



**£60**

# Here is a VALVE TESTER

**with  
sufficient scope  
for YOUR  
requirements!**

**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.

*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.

*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.

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*  
**Valve  
CHARACTERISTIC  
Meter**



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

VC.5

# PLASTIC MOULDINGS

FOR THE  
**ELECTRONIC**  
AND  
ALLIED INDUSTRIES



- FULLY A.I.D. APPROVED FOR DEFENCE PROGRAMME REQUIREMENTS.
- AMPLE CAPACITY AVAILABLE FOR ALL COMPRESSION MOULDINGS, UP TO 250 TON PRESSES, AND SMALL PRECISION MOULDINGS IN THERMOPLASTICS.
- SPECIAL GRADE MOULDINGS IN MELAMINE AND NYLON-FILLED PHENOL.
- PROMPT ATTENTION TO ALL ENQUIRIES.
- GOOD, RELIABLE DELIVERY, AND FIRST-RATE QUALITY IN PRODUCTION.
- A REPRESENTATIVE WILL CALL, IF DESIRED.



INSET PHOTOGRAPH  
ABOVE

*Introducing...*

PLEASE WRITE FOR  
FULL DETAILS

THE **VISCOSE** RANGE OF **INSTRUMENT CONTROL KNOBS**  
SKIRTED AND UNSKIRTED, IN TWO SIZES, AT EXTREMELY KEEN PRICES

**VISCOSE DEVELOPMENT COMPANY LIMITED**  
WOLDHAM ROAD, BROMLEY, KENT.      RAVENSBORNE 2641

ACTUAL SIZE

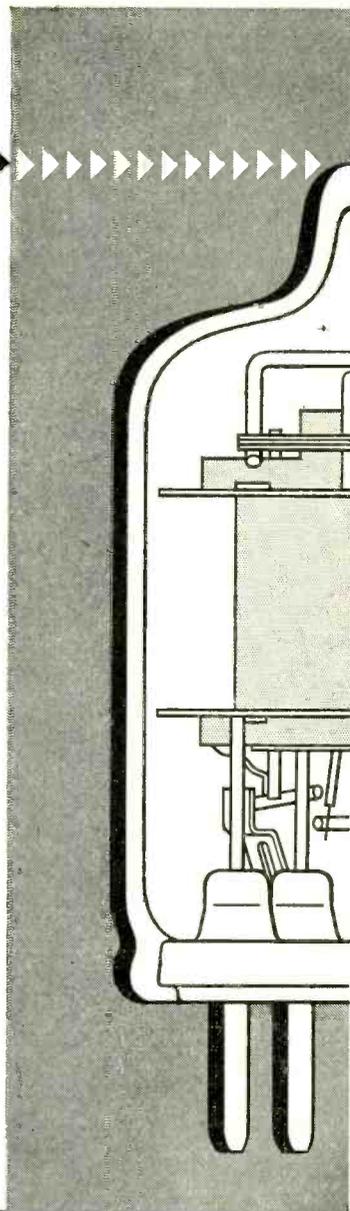


# EF95

## 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.



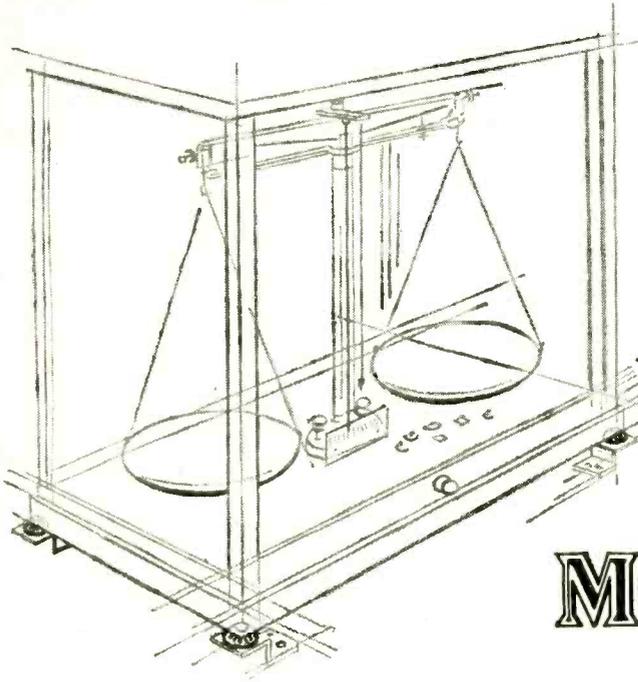
HEATER		TECHNICAL DATA		LIMITING VALUES	
$V_h$	- 6.3V	<b>CHARACTERISTICS</b>		$V_a$ max.	- 180 V
$I_h$	- 0.175 A	$V_a$	- 180 V	$p_a$ max.	- 1.7 W
<b>CAPACITANCES</b>		$V_{g2}$	- 120 V	$V_{g2}$ max.	- 140 V
$c_{in}$	- 4.0 $\mu\mu\text{F}$	$V_{gt}$	- -2.0 V	$p_{g2}$ max.	- 0.8 W
$c_{out}$	- 2.8 $\mu\mu\text{F}$	$I_a$	- 7.7 mA	$I_k$ max.	- 18 mA
$c_{a-gl}$	- 0.02 $\mu\mu\text{F}$	$I_{g2}$	- 2.4 mA		
		$g_m$	- 5.1 mA/V		
		$r_a$	- 690 $K\Omega$		

BASE B7G



## APPLICATION 95

### SERIES 38



*Yet another  
application of a*

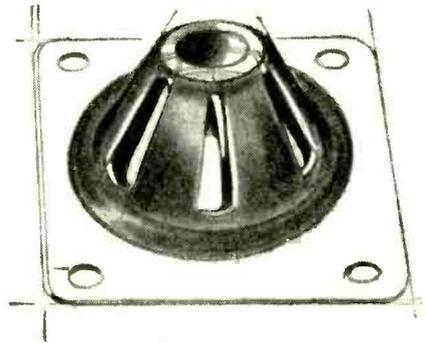
**"FLEXILANT"**

## MOUNTINGS

### SERIES 38

*IN this instance the Series 38 "Flexilant" Mounting protects a delicate instrument from vibration and shock. Other applications are manifold — from aircraft to power-station instrument panels; from ship's instruments to the protection of pyrometers in a steel works.*

*We produce a range of components that absorb vibration; eliminate noise; suppress shock. Our new catalogue lists all these for you.*



## RUBBER BONDERS LIMITED

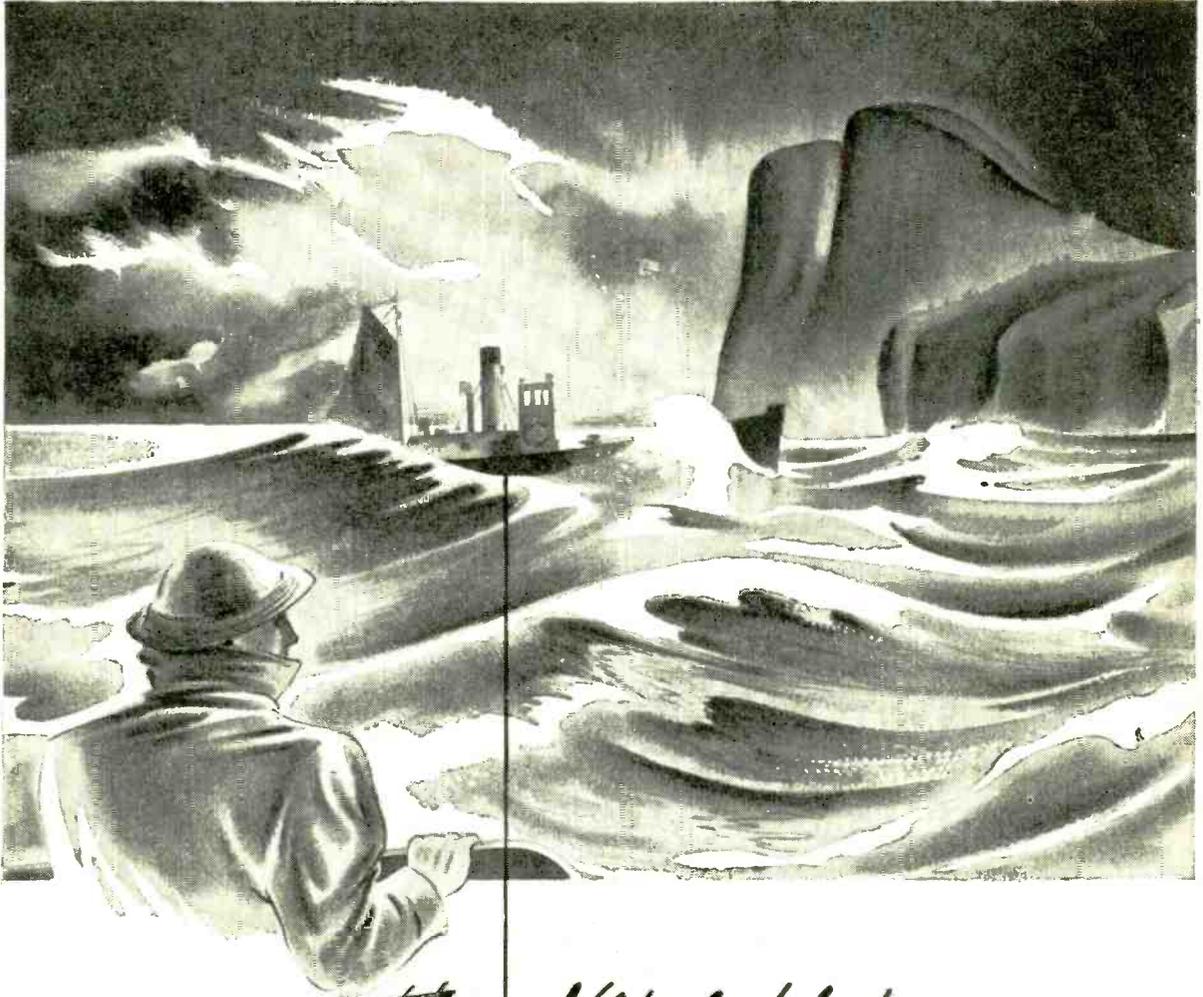
IN ASSOCIATION WITH EMPIRE RUBBER COMPANY (Proprietors: H. G. MILES LTD.)

**DUNSTABLE . . . BEDFORDSHIRE**

TELEPHONE: DUNSTABLE 533-536 (4 LINES) TELEGRAMS: SPANDIT. DUNSTABLE



R.B. 65



## 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 booklets 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



present

# THEIR LATEST DEVELOPMENTS IN CONDENSERS...

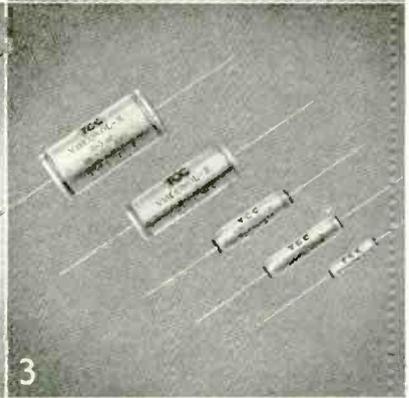
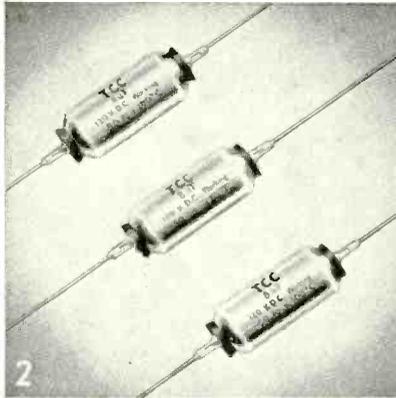


FOR the benefit of those who were unable to visit the recent R.E.C.M.F. Exhibition, and for those who had not the time available to inspect our Stand in detail, we illustrate here the range of T.C.C. latest developments displayed thereon.

These are indicative of the progress which is constantly being maintained, and which ensures that "T.C.C. Leadership in Condensers" is a tangible reality.

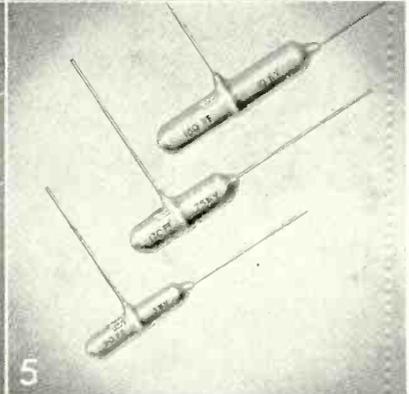
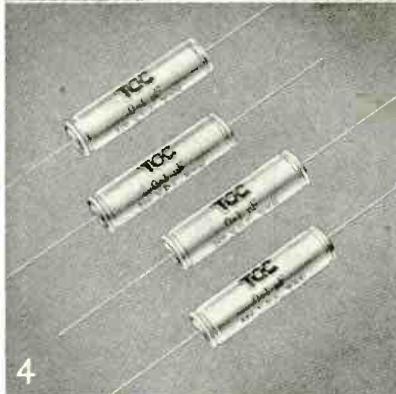
## 1. SMALL CAPACITY CLOSE TOLERANCE TUBULAR CERAMICS

For top end coupling in Band Pass Filters. Capacity range 0.5 pF to 5 pF at 500 v. D.C. Tolerances  $\pm 20\%$  and  $\pm 10\%$ .



## 2. TANTALUM ELECTROLYTICS

The special neutral electrolyte prevents corrosive injury in the event of mechanical damage. These 8  $\mu$ F condensers are for working voltages up to 120 v D.C. and for temperatures up to 120°C.

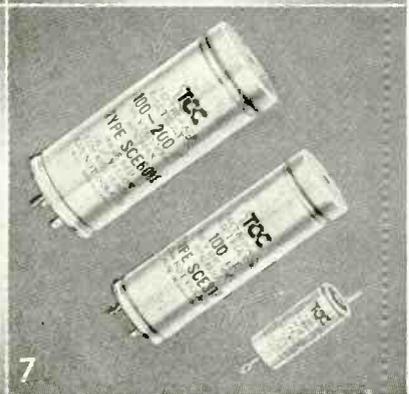
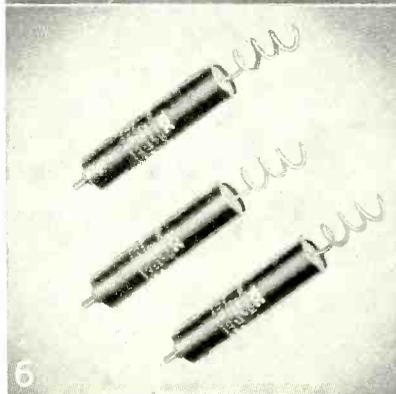


## 3. "METALPACK" & "METALMITE" PAPER TUBULARS IMPREGNATED in "VISCONOL-X"

New impregnant improves reliability at 100°C. Full Ministry Type Approval (R.C.S.131 Cat.A.H2) has been granted.

## 4. "METALPACK" PAPER TUBULARS with CERAMIC END SEALS

New external construction gives complete protection against moisture in 100% humidity at 100°C.



## 5. H.V. TUBULAR CERAMICS

For Pulse Feeders in Radar equipment and Line Time bases in T.V. receivers. Ranges available for 1 kV. to 10 kV. D.C. working. Capacities from 10 to 620 pF.

## 6. HIGH VOLTAGE PAPER SMOOTHING CONDENSERS TYPE C.P. 561

For 25 kV. E.H.T. smoothing in large screen T.V. receivers. Absence of metal at "hot end" prevents corona losses.

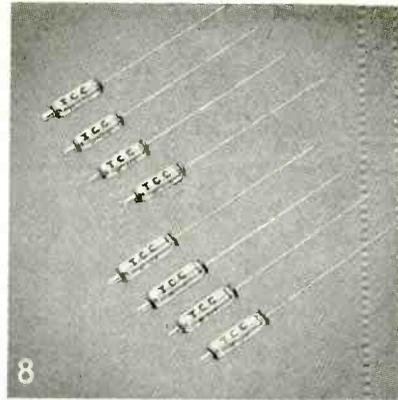
## 7. HIGH TEMPERATURE ELECTROLYTICS

Ability to work at 85°C. without voltage de-rating. Characteristics low leakage current and high ripple rating.

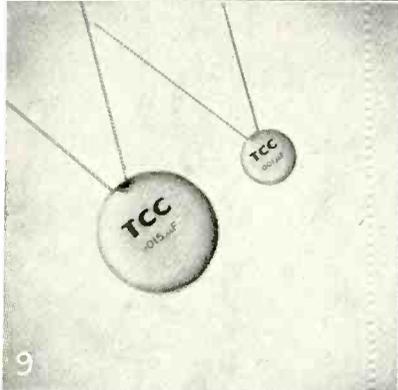
THE TELEGRAPH CONDENSER COMPANY LIMITED

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

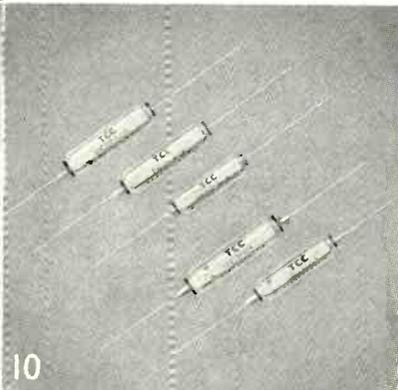
... as shown at  
 the **R.E.C.M.F.**  
**EXHIBITION**  
**IN LONDON . . .**



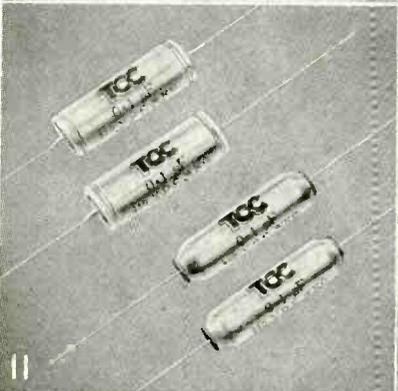
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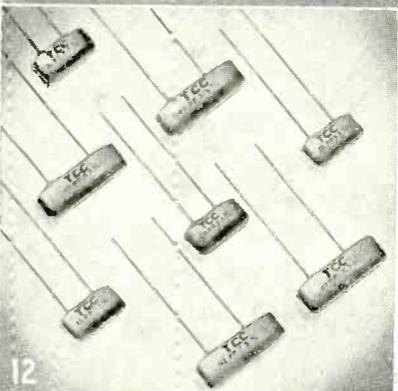
9



10



11



12



13



14

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  $\mu$ F for 3 v. D.C. working and 8  $\mu$ F 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  $\mu$ F to .02  $\mu$ F.

**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  $\mu$ F 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—8  $\mu$ F. 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**

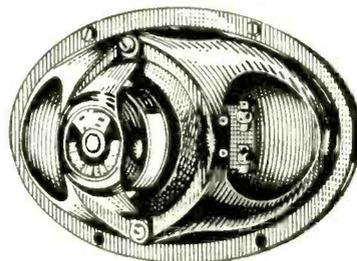
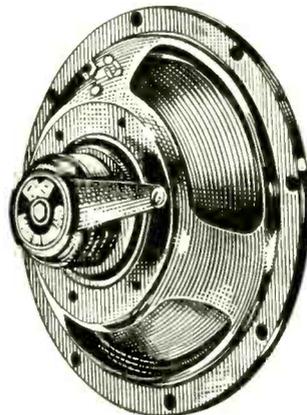
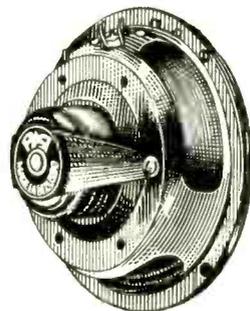
For Tuned Filters in Carrier Telephony equipment and Reference Standards. Exceptionally stable capacity, better than 0.1%. Tolerances  $\pm \frac{1}{8}\%$ .

**THE TELEGRAPH CONDENSER COMPANY LIMITED**

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

**WE PRESENT** another advance in our new Series 800, Mark II Reproducers. Skilful design of the magnet system enables us to provide increased sensitivity in the three most popular sizes—5in., 6½in. and 7 x 4in. elliptical—with a negligible increase in overall depth.

Designers of sets in which bulk, weight and cost are important factors are invited to ask for samples of the 10,000 Gauss versions of Types 850, 865 and 874. These will gladly be supplied, together with full technical information.




