or loudspeaker. Outside dimensions (closed) 15½in. x 10in. x 5½in. ; thickness of wall, 1/16in. Price, 22/6, to callers only. **(M)**

AMPLION TESTMETER. 10 ranges A.C. and D.C. up to 500 v. Resistance up to 200,000 ohms, 1,800 ohms per volt A.C. and D.C. Price £5. **(P)**

HIGH WATTAGE WIRE WOUND RESISTORS. Capped end type, porcelain covered, at the following prices : 20 watt, 1/- ; 40 watt, 1/3 ; 80 watt, 1/6 ; 100 watt, 1/9 ; 200 watt, 2/6 ; 3 ohm, semi-variable, 20 watt ; 4 ohm, 40 watt : 13.852 + 1.352 + 8.352 ohm, 40 watt ; 80 ohm, 40 watt ; 350 ohm, 40 watt ; 430 ohm, 200 watt ; 5 k, 40 watt ; 7.5 k, 40 watt ; 12 k + 2 k, 80 watt ; 20 k, 80 watt; 50 k. 100 watt ; 75 k, 40 watt ; 100 k, 200 watt. Packing and carriage extra on all of these resistors. **(G & M)**

TWIN SCREENED CABLE. Suitable for carrying currents of up to 5 Amps. Cotton covered, 9d. per yard. Ditto uncovered, 8d. per yard. **(M)**

RUBBER TUBING. External diameter, 0.25in. internal diameter, 0.1in. Price 2d. per yard. **(G)**

WALNUT VENEERED CABINETS. Size 12in. x 7in. x 5½in. Suitable for housing a T.R.F. receiver or inter-com. Complete with back, chassis, dial and clips. Price, to callers only, 22/6. **(P)**

LARGE DIAMETER SLEEVING. Transparent plastic, ½in. diameter, 6d. per yard length. **(M)**

LITZ WOUND INDUCTORS. 199 micro Henry, wound on Aladdin ⅜in. coil former (no iron dust core). Price, 2/6 per half-dozen. **(G)**

BRENETTE MICROPHONE STANDS. Desk type with flexible member to ease adjustment. These stands will suit all British and Continental microphone stands. Price 16/6 each. **(PZ)**

CONDENSER OFFER. 25 mfd. 25 v. ear mounting. Price complete with ear, 1/- each or 10/- per dozen. .1 mfd. Condensers 350 v. screw mounting 1/- each, 9/- per dozen. **(G)**

AMPLIFIER AC11. Incorporating own power supplies ensuring that the chassis is completely isolated from the mains. Maximum output 3 watts ; response 3 db. down at 30 c/s and 30,000 c/s. Distortion at 2 watts output and 1,000 c/s, .08%. Top cut tone control is fitted. Price £6/2/6, plus 5/- carriage. **(PX)**

ELECTRIC MOTORS. For use on 24 v. D.C. supply, 7/6 each. **(G)**

HIGH QUALITY LOUDSPEAKERS. Wharfedale Bronze 10in., £4/12/8. Wharfedale Golden 10in., £7/13/3. Wharfedale Golden 10in. C.S.B., £8/6/7. Goodmans Audiom 60, 12in., £11/10/3. Goodmans Axiom Mk. II, 12in., £13/12/4. All above prices include new P.T. **(P)**

EX-GOVT. AND SURPLUS POTENTIOMETERS. Still available as in April copy of "Wireless World" with the exception of 50 ohm and 500 ohm. **(G)**

ROTARY WAFER SWITCHES. 3-way, 3-pole, 3-bank, 2/3 each. 4-way, 2-pole, 4-bank, 2/6 each. **(G)**

TAMSA TYPE 100 TAPE RECORDING HEADS. Housed in chromium plated brass case on adjustable mounting. Record/playback heads have ¼-thou. gaps and erase heads have 2.5 thou. gaps. These heads are of high impedance. Price 45/- each. **(PZ)**

PAXOLIN COIL FORMERS. These are of rectangular cross section and are suitable for mains transformer bobbins. 2¼in. x 2¼in. x 3½in. long, 1/- each. 2⅝in. x 1⅝in. x 12in. long, 1/3 each. **(M)**

GARLAND BROS, Ltd.

CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8

Telephone :- TIDEWAY 4412/3

5 OBELISK PARADE, LEWISHAM, S.E.13

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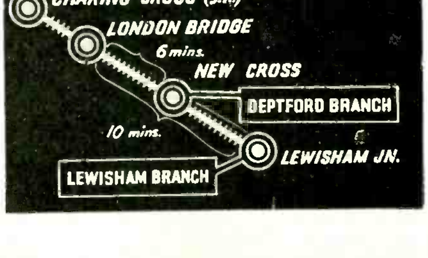

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A practical 5-channel SUPERHET TELEVISION RECEIVER

Using the new 16-inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

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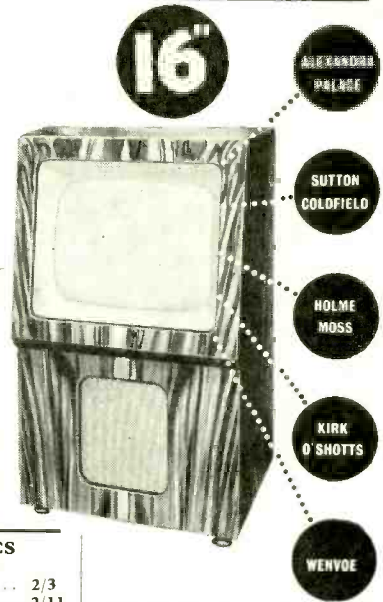


ALLEN WIDE ANGLE COMPONENTS D.C. 300 latest type Ferroxcube Coils .... 39/6 GL.16 Coil 10/- GL.18 Coil 10/- Focus Coil 35/- FO.305 trans. 21/- Frame B.O. transformer 15/- Line E.H.T. transformer, L.308 .... 50/-

CHASSIS Power pack Sound-vision and Scan chassis. PRICE 15/- each. All other metalwork available from stock.

COILS 13 all exactly as specified. Price £2/14/3.

RESISTANCES 72 Resistances, all exactly as specified, 18/-.

CABINET As illustrated, £8/10/- plus carriage.

WIDE ANGLE CATHODE RAY TUBES 14in. MW36-22 £19/9/3 14in. C14B, £20/10/1, 16in. MW41-1. £22/4/10, 16in. T901, £22/4/10, 17in. MW43-64, £23/12/8, 17in. C17BM, £24/13/-. Carriage and insurance extra.

SPECIAL C.R.T. OFFER. Brand new and unused 12in. ion trap cathode ray tubes. 6.3 volt heater, 7-9 Kv. E.H.T. 35 mm. neck. Black and white picture.

Screen has very slight blemishes .... £11/19/6.
Perfect .... £12/19/6.
Carriage and insurance 15/- per tube extra.

10,000 VALVES IN STOCK. B.V.A., Special Purpose, Transmitting, etc. A few specials: Raytheon sub miniature CK510AX, pentode, 3/11. 954, 956, VU120, 32, 57, E1148. All at 2/6 each. RK34, 2/-; MS/PEN 3/6; VU111, 3/6. Sylvania (red) EF50, 12/6.

CRYSTAL DIODES Germanium 2/3d. each, post free.

ION TRAPS. All types available. PRICE 5/- each. State type number of c.r.t.

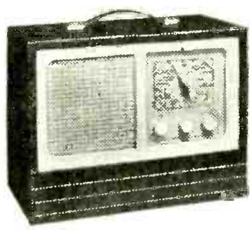
SPECIAL OFFER. IT/6. (For MW31-16), 3/- each.

MANUFACTURERS SURPLUS T.V. COMPONENTS.

Frame blocking oscillator transformer, Plessey	10/6
Multi ratio frame output transformer	10/6
Scanning coils. High impedance frame, low line. By Plessey	17/6
P.M. Focus units. For any type c.r. tube with 35 mm. neck, with vernier.	25/-
Scanning coils. Low impedance frame, low line. With aluminium shroud ..	12/6

ALL DRY PORTABLE CHASSIS. Superhet. Medium and short wave bands. 1 each: 1T4, 1S5, 1R5, 3S4. 465 Kc/s. I.F. Fully assembled and wired. Ready to fit into a cabinet. H.T. 90 volts. L.T. 1.4 volts. Size of chassis: 9in. wide, 5½in. deep, 2in. high, 6in. overall height. LASKY'S PRICE. With valves, 85/-. Less valves, 52/6. Carriage 5/- extra.

PORTABLE RADIO CABINETS



Rexine Finish. In all colours, blue, lizard, brown, red, etc. Complete with dial, pointer, knobs, back, speaker fret, handle and escutcheon. Size: 13 x 7 x 10in. (When ordering give second choice of colour). LASKY'S PRICE **37/6** Complete. Carriage 5/- extra.

A.C. MAINS POWER UNITS. Brand new, in original cartons. Size: 5in. wide, 2⅞in. high, 7⅛in. long. Input 200/250 volts A.C. Output: H.T. 90 volts, D.C.; L.T. 1.4 volts D.C. LASKY'S PRICE **39/6** Ready for use. Carriage 5/- extra.

ELECTROLYTICS CONDENSERS

8 mfd. 450 v.w.	2/3
8 mfd. 500 v.w.	2/11
16 mfd. 350 v.w.	2/6
16 mfd. 500 v.w.	3/6
32 mfd. 500 v.w.	4/11
50 mfd. 350 v.w.	3/11
60 mfd. 350 v.w.	3/11
250 mfd. 350 v.w.	4/11
8+8 mfd. 450 v.w.	4/6
8+16 mfd. 500 v.w.	4/11
12×12 mfd. 350 v.w	3/6
16+16 mfd. 500 v.w.	4/6
16+24 mfd. 450 v.w.	5/11
32+100 mfd. 450 v.w.	7/6
60+100 mfd. 350 v.w.	9/6
25 mfd. 25 v.w.	1/6
50 mfd. 12 v.w.	1/6
50 mfd. 50 v.w.	1/6
75 mfd. 12 v.w.	1/-

All brand new and guaranteed (not ex-Govt.). All other types, paper, tubular, waxed, etc., in stock.

RF25 UNITS. New, with valves. 19/11. Carriage 2/6.

GARRARD RECORD PLAYERS
For 6 and 12 v. operation Complete with magnetic pick-up, and volume control. In metal cabinet size: 17in. x 14in. x 11in. Very limited quantity. Lasky's Price **£5.19.6** Carriage 10/- extra.

VCR97 C.R. TUBES, new unused, 40/-. Carriage 5/-.

EHT. Transformer for VCR97, 45/-.

Screen Enlarger for VCR97 Filter type, 17/6. Postage 2/6.

E.H.T. Condensers. .1mfd. 3Kv. 3/6. .1mfd. 2.5 Kv. 2/6.

R1132 RECEIVERS. New. boxed, with all valves, £3/19/6. Carriage 10/-.

METAL RECTIFIERS
12 v. 1 a. 6/9 12 v. ½ a. 3/6
6 v. 1 a. 3/11 6 v. 4 a. 18/6
12 v. 4 a. 18/6

OUTPUT TRANSFORMERS

40 mA. Multi ratio	6/11
80 mA. Multi ratio	14/11
80 mA. Pentode	12/6
60 mA. Plessey, 6,000 ohms	5/11
Standard pentode	4/11
Pentode	3/6
Midget Pentode	4/3
Miniature Pentode. 3S4, 1S4	4/6
PX4 Intervalve	8/6
5 : 1 Intervalve	5/11

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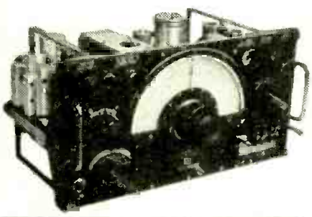
All less o'trans. new and unused. First quality.
3in. .. 12/11 5in. .. 12/6
6½in. .. 13/6 8in. .. 15/-
10in. .. 32/6

R.1155 RECEIVERS. BRAND NEW. AERIAL TESTED BEFORE DESPATCH



These well-known ex-Air Ministry Receivers need no further introduction.

Supplied complete with 10 valves.

LASKY'S PRICE **£11 . 19 . 6**

USED MODELS **£7 . 19 . 6**

Carriage 12/6 per unit extra.

Fully Assembled Power Pack and Output Stage, for R.1155 Receiver. For use on 200-250 volts A.C. mains. LASKY'S PRICE **79/6** Carriage 5/- extra.

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Sound-Vision, 18/6. Power-Pack/Time base, 18/6. Support for S.V. chassis, 6/-.

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Line Trans.	29/6
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Width Coil	6/11
Boost Choke	3/9

All suitable for Home Construction T/V.

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RF. EHT for line fly back. 6-8Kv, with EY51 heater winding. Suitable for home construction T/V 25/-.

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The very latest "Sentercell" S.T.C. range

K3/40, 3.2 kV	7/6
K3/45, 3.6 kV	8/2
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K3/100, 8.0 kV	14/8
K3/160, 12.8 kV	21/6

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18in. × 14½in.	25/-
14½in. × 12⅛in.	19/6
13¾in. × 11in.	14/11

PERSPEX. 13½ × 10¼ × ⅛in. Neutral shade, slightly marked 5/11 per piece.

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Frame trans.	25/6
3 Mc/s boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke	15/6
Focus ring	22/6
Heater trans.: WB/103	42/-
WB103A	52/6
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C.R.T. MASKS.
Brand New.
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16in. Double D	31/6
17in. Rect'glr.	25/-

SOILED. NEW ASPECT RATIO

9in. sorbo	5/-
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12in. with fitted armour plate glass, cream	11/6
12in. do. Black	8/6

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WX3 and 6. Ea.	3/9
14D36	12/4
14A86	20/4
14A100	21/6
36EHT45	23/8
36EHT50	26/1
36EHT100	29/6

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Scan coils per pair	25/-
Width Control	6/6

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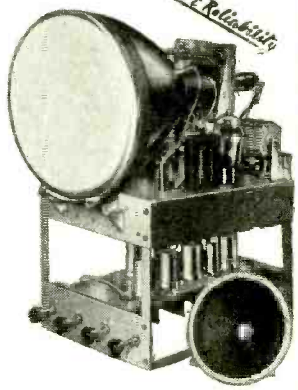

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Output 230 volts 80 mA. BRAND NEW AND UNUSED. Size: 9 × 5 × 5⅜in. Supplied less vibrator. Vibrator required is 6 pin synchronous.
LASKY'S PRICE 19/6
Carr. 3/6 extra.

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All 200-250 volts c.p.s. primary. Finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA., 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacement trans. Price 18/-.
MBA/6. 350-0-350 v. 100 mA 6.3 v. 3 a. 5 v. 2 a. With mains tapping board. Price 22/6.
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AT/3. Auto transformer. 0-10-120, 200-230-240 volts, 100 watt. Price 17/6.