---

**R & A**

*Loud-speaker  
Manufacturers  
to the radio industry  
since 1930*

**REPRODUCERS AND AMPLIFIERS LIMITED  
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# ★ A NEW, BETTER TV TUNER!



## PERFORMANCE

### **GAIN**

Power gain of the unit is 24dB, measured from the aerial input to the I.F. output, the mixer anode load for measurement purposes being 1k/ohm shunted by 12pF. As a practical example, using a two valve transformer-coupled amplifier with a bandwidth of 2.75 Mc/s (including sound rejector circuits) an aerial input of 25 microvolts modulated 100% produces 2 volts p.p. across the diode load.

### **NOISE**

Noise figure on all channels better than 10.5dB.

### **I.F. REJECTION**

Better than 45dB, on all channels at any spot frequency in the I.F. channel.

### **IMAGE REJECTION**

Better than 60dB, on all channels.

### **OSCILLATOR DRIFT**

Measured on channel 5, with stable H.T. supply, for a period of two hours after a warming-up period of two minutes, ambient temperature increased from 18°C to 60°C, total drift 30Kc/s. Drift, with change in H.T. supply from 160 volts to 230 volts, less than 10Kc/s.

### **SWITCH RESETABILITY**

Better than 5Kc/s on all channels.

### **POWER REQUIREMENTS**

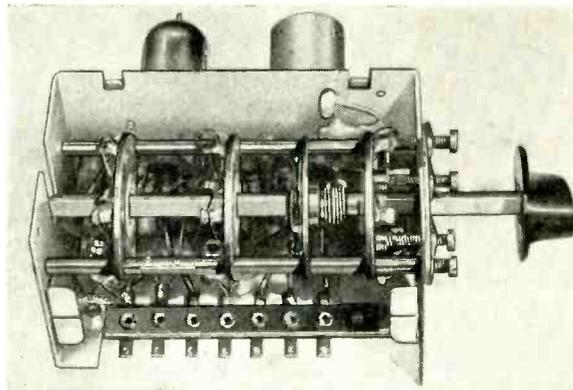
180V. 12.6V. at .3 amps. Heaters are series connected with both ends isolated from chassis.

# "Cyldon"

## 5-Channel, Switched TELETUNER Type TV.5

INSTANT and POSITIVE SELECTION by single knob control of any one of the five B.B.C. Television channels is the job for which we designed this new "Cyldon" Switched Teletuner. It was the centre of great interest at the recent R.E.C.M.F. Exhibition, and we are pleased and proud to present these further details.

The "Cyldon" TV.5 Teletuner comprises a pentode R.F. amplifier stage and a double triode frequency changer, channel selection being accomplished by the switching of incremental inductances. More constant performance over the television band is thus obtained by avoiding the tracking difficulties inherent in the infinitely variable type of tuner. Ease of handling by the user and rapid conversion as alternative transmissions become available are further important advantages of this unit.



Underside view of "Cyldon" TV.5 Teletuner, with casing removed.

Another new "Cyldon" Teletuner . . . Type TV.12, a 12-channel Tuner which performs the functions of RF amplifier and frequency changer of a television receiver. Write for booklet TV.1953 giving full details.

**SYDNEY S. BIRD  
& SONS, LTD.**

*Contractors to Ministry of Supply, Post Office, and other H.M. Government Depts*

CAMBRIDGE ARTERIAL ROAD · ENFIELD · MIDDX. Enfield 2071-2

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 100  $\mu$ F in 18 ranges.

Resistance range — 1  $\Omega$  to 10,000 M $\Omega$  in 18 ranges.

Ranges increase in alternate decimal multiples of 3 and 10.

Frequency 1592 c/s ( $\omega = 10,000$ ).

Accuracy  $\pm 1.0\%$  of full scale on all ranges.

Full technical details are available on request.



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A Company within the J. Arthur Rank Organisation

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*A truly revolutionary*  
**A CAR AERIAL** *that can be*

**completely fitted  
 FROM THE OUTSIDE  
 and READY FOR USE  
 IN FIVE MINUTES!**

The **“AUTEX”**

Here is revolution in car aerial design—a ONE hole fixing aerial that can be completely installed FROM THE OUTSIDE. No longer is it necessary to manoeuvre under the scuttle or dashboard and to work “by feel.” Thanks to the use of a special split washer device, in conjunction with a positioning sleeve, the aerial is self-locating, and is firmly secured FROM THE OUTSIDE. It can be mounted vertically or horizontally (or at any angle in between) in any convenient position on the car—on either a flat or curved surface, such as the bonnet, scuttle, roof or mudguard.

**NO ASSEMBLING—  
 WIRED COMPLETE  
 FOR IMMEDIATE  
 INSTALLATION**

*And in position* it is entirely free from rattle—due to the special packing glands which also ensure the smooth action of the telescopic rod. This aerial has that high-signal pick-up and electrical efficiency always associated with every Antiference Aerial.

**MODEL TCA/6236** with mounting assembly of sturdy die-cast metal; three section telescopic rod (extended 62 in., closed 24 in.) of high-grade brass. All exposed parts heavily chromium plated and with fully weatherproofed connections. Complete with 36 in. low-loss co-axial polythene insulated P.V.C. covered cable, fitted with standard co-axial plug.

LIST PRICE **35/-**

**MODEL TCA/6260** as above but with 60 in. cable.

LIST PRICE **37/6**

Full details are given in leaflet No. NI/W, available on request.

**ANTIFERENCE**  
*Aerials*

**ANTIFERENCE LIMITED, BICESTER ROAD, AYLESBURY, BUCKS.  
 67 BRYANSTON STREET, LONDON, W.1.**

# FOR HIGH-FREQUENCY INSULATION

specify

## 'FREQUELEX'

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.

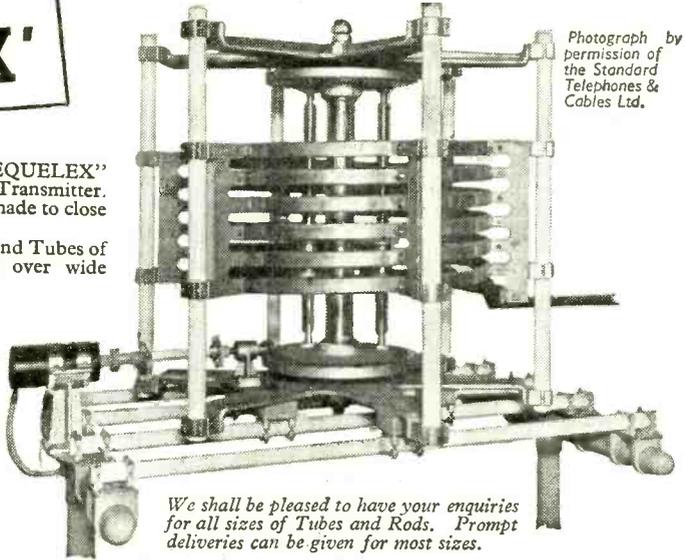
We specialise in the manufacture of Ceramic Rods and Tubes of various sections in several classes of materials over wide dimensional ranges.

The Principal Materials are :—

1. Porcelain for general insulation.
2. Frequelex for High Frequency insulation.
3. Permalax 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 1½" square are used as supports for Tuning Coils, etc.



Photograph by permission of the Standard Telephones & Cables Ltd.

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

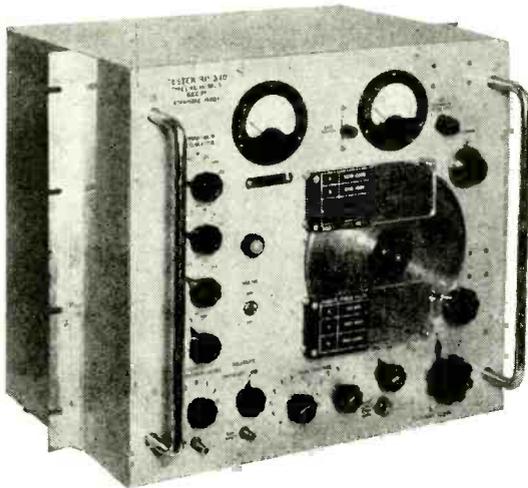


## Bullers LOW LOSS CERAMICS

BULLERS LIMITED, 6 Laurence Pountney Hill, E.C.4.

Phone: MANsion House 9971 (3 lines) Grams: Bullers, Cannon, London

BL4B



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

## SELECTIVE 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.

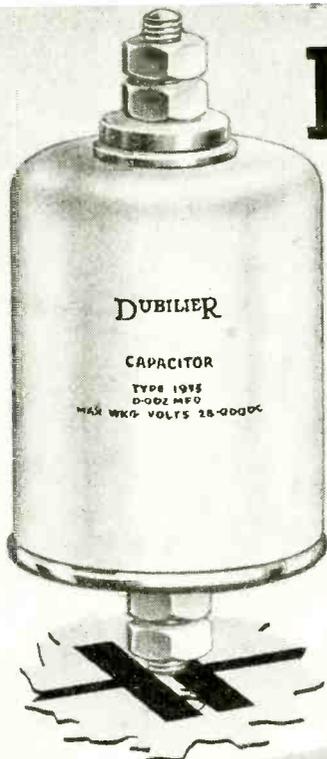
Calibration accuracy: below 0.2% or 2 Kc/s whichever is the greater.

# BRITISH COMMUNICATIONS CORPORATION LTD.

SECOND WAY, EXHIBITION GROUNDS, WEMBLEY, MIDDX.

Telephone: WEMBLEY 1212

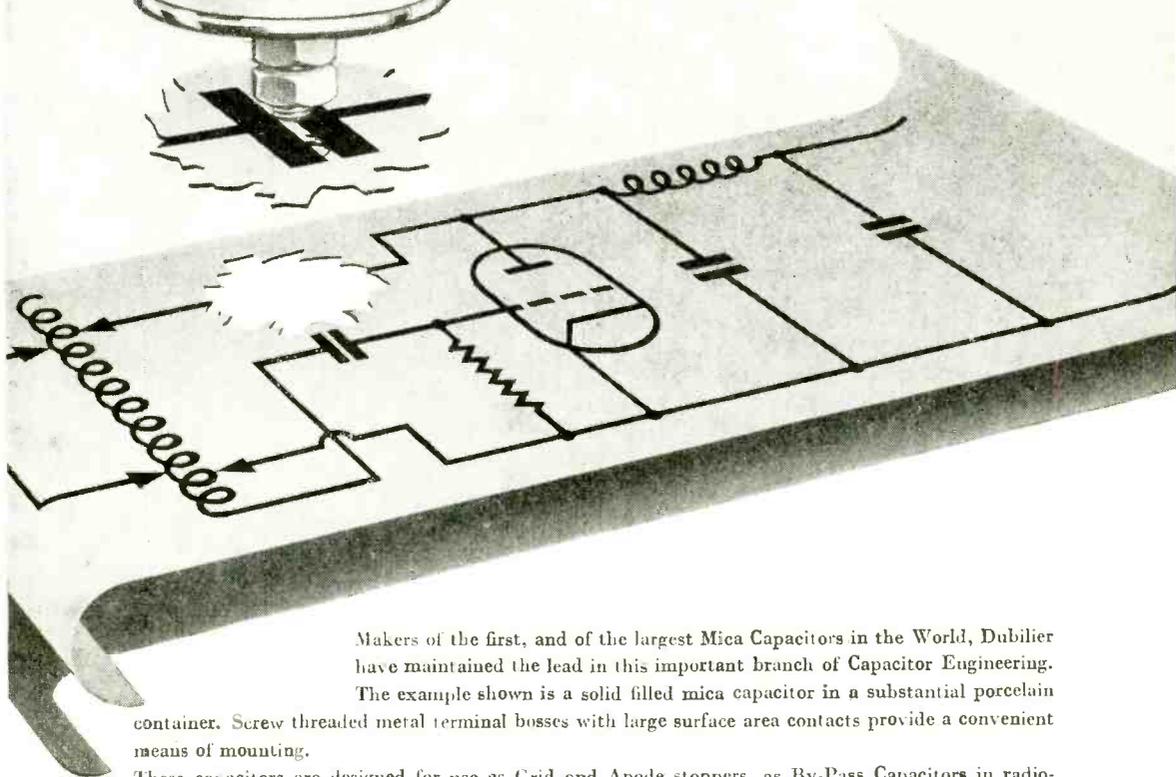
Cables: BEECEEE, WEMBLEY



# DUBILIER

## MICA DIELECTRIC CAPACITORS

*Eminently suitable for H.F. Transmitting and R.F. Heating Circuits.*



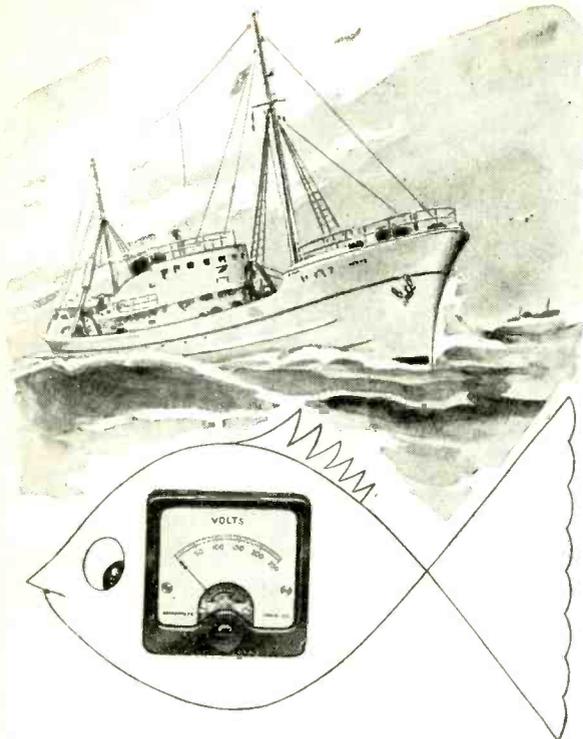
Makers of the first, and of the largest Mica Capacitors in the World, Dubilier have maintained the lead in this important branch of Capacitor Engineering. The example shown is a solid filled mica capacitor in a substantial porcelain container. Screw threaded metal terminal bosses with large surface area contacts provide a convenient means of mounting.

These capacitors are designed for use as Grid and Anode stoppers, as By-Pass Capacitors in radio-frequency power circuits where a small radio-frequency component is superimposed upon a higher D.C. or low-frequency A.C. voltage, and in oscillatory circuit positions in low power radio-frequency transmitters and similar equipment.

*Full details of these and other outstanding Capacitors are available upon application.*

# DUBILIER CAPACITORS

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA RD., N. ACTON, LONDON, W.3.  
 Phone: Acorn 2241 (5 lines). Grams: Hivoltcon, Wesphone, London. Cables: Hivoltcon, London, Marconi International Code



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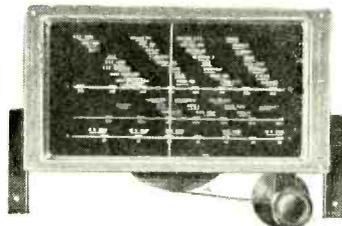


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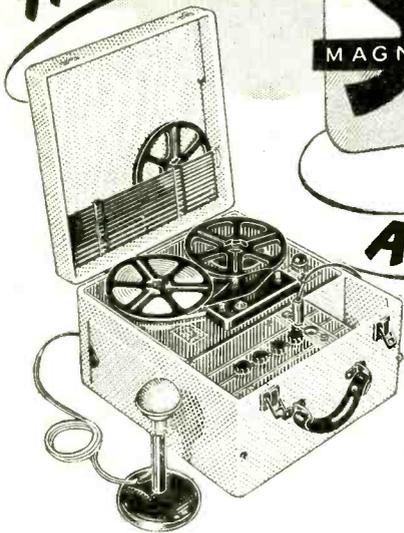


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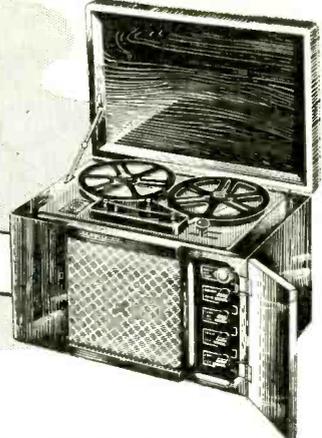


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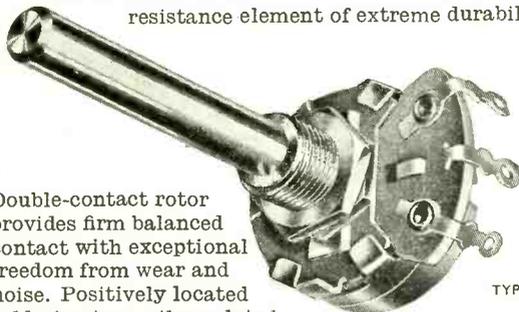


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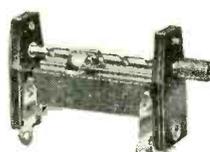
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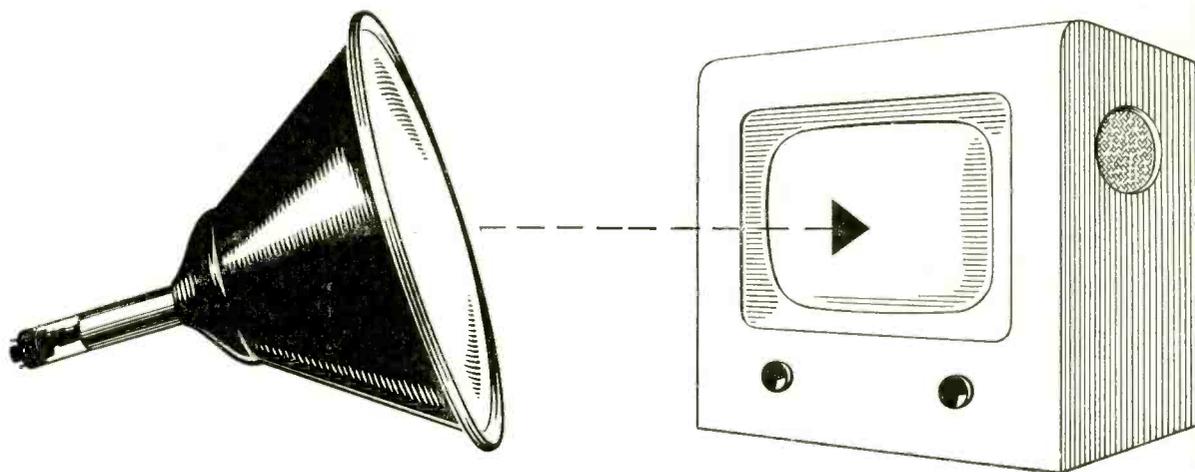
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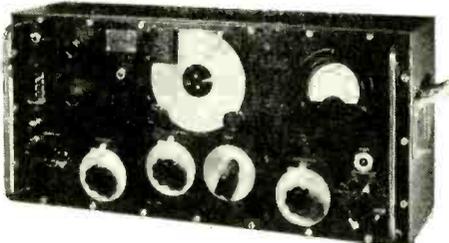
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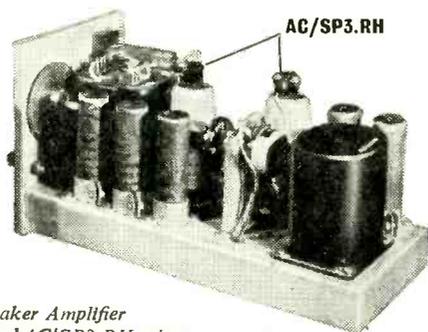


The B.B.C. make wide use of this valve

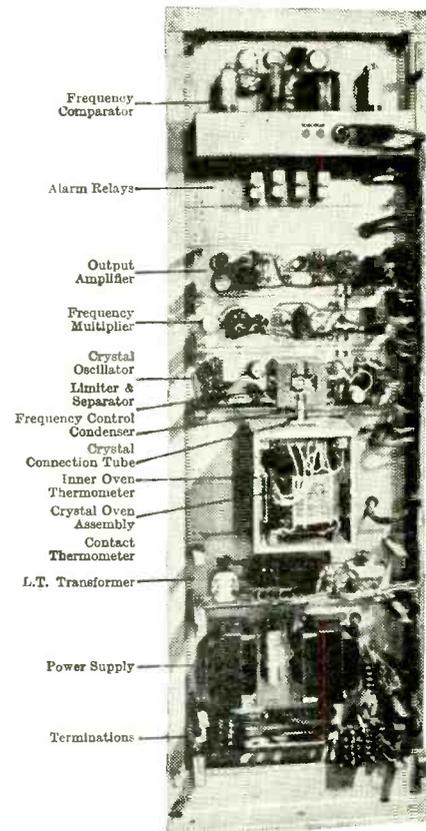
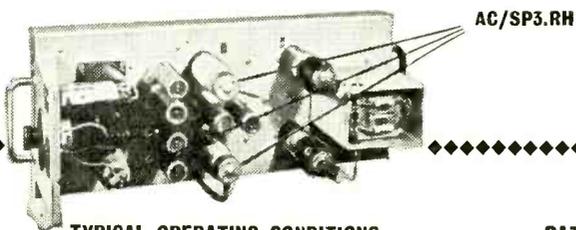
The Ediswan Mazda AC/SP3.RH is an indirectly heated Pentode with a special heater construction designed to reduce hum due to A.C. fields within the valve. Its high working slope makes it very suitable for use in audio frequency stages employing negative feed back.