PORTABLE TAPE RECORDERS
Brand New—Unused—Complete. Fully assembled and wired. Ready to operate. Attractive carrying case. Twin track recording. Instant playback. Total playing time of 66 minutes. 6 Valves. A.C. Mains 200-250 volts. Fast rewind. complete. Ready to switch on. Write for full illustrated details and circuit diagrams.
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THE RECORDING AMPLIFIER, as used in this recorder, can be purchased separately. Complete with 6 valves: 1 5Z4, 1 6J5, 2 6V6, 2 6J7, 5in. P.M. speaker, etc. Fully assembled and wired. Size: 15½in. wide, 8½in. deep, 6in. high. Circuit available.
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.001 mfd. 15 kV.	10/-
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Plastic case, single bolt fixing, Other high voltage condensers

.1 mfd. 7 kV.	15/-
0.04 mfd. 12.5 kV	7/6
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6.3 v. 1.5 a., 7/11.
6.3 v. 3 a., 12/6.
Special Transformer. 2 amps., with the following tappings: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 17/6.

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10 watts. 7.5-ohms impedance. Last Few only
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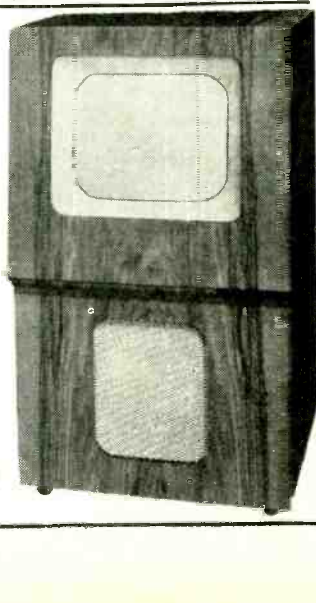
Outside dimensions of cabinet 17½in. × 16½in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

This cabinet can also be supplied cut out for a 16in. C.R. tube.



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SKY RIDER DEFIANT SX24 is similar to above but includes crystal IF filter and S meter, etc. Complete with valves and crystal for **£27/10/-** plus 10/- carriage. Further details—send S.A.E.

COMMUNICATION RECEIVER R1155 for world wide reception. Can be heard at any time during shop hours. Air tested prior to despatch. Brand new at **£11/19/6**. A few soiled at **£7/19/6**. Also have a number of R1155N's at **£17/19/6**. Carriage in original transit case 10/6 extra on all models. Send **1/3** for circuit details etc.

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45MC/S PYE STRIP Vision unit for London frequency, complete with 6-EF50 and EA50. Circuit provided. Price **£3/10/-** plus 2/6 carr.

T.V. PRE-AMP uses 2-EF50's and tunes to 45Mc/s. Easily altered to other frequency. With valves **19/6**, less valves 10/-. Post 1/- extra.

E.H.T. TRANSFORMER for the VCR97, etc. Mains input. Output 2,500 volts, 4 volts 2 Amp, 2-0-2 volts 2 Amp. Fully guaranteed at **35/-** plus 1/- post.

6in. MAGNIFYING LENS for the VCR97, etc. First grade, oiled filled. Now only **17/6** plus 2/6 post.

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30 VOLT TRANSFORMER standard primary, secondary 30 volts 2 Amp. tapped at 3v, 5v, 6v, 8v, 9v, 10v, 12v, 15v, 18v, 20v, 24v. Has countless uses. Price **17/6**.

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COMPLETE SET OF AR88 TUBES (14) for LF or D model receivers, **£5/10/-**.

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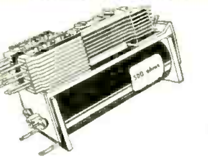

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1 mA., M/c., 2in. square panel mounting	12/6
1 mA., M/c., 2½in., flush panel mounting	22/6
5 mA., M/c., 2in., square panel mounting	7/6
10 mA., M/c., 2½in., flush panel mounting	12/6
30 mA., M/c., 2in. round panel mounting	7/6
30 mA., M/c., 2½in., flush panel mounting	12/6
50 mA., M/c., 2in., square panel mounting	7/6
150 mA., M/c., 2½in., flush panel mounting	12/6
200 mA., M/c., 2½in., flush panel mounting	12/6
500 mA., M/c., 2½in., flush panel mounting	12/6

AMP-METERS

1 amp., T/C., 2½in.	7/6
3 amp., T/C., 2in., square panel mounting	7/6
6 amp., T/C., 2½in., flush mounting	10/-
15 amp., M/I. (50 c.) projection	35/-

300 volts 50 cycles A.C., 5in. dial, projection type 75/-

M/c = Moving Coil. M/I = Moving Iron. T/C = Thermo-Coupled.

ALL METERS ARE BRAND NEW IN ORIGINAL BOXES.

RADIO-GRAM CHASSIS

3 Wave-band Superhet. Med., long and short.

5 Latest Type MULLARD Valves.

4 Position Switching. Gram., med., long and short.

Provision for Extension Speaker. A. C. Mains 110/250 volts.

Chassis 11in. x 7in. x 2½in. Scale 8in. Square. Or Chassis 13½in.x6½in.x2½in. Dial 10in.x5½in.

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PYE 45 Mc/s STRIP, TYPE 3583 UNITS. Size 15in. × 8in. × 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price **£5**. Carriage paid.

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3 in. Plessey, with Trans.	15/-
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8in. Elac, less Trans.	17/6
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10in. Rola, with Trans.	30/-
10in. Goodmans, with Trans.	30/-

WELWYN WIRE-WOUND SLIDER RESISTORS

MOUNTED ON PANEL FOR T/V SETS.

4 Bank: 100Ω, 500Ω, 2-10K	5/-
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W/W. PRE-SET VOLUME CONTROLS TYPE "901"

100Ω, 500Ω, 2K, 10K and 30K ....each 2/6

METRO-VIC (METROSIL) PENCIL TYPE E.H.T. REGULATOR up to 10 k.v.

particularly suitable for regulating E.H.T. Fly-Back. **5/-**

STROBE UNITS. Brand New, in sealed cartons, these contain 6 EF50s, 5 EA50s, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches, 7 pots. and 5 smoothing condensers. Size 18in. × 8½in. × 7½in. Only **67/6**, plus 3/- carriage.

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6 v. 1 amp. G.E.C.		4	0
12 v. 2½ amp. Westinghouse		12	6
12 v. 4 amp. S.T.C.		17	6
12 v. 8 amp. S.T.C.	£1	12	6

25/73 TR1196 RECEIVER

This unit is complete with 6 valves, 2 EF36, 2 EF39, 1 EK32, 1 EBC33 and 465 kc/s I.F.T.s. In new condition. Circuit and conversion data supplied. **39/6.**

S.T.C. RECTIFIERS E.H.T.

K3/25, 650 v. 1 mA.		4	7
K3/40, 1,000 v. 1 mA.		6	0
K3/100, 8,500 v. 1 mA.		14	8
K3/200, 10,000 v. 1 mA.	£1	6	0

H.T. RECTIFIERS

S.T.C. 125 v. 60 mA.	4	6
S.T.C. 125 v. 100 mA.	5	0
S.T.C. 125 v. 125 mA.	6	0
S.T.C. 250 v. 250 mA.	18	0

WESTINGHOUSE 14D/972

250 v. 25 mA.	6	6
S.T.C.M.1/3 Noise Limiter	2	0

G.E.C. METER RECTIFIER, 1 mA. .. 11 6

RECEIVER R1355. As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 each 5U4G, VU120, VR92. Only **55/-**, carriage 7/6. Brand new in original packing case.
RF24. **25/-**; RF25. **25/-**; RF26. **59/6**; RF27. **59/6.**

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WALKIE-TALKIE TYPE "46," complete with 6 valves. 2VP23, HL23 DD, QP25, TP25, and ATP4, aerial rods, I.F. trans., 1.6 Mc/s. mike trans. in new condition, but less transmitting components and coils removed by M.O.S., **35/-**, carr. paid. (Less valves, **12/6**.)

V.C.R. 517C BLUE & WHITE 6½in. TUBE.

This tube replaces the VCR97 and VCR517 without alteration and gives a full blue and white picture. Brand new in original crates. **45/-**, plus 2/- carr.

CATHODE RAY TUBES

VCR97. Guaranteed full T/V Picture (carr. 2/-)	£2	0	0
VCR517. Guaranteed Full T/V Picture (carr. 2/-)	£2	0	0
Mu Metal Screens for above		10	0
6in. Enlarger Lens for above		17	6
VCR139A (ACR10). For T/V or 'Scope, brand new and boxed (carr. 1/6)	£1	15	0
3BP1. For T/V or 'Scope (carr. 1/6)	£1	5	0

VR91 (EF50). Brand new Red Sylvanian, original boxes 10/-
British types, brand new and boxed 8/6
VR91 (EF50). Ex-Brand new units, **6/-**, or ten for **55/-**.
PX25. 12 6. Matched PX25's at **25/-** per pair.
Raytheon CK510AX Sub-Miniature Valves, brand new, **7/6.**

No. 38 "WALKIE TALKIE" TRANS-RECEIVER, complete with Throat Mike, phones, Junction Box and Aerial Rods in canvas bag. Freq. range 7.4 to 9 Mc/s. Range approx. 5 miles. All units are as new and tested before despatch. Offered complete with battery, **£4/10/-**.

T.V. PRE-AMPLIFIER FOR LONDON AND BIRMINGHAM. Complete with 6AM6. Ready to plug in to your set, **27/6.** P.P. 2/6.

INDICATOR UNIT TYPE SLC5

This Unit is ideal for conversion for a 'Scope' Unit or basis for Midget Television. It contains C/R Tube type ACR10 (VCR193A) complete with holder and cradle also earthing clip. 1-VR66, 2-VR65, 24 mfd. 550 v. wkg. condenser, potentiometers and a varied assortment of resistors and condensers. These Units are in new condition and packed in wooden transit cases. The C/R. Tube will be tested before despatch. Dimensions 8¾in. × 6½in. × 11¾in.

57/6

INDICATOR UNIT TYPE 182A.

unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (less relay) in original packing case at **79/6**. Plus 7/6 carr.

VIBRATOR PACKS

Input 6 v., Output 200 v., 60 mA.	25/-
Input 6 v., Output 150 v., 40 mA.	25/-
Input 6 v., Output 180 v., 40 mA. (ex. 21 set)	17/6
Input 2 v., Output 180 v./90 v., 35 mA., 1.4 v., 250 mA.	50/-
Input 6 v., Output 200 v., 80 mA. (Masteradio)	30/-
Input 12 v., Output 300 v., 100 mA.	30/-
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WEARITE

705 Coil Pack 3 waveband	£1	17	10
501A and 502 465 kc/s. pair		10	0
Wearite Mans Trans. Input 110/250 volts, output 325-0-325 80 mA., 6.3 v. 2.5 amps., 5 v. 2 amps.	£1	1	0

PLESSEY midget type 230 volts input, output 230-0-230. 50 mA., 6 volt 2.6 amps., screened primary. **12/6.**

WEYMOUTH SUPERHET MINIATURE COIL PACK Covering Med./Long/Short wave bands. Iron cored coils. Dimens.: Height 1¾in. Length 3¾in. Width 2¾in. Spindle length 2in. Complete with Circuit. Price **19/6.**

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2 gang .0005 standard ¼ spindle, with trimmers	7/6
3 gang .0005 with ceramic insulation ¼ spindle	7/6
Midget two gang, .000375, with trimmers. Size 2in. × 1¾in. × 1⅞in.	6/6
Midget .0005 mfd. 2 gang tuning condenser. Size only 2¼in. × 1⅝in. × 1⅞in.	5/-
Or with built-in trimmers	6/6
Two-gang Midget. .0005 with 4-way push-button assembly. Suitable for car radio. etc.	8/6

WANTED

723 A/B and CV129 Klystron Valves, Philips Trimmers, 3-30 pF. RL18, NR88. Any quantity.

PLEASE ADD POSTAGE. ARTICLES UP TO 10/-, 1/-. £1, 1/6. £2, 2/-.

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SPECIAL OFFERS. Germanium Crystal Diodes **2/9.** Midget Mains Transformers (size approx. 2½ × 3 × 2½in.). Screened Primary 220/240 v. 50 c/s. Output, 250-0-250 v. 60 mA., 6.3 v. 2.5 a. Only **11/9.** Small Filament Transformers, 220/240 v. input, 6.3 v. 1.5 a. output, **5/9.** Auto Transformers (with separate l.t. 6.3 v. 1.5 a.), 0-110-200-210, 230-250 v. 50 watts, **4/9** each.

BATTERY SET CONVERTER KITS. All parts for converting any type of Battery receiver to All Mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed h.t. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed l.t. of 2 v. at up to 1 a. Price complete with circuit, only **47/9.** Supplied ready for use to **7/9** extra.

PERSONAL SET BATTERY SUPERSEDER KIT. Complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s. Mains. For 4 valve Superhet Receivers. Price with circuit **31/6.** Or ready for use, **38/9.** Size of Unit 5¼ × 3½ × 1½in.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic, choke, and steel case. For Mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. ½ a. Price with circuit, **29/6.**
Or in working order, **37/6.**

BATTERY CHARGER KITS
For 200-250 v. 50 c/s. Mains input.
To charge 6 v. acc. at 2 amp., **25/9.**
To charge 6 v. or 12 v. acc. at 2 a., **29/6.**
To charge 6 or 12 v. acc. at 4 a., **49/9.**
Above consists of transformer, full wave rectifier, fuse, fuseholder, steel case and circuit.
Or in working order, **6/9** extra.

SELENIUM RECTIFIERS. 2/6 v. ½ a. H.W.. **2/11**; 120 v. 40 mA. H.W., **4/6.** 2/6 v. ¾ a. H.W., **3/9**; 230 v. 50 mA. H.W., **6/9.** 6/12 v. 1 a. H.W., **4/6**; 230 v. 80 mA. H.W. (ex. equipt.), **7/9.** 6/12 v. 2 a. F.W. (Bridge), **10/9.** 6/12 v. 4 a. F.W. (Bridge), **18/9.**

ELECTROLYTICS (Current production. Not ex-Govt.).

Tubular Types		Can Types	
8μF 450 v.	1/11	16μF 450 v.	2/9
8μF 500 v.	2/9	24μF 350 v.	2/11
16μF 350 v.	2/3	32μF 350 v.	2/11
16μF 450 v.	2/8	32 mfd. 450 v.	4/9
16μF 500 v.	3/9	40μF 450 v.	4/9
24μF 350 v.	3/3	50μF 350 v.	4/9
32μF 350 v.	3/9	8-8μF 350 v.	3/9
32 mfd. 500 v.	5/9	8-8μF 450 v.	3/11
8-16μF 500 v.	4/11	8-16μF 450 v.	4/6
25μF 25 v.	1/3	16-16μF 450 v.	4/11
50μF 12 v.	1/2	16-16 mfd. 500 v.	5/9
50μF 50 v.	2/3	16-32 μF 350 v.	4/9
Can Types		32-32μF 350 v.	4/9
8 mfd. 450 v.	2/3	32-32μF 450 v.	5/11
8 mfd. 500 v.	2/11	60-100 mfd. 350 v.	7/6
16 mfd. 350 v.	1/11	3,000 mfd. 6 v.	6/9

CAN TYPES

32-32-8μF 350 v. (Small)	5/11
16-16μF 450 v. plus 20μF 25 v.	5/3
50μF 350 v. plus 250μF 12 v.	4/11

CHASSIS. (16 s.w.g. Undrilled Aluminium) Receiver type. 6 × 3⅜ × 1½in., **1/11**; 7½ × 4½ × 2in., **2/9**; 16 s.w.g. 10 × 5½ × 2in., **3/9**; 11 × 6 × 2½in., **4/3**; 12 × 8 × 2½in., **5/3**; 16 × 8 × 2½in., **7/6** 20 × 8 × 2½in., **8/11**; Amplifier Type, 12 × 8 × 2½in., **7/11**; 16 × 8 × 2½in., **10/11**; 14 × 10 × 3in., **13/6**; 20 × 8 × 2½in., **13/6.**

SILVER MICA CONDENSERS. 5μμF, 10μμF, 15μμF, 20μμF, 25μμF, 30μμF, 35μμF, 50μμF, 120μμF, 150μμF, 180μμF, 200μμF, 230μμF, 300μμF, 330μμF, 400μμF, 470μμF, 500μμF, 1,000μμF (.001μF), .002 mfd. (2,000 pfd.). All at **5d.** each. **3/9** dozen one type.

WILLIAMSON AMPLIFIER KIT. To authors specification and complete in every detail. Only **14 gns.**

A PUSH-PULL 3-4 watt HIGH-GAIN AMPLIFIER FOR £3/12/6. For Mains input 200-250 v. 50 c/s. Complete kit of parts including circuit diagram and instructions. (Point-to-point wiring diagrams available for 1/6 extra). Amplifier can be used with any type of Feeder Unit or Pick-up. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Goodmans at **31/-**.) The amplifier can be supplied ready for use for **£4/17/6.** Full descriptive leaflet **1/-.**

MASTER INTERCOMM. UNIT with provision for up to 4 "Listen—Talk Back Units." A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A bakelite or wood cabinet is included. Mains input is 200-250 v. 50 c/s. Sound amplification 4 watts. Price only **£5/19/6.** "Listen—Talk Back Unit" can be supplied at **£1** each. Full descriptive leaflet **1/-.**

CABINETS. BAKELITE (Brown or White) and **WOOD** (Walnut veneered). Size approx. 12 × 6½ × 5in. Very attractive appearance. For illustrations see our List. Supplied complete with fully punched T.R.F. 3-valve Chassis, back, 2 or 3 wave. Glass scale with coloured station names, Dial Backplate, **25/-**, plus Carr. 2/6.
All parts available for construction of T.R.F. or Superhet Receiver in above cabinets.

VOLUME CONTROLS with long spindles, all values less switch **2/9**, with S.P. switch **3/11.** **WIRE WOUND POTS.:** 5K, 10K, 20K, 25K, 50K (medium length spindles), **2/9.**

AMMETERS. Moving coil. G.E.C. 0-5 amps., 2in. scale, **12/6.**

COAXIAL CABLE, 75 ohms, ¼in., **10d.** yard.

DIAL BULBS, M.E.S., 6.5 v. 0.15 a., 8 v. 0.15 a., **6/9** dozen.

VALVE SCREENING CANS. International Octal 3 piece, B7G (Button Base) 2 piece **10/6** doz., **1/3** each.

EX-GOVT. ITEMS. Cathode Ray Tubes, VCR137, **29/6**, plus carr. 5/-. VCR139A, **25/-**, plus 4/6 carr. Slydelock Fuses, 15 a., **1/9.** VR91, **4/6**, VR65, **1/11.** Pye coaxial plugs and sockets **7/6** doz. prs. Belling-Lee moulded type 5-pin and 7-pin plugs and sockets **1/11** pr. .02 mfd. 5,000 v. Tubulars, **1/9.**

EX-GOVT. SMOOTHING CHOKES

330 mA. 5 H. 50 ohms. Potted type	12/9
220 mA. 5 H. 50 ohms. Potted type	10/9
150 mA. 10 H. 200 ohms. Potted type	10/11
100 mA. 5 H. 100 ohms. Tropicalised	4/6
50 mA. 50 H. 1,250 ohms. Potted type	8/11

EX-GOVT. BLOCK PAPER MANSBRIDGE TYPE CONDENSERS

4μF 500 v.	2/11
8μF 500 v.	4/9

EX-GOVT. RF26 UNITS. Brand new, cartoned, **59/6**, plus carr. 5/-

P.M. SPEAKERS. All 2-3 ohms., 5in. Plessey, **13/9.** 5in. Goodmans, **14/9**, 6½in. Elac, **14/11**, 6½in. Plessey with Pentode Trans., **14/11**, 6½in. Goodmans, **16/9**, 8in. Plessey, **15/9**, 10in. Goodmans, **31/-**, 10in. Plessey, **18/6.**

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola field 700 ohms., **11/9**, 8in. R.A. field 600 ohms, **12/9**, 10in. R.A. field 600 ohms, **23/9.** 10in. R.A. field 1,500 ohms., **23/9.**

COLLARO TAPE DESK MOTORS, shaded pole type, clockwise or anti-clockwise, **29/9** each.

R.S.C. MAINS TRANSFORMERS (Fully Guaranteed)

Fully interleaved and Impregnated

Primaries 200-230-250 v. 50 c/s.

TOP SHROUDED DROP THROUGH

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	12/11
260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.	14/11
260-0-260 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	15/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

FULLY SHROUDED UPRIGHT

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2½-3-3in.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
375-0-375 v. 60 mA., 12 v. 1.5 a., 5 v. 2 a.	18/11
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	29/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a. for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a. c.t., 6.3v.-4v 4a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	51/-
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6

E.H.T. TRANSFORMERS

2,500 v. 5 mA., 2-0-2 v., 1.1 a., 2-0-2 v. 1.1 a., for VCR97, etc.	35/-
4,000 v. 5 mA., 2 v. 2 a.	39/6

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s primaries: 6.3 v. 2 a., **7/6**; 0-4-6.3 v. 2 a., **7/9**; 12 v. 1 a., **7/11**; 6.3 v. 3 a., **9/11**; 6.3 v. 6 a., **17/6**; 0-2-4-5-6.3 v. 4 a., **16/9**; 12 v. 4 a. or 24 v. 1.5 a., **17/6.**

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., **14/9**; 0-9-15 v. 3 a., **16/9**; 0-9-15 v. 6 a., **22/9**; 0-4-9-15-24 v. 3 a., **22/9**; 0-9-15-30 v, 3 a., **23/9.**

SMOOTHING CHOKES

250 mA. 7-10 H. 200 ohms. Fully shrouded	16/9
250 mA., 3 H. 50 ohms.	11/9
150 mA., 6-10 H. 100 ohms.	11/9
100 mA., 10 H. 100 ohms.	7/6
100 mA., 5 H. 150 ohms.	5/6
80 mA., 10 H. 350 ohms.	5/6
60 mA., 10 H. 400 ohms.	4/11
50 mA., 50 H. 1,000 ohms.	9/11

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s., 120 v. 40 mA.	7/11
90 v. 10 mA., 9-0-9 v. 250 mA.	10/6
120 v. 40 mA., 6 v. 1.5 a.	14/9
120 v. 40 mA., 5-0-5 v. 1.5 a.	15/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Small Pentode, 8,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Standard Pentode, 10,000 ohms to 3 ohms	4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 8 watts 6V6s to 3 ohms	7/11
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker	22/9
Push-Pull 20 Watts, high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9

MICROPHONE TRANSFORMERS

100 : 1	5/9

COMMUNICATIONS RECEIVER R1155. The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges 18.5-7.5 Mc/s, 7.5-3.0 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. These are BRAND NEW AND UNUSED IN MAKER'S ORIGINAL TRANSIT CASES, ONLY **£11/19/6.**
A few used receivers, also tested working before despatch, are available at **£7 19 6.**
A few of the R1155N model can also be supplied. This is the latest version which covers the Trawler Bands, and in addition is fitted with ultra slow motion tuning. Used, but tested working before despatch, ONLY **£17 19/6.**
A factory made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied at ONLY **£5 1/0-.** Operates receiver immediately.
DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.
Please add carriage costs of 10/6 for receiver, and 5/- for power pack.
RECEIVERS R1355, as specified for "Inexpensive Television." Complete with 8 valves SP61, and 1 each 5U4G and VU 120 or VU 111. Used, good condition, ONLY **29/6** (carriage etc. 5/6).
RF UNITS TYPE 26 AND 27 for use with the above receiver. The very popular variable tuning units, which use 2 valves EF54 and 1 EC 52. Type 26 covers 65-50 Mc/s, (5-6 metres), and Type 27 covers 85-65 Mc/ Mc/s, (3.5-5 metres).
BRAND NEW IN MAKER'S CARTONS. ONLY **59/6** each.
VIBRATOR UNITS. 2 volt type, American made, delivers 67 volts at 4.7 mA, 130 volts at 20 mA, and 1.4 v. L.T. Easily adapted for use with any battery receiver, full details being supplied. ONLY **50/-** (postage 2/-).
6 volt type, made by The National Co. of America for use with HRO Communication Receivers, supplying 165 volts at 85 mA, fully smoothed D.C. Complete with vibrator and 6X5 rectifier in black crackle cabinet, size 7in. x 7½in. x 6in. Slightly used. ONLY **39/6.**
INDICATOR UNIT TYPE 62A. Contains VCR97 tube with mu metal screen, 12 valves EF50, 4 of SP61, 3 of EA50, and 2 of EB34. Built on a two deck chassis containing hundreds of condensers and resistors, potentiometers, etc. In BRAND NEW CONDITION IN MAKER'S TRANSIT CASES. ONLY **£7/10/-** (carriage 9/6).
ADMIRALTY TEST SET TYPE SE2. For 160/230 Mc/s, this contains standard 230/250 v. 50 c. A.C. Mains power pack, 2in 500 microamp. meter, and 7 valves as follows ; 2 ea. 6J5 and EA50, 1 each 6X5, VR 137, CV 172. Fitted in metal lined wood case with removable front. ONLY **50/-** (carriage etc. 10/-).
6 VOLT 90 A.H. BATTERIES. By famous American makers, these have genuine hard rubber cases, and are BRAND NEW AND UNUSED IN MAKER'S PACKING. Size 8½in. long x 6¼in. wide x 7½in. high. ONLY **59/6** (carriage, etc., 7/6).
TELESCOPIC AERIAL. Pulls out of metal tube 15in long to extend to 73in. BRAND NEW. ONLY **7/6** (post 10d.).
194 I.F. STRIP. An easily modified I.F. Strip recommended for TV constructors who want good results at moderate cost, or for those who have built televisors but are having trouble in the vision or sound receivers. Can also be modified for 2 channel working as per details in "Practical Television" October issue. This 6 stage strip measures 18in. x 5in. x 5in., and contains 6 valves VR 65, 1 VR 92 and 1 of VR 56 or VR 53. Mod. data supplied. ONLY **45/-** (postage, etc., 2/6). Or less Valves **19/6** (post 2/6).
208 AMPLIFIER. Ideal for conversion into a high gain TV pre-amp. Complete with 2 valves EF 50. ONLY **15/-** (postage, etc., 1/6).
CERAMIC 2 WAY 3 BANK SWITCHES, 7/6 each.
CHOKES. 10 H. 60 mA, **3/9** ; 30 H. 100 mA, **12/6** ; 5 H. 200 mA, **6/-** (postage 1/- per choke).
TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded normal primaries.
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Please add 2/- per transformer postage.
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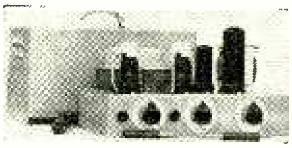

MODEL AC10E £10/7/6.

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RECEPTION SETS AEW.1. These are five valve superhet receivers, ex-New Zealand Forces, with a frequency range in four switched bands covering medium wave (188-545 metres) and short wave (12-50 metres). Incorporates power pack for operation from 6 v. accumulator. Loudspeaker is housed in its own separate case. Valves employed are 6K8, 6U7's, 6V6 and 6Q7 or equiv. types. Supplied complete with valves and speaker. Outside of cases are a little store soiled otherwise condition is as new and unused. Aerial tested before despatch. **PRICE £11/10/-,** carriage 9/6.
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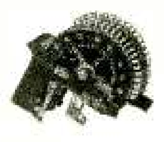

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3in.	—	10/-
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8in.	18/6	15/-

P. & P. on the above 1/- each. 10in. less trans., 21/-. P. & P. 1/6

R. & A. 8in. M.E. Speaker field. coil, 1,600 ohms O.P. trans. 5,000 ohms, imp, **18/6.** P. & P. 2/-.
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Extension speaker cabinet, in contrasting walnut veneers, size 15 x $10\frac{1}{2}$in. Will take $6\frac{1}{2}$ or 8in. speaker. **17/6.** P. & P. 2/-.
Volume Controls, by famous manufacturer. Long spindle less switch, 50K, 500K, 1 meg., **2/6** each. P. & P. 3d. each.
Expanded aluminium speaker fret, $13\frac{1}{2}$ x 9in., **2/-.**
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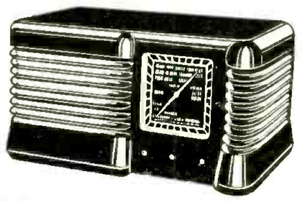
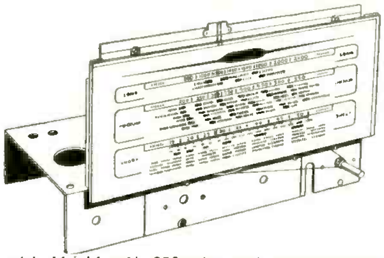


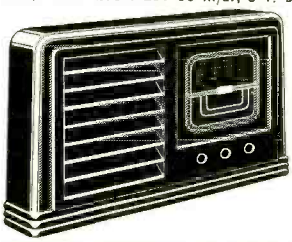
CABINET as illustrated, $11\frac{1}{2}$ x $6\frac{1}{2}$ x $5\frac{1}{2}$, in walnut or cream, complete with T.R.F. chassis, 2 waveband scale, station names. new waveband, back-plate, drum, pointer, spring drive spindle, 3 knobs and back, **22/6.** P. & P. 3/6.
AS ABOVE but complete with 5in. speaker and O.P. trans. (these speakers have been used but tested O.K.) **30/-,** P. & P. 3/6. Metal rectifier **7/6.** Gang with trimmers, **7/6.** Medium and long T.R.F. coils **5/6.** 3 obsolete Ex-Govt. valves, 3 v/holders, and circuit of an A.C. mains 3-valve plus rec. T.R.F. which can be built for approx. £4, **8/6.** Heater trans. **6/-.** Volume control with switch **3/6.** Wave-change switch **2/-.** 32+32 mfd. **4/6.** Bias condenser **1/-.** Resistor kit **2/-.** Condenser kit **4/-.**

KIT OF PARTS FOR SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 320 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s-8.5 Mc/s., 8.5 Mc/s.-20 Mc/s., Metal case 10in. x $6\frac{3}{4}$in. x $4\frac{1}{4}$in., size or scale $6\frac{1}{2}$in. x $3\frac{1}{4}$in. 2 valves and 1 rectifier valve, A.C. mains 230/250. Internal modulation 400 c.p.s. to a depth 30 per cent. Frequency calibration accuracy plus or minus 1 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts, **£3/10/-,** P. & P. 4/-. This includse the return to us for checking and calibration. We will build same for **15/-** extra. Circuit and point-to-point wiring diagram, **3/6. Kit of parts for above,** less checking and calibration, **£3,** plus 2/6 P. & P.