The high-slope short grid-base characteristic renders it suitable also as an harmonic generator and as an oscillator in high stability crystal drive equipment. Provided precautions are taken to minimise hum due to external wiring the AC/SP3.RH may also be successfully employed in the early stages of amplifiers where the reduction of hum, noise and microphony is of primary importance. Many of these valves have been supplied to the British Broadcasting Corporation for use in their special recording, amplifying, and crystal controlled precision drive equipments, some of which are illustrated on this page.

B.B.C. Type D. Recorder Line Amplifier LFA|1 using two pentode connected AC|SP3.RH valves



B.B.C. Type D. Recorder Loudspeaker Amplifier LSM|7 using three pentode connected AC|SP3.RH valves



B.B.C. Crystal Drive Equipment (Type CP-17E) using nine AC|SP3.RH valves in the crystal maintaining amplifier, frequency divider, frequency multiplier and oven temperature relay.

**TYPICAL OPERATING CONDITIONS**

Anode Voltage (Va)	250	250	250	250
Screen Voltage (Vg2)	80	100	160	200
Grid Bias (Vg1)	1.25	1.7	2.75	3.5
Anode Current (mA)	7.8	7.9	10.5	12.3
Screen Current (mA)	2.45	2.5	3.3	3.85
Mutual Conductance (mA/V)	7.0	7.0	7.45	7.6
Anode AC Resistance (ra) (Meg ohms)	0.55	0.55	0.4	0.3
Input Capacity (Hot) (pF)	20	19.9	19.7	19.5

**RATING**

Heater Voltage	V <sub>H</sub>	4.0
Heater Current (Amps)	I <sub>H</sub>	1.0
Maximum Anode Voltage	V <sub>a</sub>	250
Maximum Screen Voltage	V <sub>g2</sub>	250
Mutual Conductance (mA/V)	g <sub>m</sub>	7.7

Taken at V<sub>a</sub> = 250; V<sub>g2</sub> = 100; V<sub>g1</sub> = 1.5

**BASE**

British 7 pin	Pin No. 5 Heater
Pin No. 1 Metallising	Pin No. 6 Cathode
Pin No. 2 Anode	Pin No. 7 Screen (G2)
Pin No. 3 Suppressor Grid (G3)	Top Cap Control Grid (G1)
Pin No. 4 Heater	

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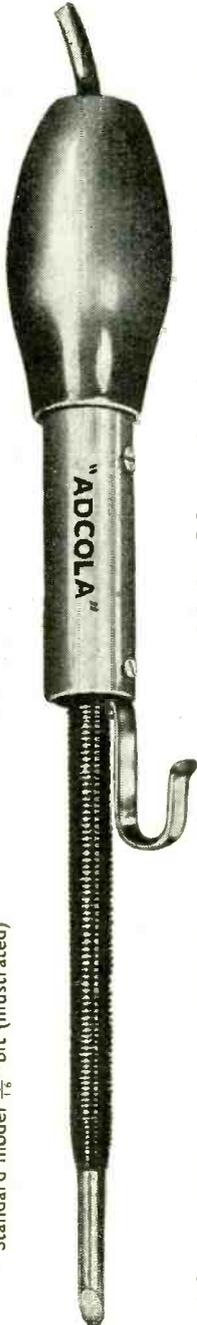
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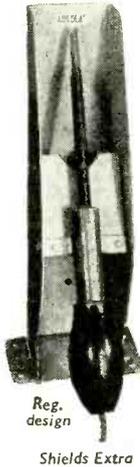
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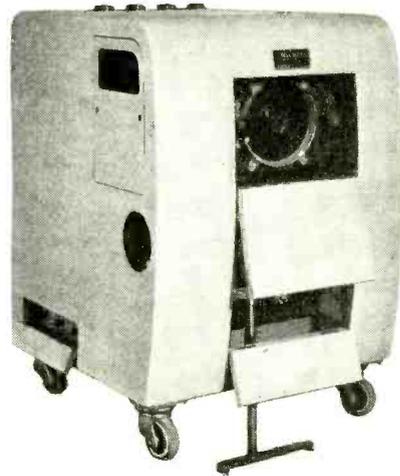
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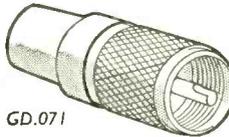
## The "TELEMAX" TELEVISION PROJECTOR



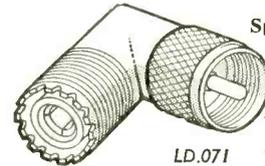
**SCREEN SIZE**  
**4 FEET BY 3 FEET**

23 valve s/h. circuit. Sensitivity better than 50 microvolts. Full bandwidth. 4' x 3' picture. 5 channel facility. A.C. only. Insulated chassis. Neutral coloured rexine covered case, size approx. 23" x 22" x 21", fitted with castors and geared lifting jack for tilt. Detailed Specification from the Manufacturers:— Complete with **TELEMECHANICS LTD.** 3 NEWMAN YARD, NEWMAN ST., LONDON W.1 L.A.Ngham 7965

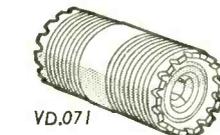
## SCREENED CONNECTORS



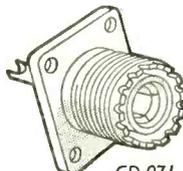
GD.071



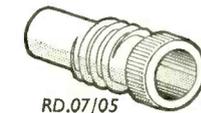
LD.071



VD.071



CD.071



RD.07/05

for cables of 0.2" to 1.03" O.D.  
Single and multi-way types.  
Special types fitted with coupling rings.  
Cable joining connectors.  
U.S. Type Connectors  
as illustrated.

CABLE O.D.	TYPE	CODE NO.
0.41"	Straight plug	GD.071
0.25"	Reducing adaptor	RD.07/05
0.2"	Reducing adaptor	RD.07/03
fits on GD.071 CD.071 VD.071	Elbow plug adaptor	LD.071
fits on GD.071 LD.071	Bulkhead (Junction) adaptor	VD.071
fits on GD.071 LD.071	Chassis receptacle	CD.071

Other Transradio specialised products:  
CO-AX air-spaced articulated  
Very Low Loss Cables.  
Microdual Two-speed Precision Drives.

**TRANSRADIO LTD**  
138A CROMWELL ROAD, LONDON, SW7,  
ENGLAND Telephone: FREmandle 4421 (P.B.X.)

Standard model  $\frac{3}{16}$ " bit (illustrated)

# 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.



"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.

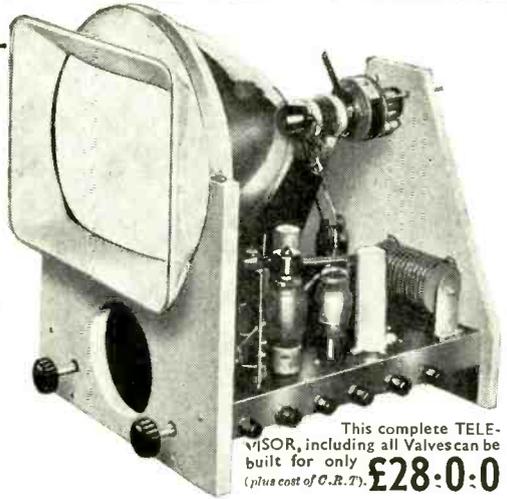
We confidently believe that not only have we achieved a T.V. Receiver that surpasses in efficiency any other designed for the home constructor, but that successful construction, even by the most inexperienced is assured by the step by step wiring detail and diagrams provided, and at about half the cost 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 14½ in. x 6½ in. x 3½ in.
- Rigid C.R.T. mounting enables entire receiver to be safely handled with tube in position.



This complete TELE-VISOR, including all Valves can be built for only **£28.0.0** (plus cost of C.R.T.)

- 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.**  
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## 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.



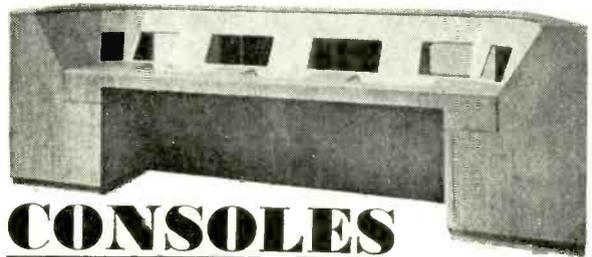
The Minimum life of 'ACRU' Neon Indicator Lamps is 25,000 hours.

Ask for leaflets

**THE ACRU ELECTRIC TOOL  
MFG. CO., LTD.**

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Tel. : RUSholme 4613



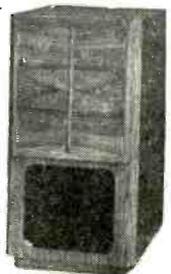
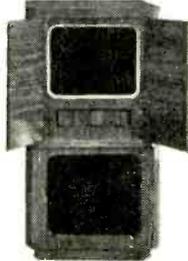
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Beautifully designed and finished in Walnut, Oak, Mahogany and Teak, to customers' requirements



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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

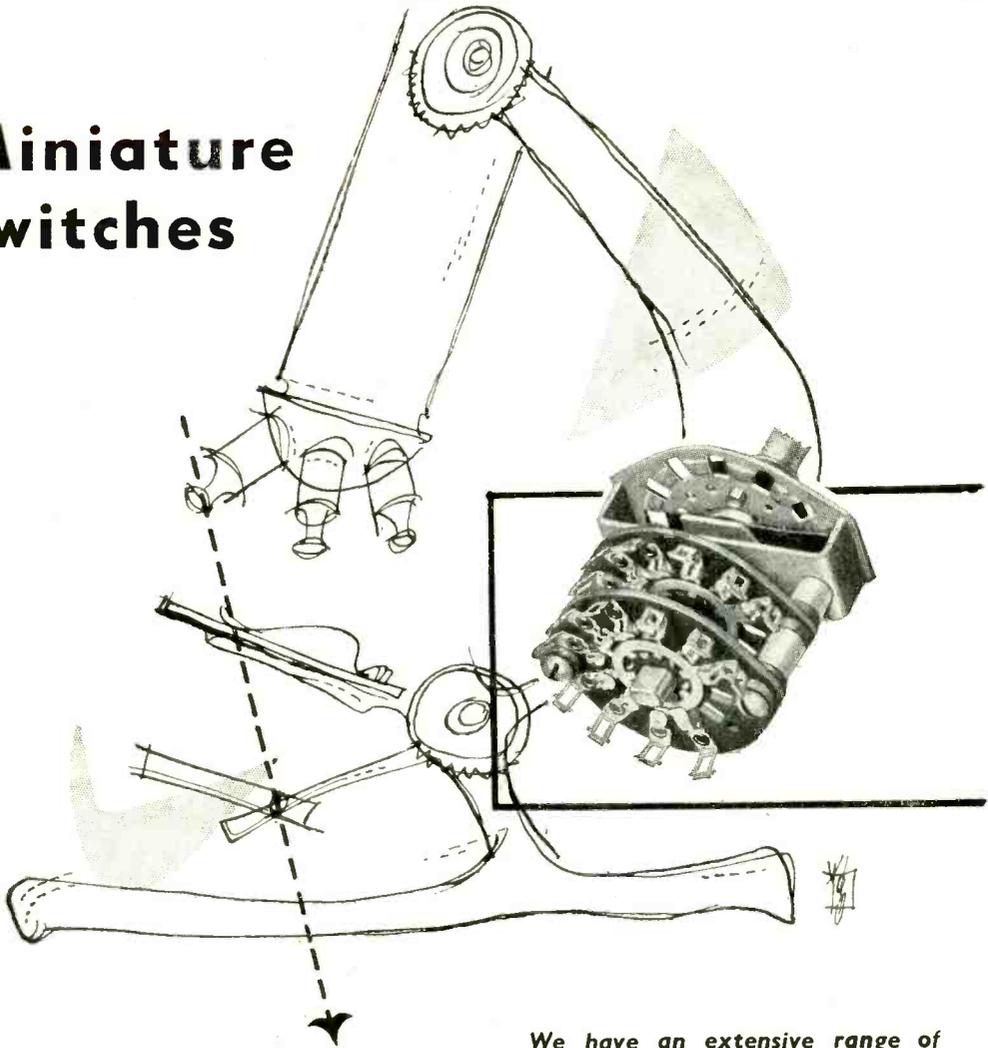
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CABINET MAKER

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# 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



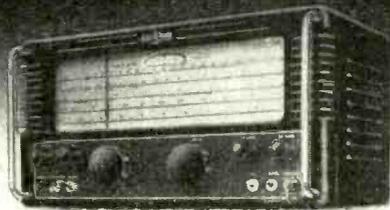
## Metal Products Ltd

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'Phone: GROsvenor 5206/7.

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## RADIO ENGINEERING OF SURPASSING EXCELLENCE



### MODEL '680X' COMMUNICATION RECEIVER

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- Separate oscillator
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- Crystal filter
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LIST PRICE IN U.K. £106 : 0 : 0  
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- Double superheterodyne
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### SPECIAL ANNOUNCEMENT TO ALL TAPE RECORDING ENTHUSIASTS

A new version of the famous "LANE" Tape Table is now available incorporating—

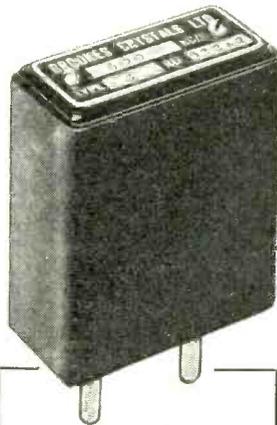
- Three very high grade motors designed and made for the job, by the Verdik engineers.
- Even better heads.
- Positive braking on all functions.
- Fast forward run and rewind in 50 secs. WITHOUT UNLACING TAPE.
- Very simple to use. Only two controls. One for rewind and one ON-OFF switch.

No Tape Table of this grade has ever been offered to the public at anything like the price and it is fully guaranteed.

**LANE TAPE TABLE**  
**MK. IV £17.10**

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We are suppliers to Ministry of Supply, Home Office, etc.

**Type "S"**  
Frequency range: 100 Kc/s to 15 Mc/s.

Quartz crystal plate of appropriate cut and dimensions to suit the frequency requirement, mounted in bakelite case 1 1/2 in. high, 1 1/2 in. wide, 3/4 in. thick, with two 1/4 in. diameter pins 3/4 in. apart. Frequency tolerance 0.01% of nominal at 20°C., or better for special applications. Frequency-temperature co-efficient better than 2 parts in 10<sup>6</sup> per 1° C., over temperature range of -20°C. to + 70° C.

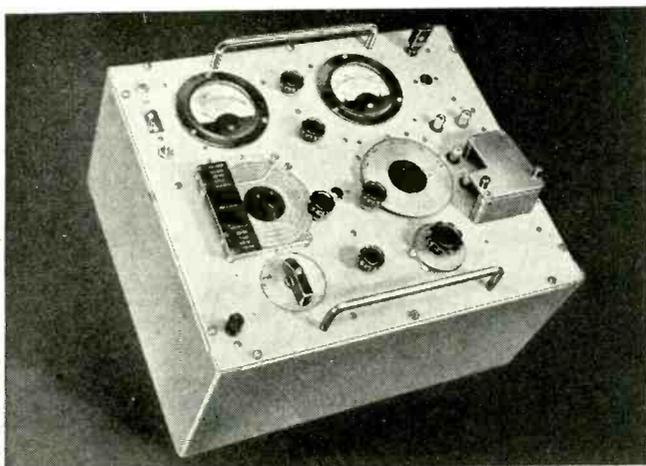
### BROOKES CRYSTALS LTD.

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Phone: Greenwich 1828. Grams: Xtals Green, London. Cables: Xtals, London

# *Circuit Magnification Meter*

TF329G

For the measurement of the  $Q$  of a circuit, there are no better instruments than Marconi. Model TF 329G applies to the frequency range 50 kc/s to 50 Mc/s. In addition to direct  $Q$  readings, the TF 329G can be used for a considerable range of indirect measurements carried out by the normal resonance methods. These include inductance of coils, capacitance and phase defect of condensers, the characteristics of transmission lines. Special jigs are available for investigating dielectric losses.



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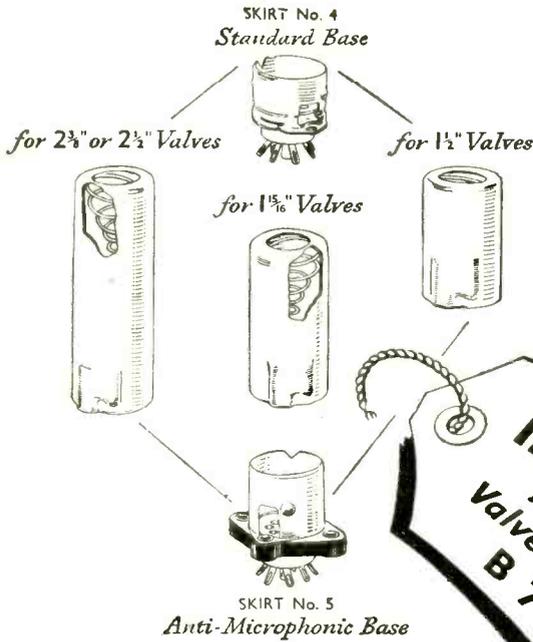
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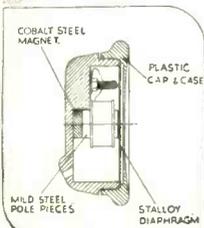
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"F"  
TYPE  
HEADPHONES

for LONG LIFE and  
TROUBLE-FREE SERVICE

This is a featherweight model of exceptionally strong construction and high sensitivity. It appeals equally to both amateur and professional radio-engineers. It incorporates powerful cobalt steel magnets with flat Stalley diaphragms.  
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Impedance: 14,000 ohms at 1,000 c/s.  
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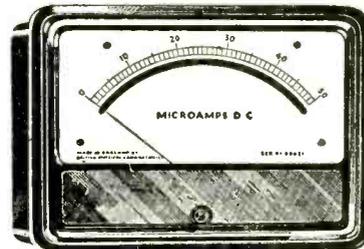


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(13)

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HM Hand Microphone with Filtercel Insert ...	£4 7 6	£1 7 6	8 0
038 Ball Microphone with Filtercel Insert ...	£4 10 0	£1 7 6	8 3
083U, do. do. with Universal Joint ...	£5 2 6	£1 12 6	9 0
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TAPE TABLES (cont)	Cash	Deposit	12 Monthly Payments
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(Carriage and Packing 10/-).			
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<b>GRUNDIG Console</b> , 2-sp.	£99 15 0	£33 5 0	£6 7 0
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<b>S. G. BROWN</b> , Type F, Featherweight General Purpose ...	£1 15 0	—	—
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TAPES	Cash
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<b>FERROGRAPH 1,200ft.</b> High Coercivity ...	£2 5 0
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<b>SCOTCH BOY 600ft.</b> Medium Coercivity ...	£1 1 0
<b>SCOTCH BOY 1,200ft.</b> Medium Coercivity ...	£1 15 0
<b>SOUND MIRROR 1,200ft.</b> Paper Tape ...	£1 5 0

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<b>AGFA 1,200ft.</b> High Coercivity ...	£1 17 6
<b>AGFA 600ft.</b> High Coercivity ...	£1 2 6
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Tape Spools 600ft. ...	3 6
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<b>MOTORS</b> 4 pole 3in./03 Torque ...	£1 18 0
<b>B.S.R.</b> Type SR.1, 2,750 r.p.m. 2 pole 3in./03 Torque ...	£1 12 0
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<b>COLLARO</b> Clock or Anticlock-wise. (Inc. cooling fan), 1,400 r.p.m. 4 pole 4in./03 Torque ...	£1 18 6

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<b>BURGOYNE</b> high impedance, half track width, built in tape guides, fully enclosed, single hole fixing. Record Playback or Erase ...	£1 17 6
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<b>WEARITE 679 Oscillator</b> or Bias Transformer ...	7 6

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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—RADIO-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.