CONSTRUCTOR'S PARCEL, comprising chassis $12\frac{1}{2}$ x 8 x 2in., cad. plated 18 gauge, v/h., IF and trans. cut-outs, back-plate, 2 supporting brackets 3 waveband scale, new wavelength station names. Size of scale $11\frac{1}{2}$ x $4\frac{3}{4}$in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs, and pair of 465 IF's., **16/6.** P. & P. 1/9.



AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 60 m/a., 6 v. 3 amp. Pri. 200-250. **28/6.** P. & P. 3/-.



MODERNISE YOUR OLD CABINET BY FITTING THE WALNUT BAKELITE ESCUTCHEON as illustrated. Size 15x$8\frac{3}{4}$in., complete with 3 wave-band scale size $5\frac{1}{4}$ x $4\frac{3}{4}$in. **5/-.** P. & P. 1/6.

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Variable selectivity IF Switch to suit above, **7/6.**
MAINS OR BATTERY SUPERHET PORTABLE COILS. Medium-waved frame aerial and long-wave loading coil, used as aerial coils. Midget iron-core screened L/M osc. coils, with circuit I.F. 465 Kc., **9/6.**
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TELEVISION CHASSIS. Size $9\frac{3}{4}$ x $9\frac{1}{2}$ x $3\frac{1}{4}$in., 18 gauge steel cadmium plated complete with 5-coil cans size $1\frac{1}{4}$ x 1in. with iron cored former. These are wound for television frequency, **6/6.** P. & P. 1/6.
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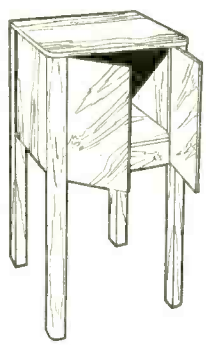
USED C.R. TUBES. Heater cathode shorts, 9in. **45/-.** P. & P. 7/6.

CONSOLE CABINET



In polished walnut originally made for gram. motor. Would make ideal bedside cabinet or T.V. stand. Size $28\frac{1}{2}$in. high by $17\frac{1}{2}$in. wide by $13\frac{1}{2}$in. deep. **39/6** plus 7/6 P. & P.
Valve Holders, moulded, octal Mazda, and loctal, **7d.** each. Paxolin, octal, Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded with screening can, **1/6** ecah.

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Ex-Govt. 8 mfd., 500 v. wkg., size $3\frac{1}{2}$ x $1\frac{3}{8}$, 2 for	2/6
60+100 mfd., 280v. wkg.	7/-
16 x 32 mfd., 350 wkg.	6/-
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60+100 mfd., 280 wkg.	8/6
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/-
50 mfd., 50 wkg.	1/9
Miniature wire ends moulded 100 pf., 500 pf., and .001 ea.	7d.

Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet, **17/6.** P. & P. 2/-.
Frame Oscillator Blocking Transformer, 4/6.
Frame O.P. Transformer. Inductance 10 hy. ratio 10 : 1, **9/6.**
Tube Mounting Bracket, size $9\frac{1}{2}$ x $4\frac{3}{4}$in., 12in. tube clamps, **2/-.**
Smoothing Choke, 2 henry 150 mA., **3/6.** 250 mA. 4 henry, **5/-**; 250 mA. 5 henry, **6/-**; 250 mA. 10 henry, **10/6**; 250 mA. 8 henry, **8/6.**
P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, **15/-.** P. & P. 1/6.
P.M. Focus Unit for Mazda 12in. with Vernier adjustment **17/6.** P. & P. 1/6.
Energised focus coil, high resistance with mounting bracket **17/6** plus 2/-. P. & P.
Scan Coils, low line low impedance frame, complete with O.P. transformer. **17/6.** P.&P. 2/-.
Ion Traps for Mullard or English Electric tubes, **5/-,** post paid.
465 Kc. I.F.s, size $2\frac{1}{2}$ x $1\frac{3}{8}$in. Q.110 removed from American equipment, **5/-** per pair. Standard 465 Kc. iron-cored IF's. 4 x $1\frac{1}{2}$ x $1\frac{1}{2}$in., per pr. **7/6.** Wearite standard iron-cored 465 Kc. IF's, $3\frac{1}{2}$ x $1\frac{3}{8}$ x $1\frac{3}{8}$in., per pr., **9/6.**
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WARNING

Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee: Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

AMPLIFIER XL/AC (1) (HIGH gain) INCORPORATES volume and tone controls. latest miniature valves. providing 4/5 watts output, for use with 2 to 15 ohm speaker. a.c. mains 200-250 volts; size of chassis. 8×6×2¼in. tested and ready for use; price £6/10 plus 5/- postage and packing; battery chargers (metal rectifier type) 200-250 v. a.c. in and 72 v at 15 amps d.c. out. new; £20.
LET us quote you for all RADIO components. valves. press tools and jigs for the radio trade.
TELEKIT SUPPLY Co.. Chantry Lane Works. Chantry Lane. Bromley. Kent. Rav. 5845. [1122

10-WATT quality amplifiers. bass and treble controls, £8/10.—Imperial Radio & Television Co., 69, Buxton St., Leicester. [1105

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

R.C.A. AR77E, good condition; £32, Northern Ireland area.—Box 7074. [1077

BAYSWATER radio dealer requires outlet for second-hand TV sets.—Tel. Bay. 4860. [1036

358× Eddystone communications receiver, speaker, 'phones, data; £30 o.n.o.—Box 6737. [1016

DYNATRON Merlin console (cost £125, Mar., 1949), perfect condition; £65, or near offer. —Box 6854. [1031

MURPHY table television, V204, 15in. £75; Wharfedale Golden 10in speaker, £6; both as new.—Box 6856. [1034

TRIPLE diversity receiver. R.201. new condition, every possible refinement.—Harris, Organford, Dorset. [1128

1155 p/pack, 10in speaker, good condition; £7/10 or nearest.—Bain, 63, Castlecroft Rd., Wolverhampton, Staffs. [9934

1132A V.H.F. receiver with power unit and spare valves, all as new; £8 or nearest, trial given.—Box 7073. [1078

LEAK point-one amplifier (tone control) pre-amplifier, moving coil speakers (16in, 9in "tweeter") oak cases, offers set?—Box 6915. [1041

TELEVISION Baird new 12in tube, completely overhauled, chassis only, bargain; £30, o.n.o.—Bexleyheath 8080, 96 Ramillies Rd., Sidcup. [1109

HRO Rx's and coils in stock. also AR88, BC348R, CR100, etc.—Requirements please to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

CONSOLE 12in and Console 6in television both good working order; also Taylor pattern generator, as new; must sell.—Details from 59, Beech Rd., Harrogate, Yorks. [1056

LEAK TL/12 12w point one, mint condition amplifier, control panel, metal cover; £20 or best offer; inspection by appointment, please. —John Goodman, 2, Spencer Drive, N.2. Speedwell 6940. [1118

DENCO Comm. Rec. 19, as new, £32; 6in TV part Premier, superhet vision, giving good results, Wenvoe, no cabinet, £15.—Hipwell, Stockton, Warminster, Wilts. Codford 373 (evenings). [9991

HRO receiver, complete, 9 coil packs, good condition, £20; Taylor 65P, £7; Telecheck, as brand new, £20; Cossor 1039 oscillograph, as new, £22; all genuine goods.—W. Smith, 30 Union St., Trowbridge, Wilts. [1093

IDEAL for club, hotel, hospital, etc., pack equipment consisting of two 30 watt amplifiers, med. wave tuner, mixer, etc., all unused, undelivered overseas order, no reasonable offer refused, inspection by appointment.—Box 6851. [1030

LOUDSPEAKERS—SURPLUS AND SECONDHAND

SOUND sales phase, inverter speaker with transformer, £6 or offer.—Box 6529. [9983

TWO public address horn loudspeakers; £5 each, excellent condition.—16, Lovett Rd., Portsmouth. [1115

WHARFEDALE Golden 10in 3ohm in cabinet; £6.—112, Alcester Rd. South, Birmingham, 14. Highbury 1314. [1043

PAMPHONIC 18in twin cone speaker 10 ohms complete with rectifier for mains operation, as new, £14/10.—L. E. Simmonds, Ltd., 5, Byron Rd., Harrow, Middlesex. [1048

NEW DYNAMOS, MOTORS, ETC.

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C.; any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0112

ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.
DIESEL Electric generating plants, 3kva, 230v with push-button remote control, starting equipment, ready for use; £250.
CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

THE Pearce new model diesel alternator plant, on welded steel frame, 230/1/50 3kva plus 32v 15a d.c., Petters latest AVAI, air-cooled diesel engine, alternator, self-energized, automatic voltage control by winding on stator, at govern, speed 1,500 rpm d.c. output trickle charges or charges lighting and starter battery up to 15amps, 24v lighting is used when plant is not in use; start and stop by remote control push-button; complete with main switch and fuses, battery cables 24v 72 amp/hr batt., instruction book, spares; engine covered by Petters' inspection service; reduced price £260, free delivery; where remote start and stop not required, but only push start on plant, reduction of £6/10; a few from stock, others quick delivery; if you collect, or we deliver, battery is charged and a 10 cu ft concrete bed given free.
SEND p.c. for full description and photographs.
ALSO above plant fitted Lister slow-speed water-cooled diesel, and electric flywheels.
ALTERNATORS, 230/1/50, 400VA, self-energized, 3,000rpm, ball bearing, £23/15 del.; also special television model same price; voltage regulator 30/- extra.
J.A.P. No. 2A 1.2hp petrol engine, air cooled, 4-stroke, starting rope, tools, £17/10 del.
SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb d.c. input, 12v 200va out, 24v, 32v, 50v, 110v, 230v d.c. to 230v out, 250va, £27/10 del.; also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £24/10 del., immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield, a 24v
TELEVISION converter was tested on Ekco television, 12in tube, stated consumption 135watts, d.c. current from battery only 9½amps, picture and sound were perfect and completely free of interference or flutter.
THE above are the latest products of British manufacture, and are guaranteed for one year; fullest details of plant, alternators or 400VA alt. or rotary converters, by return post; state which required; terms c.w.o., pro forma invoice c.o.d. (post goods only).
T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

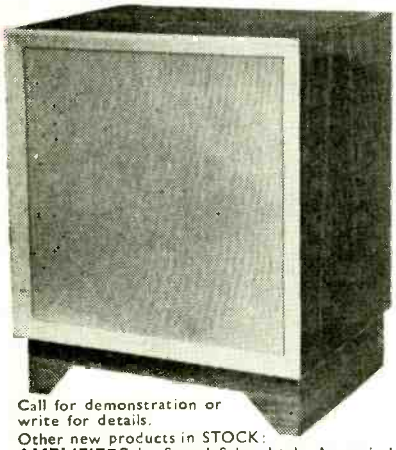
DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

ROTARY convertor unit input 230v D.C., output 110/250v A.C., starter, suppressor, 500w; nearest £12.—Lamorna, Westbourne Rd., Penarth, Glam. [1072

TV without mains, picture equal to mains supply as supplied to the B.B.C. special Chorehorse A.C./D.C. petrol electric generators, self-starting, self-contained, compact, A.C. voltage 220/250, 50/60 cycles, 25 0/350 watts; will also run radios, vacuum cleaners, small tools, etc.; D.C. output will charge batteries for permanent lighting.
PRICE £47/10 plus 10/- delivery.—Below.
STORAGE batteries, finest possible specification, dry, uncharged, 12v 75 a.h. heavy duty, 19 plates, separate cells, in hardwood cases, price £7/17/6 plus 9/6 delivery.
6V 90 a.h., 15 plate hard rubber cells, also suitable for cars, tractors, lorries; price £3/7/6 plus 7/6 delivery.
TEDDINGTON ENGINEERING Co., Ltd., Dept. "D," High St., Teddington, Middx. [0023

FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE NO. 114.

GET THE BEST
from your Speaker Unit by using the A.P. Enclosure
Price 16 gns.



Call for demonstration or write for details.
Other new products in STOCK:
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TUNERS by Lowther and Sound Sales.
LOUDSPEAKERS by Voigt., Wharfedale, Decca, Goodmans, Tannoy and Whiteley.
TELEVISION SETS. Ekco 12in. models. Projection models by Decca and Sound Sales.
Grundig **TAPE RECORDERS** and Wearite **TAPE DECKS.**
Full range of **AUTOCHANGERS & PICK-UPS.**
For further details see our May advt.
HOLLEY'S RADIO STORES,
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- **BRITISH APPARATUS,** includes Carrier, Telephone and Telegraph Equipment. TRANSMITTING Components up to 10 KW. High Power RECEIVERS R.201, DST.100 etc.

Many other items too numerous to mention. Send your requirements. Lists available. Packing and Shipping facilities.

H. HARRIS
ORGANFORD · DORSET
Telephone: Lychett Minster 212

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

ROTARY converters. 200 DC to 220 AC. E.D.C. .366A. in case with filter; £12/10.
220 DC to 220 AC. .366A E.D.C., less case and filter; £9.
220 DC to 220 AC. 1A Lang, as above: £10.
24V DC to 220 AC 120w. ex W.D., in neat case: £8.
PHILPS charger. Type S66; £5. carr. extra.
WYCOMBE ELECTRICAL SUPPLIES, Ltd., 51-52, Oxford St., High Wycombe, Bucks. H.W. 457. [1007

TRANSMITTING EQUIPMENT WANTED

REQUIRED. 4 or 5 second-hand Canadian. American or British portable transmitter receiver radio sets in good working condition.—Write to Box 6680. [1012

TRANSMITTING EQUIPMENT

NEW 50ft and 100ft lattice ladder towers by Trylon. U.S.A., complete.—Harris, Organford, Dorset. [1129

TEST EQUIPMENT—SURPLUS AND SECONDHAND

CLOUGH Brengle (American) oscillator, 100kc to 31 m/cs: £8.
CLOUGH Brengle (American) freq. modulator, 0-50 m/cs sweep; £4.
E.M.I. all-wave (AC mains) oscillator: £8.
RADIO meter valve tester: £3. carr. extra.
WYCOMBE ELECTRICAL SUPPLIES, Ltd., 51-52, Oxford St., High Wycombe, Bucks. H.W. 457. [1006

COSSOR model 3339D/B oscillograph and spare tube, in excellent condition; £35.
THE MACFARLANE ENGINEERING Co., Ltd., Netherlee Rd., Glasgow. [9974

VALVE tester, 1-177, as new, offers.—Bohan, 129a, Graham St., Penrith, Cumberland. [9997

FOR sale, surplus requirements. Cossor model No. 1035 double-beam oscillograph.—Box 6490. [9971

TAYLOR TV pattern generator 240a, £9.—Hipwell, Stockton, Warminster, Wilts. Codford 373 (evenings). [9992

COSSOR D.B. oscilloscope, perfect, £20; Taylor valve tester, as new, £10; Advance E1 signal generator, as new, £14.—Box 6692. [1013

SELL out, AR88, wire-recorder, CR100, Cossor Oscill, many unused valves, etc.—Write L. Robinson, 18, Alexandra Rd., Liverpool, 22. [9977

SIGNAL generator W4999 TV bands, unused, offers or exchange one broadcast bands.—L. Streatfield, 9, Parkfield Drive, Taunton, Somerset. [1049

EVERSHED Vignoles 250v bridge megger, recently overhauled and recalibrated; £15/10.—W. E. Thompson, 8 Coventry Rd., St. Leonards-on-Sea, Sussex. [1089

MARCONI receiver tester T.F.888 and audio tester T.F.894, also three model 8 avometers, as new; further, slightly used Cossor 1035 D.B. oscilloscope; seen by appointment.—75, Grasmere Rd., Barnehurst, Kent. [1086

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986 [0056

HICKOK 19×D.S.S.G., 230V AC. 100kcs to 114mcs in 8 ranges, 100kcs, 1,000kcs, crystal outputs 0.01%, combined RF/AF valve voltmeter, output meter, −10 to +38dB in 3 ranges, buyer collects.—Bryant, 21, Langham Close, Langham Rd., N.15. [9973

NEW GRAMOPHONE AND SOUND EQUIPMENT

RECORDING equipment to the trade.
WEARITE tape decks and special parts, disc recording machines.
BLANK discs Scotch-boy tape. Emitape.
RADIO feeder units, microphones, etc.
ALL from stock.—Sound Discs (Supplies), Ltd., 178, Bispham Rd., Southport, Lancs. [1087

TAPE recorder motors, 230v a.c., powerful quiet, brand new, 13/11; post, etc., 1/1.—K. W. Logan, Westalley, Hitchin, Herts. [0232

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., manufacturers of high quality portable and console magnetic tape recorders for professional and amateur use; full details on application.
BICKFORD Rd., Witton, Birmingham, 6. East 0822. [9968

WEARITE tape decks, £35; 9 watts P.P. R./P. amplifiers to suit, £25; these are first-class amplifiers, freq. res. 25-19 kc/s, with sep. bass and treble controls; amplifiers for Bradmatic desks, £30; for Truvox, 18gns (9 watt P.P.); for Lane, etc., 14gns and 17gns, or built to order.—Harding Electronics, 120a, Mora Rd., London, N.W.2. [9875

CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment, price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7, for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., 60, Aylward Rd., London, S.W.20 (Liberty 2426.) Callers by appointment only. [0209

BARKER SOUND UNITS NOW COST LESS THAN EVER BEFORE

The Barker 148a Sound Unit now costs you less than at any time since its introduction in 1948, and less than before the imposition of purchase tax. It is without question the most economical unit available today for anyone who values really NATURAL SOUND REPRODUCTION.

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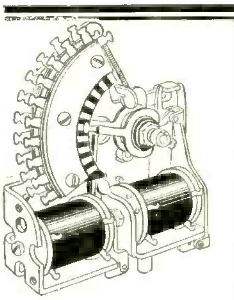
BARKER SOUND REPRODUCERS
3 Newman Yard, London, W.1



UNISELECTOR Minor Type 2 banks of 10 contacts, will operate from 24 v. or 12 v. with slight adjustment. Electro magnetic release when wipers reach end of bank. Resistance of drive coil 50 ohms, release coil 70 ohms. Ideal for sequence switching, model radio control, telephone exchanges, etc. Used, but new condition. **25/-.** *Post 1/6.*

MINE DETECTORS. Consisting of 2 v. amplifier, complete with valves, satchel, search coils, headphones, etc. Ideal for locating metals, hidden treasure etc. 45/-. Carriage 3/6.

INDICATOR UNIT SLC No. 5. Suitable for conversion into oscilloscope, using a 139A or a 3BP1 Tube. Unit consists of 3 valves, two VR65's and 1 VR66, condensers, 24 mfd. 500 v. working, tube holder and base, 4 potentiometers, 2 group boards containing 22 resistors, 17 condensers, three 4-way sockets. Mounted on a chassis 11 x 6 x 3in., deep, complete with cover open at one end to take glass screen. **17/6.** *Post 2/6.*

TEST UNIT REPAIR TYPE 58. Containing volume controls, switches, resistances, condensers, built-in 230 v. power supply complete with all valves, front panel 18 x 15, case 11in. deep. **£4/10/-.** *Carriage 10/-.*

LARGE MAGNETS. As taken from magnetron units, weight approx. 9lbs. Will lift up to 30-40lb. **30/-.** Post 2/6.

PRE-AMPLIFIERS. H.F. Suitable for conversion for television amplifiers, chassis size 4in. x 3½in. x 1½in. deep. Complete with valve VR136 (EF54). **12/6.** *Post 1/6.*

Our new list, No. 10, *now available. Price* ***6d.*** *inland.* ***1/6*** *overseas air mail.*

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TERMS : CASH WITH ORDER. NO C.O.D.

All goods sent on 7 days' approval against cash. *EARLY CLOSING DAY THURSDAY.*

MAINS TRANSFORMERS (NEW), 200/250 volts input in steps of 10 volts, output 0, 6, 12, 24 volts 6 amps., **42/6** each, post 1/6. Another as above but 10-12 amps, **55/-** each, post 1/6; another, as above, but 25/30 amps., **75/-** each, carriage 3/6; another, input as above, output 0/18/30/36 volts 6 amps., **47/6** each, post 1/6.

MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts, 180 m/amps., 4 volts 4 amps., 5 volts 3 amps., 6.3 volts 4 amps., **45/-** each, post 1/6; another 350/0/350 volts 180 m/amps., 6.3 volts 8 amps., 0/4/5 volts 4 amps., **45/-** each, post 1/6; another 500/0/500 volts 150 amps., 4 volts 4 amps. C.T., 6.3 volts 4 amps., C.T., 5 volts 3 amps., **47/6** each, post 1/6; another 425/0/425 volts 160 m/amps., 6.3 volts 4 amps., C.T. twice 5 volts. 3 amps., **47/6** each, post 1/6.

MAINS TRANSFORMERS, input 200/250 volts, output 45/50 volts, 70 amps., suitable for arc welding, **£15** each; another 70 volts, 50 amps., **£10** each.

MAINS TRANSFORMERS, input 180/250 volts, output 435/0/435 volts, 250 m/amps., 6.3 volts 10 amps., 6.3 volts 8 amps., 6.3 volts 8 amps, 5 volts 6 amps, **65/-** each; another, intput as above, output 4,000 volts 2½ m/amps., 4 volts 1 amp., 2 volts 2 amps., **45/-** each.

MAINS TRANSFORMERS, 200/250 volts input, output a combination of 6, 12, 18, 24, 30 and 36 volts at 6 amps., **45/-** each, post 1/6.

AUTO WOUND VOLTAGE CHANGER TRANSFORMERS, tapped 0/110/200/230 volts 350 watts, **55/-** each, post 1/6; as above, but 500 watts **70/-** each, carriage 3/6; as above, 200 watts, **40/-** each, post 1/6.

MAINS TRANSFORMERS, 230 volts input, 150/0/150 volts, 200 m/amps., 6.3 volts 8 amps., 5 volts 2 amps. output, **23/-** each.

3 KILOWATTS DOUBLE-WOUND VOLTAGE CHANGER TRANSFORMERS, 110/230 volts or vice-versa, as new, weight approx. 100 lb., **£12/10/-** each, carriage forward.

METERS, Moving Coil, 0 to 14 amps., **18/6** each. Ditto, Moving Iron, suitable for A.C. 0 to 30 amps., **25/-** each. Another, Moving Coil, 100 to 250 amps. D.C., **35/-** each, all 4in scale. (Others in stock, please state your requirements.)

ROTARY TYPE RESISTANCES, stud S/arm type 10 ohms 3 amps., **17/6** each. (Other types in stock please ask for quotation.)

D.C. MOTORS, 230 volts, .3 h.p., 3,000 r.p.m., in good condition, **£3/5/-** each; ditto Fan Motors, 230 volts D.C., **20/-** each; 110 volts D.C., **17/6** each.

6 or 12 VOLT RECTIFIERS at 4 amps. output, complete with suitable transformer 200/230 volts input, **45/-** each, post 1/6.

ELECTRIC LIGHT CHECK METERS, useful for subletting, garages, etc., all for 200/250 volts A.C. mains, 5 amp. load, **19/-** each; 10 amps, **22/6**; 20 amps., **27/-**; 25 amps., **32/6**; 40 amps., **38/6**; 50 amps., **46/6**; and 100 amps., **57/6** each, all carriage paid.

10 M.F.D. CONDENSERS at 350 v/wkg., **40/-** each. Relays 1,000 ohm, coil 2 breaks, **3/6** each. 12 volt Mallory Vibrator, 4-pin type, **4/6** each.

12/24 VOLT RECTIFIERS at 4 amps., with suitable Mains Transformer, 200/230 volts input, **55/-** each.

MAINS TRANSFORMERS (NEW), suitable for spot welding, input 200/250 volts, in steps of 10 volts, output suitably tapped for a combination of either 2/4/6/8/10 or 12 volts 50/70 amps., **95/-** each, carr. 7/6.

MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts 300 m/amps., 6.3 volts 8 amps. twice, 4 volts 4 amps., 5 volts 4 amps., **70/-** each, carriage 3/6. Ditto, 450/0/450 volts 250 m/amps, 6.3 volts 8 amps twice, 4 volts 4 amps, 5 volts 4 amps., **70/-** each, carriage 3/6; another, input as above, output 500/0/500 volts 250 m/amps., 6.3 volts 8 amps. twice, 6.3 volts 4 amps., 4 volts 4 amps., 5 volts 4 amps., **75/-**. Carriage 3/6. Another wound to (electronic) specifications, 350/0/350 volts 250 m/amps, 4 volts 8 amps., 4 volts 4 amps., 6.3 volts 8 amps., 0/2/6.3 volts 2 amps., **70/-** each, carriage paid; another, input as above, output 500/350/0/350/500 volts 250 m/amps., 6.3 volts 6 amps., 0/2/6.3 volts 2 amps, 0/4/5 volts 4 amps twice, **75/-** each, carriage 3/6.

TRANSFORMERS SPECIALLY MADE TO ORDER, delivery 72 hours from date of order. Please let us quote you

NEW GRAMOPHONE AND SOUND EQUIPMENT

POLLOCK lightweight m/c pick-up, response 40cs to 20kc/s, h.f. resonance 25kc/s approx.; complete set of parts for constructing head, 25/- plus 1/- post and packing; building instructions, 5/-; sapphire stylus .001in or .0025in, 7/6; model also for thorns; 100:1 input transformer, steel case, 20/- plus 1/- post, etc.—S.a.e. for details to A. M. Pollock, 31, Brooklawn Drive, Manchester, 20. [9909

FREQUENCY modulation.—Amos & Johnstone's new receiver; enjoy the superb reproduction offered by this service, with the added advantages of silent background and great volume range; sets in kit form (see New Components also), 145/-, or complete ready to drive amplifier; demonstrations dly. exc. Fri.'s 3-4.30. —Ring Arc. 5078. Bel Sound Products Co., Marlborough Yard, Archway, N.19. [0185

MAGNETIC recorders, all types, new and secondhand for sale; hire service in greater London area only; mechanical and electronic repairs carried out by specialists; "Magnegraph" limpet telephone pick-ups, suitable for all types of recorders, 25/-; tape storage racks for 12 reels, 37/6; B. & H. recording wire, new and used, from 15/- reel; tape, accessories, etc.; full details, s.a.e.—The Magnegraph Recording Co., Ltd., 1, Hanway Place, W.1. Tel. Langham 2156. [0236

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

FOR sale, Wearite tapedeck, almost new, £30. —Box 7131. [1090

TAPE recorder, C.J.R. type D.1, £95; Scotch Boy tape used once and erased.—Box 6916. [1044

SIMON tape recorder, perfect, showroom model, £44; Grundig, £68.—Tel. Arnold 5201/2. [9982

FOR sale, Wearite tape deck, as new, can be seen working by appointment; £30 or offer. —Box 6637. [9994

GARRARD 201B/AC trans. motor, 33, 45 or 78, perfect; £11.—Dix, 41, Talbot Rd., Trowbridge. [9700

36 new unused 1,200ft reels Scotch Boy tape, 27/6 each; a few used once at 25/-.—Tel. Mountview 6875. Box 6850. [1029

TAPE recorder, complete £28 for quick sale. —Tel. Bexleyheath 8080. Smith, 96, Ramillies Rd., Sidcup. [1110

SOUND Mirror tape recorder, model TP445, mahogany case with microphone, slightly used, guaranteed; £45, carr. extra. WYCOMBE ELECTRICAL SUPPLIES, Ltd., 51-52, Oxford St., High Wycombe, Bucks. H.W. 457. [1006

WEARITE tape deck, as brand new, £25; owner going abroad; amplifiers, etc.—L. Frances, 82, Wood Lodge Lane, West Wickham, Kent. [9988

M.S.S. portable disc recorder, list £80, accept £45; Ferrograph tape recorder, £65; Goodsell amplifier and T/C prestage, £18; all as new.—Box 7132. [1091

NEW COMPONENTS

"WIRELESS WORLD" portable P.A. output transformers, 14/-.—H. L. Brown, 16, Rowan Rd., Walsall. [1071

SWIFT RADIO.—Send for our free component catalogue to-day, Viewmaster, tape, gram., etc.—21, Hibbert Rd., Harrow. [9918

BRIGHTON viewers.—Convert to channel 3; booster, set of coils, as W.W. design, £1; trade, and wired unit enquiries cordially invited. —Bel, Marlborough Yard, Archway, N.19. Arc. 5078. [0184

TRANSFORMERS, mains isolating, double-wound 230-230, ideal for universal TV set testing and servicing; 67/6.—Malden Transformer Supplies, 200, Cambridge Rd., Kingston, Surrey. Kin. 5501. [0058

MALDEN TRANSFORMER SUPPLIES offer 250v 100 ma metal rects., 9/6; 20k 20w w/w pots 6/6; 2mfd 3,000v paper condenser, 5/9; metal rects., 12v 2amp F/w, 8/9; 80w fluorescent choke, 230v, with starter lamp, 14/6; battery charging transformers, 10v 18v at 5amps, 15/6.—Kin. 5501. 200, Cambridge Rd., Kingston-on-Thames. [0038

FOR really good results you can do no better than use Osmor coils and coilpacks, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new coil data leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, all Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1.
OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9. [0046

FREQUENCY Modulation.—Parts for the Amos & Johnstone receiver; input 50μV for 0.3v AF from the Wrotham high fidelity station at 91Mc/s; avg. London field produces 3 volts, audio output ready to feed amplifier consumes 30ma at 250v, 6.3v at 0.9a, described Oct., '52; complete set of parts including valves, wound coils, germanium diodes, drilled chassis down to nuts and bolts, price, post free, 145/-; add full frequency range transmission to your set or amplifier; programmes 6-11 p.m. and daytime; trade enquiries also invited.—Bel, Marlborough Yard, London, N.19. Arc. 5078. [0186

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Est. 1925

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PROMPT & EFFICIENT SERVICE

CASH or EASY TERMS

NEW EASY TERMS

LEAK

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TL/12 'POINT ONE' AMPLIFIER
Cash **£28 . 7 . 0**

'VARI-SLOPE' PRE-AMPLIFIER
Cash **£12 . 12 . 0**

For the two units: Deposit £9.0.0 with order and 18 monthly instalments of 40/-. Passenger carriage 10/- extra payable with deposit.

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Three-speed Gram Units and Super Lightweight Pick-ups to match the above can be supplied from stock. Terms available.

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The complete **Wharfedale** and **Goodmans** range of speakers are available on Easy Terms—please let us have your requirements.