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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**  
Deposit £2.19.6  
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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.



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



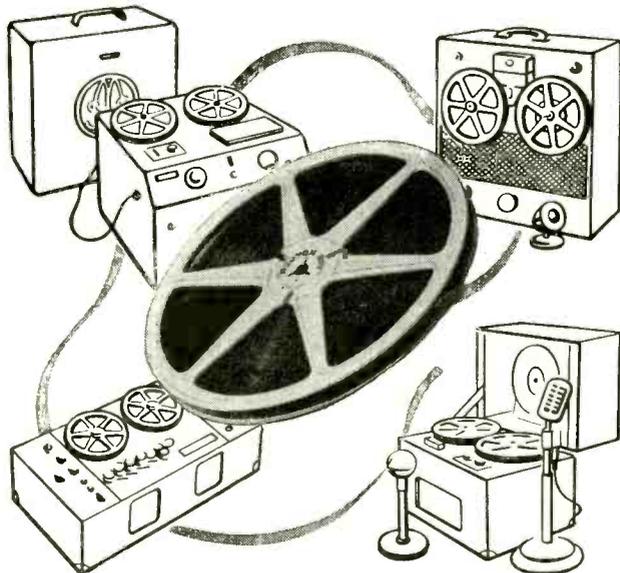
'Scotch Boy' fits all makes of tape recorders. It brings new clarity, new fidelity, an all-round improvement to your own recordings.

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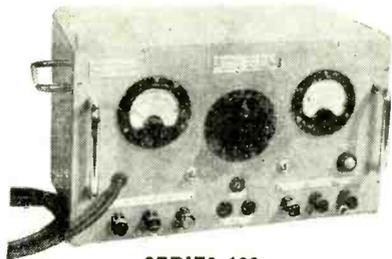
'Scotch Boy' is used by the B.B.C. and most other big recording and broadcasting corporations. Ask your dealer for 'Scotch Boy' and hear the difference it makes on your own machine.

Another **3M COMPANY** Product

Write for further details of  
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SERIES 100

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

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

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

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Precision Mechanical and Electrical Engineers

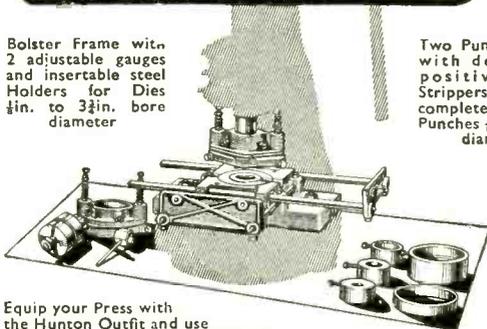
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Bolster Frame with 2 adjustable gauges and insertable steel Holders for Dies ¼in. to 3¼in. bore diameter

Two Punch Holders with detachable positive-action Strippers take the complete range of Punches ¼in. to 3¼in. diameter.



Equip your Press with the Hunton Outfit and use inexpensive standardised Punches and Dies ¼in. to 3¼in. diameter, obtainable from stock—in ¼in. sizes—when required.

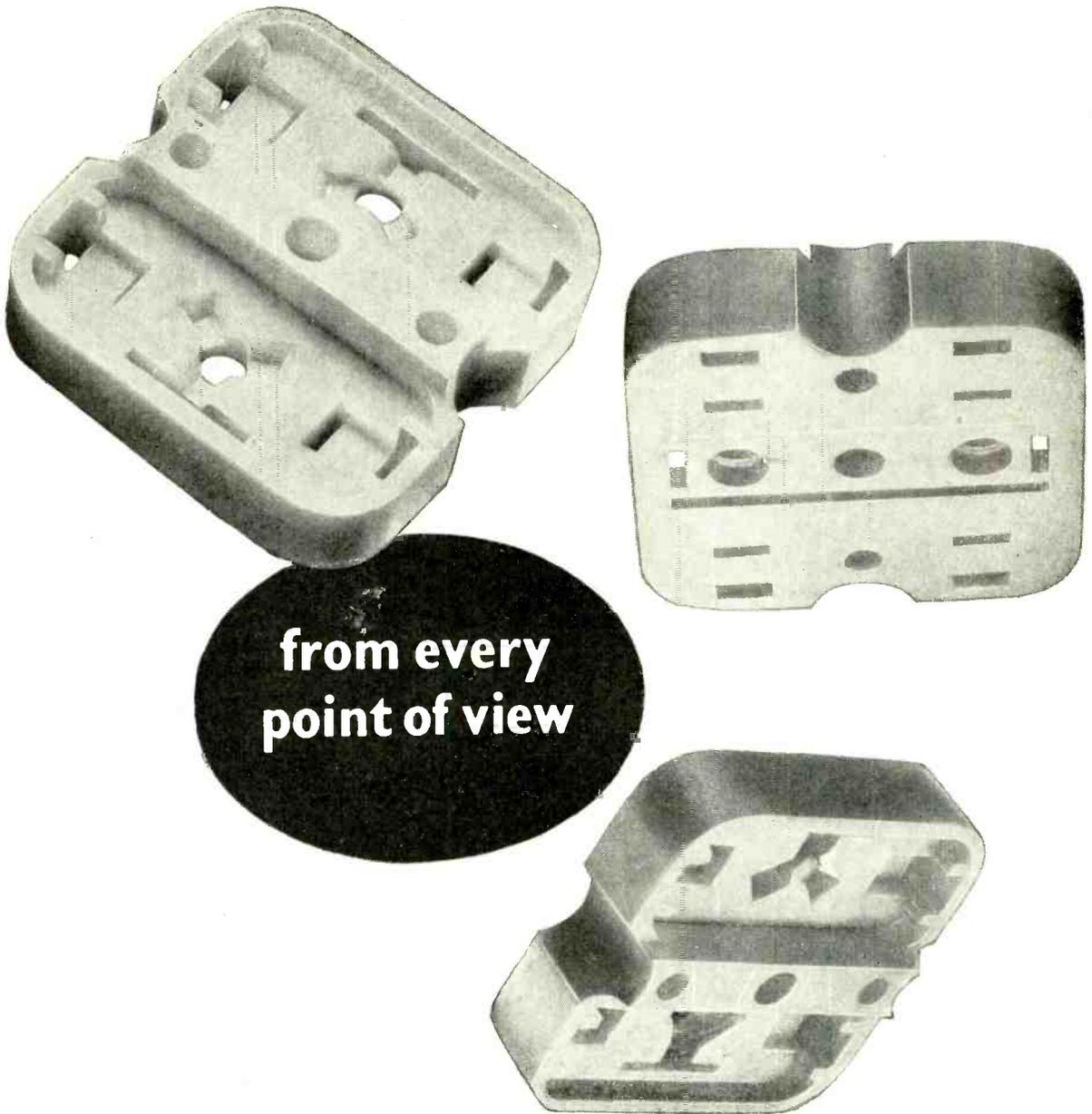
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Phoenix Works, 114-116, Euston Road, London, N.W.1  
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from every  
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“Frequentite” is the most suitable insulating material for all high frequency 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.

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S.P.77

# Connoisseur 3-speed MOTOR



PRICE (without Pick-up)  
**£16.10.0 Plus £5.7.3 tax**

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You will find it possesses all the qualities you have been looking for !

12in. turntable, 33 $\frac{1}{3}$ , 45 and 78 r.p.m. Synchronous motor, virtually vibrationless.

Suitable for standard, transcription and micro-groove recordings.

Input voltages : 200-250 A.C. 50 cycles.

110 volts 60 cycles to order.

## 3 Head PICK-UP

### The CONNOISSEUR SUPER LIGHTWEIGHT PICK-UP

Extremely low mass at needle point (4/5 m.g. only), allowing for reduction in downward pressure to 8/10 grams for standard recordings, and 4/6 grams for microgroove recordings.

PRICES with one Head, £4/10/-, plus £1/9/3 tax.

Extra Heads, each £2/10/-, plus 16/3 tax.

Spare Armature System with sapphire, 10/3, plus 3/4 tax.

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## Announcing the SCALAMP ELECTROSTATIC VOLTMETER



Cat. No.  
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**DIRECT READING.**

**ZERO CURRENT  
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**LAMP OPERATES  
 FROM MAINS OR  
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**BRIGHT SPOT-  
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This instrument introduces a completely new conception of electrostatic voltmeter. It is compact, portable and robust, and does not require critical levelling or special mounting. The movement has a taut suspension, is critically damped, and readings can be taken with rapidity and ease. Three models are available:

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 5 - 18 kV D.C. and  
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Please write for illustrated leaflet.

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ONCE A YEAR at least 24 Scholarships (to the value of £3,000) are awarded for a four-year course in Electronic Engineering. With this Scholarship and grants, students may become almost self-supporting while still under training. During the course the students' progress and welfare are the main consideration.

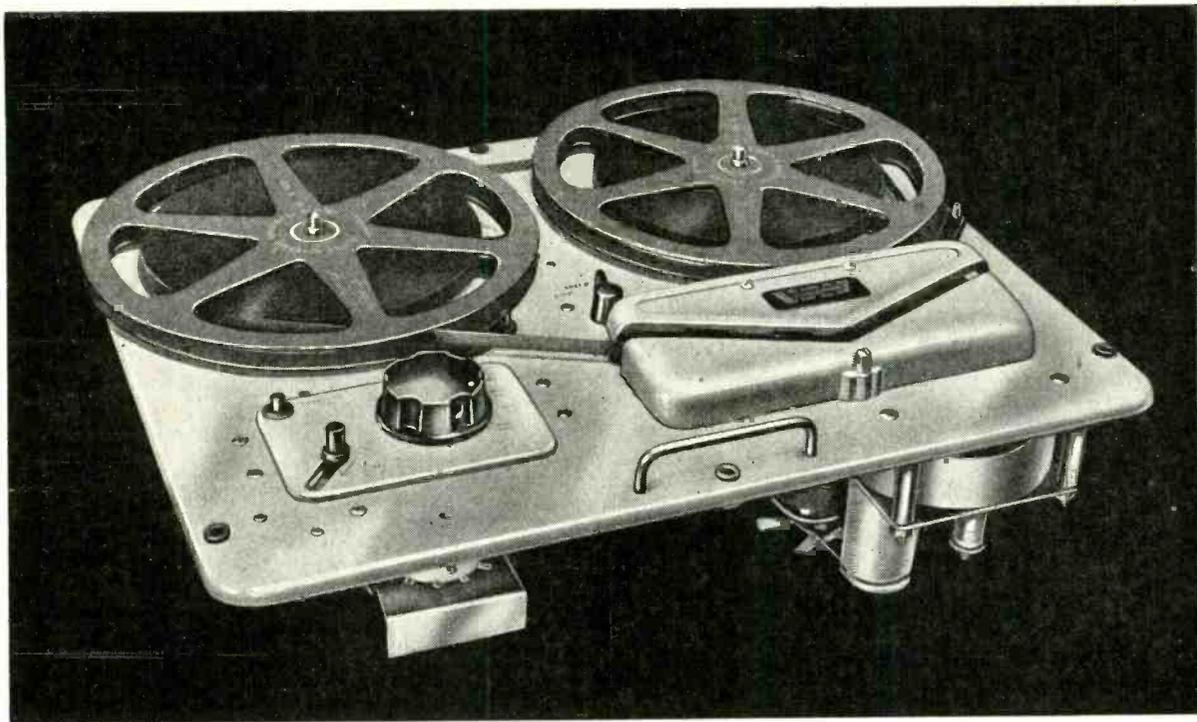
Write immediately for full details. *Next course commences October 6th.* Selected applicants will be required for a personal interview in late July or early August.

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 MARCONIPHONE  
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## THE WEARITE "TAPE-DECK" ★

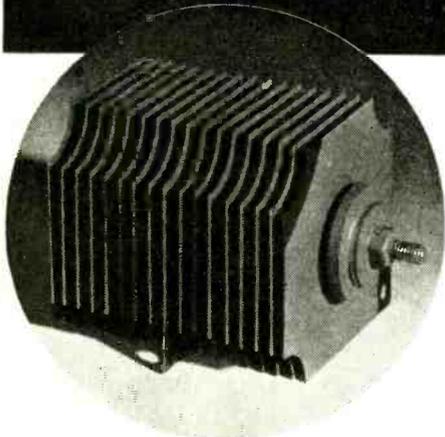
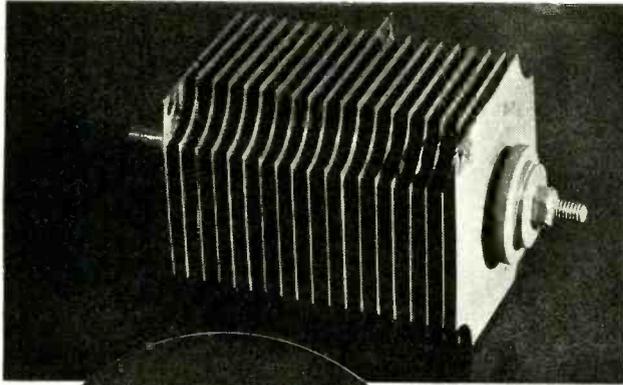
**T**HE Wright and Weaire "Tape-Deck" is a basic unit which permits the construction of recorders of many and varied types to meet the diverse needs of Science, Education, and Entertainment. Its extreme operational simplicity and robustness will commend it on the one hand to those applications where unskilled hands may use it, while on the other its technical performance and engineering features will engage the attention of the serious recordist.

**MEDIUM** Standard  $\frac{1}{4}$ " plastic or paper based coated tape.  
**TRACK WIDTH** 0.1"  
**NUMBER OF TRACKS PERMISSIBLE** 2.  
**OPERATING TAPE SPEEDS**  $7\frac{1}{2}$ " per sec. and  $3\frac{3}{4}$ " per sec.  
**PLAYING TIME PER TRACK** 45 mins. at  $7\frac{1}{2}$ " per sec.  
 (1,750 ft. reel) 90 mins. at  $3\frac{3}{4}$ " per sec.  
**REWIND TIME (AND RAPID WIND-ON)** Less than 1 minute.  
**ATTAINABLE FREQUENCY RESPONSE**  $\pm 3$  DB  
 (Tape to Spec. WW372/49) 50-12,000 c.p.s. at  $7\frac{1}{2}$ " per sec.  
 50-6000 c.p.s. at  $3\frac{3}{4}$ " per sec.  
**"WOW" AND FLUTTER** Less than 0.2%.  
**LONGTERM SPEED STABILITY** Better than 0.5%.  
**POWER CONSUMPTION** 57 watts.  
**DIMENSIONS**  $16\frac{3}{8}$ " x  $13$ " x  $1$ " above deck and  $6$ " max. below  
**WEIGHT** 18 lbs.

★ "Tape-Deck" is registered Trade Mark No. 684413 granted in 1949. The Manual of the Tape Deck—price 2/6—can be obtained from your local dealer or direct if difficulty is experienced. The Manual contains a technical description of the "Tape-Deck" and suggests a tried and proven circuit for its best usage.

### WRIGHT & WEAIRE LTD.

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**THE POWER  
BEHIND  
THE PICTURE**

Since they were first marketed 25 years ago, Westinghouse Metal Rectifiers have been used extensively for anode supplies to both home constructed and commercial radio receivers. The original copper-oxide types have long been superseded by Westalite rectifiers for this particular application, the latter having an extremely high efficiency. The advent of television widened the scope of Westinghouse Metal Rectifiers and today very many thousands are used in commercial television receivers. Long life—high efficiency—reliability—are salient features of . . .

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**METAL RECTIFIERS**

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THE WORLD'S BEST

**CONTRACTING  
TUBE  
ADAPTOR**

For  $\frac{7}{8}$ ", 1",  $1\frac{1}{8}$ ",  $1\frac{1}{4}$ " tubes. Quickgrip Adaptors are fitted by hand as no tools are required. 2",  $2\frac{1}{2}$ ", 3" and 4" wheels may be used.

Ask for Brochure and pages 8, 25, 57.

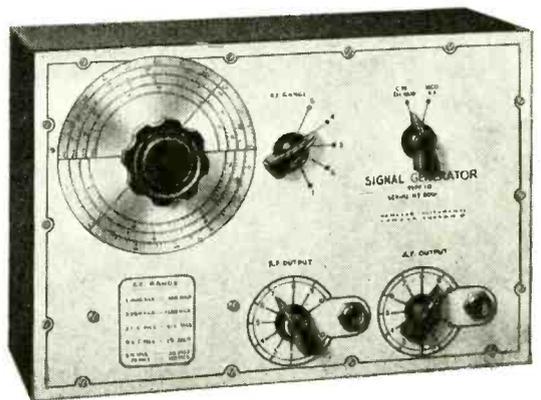
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Please mention "Wireless World"



**SIGNAL GENERATOR TYPE 10. 100 Kc/s-100 Mc/s**  
**Price £7 . 10 . 0**

The accuracy, reliability and comprehensive specification, are some of the reasons why the TYPE 10 has achieved such outstanding success.

- 100 Kc/s to 100 Mc/s ● Modulated or unmodulated carrier ● Direct calibration ● Adjustable 400 c.p.s., AF signal ● Stable RF oscillator
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New instruments now available include the **HOMELAB CHECKTEST** price 37/6d, and a range of accurately calibrated variable condensers, 100pf, 500pf, and 1000pf, price 42/- each.

Obtainable only direct from the manufacturers. Send for full technical details or call at address below.

Overseas enquiries invited.

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Telephone: LEY 5651

# Letter from America

West 110th Street,  
New York,  
U.S.A.  
21st March, 1953.

Dear Mr. Briggs,

Upon acquiring HiFi equipment recently I found the speaker I had thought suitable was far from it. While pondering what to do next a speaker was flicked on in the sound studio housed in a 20x20x16in. cabinet on the floor close by my feet. Immediately my ears went up and I enquired what it was. A Super 12/CS/AL Wharfedale. The salesman assured me it would sound even better in the cabinet I planned, a bass reflex about 6 cu. ft. I settled for it with no hesitation whatever. When it arrived in my apartment the test ticket showed it to have been a scant 6 or 7 weeks from leaving your works to getting into my hands, which for some obscure reason pleased me greatly.

Scarcely a day has passed but this speaker has amazed me. In your book "Loudspeakers" (which I have read and re-read from cover to cover) you say it is astonishing how well a good speaker sorts out the instruments. By saying this you do not convey the fact that this speaker, given suitable microphonic program source, is completely 3rd dimensional. To me it is miraculous that a record can be made and broadcast and when picked up on one's receiving set the instruments are set forth before you as though you, the listener, were standing at the conductor's desk (or podium as Americans will have it). You will gather from this that the Super 12in. will have it). You satisfaction. In fact I would never have dreamed that a speaker could do this. Incidentally, I am receiving on FM only. Once in a while I have turned the volume fairly high. On Washington's Birthday a record was broadcast of Sousa's Stars and Stripes conducted by, of all people, Toscanini. On such an occasion as this one thinks any neighbour who objects can go jump in the river so I poured it on and the speaker took it gloriously.

(Signed) L. J.

# Letter from N. Rhodesia

Central Research Station,  
Mazabuka.  
1st April, 1953.

Dear Mr. Briggs,

The Super 8/CS/AL arrived last week, and I have given it a thorough testing before writing to acknowledge its receipt. I now write to say how pleased I am with it. For a small speaker its performance verges on the incredible when used by itself in an acoustic chamber, and when used as a treble speaker to the Super 12/CS/AL the dual performance is fantastic. Your speakers seem to be almost unknown out here—except to the Broadcasting bods who use the Golden and the W.10/CS.