ARMSTRONG CHASSIS

The EXP. 73—RF. 104—and EXP. 125 Chassis can be supplied on Easy Terms. Write for full specifications.

CABINETS

We can supply suitable high-grade radiogram and loudspeaker cabinets for all the above. Made to special order only.

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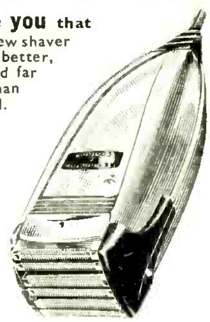
SUPER REMINGTON

CONTOUR 6 ELECTRIC SHAVER



will convince you that this remarkable new shaver really does give a better, more pleasant and far quicker shave than *any* other method.

OUR 14 DAYS' FREE TRIAL is available on receipt of **20/-** deposit (returnable if not entirely satisfactory), with eight monthly instalments of **20/-**. Cash **£8 . 10 . 0.** AC/DC 200/250v.

GUARANTEED 12 MONTHS

Other voltages available. Each shaver is BRAND NEW and despatched in superb silk lined presentation case.

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(LONDON RADIO SUPPLY CO.)

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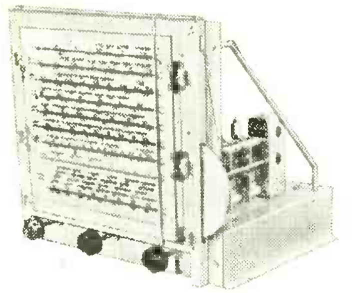
Telephone : Balcombe 254

—TUNERS—



S6BS 9 Band (6 Electrical band spread) with R.F. F.C. 2 I.F. Delayed Amplified A.V.C. Variable Selectivity. Fly Wheel Tuning. Tropicalised. Suitable for use with any High Quality Amplifier. **£44.** Tax paid.

S5 3 Wavebands. 16m.-2,000m. R.F. Pre-amplifier, variable selectivity I.F. Delayed amplified A.V.C. Very low distortion. **£21/6/8.** Tax paid.

S5E As S5 but 12.5m.-550m. **£21/6/8.** Tax paid.

S4 The Standard high-quality Feeder Unit. Specification as S5 but without R.F. amplifier. **£16.** Tax paid.

A modified version of all models is available for use with Leak or Acoustical Amplifiers.

C. T. CHAPMAN (Reproducers) LTD.
RILEY WKS., RILEY ST., CHELSEA, S.W.10
FLAxman 4577/8
Export Enquiries Invited

THE BRITISH NATIONAL RADIO SCHOOL
ESTD. 1940

BIASED BACK?
LOW GAIN?
ROUND THE BEND?

We can improve the slope of your REWARD/GAIN curve, especially at the top end.

A.M.Brit.I.R.E. and CITY and GUILDS Radio and Telecommunications Exams, etc., etc.

Please mention this advert. and send for free booklet to:—

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BRITISH NATIONAL RADIO SCHOOL
66, ADDISCOMBE ROAD, CROYDON
Phone: Addiscombe 3341

NEW COMPONENTS

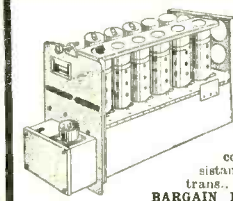
CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new, 15/6, post free; Cosmocord Mic-30 hand stand microphones, black or white, £4/4 each, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

COMPONENTS—SURPLUS AND SECONDHAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188.
ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid, in that order; 400, 6v, 1×2in, lug, 2/3; 250+250, 6v, 1×2in, lug, 2/6; 500+500, 6v, 1×3in, lug, 2/6; 40+40, 150v, 1⅛in×2in, clip, 3/-; 40, 150v, 1×2in, clip, 2/6; 20+20, 275v, 1×2in, lug, 3/6; 16+32, 275v, 1×2in, lug, 3/6; 16+16, 275v, 1×2in, clip, 3/6; 32+32, 275v+50mf 25v, 1×3in, lug, 4/-; 60+100, 275v, 1⅜×3in, lug, 5/6; 100, 275v, 1⅜×2in, clip, 3/9; 32+12, 350v, 1⅜×2in, clip, 4/6; 16+16+16, 350v, 1⅜×2in, clip, 5/-; 40+40+20, 350v, 1⅜×3in, lug, 5/-; 16, 350v, ¾×2in, lug, 2/-; 40+40, 300v, 1×3in, lug, 4/-; 10, 450v, ¾×2in; lug, 2/-; 16, 450v, ⅞×2in, 3/-; 20, 450v, 1×2in, lug, 2/9; 32, 450/525v, 1⅜×2in, clip, 4/-; 16+16, 450v, 1⅜×2in, clip 5/6; 32+32, 450v, 1⅜×3in, clip, 5/9; 30+30, 450v+20mf 25v, 1⅜×3in, lug, 5/6; 15+15, 450v+20mf 25v, 1⅛×3in, lug, 5/3; 200, 6v, ⅝×1⅜in, clip, 2/-; 100, 12v, ⅝×1¾in, wire, 1/9; 8, 450v, 1×2in, clip, 2/3; 50, 12v, ¾×1⅝in, wire, 1/6; 150, 25v, ¾×1¾in, clip, 2/-; 250, 12v, ¾×1¾in, wire, 2/3; 350, 25v, 1×2¼in, clip, 2/6; 16+16, 450v, 1⅛×2in, clip, 4/-; 40+40, 275v, 1⅜×2in, clip, 3/6; 16+32, 450/525v, 1⅜×2in, clip, 5/6; 24+24+16, 350/425v, 1⅜×2in, clip, 4/9; 60+200, 275/350v, 1¾×4½in, clip, 6/6; 1,000, 12v, 1×2¼in, clip, 2/9; 4, 150v, ⅜×1¾in, clip, 1/1; 60+100, 350/425v, 1⅜×4½in, clip, 6/6; 500, 12v, 1⅜×2¾in, clip, 2/6; 8, 350v, ¾×2in, 2/-; 6,000, 12v, 1⅜×4½in, lug, 4/6; 100+200, 275/350v, 1½×4½in, 6/6; 100+175, 275/350v, 1⅜×4½in, clip, 6/-; 8+16+16, 450/525v, 1⅜×2in, lug, 5/9; 32+32, 350/425v, 1⅜×2in, clip, 5/-; 2,000, 6v, 1×3in, clip, 3/3; 8+16, 450/525, 1×2in, clip, 4/3; 2, 450/525v, ¾×1¾in, tag, 1/6; 2, 350v, ¾×1¾in, tag, 1/3; 8, 350/425v, ¾×2in, clip, 2/-; all are ali cans, some with sleeves.
ALL new stock, all voltages WKG, with surge v where marked; trade supplied most types.
TELEVISION! Set of 3 components, comprising line output trans., with E.H.T. winding to give 7kV, using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res. 10,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post, diagram of line trans. supplied.
PERSONAL receivers, 3 valve T.R.F. using IT4s, contained in handsome bakelite case with lift-up lid, size 7×6½×5in with lid closed, plastic carrying handle, fram. AE in lid, these receivers cover the medium waveband and operate from self-contained dry batts., standard types W1435 and U2, output to a pair of lightweight 'phones (H.R.) controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids hosp. patients, etc., these receivers are not Govt. surplus and are offered ready to play; carr. paid; £4/10.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

LARGE stocks of ex-Govt. radio equipment to clear.—Box 7140. [1101

P. B. CRAWSHAY, 166, Pixmore Way, Letchworth, Herts. Tel. 1147.
VOLTAGE regulators, Ferranti 230v motor-driven moving coil, 480va, £18; 1,440va, £28.
METADYNE generators, 45v, 60a type MD70EX, new, £28; Servo d.c. motors, 1½hp, 1,000 r.p.m., for use with MD70EX metadyne, fitted e.m. brake and worm drive for inching, new, £15.
POWER-SERVOS, AP 55938 motor torque transmitters, £8.
AMPLIDYNE motor generators, in 78/110v d.c., out 250v 1a, 3,800/5,000 r.p.m., G.E. (U.S.A.), £7.
SELSYN motors, B.T.H. type SJ2512, 230v a.c., 45lb in torque, wt. 38lb, 95/-; type 54, 50v a.c., wt. 13lb, 45/-; Diehl (U.S.A.), wt. 8½lb, 115v a.c., new, 45/-.
MAGSLIPS, 3in resolvers AP 10861, new, in tins, 45/-; large quantity; other types.
MULTIVIBRATOR, 100 kc/50 cps, G.E.C., 230v a.c., rack mounting, complete unit, new, £55.
MOTOR alternators, in 230v d.c., out 210/420v, 3ph, frequency variable 25/50 cps, 25/50 kva, B.T.H., £12; in 230v d.c., out 115/1/60, 33a, G.E., £18; in 400/3/50, out 180/1/500, 27a, £24; in 24v d.c., out 80v, 1,200c, 6.25a, £5.
FREQUENCY meters, 40/60 cps, 230v, 6in, £9; ditto 130v, 5in, £5; ditto 12/18v, 5in, for use with alternators below, new, 40/-.
ALTERNATORS, small, 12/18v, 3,000 r.p.m. 18/-.
AMMETERS, 5in 0/14a, MI, a.c./d.c., new 25/-; ditto, M.C., d.c., new, 25/-.
PROCESS timing controls, Londex ASR/IMP, automatic repeating, 230v a.c., 0/60 secs, £8.
SELENIUM rectifiers, S.T.C., 12v 4a bridge, 112mm discs, heavy duty tags, new, 17/6.
RECTIFIER units for 230v a.c. complete, 90v ¾amp, £6; 24v, 10a, £11; 30v, 40a, £18.
PHOTO-RELAY sets, G.E.C., 230v a.c., complete set of 2 massive watertight units, £9.
TRANSFORMERS, 15 kva, HV; 528, 480, 432, 264, 240, 216, 132, 120, 108v, LV 240, 120v, double wound, 1ph, 50/60 cps, £22; 5kva in 230v, out 100/270v by 10v steps, auto, £10.
VARIACS, in 230v out 0/230v, 8 amps, type 100L, as new, last few, to clear, £14.
BRIDGE-MEGGERS, by E. & V., 250v, self-contained type, accuracy tested, last few, £14.
P. B. CRAWSHAY, 166, Pixmore Way, Letchworth, Herts. Tel. 1147. [0240



SUPERHET V.H.F. 6-VALVE RECEIVER. Ex W.D. R1124, but brand new condition. Six channel switching, tuning 30.5 to 40 mc/s. Components include 30 ceramic trimmers, 30 small condensers, 30 resistances (¼-1 watt), 2 trans., 3 coils, etc. **BARGAIN PRICE 7/6.** Also complete with valves at **17/6.** Post 2/9. Drawings available for suggested conversions to A.C. or A.C./D.C. mains.

MAINS TRANSFORMERS. Brand new. Primary tapped 0, 205, 225, 245, 300 volts, at 200 m/A. Secondary 5 v. at 2 a., and 6 v. at 7 a. **OUR PRICE 12/6.** Post 1/9.

LOUD HAILER. Powerful P.A. system. Weatherproof. Consists of microphone and combined amplifier/speaker. Colossal range. Works off 12 or 24 volts. **PRICE £8/17/6.** Carr. 5/6.

TUNING CONDENSERS. Two gang, .0005 mfd., standard size. Store soiled, but all tested. **CLEARANCE OFFER 2/9.** Post 9d. **BARGAIN** of 3 for **7/-.**

RADIO-TELEPHONE. U.H.F. walkie-talkie type transreceivers. 53-75 mc/s., tunable. Visual range. Works off set of internal batteries, or through a vibrator unit from 12 volts. Brand new and boxed. Maker's handbook with each pair. **£9/17/6** each, or **£18/17/6** per pair. Carr. 5/6 each. Vibrators 27/6 each.

FREE GIFT OF 8in. P.M. SPEAKER with either of following two chassis. 6 wave Export model at **£15/15/-**; and 3 wave Home Market model at **£12/12/-** Both measure 11½in. × 7in. × 8½in., have flywheel tuning, negative feed-back, gram pick-up sockets, and valve line-up 6BA6, 6BW6, 6BE6, 6AT6, 6X4. Also special reduction to **12/6** for a 10in. speaker supplied with either of these.

EXTENSION SPEAKERS. Brand new 6½in. P.M. low impedance speakers, mounted on polished and veneered baffle of modern design. Gold sprayed metal fret fitted. 5 feet of lead ready connected. **GIFT PRICE 19/9.** Post 1/9.

O.P. TRANSFORMERS. CLEARANCE OFFER AT 1/9 each. Post 1/-. Will match all normal O.P. valves to 2-5 ohm speech coil.

Stamp for **1953** List.

DUKE & CO.,
621 Romford Road, London, E.12
GRA 6677
C.W.O. or C.O.D. Money back Guarantee

CABINETS

T/V Cabinet as illustrated, **£15/-/-.** Catalogue of T/V, Table, Radiogram and Speaker Cabinets available on request. Individual cabinets made to specification. BASS REFLEX corner Cabinet for Goodmans Axiom 150 Mk. II, **£26.** Corner Baffle for 8in. or 10in. unit, **£7/15/-.**

COMPONENTS

Comprehensive catalogue available.

TAPE RECORDER

We proudly present our latest product—a versatile portable Tape Recorder capable of being used as a high quality amplifier or radio receiver. Full details on request. List price **53 gns.** Trade enquiries invited.

LEWIS RADIO CO.
(Dept. 653)
120, Green Lanes, Palmers Green, London, N.13. (Near Bowes Road)
Phone: BOWes Park 6064.

COMPONENTS—SURPLUS AND SECONDHAND

MORRIS, 89, Tottenham Court Rd., W.1 (Goodge St. Tube).
MIDGET radios, complete 1953 Cadet, universal a.c./d.c. portables, ivory plastic with handle, fine tone and volume, 5in speaker, maker's guarantee; £6/19/6.
DULCI 1953 all-wave 5v superhets, ivory plastic, maker's guarantee; £10/19/6.
B.S.R. gram motors with turntable, brand new, 59/6; Rothermel S8 crystal pick-ups, 27/6.
VALVES: VR108 (Sp13C), 3/11; VT171 (DK92), VT172 (DAF91), VT173 (DF91), VT174 (DL92), 11/6; VU39 (MU12/14), 9/6; HL2/K, 5/6; 500 other types, this month's list, s.a.e. please; trade welcomed; 9-6 week-days, 9-1 Saturdays. [0237

PROJECTION TV optical e.h.t. deflection MW6-2 units, as new; £20.—Box 6879. [1035

SEE our displayed advt. on page 108 for surplus bargains.—Radio Exchange, Bedford. [0012

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. Ilford 1260. Est. 17 years.
P.M. speakers, all less trans, 2-3 ohm v/coil, 5in 10/6 ea., 6½in 12/11 ea., 8in 13/11 ea., 10in 18/11 ea.; 10in P.M. speakers by Elac, 2-3 ohm v/coil, less trans to handle 5 watts, our price 27/6 ea. or 7-watt type 37/6 ea.; these are really capable speakers.
ALSO in stock the famous Goodmans 10in P.M., 2-3 ohm v/coil, less trans at the very keen price of 22/6 ea.
ANOTHER good buy!! Small vol controls with long spindle and d/p switch, 1 meg or ½ meg 3/- ea.
STANDARD size vol controls with long spindle and s/p switch, 250K ohms, 100K ohms, 25K ohms, and 5K ohms, our price 2/3 ea.
ALSO the following values, less switch, 2 meg ohms, 250K ohms, 100K ohms, 10K ohms, and 5K ohms, cannot repeat at 1/6 ea.
MAINS trans by Parmeko, universal fixing, primary tapped, 0-200-220-240v, sec 290-0-290v 80 M/A 6.3v 3a and 6.3v tapped at 4v 2amp, with screen, our price 15/11 incl. post and packing.
HEATER trans, primary 0-250v, sec 6.3v at 1.5amp 6/3 ea. or 6.3v at 3amp type, 9/3 ea.
OUTPUT trans, 40 M/A type matched for 5000 ohms to 2 ohms 4/6 ea., push-pull type 6/11 ea., ideal for a pair of 6v 6 valves
VERY popular line in condensers, 32+32+16 mfd 350v metal can type 3/6 ea., 60+150 mfds 275v d.c. wkg, our price 4/11, 200+200 mfd 25v 1/- ea., 16+8 mfd 500v 4/9 ea., 16+16 mfd 450v, 4/11 ea.; tubular card board cond, 8 mfd 500v tag end 2/- ea., 8 mfd 500v tub/card wire-end small 2/9 ea., 100mfd 12v tub/cardboard wire-end bias cond 1/6ea. (all cond listed are brand new stocks)
TELEVISION rectifiers Sentercell type, K3/25, 650v 4/7 ea., K3/40, 3.2 k/v 7/6 ea., K3/45 3.6 k/v 8/2 ea., K3/50 4 k/v 8/8 ea., K3/100 8k/v 14/8 ea., S.T.C. metal rectifiers, R.M.I. 3/11 ea., R.M.2 4/3 ea., R.M.4 18/- ea.; L.T. rectifiers, 12v lamp 8/6ea., 12v 2amp 13/6 ea., 6v lamp 3/11 ea.
MOULDED midget mica cond, 100 p/f, 200 p/f, 300 p/f and 500 p/f, all at 7d ea. or 6/- doz, or ass. doz .001 mfd 1/3 ea. or 12/- doz.
JUST arrived!! I.F./T.S. 465 Kc/s in small All. can 2¼in 1×1⅜in dia with dust cores, our price 6/6 pair; twin balanced feeder for television 80 ohms, our price 4d per yd.
MANY other bargain lines in stock.
TERMS: c.w.o., no c.o.d.; send 9d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

MAGSLIPS at 1/10 to 1/20 of list prices, huge stocks, please state requirements.
K. LOGAN, Westalley, Hitchin, Herts. [0233

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 124. [0016

RESPONSER, No. 3118A (less 5Z4G), 64/-; RF.27, less dial, 25/-; control unit No. 227, 4/-; No. 223, 5/-; all post free.—Annakin, 25, Ashfield Place, Otley, Yorks. [1124

A high vacuum impregnation unit to R.I.C. specification 214 or individual requirements; good delivery at competitive prices from Vactite Components and Assemblies, 505, Lordship Lane, S.E.22. Forest Hill 7089. [0310

MIDGET portable radios, AC/DC two wave, completely self contained, cream or brown plastic; work anywhere without external aerial, giving good quality and volume; full maker's guarantee; £6/9/6; battery ditto, all dry, inc. batts.; £6/9/6; trade enquiries invited.—Radio Facilities, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [1065

MULLARD 16in wide angle tube, new and unused, manufacturer's guarantee; Bush, focus unit and deflection yoke and E.H.T. unit, cabinet for same; also Garrard 201 B2, mounted in sycamore well with Garrard arm and Decca P.U.s, both heads, all brand new and unused; offers.—Howell, 56, Apsley Rd., Kingsway, B/ham. 32. [1024

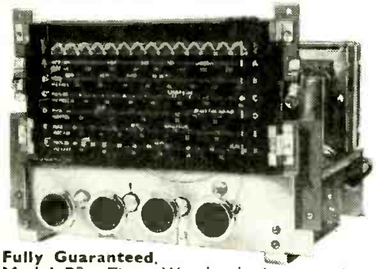
RADIO UNLIMITED, Elm Rd., London, E17, offer mns trans, 350-0-350, 6v, 5v, 4v, 4v, 80 MA 17/6, 250-0-250, 6v, 5v, 60 MA 17/6; fil trans 210-240v, 6.3v at 1.5A, 5/9; 500vw elecs, card/tub, 8mfd 2/-, 16mfd 2/9, 8×16 4/-, 32mfd 4/-, 450vw special; BEC 8mfd, midget can 1/6; 16×16 3/9, 32×32 4/6; 10in P.M. spkrs, 17/6; S.T.C. recs, RM1 3/9, RM2 4/- RM4 17/6 ea.; V/cntrls., 500K, L/sp 1/9 SP/sw 2/6, DP/sw 3/6; T.R.F. I/cored coils, Med/L, W/circ. 5/6 pair; midget I.F. trans 465 Kcs 9/9 pr.; A.C. mains amplifier, 2-valve+rec, complete with valves, brand new, 75/- post free; new list available.—Tel. Key. 4813. [0062

DIRECT FROM THE MANUFACTURER

Dulci Radio/Radiogram Chassis

A/C 100-120 & 200-250 VOLTS.

All chassis 11½in. x 7in. x 8½in. high. Latest type valves 6BE6, 6BA6, 6AT6, 6BW6, 6X4. Flywheel tuning. Negative feedback over entire audio section. Engraved knobs.



Fully Guaranteed.

Model B3. Three Wavebands, Long, Medium, Short. Gram. switching on W/Change switch. 3 Position Tone.
Price, Tax Paid **£12/12/0**

Model B3. Plus Push Pull Stage; as B3 with extra valve 6BW6. Output 6 watt max. Consumption 55 watt.
Price Tax Paid **£15/15/0**

Model B, Six Wavebands 11-115 metres continuous in 5 ranges (4 BANDSPREAD) and MW.185-550 m. Six position Tone Switch (3 radio—3 gram.).
Price Tax Paid **£15/15/0**

Escutcheon for 9in. x 5in. dial, 4/9 extra. Matching speakers P.M. type 3 ohms. 8in. or 10in. available. Chassis sent under money back guarantee conditions against remittance. Free particulars from—

THE DULCI CO. LTD.,
97 VILLIERS Rd., LONDON, N.W.2
Telephone: Willesden 7778

QUALITY TELEVISION COMPONENTS

HR

Scanning Coils
6/10 Kv. R.F. E.H.T. Units
E.H.T. and Output Transformers
Line fly-back E.H.T. Units
SEND FOR ILLUSTRATED LIST (PUBLICATION 75)

HAYNES RADIO Ltd.
Queensway · Enfield · Middlesex

LONDON CENTRAL RADIO STORES

Another fresh consignment of
PHILCO 5-VALVE Reconditioned **SUPERHETS**
— UNIVERSAL MAINS —

All thoroughly overhauled at our works. Ready for immediate use and guaranteed in working order.

2-WAVEBAND MODEL **£4 0 0**
3-WAVEBAND MODEL **£6 10 0**
Plus 10/6 per set carriage and packing.

ELECTRO MAGNETIC COUNTERS
Ex-G.P.O., every one perfect, electro-magnetic, 500 ohm coil, counting to 9,999, operated from 25-v.-50-v. D.C., 4½in. long × 1½ × 1in., many industrial and domestic applications. **15/-.**
Equal to new. Post & pkg. 9d.

10in. GOODMANS P.M. LOUDSPEAKERS. With transformer. Not new but in good working order. Post & pkg. 2/-. **25/-.**

● See previous ads. for other bargains.

N.B.—We do not issue lists or catalogues. Carriage charges relate to British Isles only.

23 LISLE ST. (GERrard 2969) LONDON, W.C.2
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COMPONENTS—SURPLUS AND SECONDHAND

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3. CANDIDATES must also be educationally qualified to proceed to a University.
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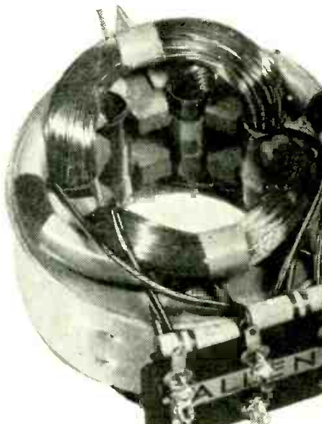

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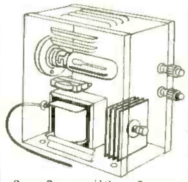

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APPLICATIONS, giving full particulars and containing the names and addresses of not more than three referees, to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. [1125

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APPLICATIONS are invited for the appointment of an electronics technician in the science workshops; some experience of instrument making is required; the appointment will be on a five-year contract in the first instance; salary £800 p.a. plus a gratuity of £100 per annum in lieu of superannuation provision; part furnished residential accommodation at rent of not more than 10 per cent of salary will be provided; family allowance of £50 per child (up to a maximum of £150) if children are resident in the Gold Coast or £100 per child (up to a maximum of £300) if children are resident elsewhere; free first-class passages will be provided for the selected candidate and his family on assumption and relinquishment of the appointment and for annual leave of eight weeks in the United Kingdom; outfit and baggage allowances are paid on first appointment.

THE duties will include the construction, maintenance and repair of electrical equipment, the training of staff and responsibility for electronic components stores.

APPLICATIONS (six copies) with the names of three referees, should be sent to the Assistant Registrar (London) University College of the Gold Coast, 29, Tavistock Square, London, W.C.1, from whom further particulars may be obtained; closing date: 30th June, 1953. [1114

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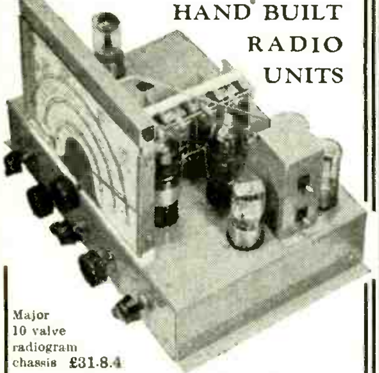

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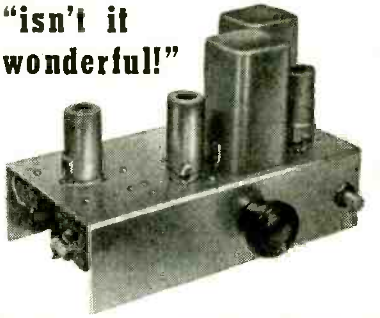

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TECHNICIAN, with experience in electronic work, required for development laboratory in large telecommunication engineering works; give particulars of experience, education and technical training, qualifications and commencing salary required; London S.E. area.—Box 6765. [1019

MESSRS. PYE, Ltd., Cambridge, have vacancies for senior and junior test engineers, also electronic wiremen on very interesting work in their television transmission equipment department.—Apply in writing to Personnel Department, St. Andrew's Rd, Cambridge. [9978

AIRCRAFT Radio Mechanic required, preferably with aircraft radio maintenance engineer's licence but not essential; to be based at White Waltham, nr. Maidenhead; apply in writing giving full particulars to—The Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlx. [9849

EXPERIENCED fault finders wanted by Midland manufacturers of radio equipment, permanent posts located in the Midlands are offered to men with experience of radar, radio control, v.h.f. equipment.—Write, stating fully, experience and salary required, to Personnel Manager, Box 5744. [9792

WIREMEN, skilled, required for high-grade electronic equipment, ability to undertake prototype work from schematic drawings an advantage, first-rate workshop conditions. West London area and pension scheme.—Write, stating age, details experience and present rate.—Box 7138. [1097

GRADUATES in chemistry, physics or electrical engineering, required for very interesting development of new materials for use in telecommunications.—Apply to Personnel Manager, Standard Telephones & Cables, Ltd., North Woolwich, E.16, stating age, qualifications and salary required. [1014

RADIO and radar testers, first-class men required for work on v.h.f. communication gear and Government contracts for radio and radar equipment by Midland manufacturers; men with wide experience of fault finding in any of the fields mentioned should write, giving full details to Box 5743. [9791

ELECTRONIC engineer required to work on development projects in small organisation situated on South Coast; experience on design of communications receivers essential; some F.M. experience an advantage; degree or equivalent desirable; write full details and salary expected.—Box 7011. [1059

SENIOR inspector for electronic equipment, preferably with some mechanical experience, must be capable of handling staff and organising accurate technical records and have sound theoretical knowledge of basic theory and of A.I.D., etc., requirements.—Allied Electronics Ltd., 28, Upper Richmond Rd., Putney, London S.W.15. [1063

SENIOR engineer required to design communications components and electronic apparatus covering all aspects up to production; wide experience and versatile outlook more important than specialization in one particular field.—Write, stating previous posts held, full details of qualifications and experience and salary expected, to Box 6572. [9985

DESIGNER draughtsman; electronic instruments, or radio, good prospects and salary according to qualifications; prospects of housing assistance to suitable applicant; Saturday interviews, if required; near City centre and all amenities; within easy reach London.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [1027

ENGINEER required to undertake the development of electronic instruments; the successful applicant must be capable of working substantially on his own initiative; salary will be in accordance with qualifications and experience; degree or equivalent preferred.—Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., London, E.17. [1131

SENIOR test/service engineers required for industrial electronics department. H.N.C. an advantage, experience in electronic control gear, H.F. heating equipment or instruments preferred.—Please apply, stating age, qualifications and experience, to Central Personnel Services, English Electric Co., Ltd., 336-7, Strand, London, W.C.2, quoting reference 979B. [1022

ELECTRONIC INSTRUMENTS, Ltd., of Richmond, Surrey, have a number of vacancies for drawing office staff and for junior technical development engineers; age, 21 upwards; qualifications, National or Higher National Certificate in appropriate subjects; excellent prospects in expanding and progressive company; apply in person or by letter, giving experience. [1060

ELECTRONIC engineer is required for an interesting development project involving D.C. amplifier, servo and pulse techniques. Applications are invited from young engineers aged 24-30, well educated and qualified to H.N.C. or equivalent. Experience in one or all of the aforementioned techniques would be an advantage.—Write full details to Box 6359. [9932

SITUATIONS VACANT

TEST room foreman, familiar with electrical and acoustical measurements, to take charge of small department manufacturing miniature acoustic devices; permanent position.—Amplivox, Ltd., Mount Pleasant, Wembley, Middx. (Wem. 5906). [1116

TELEVISION tube engineer, must be fully experienced in all aspects of mass production and test of cathode ray tubes, new project not connected with any existing company, Surrey area.—Write giving age and details of experience to Box 7144. [1119

E. K. COLE, Ltd., Electronics Division, Malmesbury, Wiltshire, require Draughtsmen (mechanical or electrical of National Certificate Standard), aged 21 to 25 years, for interesting and varied work on radar and communication equipments, also for test gear, excellent conditions and prospects.—Apply, in writing, to Personnel Manager. [1099

A DESIGNER is required to organize and control a section engaged on the design and specification of electrical and electronic equipment intended for production testing in a valve and cathode-ray tube factory; this work involves familiarity with a wide range of techniques including pulse, R.F., E.H.T., circuits and automatic switching systems.