As a single speaker, the Super 12/CS/AL has aroused most interest as its performance against others has been the outstanding feature.

In Livingstone I gave the triple corner chamber from the broadcasting people) what I think is as hard a test as it is likely to have by putting it against a . . . Horn. The consensus of opinion was that the triple combination was superior. Possibly, the 15/CS would be a better bass speaker than the 12in., but there isn't one available so we do as best we can

(Signed) C.A.W.

## WHARFEDALE SPEAKERS

Super 8/CS/AL

Diameter 8in.  
Flux density 13,000 lines.

£6/13/3, inc. P.T.



Super 5

Diameter 5in.  
Flux density 13,000 lines.

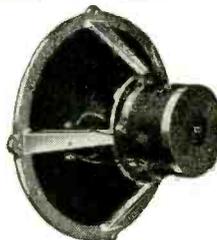
£6/13/3, inc. P.T.



Super 12/CS/AL

Diameter 12in.  
Flux density 17,000 lines.

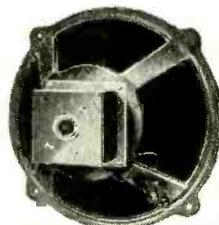
£21/6/5, inc. P.T.



W15/CS

Diameter 15in.  
Flux density 13,500 lines.

£16.

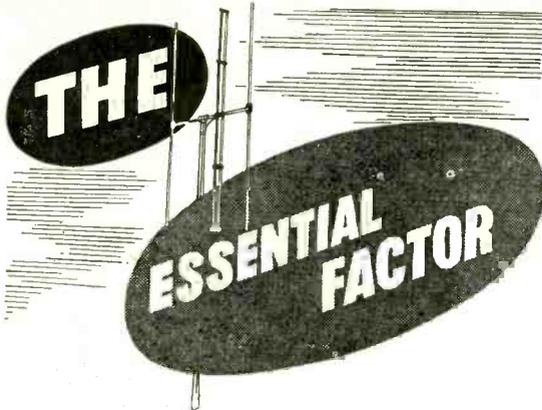


# Wharfedale

## FOR HIGH QUALITY SPEAKERS

New 32-page Catalogue now ready, containing complete set of response curves all taken under identical conditions. Available on request.

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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:—

**63<sup>A</sup>**

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.



**71**

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/- extra on above.

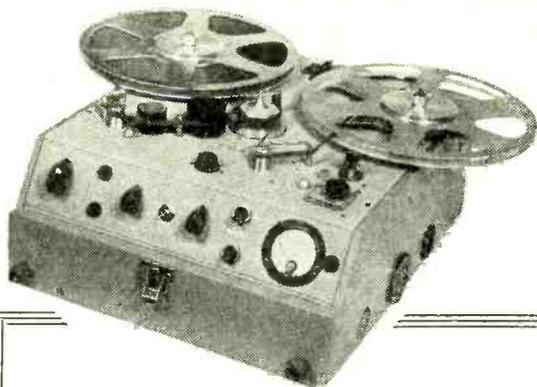


For Belfast and Newcastle Transmitters. The majority of Aerialite T/V aerials are suitable for horizontal polarisation and provide same high level of aerial efficiency. Please add the suffix HOR to the model number when ordering.



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
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- 10 1/2 in. DIAMETER FLYWHEEL
- SUPERIMPOSING
- NOISE SUPPRESSION
- TAPE CAPACITY: Standard 3250 ft. single sided spools and NAB 2400 ft. double sided spools.
- PORTABLE. WIDTH 14 1/2 in. DEPTH 17 1/2 in. HEIGHT 8 1/2 in.

For full details and nearest Agent please write to

**EXCEL SOUND SERVICES LTD.**  
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*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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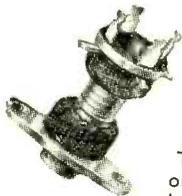
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- ★ Only 1in. high.
- ★ Packed in damp-proof containers.
- ★ Variable iron-dust cores.
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- ★ Low loss Polystyrene formers.

**4'-  
EACH**



**COILPACKS.** Now at new lower prices! A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1½in. high x 3½in. wide x 2½in. 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 mc. 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.



Type	Hole Sizes	Price
1	1in. x 1½in.	19/6
2	½in. x 1½in.	18/9
3	½in. x 1½in.	22/6
4	1½in. 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.



Type	Hole Size	Price
1	½in.	6/6
2	¾in.	7/6
3	1in.	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.

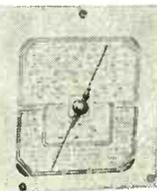
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**Type A. GLASS DIAL ASSEMBLY** (as illus.) measuring 7in. x 7in. (9½in. x 9½in. overall) mounts in any position on or above the chassis and works with any type of drive. Choice of two 3-colour scales—G1(L.M.S.) or G2(M.S.S.). Price complete, 24/6. Pulley assembly for right-angle drive if required 1/9 extra. P. & P. 1/6.



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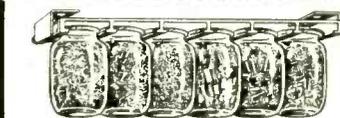
Overall size 5½in. sq., as illustrated. Cream background, 3-colour. Type M1, L.M.S. waves. M2, L. & M. waves. M3, M. & 2/S. waves. Price 3/6 each. Pointer, 1/6. Drum, Drive, Spring and Cord for use with both above types of dials, 3/2.



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 I-valver. A.C. Band-Pass 3. RI155 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)



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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 blue-prints and instructions, or ask for details.

I.F.s. 465 k/c. Permeability-tuned, with flying leads. Standard size 1½in. x 1½in. 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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Telephone : Croydon 5148/9

## 0-1000 VOLTS WITH THE NEW SOLARTRON

### Twin-Regulated Power Supply

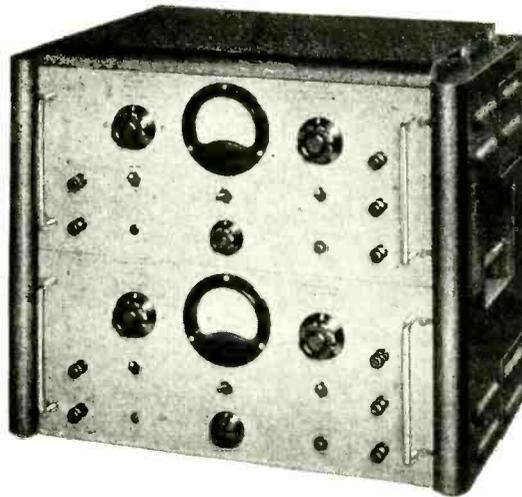
MODEL SRS.152

#### 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  $\pm 10\%$  mains input change.



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.

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



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for the Electronic and Instrument Industries

Constanta High Stability Resistors  
(Stability and tolerance from  $\pm 0.5\%$  to  $\pm 10\%$ )

Constanta Carbon Potentiometers

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  
( $\frac{1}{2}$  watt to 250 watts)

Ganged Carbon Potentiometers

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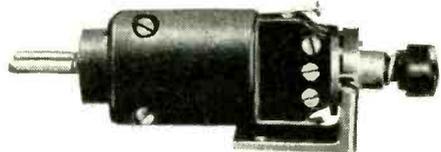
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The new



# 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  $7\frac{1}{2}$ " and  $15$ " per second, or  $3\frac{3}{4}$ " and  $1\frac{1}{8}$ " 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.

<b>TAPE SPEEDS</b>	$7\frac{1}{2}$ " and $3\frac{3}{4}$ " per second.
<b>TRACKS</b>	$1\frac{1}{2}$ " wide. Number of tracks 2.
<b>PLAYING TIME PER TRACK</b>	30 minutes at $7\frac{1}{2}$ " per second. 60 minutes at $3\frac{3}{4}$ " per second.
<b>SPOOLS</b>	Standard $7$ " and $5$ " plastic or metal.
<b>SENSE OF SPOOLING</b>	From left to right with tape coating inwards.
<b>REWIND TIME</b>	One minute for 1,200 ft. of tape (approx.).
<b>HEADS</b>	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.
<b>TAPE OPERATION</b>	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.

<b>FREQUENCY RESPONSE</b>	At $7\frac{1}{2}$ " per second 60-10,000 C.P.S. plus or minus 3 db. At $3\frac{3}{4}$ " per second 70-7,000 C.P.S. plus or minus 3 db.
<b>DISTORTION</b>	Less than 2½% total harmonic distortion at normal operating level.
<b>SIGNAL/NOISE RATIO</b>	Approximately 50 db. using standard high output tape.
<b>INPUTS</b>	(1) Up to 50 ohms low level -110 db. microphone input. (2) High Z up to 100 K at 1v. unbalanced (radio input).
<b>OUTPUTS</b>	(1) $2\frac{1}{2}$ ohms at 3 watts to internal loudspeaker. (2) 15 ohms at 3 watts for external speaker.
<b>WOW AND FLUTTER</b>	Total wow and flutter content less than .2%.
<b>MAINS SUPPLY</b>	200/250 v. 50 cycles 230 V.A. Other voltages and frequencies supplied to special order.
<b>DIMENSIONS</b>	$16$ " wide x $11$ " high x $18$ " deep approx.
<b>WEIGHT</b>	45 lbs.

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 POYLE CLOSE · COLNBROOK · BUCKINGHAMSHIRE · TELEPHONE · COLNBROOK 284

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1/2 gr. each 2/6	4BA " 5/-	" 4/-	3BA 1/9, 4BA 1/8
Brass Screws	5BA " 4/-	" 3/9	5BA 1/6, 6BA 1/6
Assorted	6BA " 4/-	" 3/6	8BA 1/6
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6BA 4/-, 8BA 4/6	8BA " 4/6	" 4/-	

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5/16" " "	1/7	5/16" " "	1/7	5/16" CS CP	1/-
7/16" " "	1/9	7/16" " "	1/9	7/16" RH SC	1/2
1" " "	1/10	1" " "	1/11	1" CS CP	1/1
1 1/8" " "	1/11	1 1/8" " "	2/-	1 1/8" " "	1/2
1 1/4" " "	2/-	1 1/4" " "	SC	1 1/4" RH SC	1/2
1 1/2" " "	1/11	1 1/2" " "	NP	1 1/2" CS CP	1/4
1 3/4" " "	2/1	1 3/4" " "	CS	1 3/4" " "	1/5
2" " "	2/3	2" " "	NP	2" RH SC	1/5
2 1/4" " "	2/6	2 1/4" " "	" "	2" CS CP	1/7
2 1/2" " "	1/9	2 1/2" " "	" "	2" CH	1/9
3" " "	1/9	3" " "	" "	3" " "	2/6
3 1/2" " "	2/-	3 1/2" " "	" "	3 1/2" H/H	2/9

4BA		BRASS		STEEL	
1/4" CH SC	2/-	1/4" RH NP	1/10	1/4" CS CP	1/2
1/2" " NP	2/1	1/2" " "	2/3	1/2" " "	1/3
3/8" " "	2/1	3/8" " "	2/9	3/8" RH	1/4
1/2" " "	2/2	1/2" " "	3/-	1/2" SC	1/2
5/8" " "	2/6	5/8" CS	1/8	5/8" " "	1/4
3/4" " "	3/3	3/4" " "	2/-	3/4" CS CP	1/4
1" Hex/H	2/6	1" " "	2/3	1" RH SC	1/6
1 1/8" " "	3/6	1 1/8" " "	1/10	1 1/8" CP	1/9

2BA		BRASS		STEEL	
3/16" RH NP	2/10	3/16" CH NP	4/6	3/16" H/HSC	1/9
1/4" " "	3/-	1/4" " "	SC	1/4" LgeRH	2/-
5/16" " "	3/3	5/16" " "	5/-	5/16" RH SC	2/-
3/8" " "	3/6	3/8" " "	NP	3/8" CH	2/6
1/2" " "	5/-	1/2" CS	4/-	1/2" RH CP	2/9
5/8" Hex/H SC	10/-	5/8" " "	SC	5/8" CS	2/-

8BA		BRASS		STEEL	
3/16" CH NP	2/-	3/16" CH SC	2/-	3/16" CH CP	2/-
1/4" " "	2/6	1/4" RH NP	2/2	1/4" CS	2/-
5/16" CS	1/8	5/16" " "	2/6	5/16" CH	2/2
3/8" CH	2/3	3/8" " "	2/9	3/8" RH	2/2
1/2" CS	1/9	1/2" Hex	2/9	1/2" CH NP	2/3
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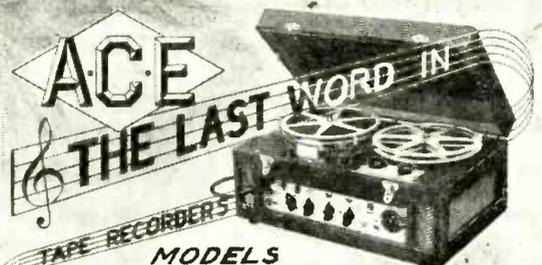
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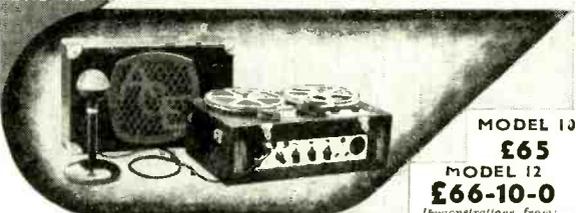


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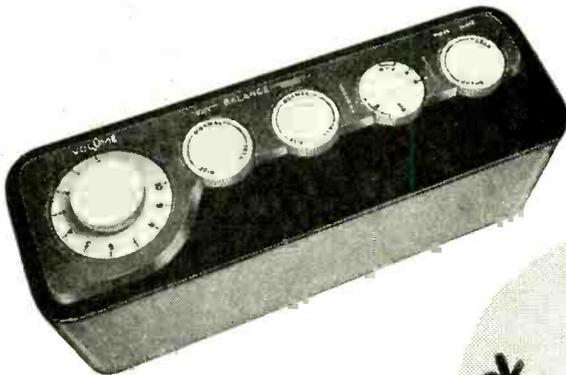
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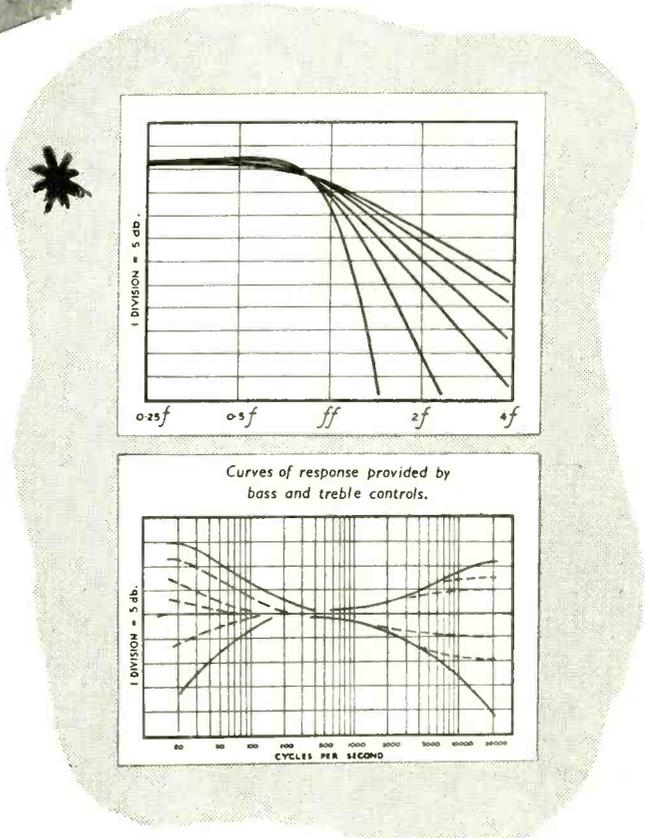
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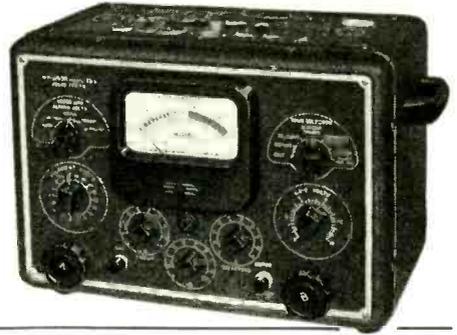
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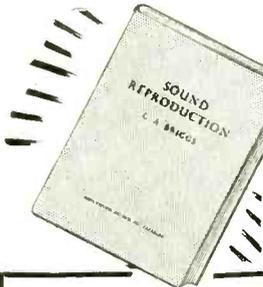
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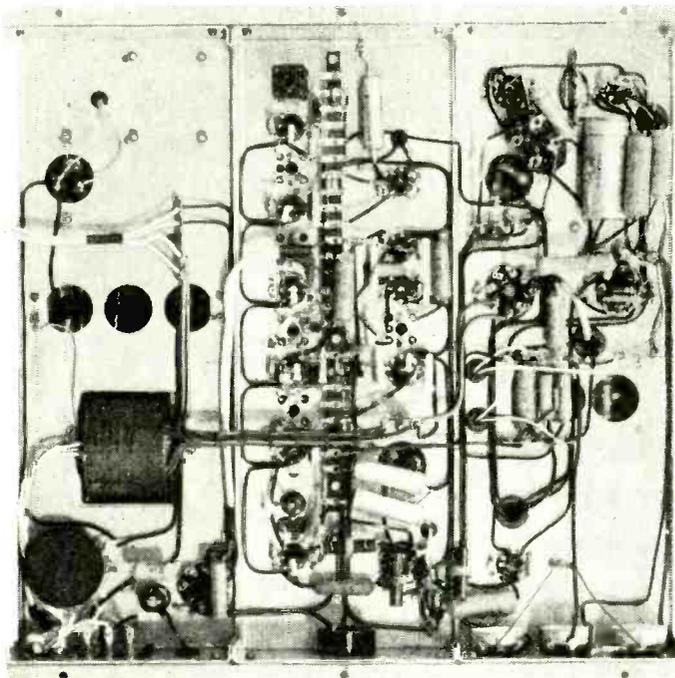
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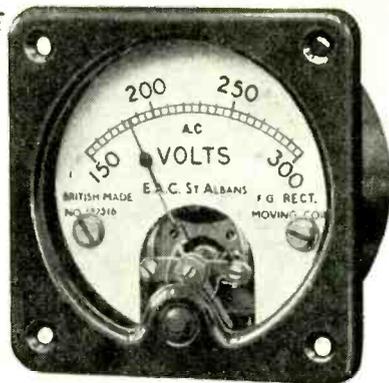
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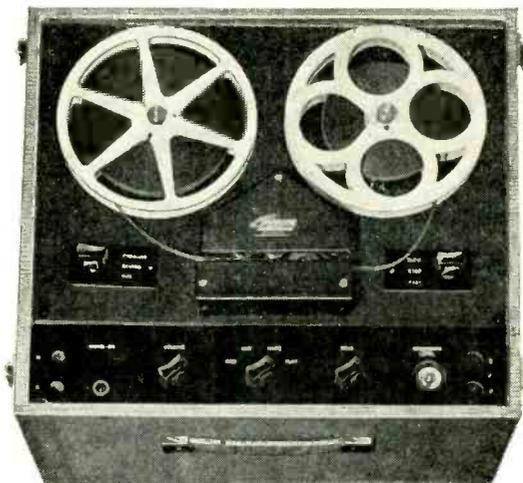
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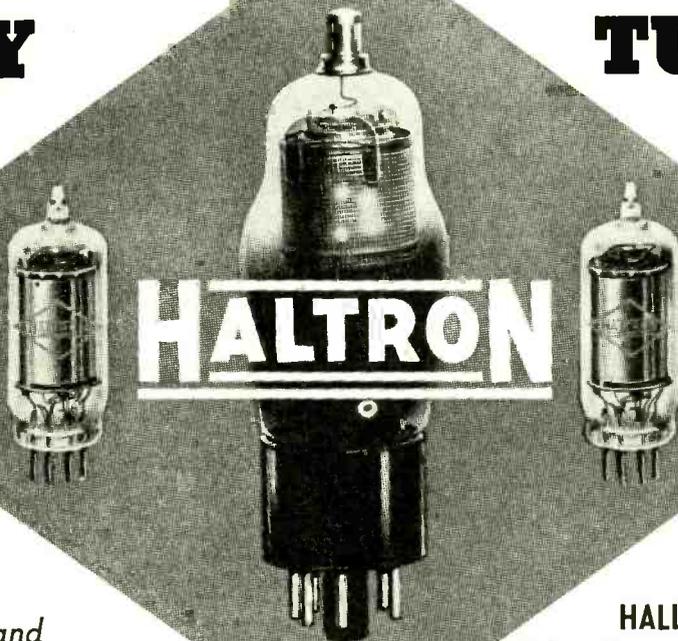
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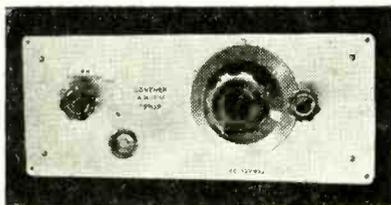
Cap. $\mu$ F.	DC. Volts Wkg.	Surge	Ripple Current Max. m/a	Dimensions L.	D.	Type Ref.	List No.	List Price
100 + 200	275	325	550	4"	1 3/8"	L33	K255	28/6
60 + 250	275	325	500	4"	1 1/2"	L33	K271	28/6
100	350	400	550	4 1/2"	1 1/8"	L32	K136	13/6
60 + 100	350	400	450	4 1/2"	1 1/8"	L33	K178	18/6
60 + 120	350	400	500	4 1/2"	1 1/8"	L33	K152	19/6
64 + 120	350	400	550	4 1/2"	1 3/8"	L33	K128A	21/6
100 + 200	350	400	800	4 1/2"	1 3/8"	L33	K147	31/-
100 + 200	350	400	800	4"	2"	L33	K189	31/-
60 + 250	350	400	450	4 1/2"	1 3/8"	L33	K207	29/-
64	450	525	600	4 1/2"	1 1/8"	L32	K102	13/-

### TYPE L. 35 TWIST PRONG MOUNTING

150	350	400	350	4"	1 1/8"	L35	K502	17/6
60 + 60	350	400	370	3 3/8"	1 1/8"	L35	K617	16/6
64 + 120	350	400	450	4 1/2"	1 1/8"	L35	K503	19/6

A. H. HUNT (Capacitors) LTD., WANDSWORTH, LONDON, S.W.18. Tel: BATtersea 1083. Est. 1901

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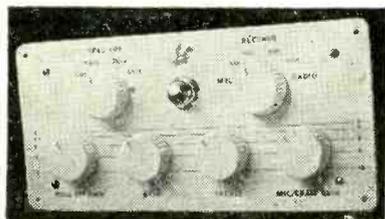
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Programme Time : 62 minutes at 7½ i.p.s.  
124 minutes at 3½ i.p.s.