IT is desirable that he shall have Graduate or equivalent status and essential that he can claim considerable practical experience in this or closely allied fields.—Write, giving full particulars of experience, etc., to Box 7075. [1079

THE De Havilland Engine Co., Ltd.—Electronic engineer required, interested in physical measurement rather than construction of apparatus, required for vibration measurement and analysis on gas turbine and piston engines.—Please write in confidence, stating age and full details of previous experience to the Personnel Officer, The de Havilland Engine Co., Ltd., Stag Lane, Edgware, Middlesex. [9951

DECCA RADAR, Ltd., invites applications from young scientists and engineers due to graduate this year, and who expect to get good Honours degrees. The posts offer interesting and well-paid careers in radar engineering for young men who are prepared to work hard. British nationality essential.—Write, quoting ref. CPH, to Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [0243

OPPORTUNITY exists for a transformer design engineer to create and manage a department to manufacture small transformers for specialized applications (such as "C" core); applicants should have the requisite mechanical as well as electrical knowledge with ability to train production staff.—Send full details of previous experience and salary required to Box 6574. [9987

DESIGN Engineer with a good degree and sound industrial experience required for design of television circuits and associated components; sound technical experience and ability to work on own initiative; permanent and pensionable staff appointment.—Please write, in confidence, quoting reference WW/Z, giving details of experience and salary required to Box 7077. [1081

SECTION leader required to develop and administer a section concerned with the electrical measurement of magnetic and resistance materials of a factory shortly moving to Crawley; candidates should be graduates in electrical engineering or hold equivalent professional qualifications; experience in measurement work desirable but not essential.—Apply Box 6971. [1052

DEVELOPMENT engineer required; experience in electronic communication field an advantage; excellent opportunity for man with technical and industrial experience to broaden experience with well-established and well-known company; near town centre and all amenities and within easy reach London.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [1028

DESIGN engineer with a good degree and sound industrial experience required for design of television circuits and associated components; sound technical experience and ability to work on own initiative; permanent and pensionable staff appointment.—Please write, in confidence, quoting reference WW/16, giving details of experience and salary required, to Box 6528. [9980

TELEVISION engineer, conversant with T/V theory, testing methods and test equipment, able to organize and handle all servicing needs of large rental organization in London; post offers permanency and prospects, attractive remuneration to man of integrity and drive.—Application (fully confidential), to Telefusion, Ltd., 69, Southwark Park Rd., Bermondsey, S.E.16. [1111

OIL prospecting; young electronic engineers, with Higher National or C. & G. Certificate and with some knowledge of physics, required to train for positions with seismic oil prospecting parties overseas; commencing salary £45 per month; free quarters and messing provided whilst overseas plus allowances depending upon area of operations; permanent career open.—Write Box 6275. [9989

EXPERIENCED engineer required to take control of and expand a vitreous enamelled wire-wound resistor project; applicants should be completely familiar with all design and production problems of this class of work, including the training of staff; an opportunity with top level potentialities for the right man.—Please write in confidence, stating the fullest particulars, to Box 6573. [9986

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THE ENGLISH ELECTRIC Co., Ltd., Luton, have vacancies for electronic engineers for work in Australia on V.H.F. sub-miniature equipment with trials applications; assistance with housing will be provided.—Applications, stating age, experience and qualifications, should be sent to Central Personnel Services, 336-7, Strand, London, W.C.2, quoting ref. 456. [1135

RECORDING studios specializing in the production of commercial discs and radio programmes require the services of an experienced balance engineer who is fully conversant with disc and tape recording techniques; a good technical knowledge of the equipment used in this type of work is essential.—Applications in writing, giving age, experience and salary required, to Box 7167. [1126

INSPECTION supervisors required by a large engineering company situated in the London area; applicants should have held a similar position and have previous experience of radar and/or radio equipment; a knowledge of pulse circuitry essential; modern factory and good staff conditions; please write, in confidence, quoting reference WW/IP, giving full details of experience to—Box 7014. [1062

SCIENTIFIC instrument makers in North London have a few vacancies for skilled laboratory assistants and wire-men for the development and production of high quality electrical and electronic apparatus.—Please apply, in writing only, stating qualifications, experience and salary required, to Personnel Officer, Hilger and Watts, Ltd., Hilger Division, 98, St. Pancras Way, London, N.W.1. [9990

YOUNG Engineers with some experience in television design and development are required for this type of work by a well-known company in the North-west of England; ability to initiate and carry out development projects and a University degree or equivalent are the essential qualifications; arrangements will be made to house the successful applicant.—Apply, quoting reference C.I.H., to Box 7101. [1088

THE National Institute for Medical Research, The Ridgeway, Mill Hill, N.W.7, requires a Junior Asst. for instrument lab., G.C.E. or equiv., an interest in Physics essential; experience of the production of experimental apparatus and some knowledge of electronics are desirable (age 23 or under). Est. superann. post after probationary period.—Apply in writing to Admin. Officer (Quote ref. AD/23). [1113

TRANSFORMER engineers required by large light engineering company situated in the London area, applicants must be fully conversant with the design of all types of transformers (up to 500 VA rating) associated with radio, electronics and telecommunications equipment, progressive and permanent appointment.—Please write in confidence, giving details of experience and quoting reference WW/20, to Box 6638. [1001

THE ENGLISH ELECTRIC Co., Ltd., Luton, have vacancies for electronic engineers for development work on V.H.F. radio sub-miniature equipment and/or recording techniques; some field trials engineers and assistants also required.—Applications, stating age, experience and qualifications, and quoting ref. 456L, should be sent to Central Personnel Services, English Electric Co., Ltd., 336/7, Strand, London, W.C.2. [9930

RADIO Engineer required immediately for Aden Refinery Project, candidates must be experienced in maintenance of single-channel duplex V.H.F. radio systems, single man preferred, attractive salary and allowances. Apply, in writing, giving complete details of previous experience, to J. E. Gill, George Wimpey & Co., Ltd., Beaufort House, Gravel Lane, Houndsditch, London, E.C.1. [1096

ELECTRONIC circuit and development engineers are required by the English Electric Co., Ltd., for interesting work on H.F. heating generators; a university degree is desirable but practical experience of this type of work or on radio transmitters or similar apparatus is essential.—Write with full details, quoting reference 357F, to Central Personnel Services, English Electric Co., Ltd., 336-7, Strand, London, W.C.2. [1023

TRANSFORMER Engineers required by large light engineering company situated in the London area; applicants must be fully conversant with the design of all types of transformers (up to 500 VA rating) associated with radio, electronics and telecommunications equipment; progressive and permanent appointment.—Please write, in confidence, quoting reference WW/TE, giving details of experience, to Box 7078. [1082

ROOTES group distributors and Radiomobile accredited dealers in Harrogate require mechanic to instal and repair car radios in new and used vehicles; applicants must be prepared to attend H.M.V. course and conform to Radiomobile standards; personality and appearance important as successful applicant will be responsible for developing the department private customers; full details on application by letter for interview to:—HOWDENS of Harrogate, Ltd., Kings Rd., Harrogate. [9976

ASSISTANT transformer designer is required by progressive electrical manufacturers, specialised experience in audio and small power transformers, sound electrical training and good general knowledge of physics essential, permanent position arises through expansion of development and research facilities, salary commensurate with experience and ability.—Apply, with full details of age, experience and salary required, to Box 6769. [1021

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EXPERIENCED TV engineer required, permanent position, good salary and prospects with pension scheme available, able to drive.—Jakens, Ltd., Seaford, Sussex. [1033

SENIOR and Junior Development Engineers required for responsible work in radio and television development laboratories. Applicants for senior position should be able to undertake development work with minimum supervision. Excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British nationality. [9713

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radio-telegraphy. Selected candidates will be considered later for permanent pensionable posts.—Application should be made to any local office of the Ministry of Labour and National Service, quoting Order No. City 4728. [9721

SALES manager required by well established organisation distributing radio and electrical components to the wholesale and retail trades: applicants must have extensive knowledge of same, and be sufficiently experienced to organise, supervise and expand existing sales force which will entail travelling throughout the country; this position offers unlimited scope to a first-class man whose ultimate remuneration will be in accordance with results.—Box 6739. [1018

TEST and junior development engineers are required to assist in the development and production of precision electronic laboratory instruments; applicants should have a sound theoretical knowledge and have had substantial practical experience of measuring instrument circuits: salary in the region of £450-£650 p.a., according to qualifications and experience.—Apply, stating full details, to the Chief Engineer, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [0244

ELECTRONIC and television engineer required, with sound technical qualifications, suitable design and practical experience, to take charge of small development unit (due for expansion) in London, producing specialized equipment for H.F. wide band line and/or space transmission systems; the post offers opportunities for initiative and progress with generous remuneration.—Replies (fully confidential), Telefusion, Ltd., 69, Southwark Park Rd., Bermondsey, S.E.16. [1112

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [0198

ELECTRICAL engineer or physicist, preferably with experience in high frequency measurements, required for industrial laboratory in West Midlands dealing with insulation and dielectrics: candidates should have a University Degree or equivalent and be between 24 and 30 years of age; the post is a pensionable and permanent one and carries a maximum salary of £1,100 in the case of a well qualified and experienced applicant.—Write to Assistant Staff Manager, Box 7049. [1070

MULLARD Research Laboratories require experienced wiremen for interesting work on electronic equipment; applicants must be able to work from theoretical wiring diagrams; high frequency wiring experience with a knowledge of components assembly preferred; staff conditions of employment; salary according to age and experience. 5-day week; pension scheme.—Apply, Mr. G. A. Taylor, Mullard Research Laboratories, Cross Oak Lane, Salfords, Nr. Redhill, Surrey. [9920

INSPECTION superintendent wanted by a firm making electrical and mechanical components for the communications industry: to supervise inspection through all stages of manufacture for a variety of components; also to supervise the test laboratories; previous experience in control of staff as well as technical training in light electrical engineering is essential; salary between £500 and £650 per annum, subject to qualifications.—Apply Painton & Co., Kingsthorpe, Northampton. [9908

LARGE engineering company situated in the London area invites applications from senior design engineers with experience of design and development of variable condensers; the appointment is concerned with important defence projects and long-term private venture development work and is permanent and pensionable; this is a first-class opportunity and a very adequate salary is available.—Write, quoting reference WW/97, giving details of qualifications and experience, to Box 6640. [1003

LONDON ELECTRICAL MANUFACTURING Co., Ltd., require Senior Production Engineers with theoretical and/or practical knowledge, applicants should have had experience in the industry, preferably with components, preference and considerably higher salaries would be offered to men who have been engaged in the production of ceramic condensers.—Please write, giving full particulars, in confidence, to L.E.M., Beavor Lane, W.6, or tel. Riverside 4824, asking for Mr. Lyons. [1076

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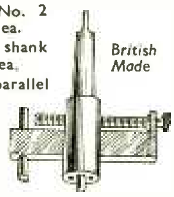

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BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials: applicants must be graduates of the I.E.E. or possess equivalent qualifications, together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [0230

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MECHANICAL design engineer required with experience of design and development of vibrators and/or valve holders, switches and panel accessories; applicants should be capable of sponsoring new components from specifications to production stage, degree or equivalent and a good industrial background; this appointment is of a permanent nature and calls for an engineer with sufficient experience and ability to justify a good salary.—Please write, quoting reference WW/67, stating qualifications and experience, to Box 6639. [1002

SENIOR mechanical designer: two or three vacancies exist in our electronics division for senior design draughtsman on electronic equipment: candidates should be of at least Higher National Certificate standard and should be capable of leading a design team in this class of work; salary £650 per annum upwards according to qualifications and experience: applications should include full details of experience to date and may be forwarded in confidence to the Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9883

MECHANICAL design engineer required with experience of design and development of vibrators and/or valve holders, switches and panel accessories: applicants should be capable of sponsoring new components from specifications to production stage; degree or equivalent and a good industrial background; this appointment is of a permanent nature and calls for an engineer with sufficient experience and ability to justify a good salary; please write, quoting reference WW/35, stating qualifications and experience to—Box 7013. [1061

DECCA RADAR, Ltd., require draughtsmen and junior draughtsmen for research drawing office, preferably experienced in any of the following fields: radar, radio and electronic circuits, electro-mechanical devices, light mechanical engineering; knowledge of workshop practice essential. Applicants must possess Ordinary National Certificate or equivalent, positions permanent and progressive: salaries based on A.E.S.D. rates.—Write, giving full details, to Chief Draughtsman, Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [0240

DRAUGHTSMEN: The English Electric Co., Ltd., have vacancies at their Liverpool works for electrical draughtsmen with good experience in the layout of power installations, wiring diagrams and switchgear; pensionable and progressive positions with excellent opportunities for promotion are offered to men with initiative; housing assistance for successful applicants and travelling expenses for interview will be paid.—Write, giving full details of age, qualifications and experience, quoting ref. 140B, to Central Personnel Services, Marconi House, 336-7, Strand, London, W.C.2. [9984

THE GENERAL ELECTRIC CO., LTD., Brown's Lane, Coventry, requires Senior and Junior Electronic Development Engineers for work on Guided Weapons and like projects, particularly in the field of Microwave and Pulse Applications; Mechanical Development Engineers, Designer Draughtsmen and Draughtsmen, preferably with experience of radar type equipments, also required for the above projects; salary according to age, qualifications and experience; houses available to selected senior staff.—Apply by letter stating age and experience to the Personnel Manager (Ref. R.G.). [0259

MURPHY RADIO, Ltd., have vacancies for two or three senior engineers to lead development teams in their electronics division: applications are invited from men with engineering or physics degrees or equivalent, and with first-class experience in the fields of Radar navigational aids, V.H.F. communications receivers and low-power transmitters: salary upwards of £650 per annum according to qualifications and experience: candidates prepared to bring energy and drive to their work may address their applications in confidence to the Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9884

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DEVELOPMENT engineers required in the radio component laboratory of The Plessey Co., Ltd.; applicants for these positions should preferably have a degree in engineering or physics, or Higher National Certificate, and should have experience in the development of light electro-mechanical devices; the appointments carry the right of entry into the company's pension fund and life assurance scheme after a probationary period, and offer excellent opportunities for promotion.—Applications, quoting reference WW/51, should be made in writing, stating full details, to the Personnel Manager, The Plessey Co., Ltd., Ilford, Essex. [9981

DRAUGHTSMEN (Electrical) required by Ministry of Supply, Chessington, Surrey, quals. O.N.C. or equivalent, at least three years' workshop experience and knowledge of radar and communication circuits, or aircraft electrical installations, wiring systems and electrical instruments, starting pay, £385 (age 21)—£533, rising to £612. 44-hour week (including meal breaks) with payment for overtime, paid sick leave, 24 days' annual holiday in addition to public holidays.—Write, giving full details of age, quals. and experience, to Employment Exchange, Kingston-on-Thames, quoting Order No. 1103. [1095

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ADMIRALTY invites applications for Experimental Officer or Assistant Experimental Officer vacancy at Royal Greenwich Observatory, Herstmonceux, Sussex, for recording of cosmic ray intensity and development of photo-electric instruments; appointment unestablished, but opportunities occur for establishment through open competition; starting salary depending upon age and experience within ranges E.O. £597-£755 (men); £502-£623 (women); A.E.O. £264-£555 (£467 women); candidates must be British at least 17½ years of age, and should possess at least H.N.C. or equivalent with some experience of modern electronics development work and circuit design; application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting A101/53/A. Closing date June 20th, 1953. [1106

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