Panel size : 20in. x 14½in.

Two speeds, 3½ 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

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Small Panel (13½in. x 15½in.), £45/10/-

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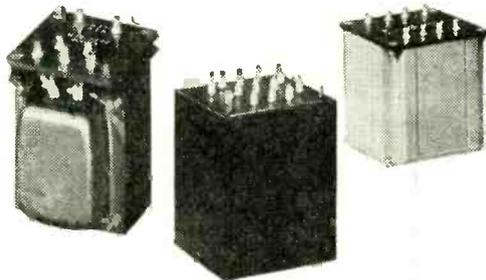
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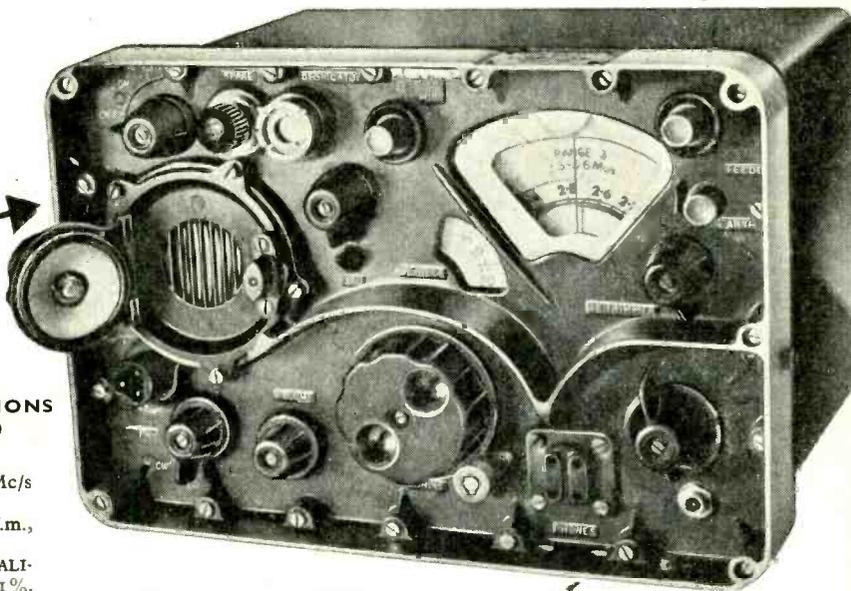
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AERIAL: Rod or wire. CALIBRATION ACCURACY: 1%.  
FREQUENCY STABILITY: 100 c/s per Mc/s per hour. SIGNAL TO NOISE RATIO: At least 20dB with 5 micro volt signal applied to 80 ohm input. C.W. FILTER: 950 c/s. POWER SUPPLY: 12 volt d.c. at 1.6 amps. DIMENSIONS: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



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Type	List Price	Screen Diameter and Colour	Heater		Anode Voltage			Modular Voltage for Cut-off Approximately	Beamletting			Base	Ref. no Table
			Volts	Amp	V <sub>a</sub> Max.	V <sub>a</sub> Mean	V <sub>a</sub> Min.		x	y	z		
B 4101 B/4	£5 0 0	1 1/2 in. Green	4	1	1,000	V <sub>a</sub> x 0.15	Internally connected (p. A)	V <sub>a</sub> 60	90	100	9 pin	1	
B 4205 B/7	£5 10 0	2 1/2 in. Green	4	1	1,500	V <sub>a</sub> x 0.15	Internally connected (p. B)	V <sub>a</sub> 80	110	120	9 pin	1	
B 4412 B/9	£13 7 6	3 1/2 in. Green	4	1	2,500	V <sub>a</sub> x 0.175	Internally connected (p. B)	V <sub>a</sub> 100	150	160	9 pin	1	
B 4504 B/16	£14 17 6	5 in. Green	4	1	2,500	V <sub>a</sub> x 0.175	Internally connected (p. B)	V <sub>a</sub> 100	150	160	9 pin	1	

### PHOTOELECTRIC CELLS

Type	List Price	Description	Spectral Sensitivity A. U.	Base	Reference on Table
CMG8	£4 5 0	Cadmium-Silver Oxide Gasfilled	3,000-9,000	4 pin	1
CMG22		Cadmium-Silver Oxide Gasfilled. Twin system			
CMG25		Cadmium-Silver Oxide Gasfilled. Twin system			
CMV28	£8 0 0	Cadmium-Silver Oxide Gasfilled. Twin system	3,000-9,000	4 pin	2
CAG25	£4 5 0	Cadmium-Silver Oxide Vacuum	3,000-9,000	4 pin	3
CAV25		Cadmium-Silver Oxide Vacuum	3,000-9,000	4 pin	4
CMV9	£9 7 0	Cadmium-Silver Oxide Vacuum	4,000-5,500	4 pin	5
CWS24	£9 18 0	Cadmium-Silver Oxide Vacuum	4,000-5,500	4 pin	6
KC7	£6 4 0	Potassium-Silver Oxide Vacuum	2,000-2,800	4 pin	7
KMV6	£9 7 0	Potassium-Silver Oxide Vacuum	2,000-2,800	4 pin	8
UNG7	£9 18 0	Cadmium Gasfilled	3,000-4,000	4 pin	9
UNGT		Sodium Gasfilled	2,000-3,000	4 pin	10

### VOLTAGE STABILISERS SINGLE GAP

Type	List Price	Striking Voltage	Operating Voltage	Max. Current mA	Min. Current mA	Regulation V
GS70 20	£1 8 3	95	70			
GSF5 10	18 9					

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.

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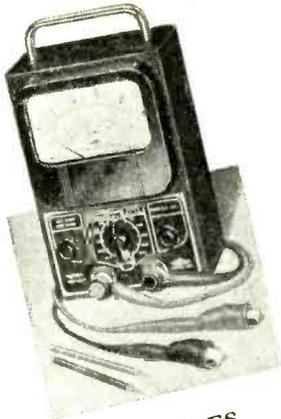


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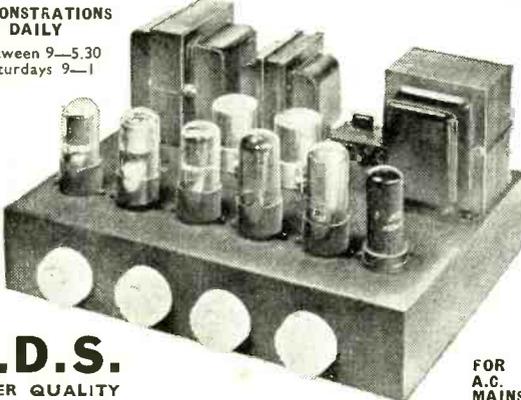
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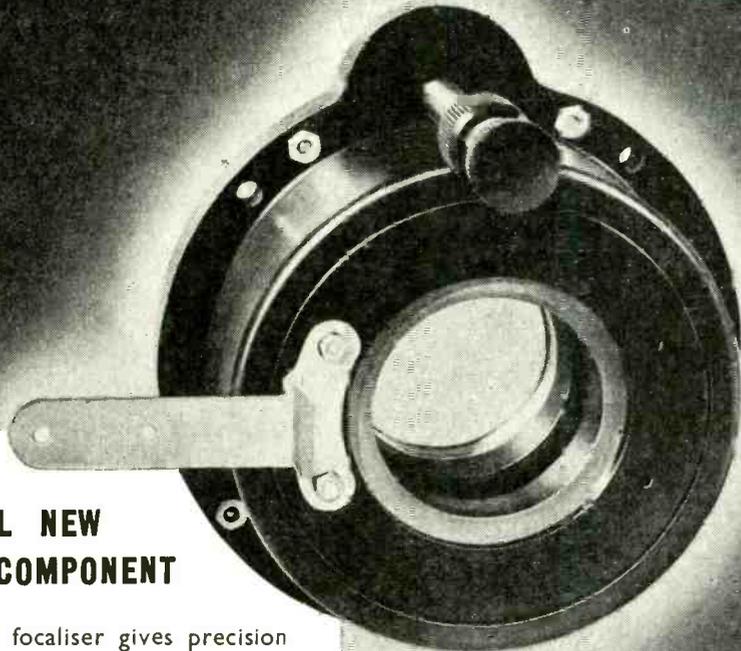
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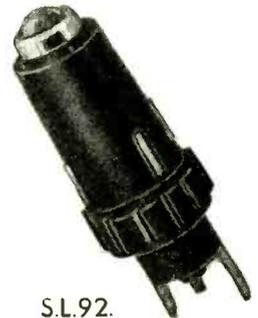
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8. Garrard RC.72A Unit with Head.
19. Garrard RC.75A.
20. Garrard RC.80.
21. Garrard Transcription Motor 201.
22. Garrard Transcription Motor 201/2B.
23. Garrard Transcription Motor 201/5B.
24. Connoisseur 3-speed.
25. Decca GU4 Unit.
26. Decca GU4A Acos Heads.
27. Decca GU4M Decca Heads.
28. B.S.R. MU10 Motors and Turntable.
29. B.S.R. MU14 Motors and Turntable.
30. B.S.R. GU4 Motors and Turntable.
31. Collaro 3-speed Auto 7", 10", 12".
32. Collaro 3-speed Mixer 7", 10", 12".
33. B.S.R. Monarch 7", 10", 12".
34. Trixette A358 3-speed Garrard.
35. Decca Decalcan 2-speed S/p.

**★ PICKUPS AND PICKUP HEADS**

**Item No.**

36. Decca XMS with two Heads.
37. Decca Hi-Fi Mag. Pickup Head
38. Connoisseur Pickup.
39. Connoisseur Pickup Head.
40. Connoisseur Pickup Transformer
41. Leak Ruby Standard or L.P.
42. Leak Diamond Std. or L.P.
43. Leak Pickup Transformer.
44. Acos G.P.19.
45. Acos G.P.20.
46. Acos L.P. and Std. Heads.
47. Acos Pickup Arm.
48. Decca Pickup Arm.
49. Collaro Pickup Arm.
50. Chancery Crystal Pickup.
51. Decca Crystal Pickup.

**★ LOUDSPEAKERS**

52. Goodman's Axiom 101 8".
53. Goodmans Audiom 60.
54. Goodman's Axiom 150 Mk. II.
55. Tannoy Duo Concentric 15".
56. Tannoy Duo Concentric 12".
57. Decca Corner Speaker.
58. Wharfedale Super 5/CS/AL.
59. Wharfedale Super 8/CS/AL.
60. Wharfedale OMMI Direc. 3-unit.
61. Wharfedale 10" Golden.
62. Wharfedale 10" CSB.
63. Wharfedale W/12/CS.
64. Wharfedale W/12/CS/AL.
65. Wharfedale W/15/CS.
66. WB Stentorian 12" unit.
67. Rola G.12 units.
68. Classic "Concert" 2-unit.
69. Acoustical Corner Ribbon.
70. Vitavox "Klipschorne"
71. Classic Hi-Fi Cabinet for Quad/Leak Amp.
72. Voigt. unit only.
73. Voigt. Corner Horn (White).

**★ TAPE DESKS AND RECORDERS**

**Item No.**

74. Wearite Type A Tape Deck.
75. Wearite Type B Tape Deck.
76. Bradmatic Desk 6RP Heads.
77. Sound Mirror Type A.
78. Truvox Type A.
79. Lane Type I.
80. Qualtape Type I.
81. Excel. Pro Tape Desk.
82. MSS Type PM RI Recorder.
83. Ferrograph Type A.
84. Vortexion Recorder with Wearite Deck.
- 84A. Vortexion with Truvox Desk.
85. CJR Portable Recorder.
86. Sound Mirror Portable.
87. Sound Mirror Table Model.
88. Simon Model 2B.
89. Simon Model IA.
90. Wirek Magnograph.
91. Wirek Reporter.
92. Bradmatic Amplifiers.
93. Scophony Baird Mk. 2.
94. Grundig Model A.

**★ TAPE RECORDING ACCESSORIES AND EQUIPMENT**

95. Bradmatic Circuits.
96. Bradmatic Plate Coil.
97. Bradmatic Oscillator Coil.
98. Bradmatic Bias Rejector Unit.
99. Bradmatic Mumetal Screens.
100. Bradmatic Tape Guides.
101. Bradmatic SRP Heads.
102. Bradmatic 6RP Heads.
103. Bradmatic SE Erase Heads.
104. Sound Mirror Tape, per reel.
105. G.E.C. Tape, per reel.
106. E.M.I. Tape, per reel.
107. Scotch Boy Tape, per reel.
108. Collaro Tape/Rec. Motors\*
109. Spare Spools.
110. Acos Microphone.
111. Rothermel Mike.
112. Reslo Ribbon Mike.
113. Reslo Table Stand.
114. Reslo Moving Coil Mike.
115. B.S.R. FP.10, 1,400 r.p.m.
116. B.S.R. SR.1, 2,750 r.p.m.
117. B.S.R. SR.2, 2,750 r.p.m.

\* Left and right drive.

SEND NOW FOR NEW LISTS SHOWING REDUCED PRICES AND TERMS.

**LARGE SCREEN T/V.** Decca Projection T/V for sale. Details on request. Also other makes, tubes, components, etc.

**H.P. DEPOSITS** All goods value £10 or more available on H.P. Terms. Minimum deposit—one-third of cash price in all cases. Longer terms on goods over £100 by arrangement.

**SERVICE** Merchandise is thoroughly tested before despatch and guaranteed. Every effort is made at all stages of business to ensure your personal satisfaction. Enquiries are invited for any items not listed here. New showrooms for tape-recorders, large-scale T/V and gramo. equipment now open.

**THIS MONTH'S SPECIAL OFFER**

Decca P.A. 6 Amplifier in case. Plessey 3-speed Autochange for 7", 10" and 12" records and Goodman's Axiom 101 8" Speaker. All famous equipment, brand new and tested. Usual price of complete outfit, £52/5/9. Our special price

**£36 cash**  
or £12 deposit and 12 monthly payments of 46/-.



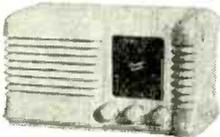
THE **CLASSIC ELECTRICAL** CO., LTD.

352/364, LOWER ADDISCOMBE ROAD, CROYDON, SURREY. Telephone: ADDISCOMBE 6061-6062.

# PREMIER ANNOUNCEMENT

We can supply all the parts to help you.

- Drum (2 1/2 in. dia.) 1/6
- Driving head 1/6
- Double pointer 3/4
- Spring 3d.
- Nylon Cord (yard) 2d.
- Dial Front Plate 6/6
- Engraved Glass Dial 180-530 and 800-2200 m. With station names, new wavebands 1/6
- T.R.F. Coils 180-350, 800-2200 metres, pair 6/6
- Punched chassis, 3-valve plus rectifier T.R.F. 3/9
- Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut Finish 17/6
- Packing and Insurance 2/6



**BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TO-DAY'S PRICE**

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. x 5in. x 6in. presents an attractive appearance. The valve line-up is: 717A—H.F. Pentode, VR116—Detector, AP74—Output, and Metal Rectifier.

Waveband coverage is for the medium and long bands. Choice of 3 Cabinets. Bake lite in Walnut or Ivory, or Wooden (Walnut finish).

### Famous Set Manufacturer's surplus of ELECTRIC 'GRAM UNITS

Two-speed, 331 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.



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

**£4.2.6**

### GRAMOPHONE UNITS

**GARRARD 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**

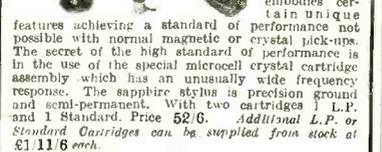
**COLLARO 3-speed single gram. unit,** complete with head for L.P. and Standard recordings. **£8.8.0**

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 cfs. 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 frequency at the correct point. **PRICE £16.10.3** plus 5/- pkg., carr.

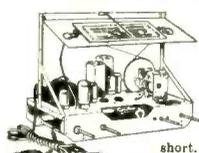
**THE FAMOUS "CHANCERY" HIGH-FIDELITY MICROCELL PICK-UP—TYPE GPX for Standard and Long Playing**

The Chancery Light Weight GPX 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 (L.P. and 1 Standard. Price **£2.6**. Additional L.P. or Standard Cartridges can be supplied from stock at **£1.11/6** each.



**Govt. Surplus—Ex. W.D. STEEL AERIALS**  
Also ideal for fishing rods—ALL BRAND NEW  
12ft.—34ft. sections of copper-plated steel highly flexible tapering 1in. to 1/4in. Brand new in container 6/9. Packing and carriage 1/6. Insulated Base 3/-. Webbing waterproof carrying case with shouldering. 2/6.

### MANUFACTURER'S SURPLUS STOCK



**5 VALVE SUPERHET RADIO RECEIVER CHASSIS**, built to high standards ensuring quality reception. SPECIFICATION—**VALVE LINE-UP:** 7B7, 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 14 1/2in., height 11 1/2in., width 6 1/2in. Distance between controls, left to right from edge of chassis: 1in., 3in., 6 1/2in., 3in. Plus 5/- pkg./carr./ins. **£7.19.6**

### A 4 Valve BATTERY SUPERHET RADIO RECEIVER CHASSIS

by the same manufacturer is also available. SPECIFICATION: MAZDA VALVE LINE-UP: TP25, VP33, HE23D, 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 6 1/2in. Distance between controls, left to right from edge of chassis, 1 1/2in., 3 1/2in., 3 1/2in. **£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 28/- extra.

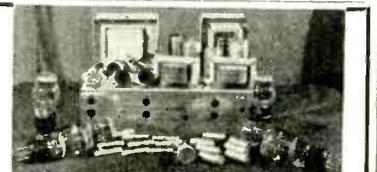
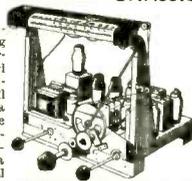


### LOUDSPEAKERS—TAX FREE!

- ELAC—2 1/2in. dia. Moving Coil, 15 ohms impd. 15/-
- PLESSEY—3in. dia. Moving Coil, 3 ohms impd. 15/-
- ELAC—3 1/2in. dia. Moving Coil, 3 ohms impd. 15/-
- ELAC—5in. dia. Moving Coil, 3 ohms impd. 14/6
- E.M.I.—3in. Elliptical, 15 ohms impd. 27/6
- PLESSEY—3in. dia. Moving Coil, 3 ohms impd. 14/6
- PLESSEY—3in. dia. Mains Energised, 3 ohms impd. (600 ohms field), with Pentode Transformer 22/6
- PLESSEY—3in. dia. Mains Energised, 3 ohms impd. (600 ohms field) 19/6
- PLESSEY—10in. dia. Moving Coil, 3 ohms impd. 23/6
- GOODMANS—12in. dia. Moving Coil, 15 ohms impd. Plus 5/- packing and carriage. **£38/8**
- VITAVOX—K12/20 12in. dia. Moving Coil, 15 ohms impd. **£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: 5 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HI41D gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 485 Kcs., using Mazda VP41. **FOUR WAVEBANDS—14 M.-24 M., 24 M.-55 M., 190 M.-800 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 2/- 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 7/8 pkg., carr. and ins. **WILLIAMSON AMPLIFIER TRANSFORMERS (To specification)** The Output Transformer 3.8 ohms sec. **£4/4/-** The Mains Transformer **PREMIER SF425A, £3/7/6.**

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

### ONLY A FEW LEFT—BUY NOW! THE '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 manufacturer's original carton. **£13.13.0** plus 7/6 pkg./carr./ins. (Complete with Battery 17/6 extra.)



### I124 RECEIVER UNIT

Range 30 to 40 Mc/s. Contains six new valves, 39D2, 1-812, 1-15D2 (frequency changer), 1-D41, 24 ceramic trimmers, 8 ceramic valveholders, 6 valve screening cans, 30 resistors, 1-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and 1 Westector WX4, 5-way 4-bank switch with long spindle, I.F. transformer, etc. Brand new in maker's carton at 17/6, plus 3/6 postage and packing.

**R132A RECEIVER.** Complete with valves **£3/10/6**. Plus pkg. and carr. 10/6.

### I155 RECEIVER UNIT

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



### POWER SUPPLY UNIT

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 63in. 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 our 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.

**R1355 RECEIVER AMPLIFIER** with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's, 1-3U4, 1-VU120, 1-EA50, **£1/19/6**. Plus pkg. and carriage 10/-.

**RF 25 UNITS** Frequency covered 40-50 Mc/s (6-7.5 metres) switched tuning. 5 Pre-set positions complete with 3 VR65's **£11/5/-**. Plus pkg. and carr. 2/6.

**RF 26 UNITS** The ideal short-wave converter for T.V., variable tuning, contains 2-BF64, 1-VK137, **£2/19/6**. Plus pkg. and carr. 2/6.

\* As a special offer we can supply the R1355 complete with RF 24 or RF 25 at 58/6 or with RF 26 at **£4.17.0** plus carr.

**ROTARY CONVERTER POWER SUPPLY UNITS** 12 v. D.C. Input 230 v. 30 mA Output. Completely smoothed. Complete with case, 19/6. Plus 5/- pkg./carr.

**WEYMOUTH MINIATURE COIL PACK** Covering Med./Long/Short wave bands. Iron cored coils, gram. position on switch. Dimens: Height, 1 1/2in. Length 3 1/2in. Width 2 1/2in. Spindle length 2in. Price 19/6.

**WEYMOUTH MINIATURE I.F. TRANSFORMERS** 45 Kcs. iron cored, permeability tuned. 10.6 pair.

**MINIATURE TUNING CONDENSERS** 2 gang .0005 mfd. with trimmers **6/9**

# PREMIER RADIO COMPANY

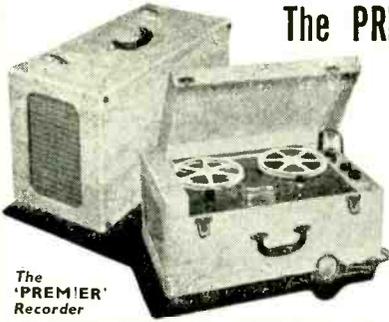
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(Dept. W.W.) 207 EDGWARE ROAD LONDON W.2  
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**The PREMIER De Luxe PORTABLE Magnetic**  
**Tape Recording Kit—Price £37.4.0**



(Plus 15/- Pkg., Carr. & Insur.)



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 7 1/2 in./sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-.

**INSTRUCTIONAL BOOKLET . . . 2 6**  
 This is credited if a complete kit of the Tape Recorder is ordered.

As is usual in all PREMIER KITS, every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included. When completed, the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.

**SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW—**  
**AMPLIFIER KIT** (including 8in. Speaker) . . . £11.0.0 plus 5/- pkg./carr.  
**AMPLIFIER** (already built, wired and tested) . . . £14.15.0 plus 7/6 pkg./carr.  
**LANE TAPE TABLE & REWIND SPOOL** . . . £16.10.0 plus 7/6 pkg./carr.  
**PORTABLE CABINET** (rexine covered) . . . £4.19.6 plus 5/- pkg./carr.  
**MICROPHONE REEL OF "SCOTCH BOY" TAPE** (1,200ft.) . . . £1.15.0 plus 6d. pkg./carr.

To those unable to build this PORTABLE TAPE RECORDER we can supply it completely wired, tested and ready to plug in at **39GNS** Plus 1 gn. pkg./carr.

**CRYSTAL MICROPHONE**  
 An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High Impedance. No background noise, really natural tone. The ideal Mike for tape, wire and sound projectors. Price 22/6.



**MICROPHONE STAND BASE**  
 Heavy Moulded Black Base fitted with Standard throat adaptor. Dimensions: 7 1/2 in. across, 2 in. deep. Weight: 1 1/2 lb. Post paid 3/11.

**MOVING COIL MICROPHONE**

Low impedance. Incorporates pre-assembled talk switch. Housed in strong black bakelite case. Dimensions: 2 in. wide, 2 1/2 in. high, 1 1/2 in. deep.  
 Plus 1/6 post and packing **19/6**  
 A matching transformer for high impedance can be supplied at 3/6 extra.



**MICROPHONES**

**LUSTRAPHONE**: Moving Coil; High Impedance. Stand Type: £5/12/6—Hand Mike £3/6/-.  
**RONETTE**—Crystal Mike; Incorp. the Filter Cell Insert; High Imped. Ball Type: £3/19/6.  
**CRYSTAL MICROPHONE**—Rothermel 2AD:6. Especially recommended. £2/19/6.  
 Table Stands for all the above 17/6.

**ALL-POWER**  
**REGULATED POWER SUPPLIES**

**MODEL 501**

STABILIZED OUTPUT . . . . .	200-500 VOLTS	0-250mA
UNSTABILIZED OUTPUT . . . . .	470/630 VOLTS	0-250mA
UNSTABILIZED A.C. . . . .	6-3 VOLTS	10 AMPS

VOLTAGE STABILIZATION WITHIN ± 0.02%  
 EFFECTIVE OUTPUT RESISTANCE 0.2Ω MAX.  
 OUTPUT RIPPLE LESS THAN 2mV RMS.

**STANDARD MODEL**

19" RACK MOUNTING . . . . . £70

**END FRAMES**

REINFORCED, POLISHED HARDWOOD  
 £1 15 0 per pair

STEEL INSTRUMENT CASE . . . . . £4 10 0



MODEL 501  
 (fitted with end frames)

**ALL-POWER TRANSFORMERS LTD.**  
 CHERTSEY ROAD, BYFLEET, SURREY

Tel.: BYFLEET 3224/5

PRICES QUOTED ARE NET EX WORKS AND ARE SUBJECT TO VARIATION WITHOUT NOTICE

FOR

# Complex Waveforms

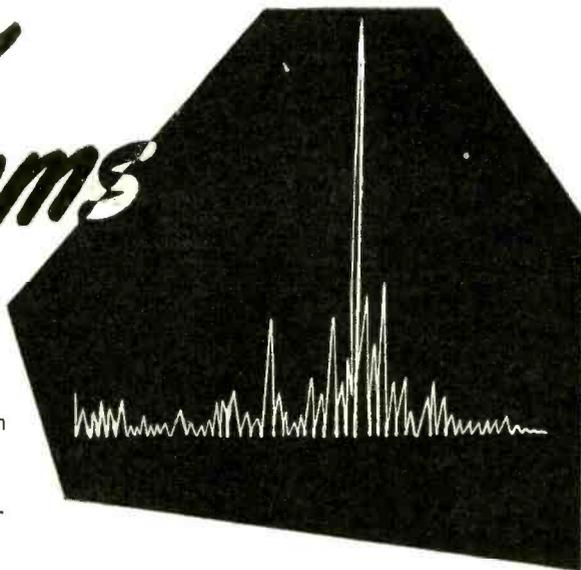
AND SIMILAR ANALYSIS

This Panoramic Display shows the Frequency and Magnitude Analysis of Torsional Vibration in the Main shaft of a Turbo-Jet Engine.

Model 1950 Panoramic Wave Analyser  
40c/s to 25Kc/s.

Sensitivity 10mV to 30 volts.

Time and Amplitude Calibration.



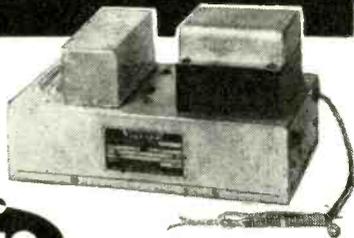
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**ALL** the A.C. power you require  
from your D.C. supply

with a

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### D.C./A.C. CONVERTER

Models for Electrical Gramophones from £8 16 0  
Models for

- Radiograms and Autochange Radiograms (inc. 3-speed motors)
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Tel.: FELTHAM 4242

Service Dept.: 57 Fortress Road, London, N.W.5. Tel.: GULLIVER 5165 & 7202

Scottish Depot: 257 Gorbals Street, Glasgow, C.5. Tel.: South 1326

Overseas enquiries to nearest E.M.I. Organisation Depot.

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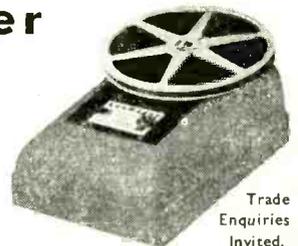
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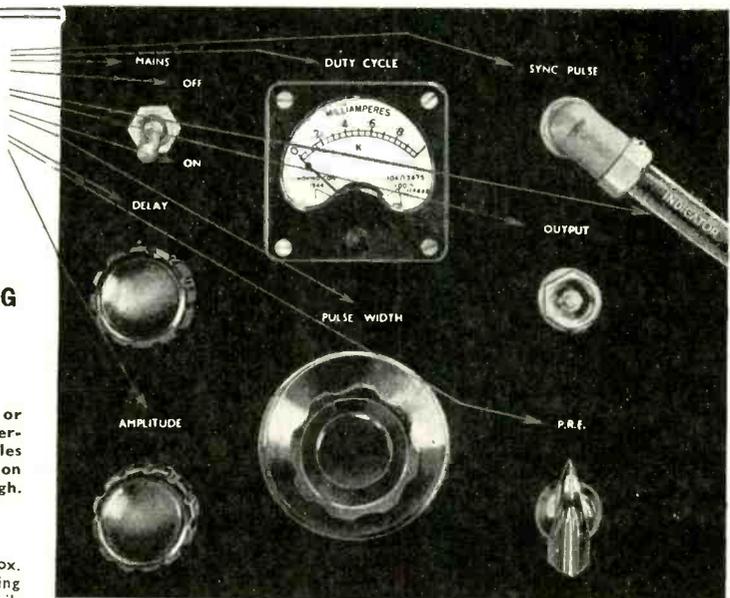
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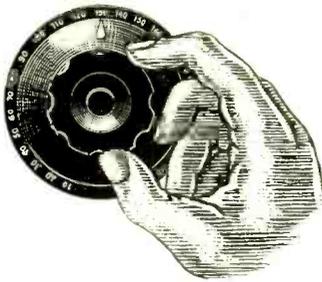
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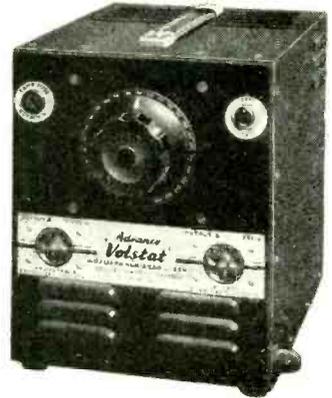
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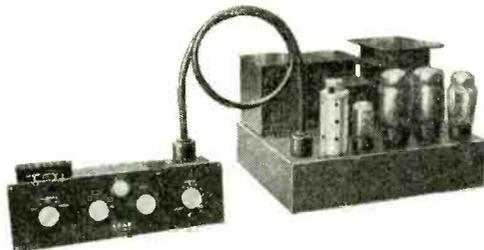
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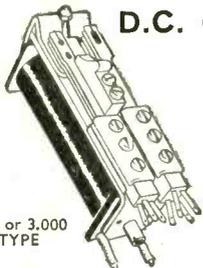
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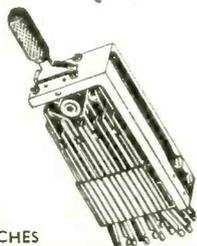
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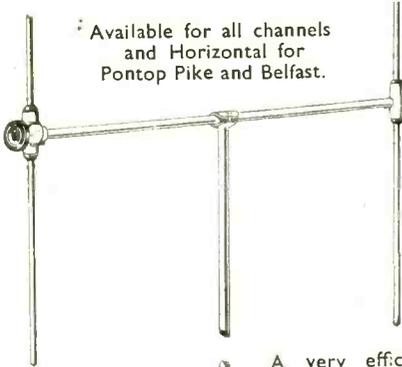
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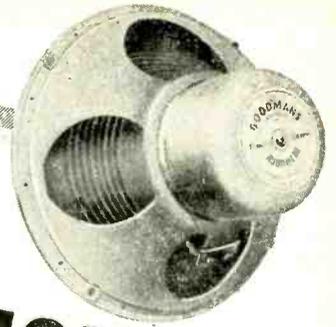


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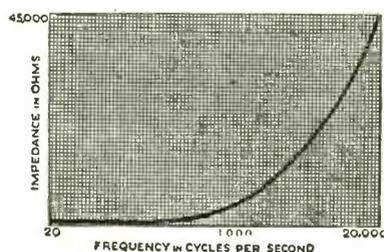
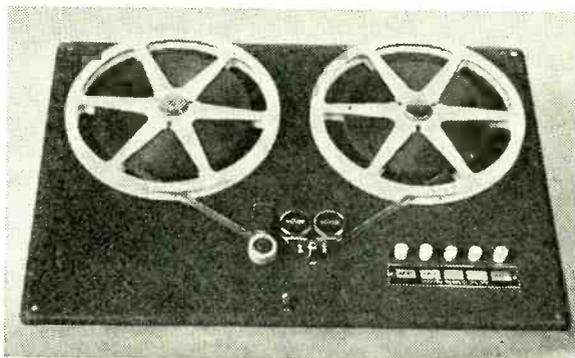
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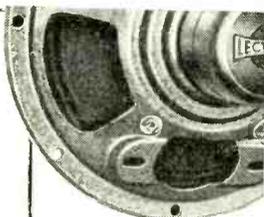
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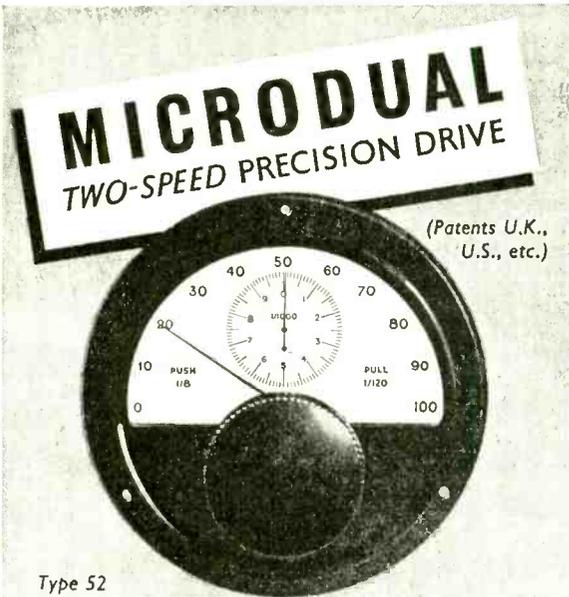
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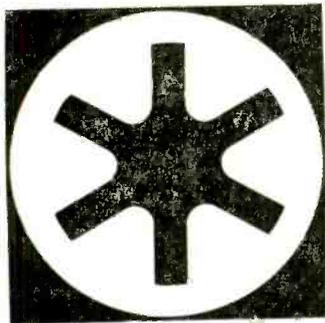
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# Wireless World

RADIO, TELEVISION  
AND ELECTRONICS

43rd YEAR OF PUBLICATION

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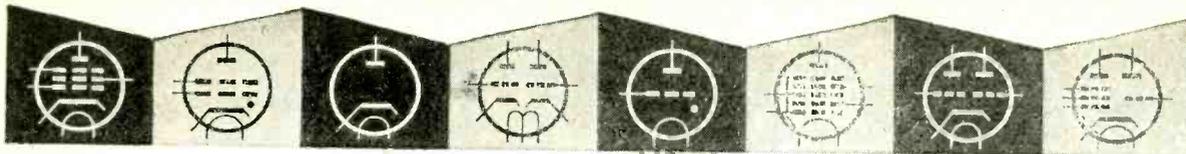
*The International Wireless Encyclopedia* JUNE 1953

*Book 1000 (continued)*

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### APPLICATION IN VARIOUS TYPES OF RECEIVERS

**Battery Receivers** Those receivers provided with a 90-volt battery operate with an h.t. of about 85V after deducting the negative grid bias required for the output valve. In such a receiver a DM70 connected with pin 4 earthed has a cut-off voltage of  $-10V$ , which is adequate to indicate the strongest signal likely to be encountered. Similarly for a 67.5V battery, the h.t. is of the order of 60V giving a cut-off voltage of  $-7V$  when connected with pin 5 earthed.

**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  $56\Omega$  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  $220\Omega \pm 5\%$ . Alternatively, a 3.15V centre-tap on the heater supply can be used, the value of the series resistor then being  $82\Omega \pm 10\%$ .

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  $18\Omega \pm 10\%$  when included in a 100mA heater chain.



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**MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2.**

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# Wireless World

JUNE 1953

VOL. LIX No. 6

## *Exhibitions*

**I**T 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*

**T**HE 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  $1\text{ M}\Omega$  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  $110\ \mu\text{A}$  and grid current of  $10^{-7}\ \mu\text{A}$ . 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 modula-

tion 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,  $1.5 \times 10^8$  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.

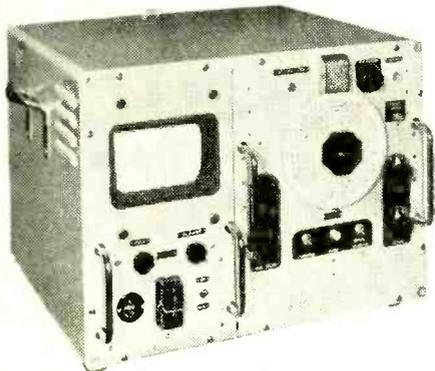
An infra-red image converter tube has been applied by Prof. B. K. Johnson (Imperial College) to the microscopy of opaque specimens, and is being used in the examination of minerals for the identification of uniaxial and biaxial crystals.

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  $10\ \mu\text{V}$  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  $10\ \mu\text{V}$ , 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 coercive 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  $1.7 \times 10^6$  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  $6.8 \times 10^6$  gauss-oersteds compared with  $5 \times 10^6$  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 Technical 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); Morrison 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); Suffix (B, CO, IM, IS, W); Swift Levick (M); H. D. Symons (IM, IS); Taylor Tunnickiff (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.

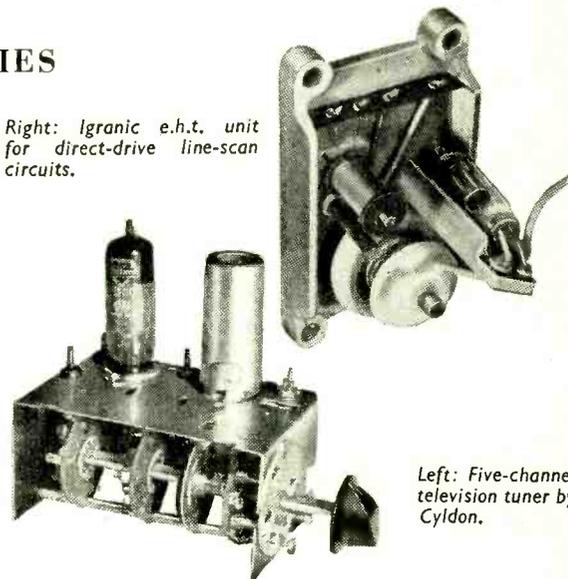
## COMPONENTS AND ACCESSORIES

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.

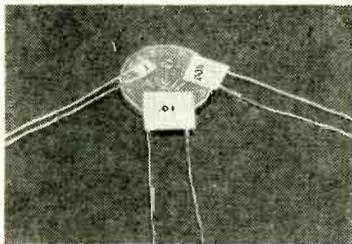
The problem of mounting the variable inductors used for width and linearity control has been solved in one way by Egen Electric, who have combined them into a twin unit, and in another by Plessey, who have stowed them in the mounting bracket of their new line scan transformers.

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

## Capacitors

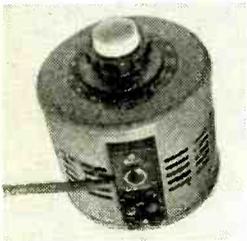
Metallized polystyrene film capacitors figure among the latest T.C.C. products. These are comparable in size to small paper types but have infinitely better characteristics. Capacitances up to 0.5  $\mu$ F are available. Another plastic film capacitor, also made by this firm, has the exceptionally close tolerance of  $\pm \frac{1}{2}$  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

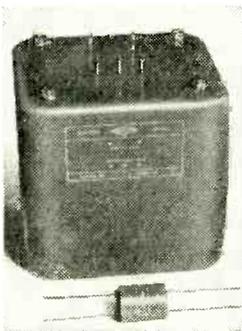


Left: Plessey "Cas-film" silvered ceramic capacitors.

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



Above: Zenith twin-brush Variac variable voltage transformer.



firing at a controlled temperature. Reduction in size is claimed as a by-product of this process.

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 "Cas-film" silvered ceramic film capacitors. The smallest, measuring 0.2 in square only, provides a capacitance of 0.001  $\mu$ F 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), Eric (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), Suffix (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.

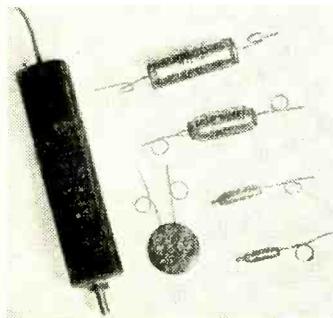
A glimpse into future development was vouchsafed by some unusual fixed resistors shown by the Ministry of Supply. In one case a form of conducting glass is applied to glass plates and rods and then fired to fuse the whole together. In another, microscopic films of one of the precious metals is applied 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), Eric (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).

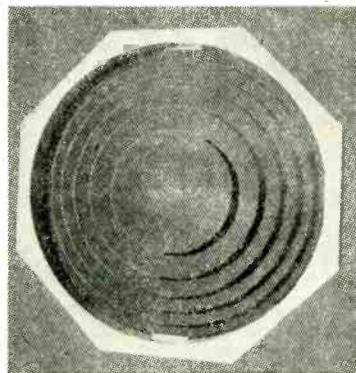
\*Abbreviations: C=carbon, Hs=high stability, S=standards, W=wirewound.

## 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.

## 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.

## Sub-assemblies

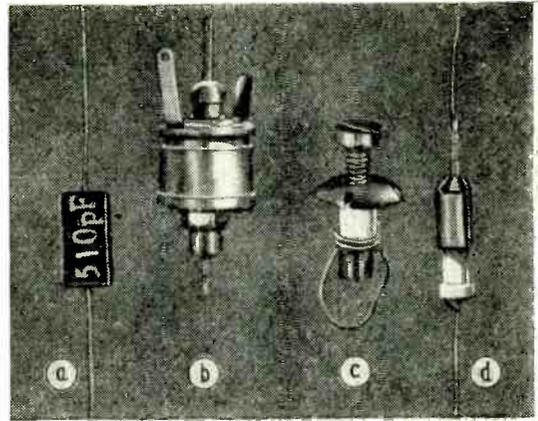
The printed circuit technique is used by Eire in a range of compact resistance-capacitance units covering such requirements as diode filters, triode and pentode RC couplings and various other combinations.

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.

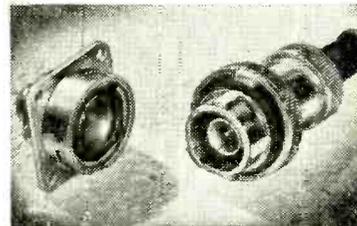
Interference suppressors form another convenient sub-assembly and as produced by Dubilier they comprise capacitors and chokes of one kind or another. A special range of television interference suppressors is now available for use on or in small domestic appliances such as electric sewing machine motors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

## Chassis Fittings

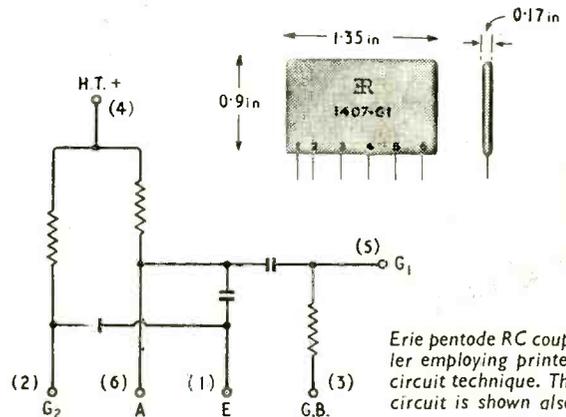
Careful insulation is the main feature of the latest valveholder from McMurdo. Intended for B9A c.h.t. rectifiers, it has a Nylon-loaded Bakelite socket moulded



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 1/2-in long.

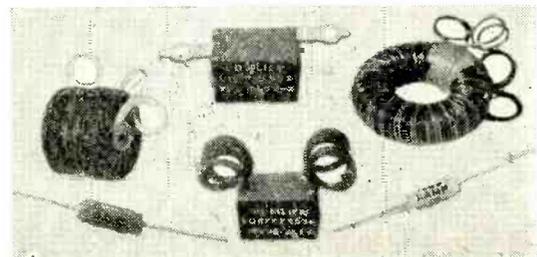


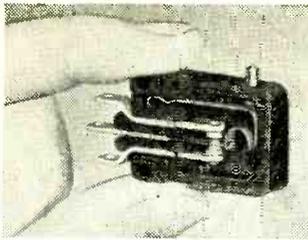
Left: Belling-Lee double-screened coaxial plug and socket.



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

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

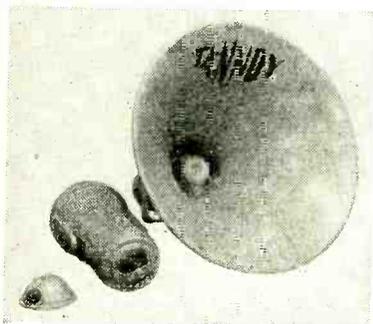




Left: Bulgin micro-switch with side cover-plate removed.



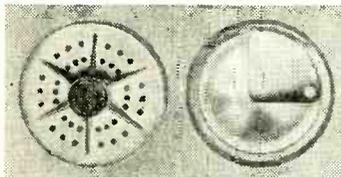
Right: Barrier terminal strip by Carr Fastener.



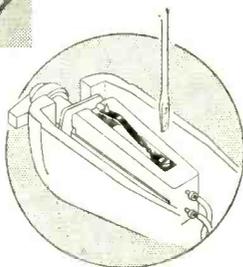
Left: Tannoy 100-watt loudspeaker for airfields, harbours, etc.



Right: Goldring No. 200 magnetic pickup.

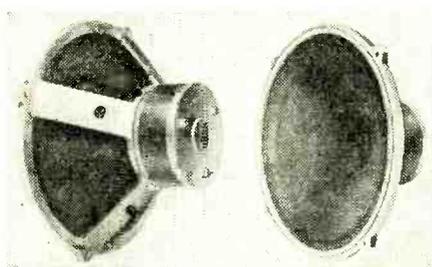


Left: Front and back plates of Acos Mic. 32 microphone capsule.



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  $\frac{3}{4}$ -in pin spacing and those with  $\frac{1}{2}$ -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 & Hanoly, McMurdo, Paton, Plessey, Resosound, Simmonds Accessories, Steatite, Telcon, Thermo-Plastics, T.M.C., Transrad Co., Tucker Eyelet, United Insulator Co., Walter, Weymouth, Whiteley, Widney-Dorlec, Wimbleton, 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  $\frac{1}{4}$ -in 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, Eric, N.S.F., Painton, Plessey, T.M.C., Walter, Whiteley, Wearite.

## Sound Reproduction

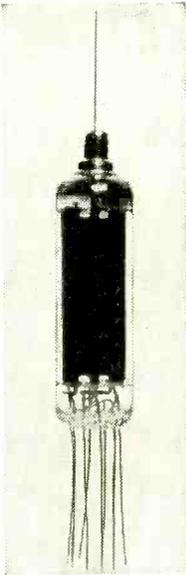
An interesting new p.a. loudspeaker has been developed by Tannoy for airfields, harbours, etc. The single driver unit is rated to handle 10 watts (120 watts peak) and is used in conjunction with a 200-c/s cut-off horn to give an electro-acoustic conversion efficiency of 50 per cent. The pressure unit 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.

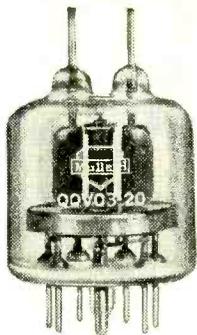
In the new "53" series of Collaro gramophone motors and record changers a new speed-change mechanism with a large-diameter, concentric-ground rubber idler has been designed with a cam mechanism to minimize wear when changing speed. A new crystal turnover pickup head, the "Studio," has been added to the 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.

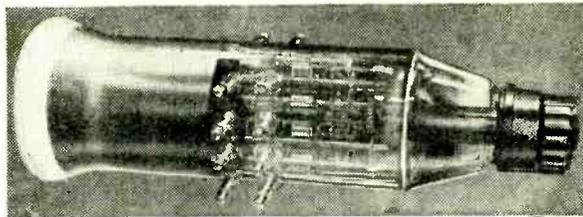
Garrard are now in production with a new transcription-



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 c.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.

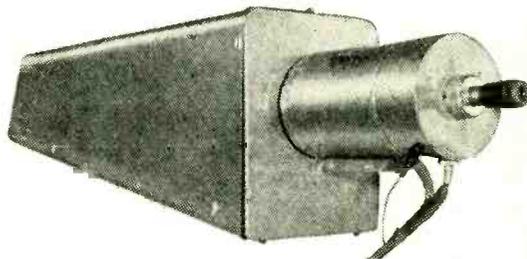
In cathode ray tubes much interest has been aroused by an oscilloscope tube containing four separate guns, made by 20th Century Electronics. It operates at 5kV on the final anode and the deflection sensitivity is just under 1/2mm per volt. Each gun has independent deflecting plates and the makers claim 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.

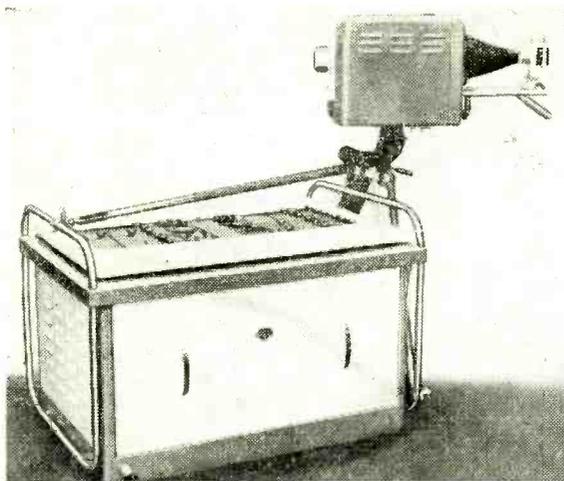
Remarkable for its extremely small size is the Ferranti KD10 voltage stabilizer, which stabilizes at 62 volts  $\pm 0.15$  volts with a running current of 1-1.2mA. It is made in a metal capsule measuring only 1/8 in  $\times$  1/8 in  $\times$  1/2 in. Miniaturization is also the main feature of the new Westinghouse tubular e.h.t. rectifiers, Type 39. They are 7/8 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 100 $\mu$ A 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 eyepiece) 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.

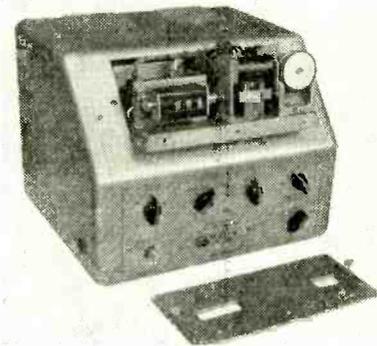
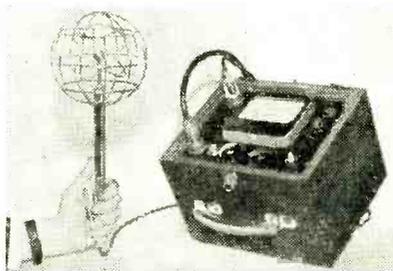
The servo or negative feedback principle is to be seen in a good many electronic instruments nowadays. In several d.c. amplifiers of the mirror-galvanometer type, for example, a portion of the output is fed back to stabilize the action of the galvo. Then in two a.c. voltage regulators a change in input 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 "thermo-balance" 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.

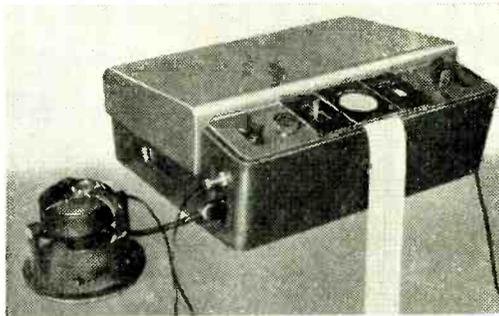
Process timers are widely used and depend usually on the time-constant of an RC circuit. As a demonstration, Allied Electronics show equipment designed to life-test an electronic d.c. voltage stabilizer through a regime of varying load and supply voltage.

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  $3\frac{1}{2}$  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



Furzehill recording watch timer.

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.

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 thyatronns 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 Edgcombe 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 μs, and the Airmec 830 (30 c/s-20 Mc/s and 25 μs 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 2½-in-tube instrument weighing only 6½ 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.

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."

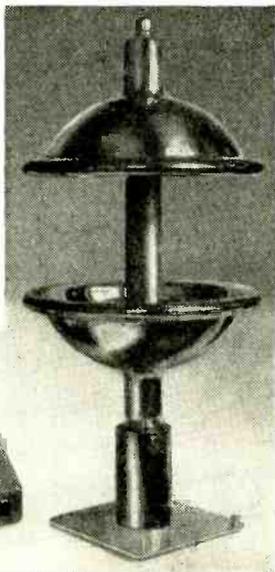
The Marconi Instruments TF948 signal generator covers 20-80 Mc/s in two ranges, the effective scale length being over 14 feet, and is provided with sine wave f.m. and sine and square wave a.m., internally at three audio frequencies. The specification is elaborate and includes crystal frequency checking 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.

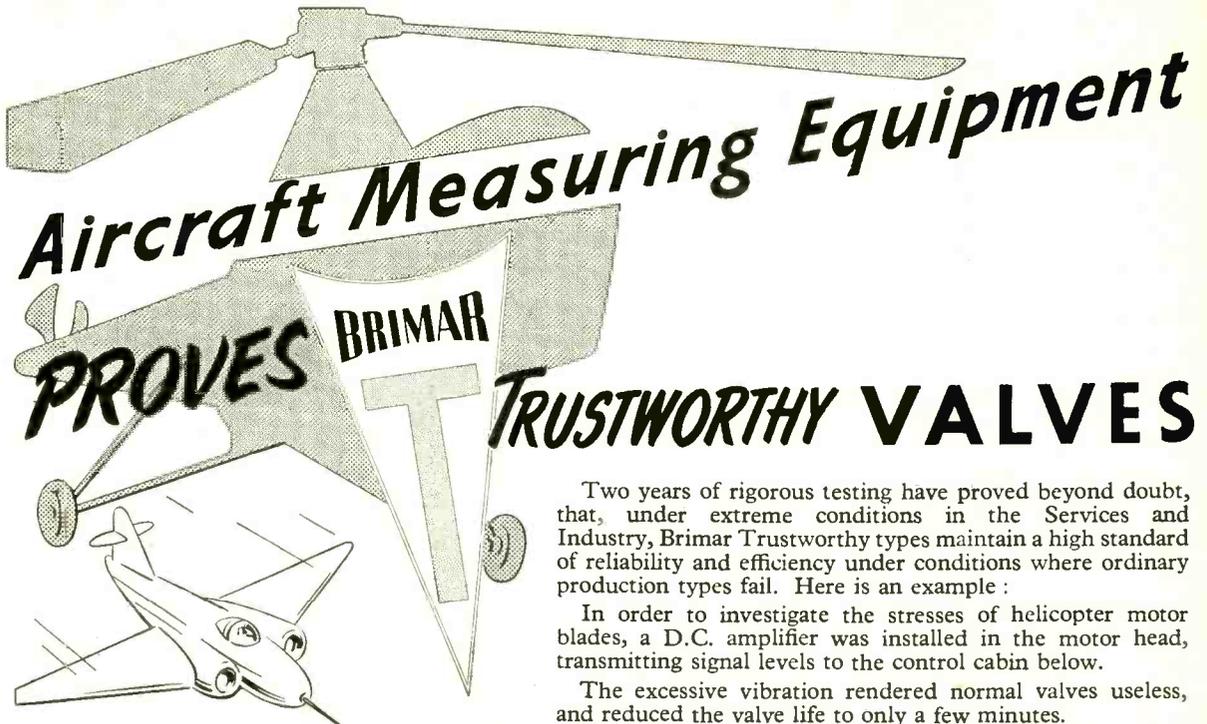
Instruments for frequency measurement are not so prominent as they have been in times past, but there are three new Furzehill crystal frequency standards: one providing 150 watts at  $50 \pm 10^{-5}$  c/s, and two portable units for general frequency checking, of which Type G.410 is provided with push-button 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



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

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





# 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.

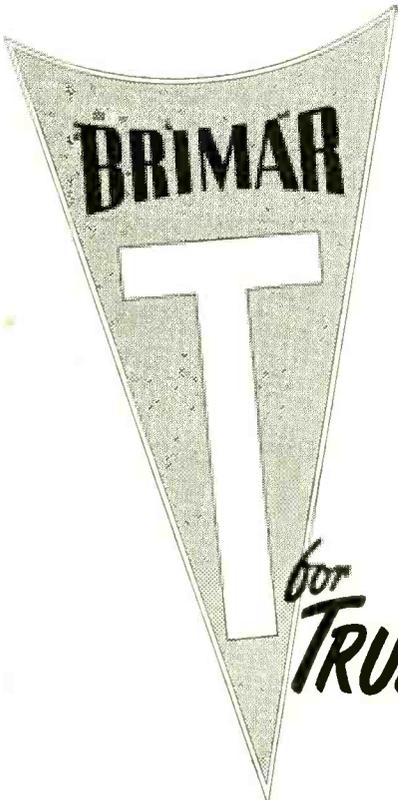
Substitution of Brimar "Trustworthy" type 6067 freed the D.C. Signals of all noise, and measurements were able to proceed.

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.

## 3 TRUSTWORTHY types are immediately available for commercial use

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



BRITISH MADE

# BRIMAR VALVES

*Standard Telephones and Cables Limited* FOOTSCRAY, SIDCUP, KENT

# Tracking 2000g at 10 grammes maximum stylus pressure



## 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.

### 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 db.

and this gives a velocity of 31.6 cm/sec. and a corresponding displacement of .0002in.

( $e = \frac{v}{2\pi f}$ ). It further

follows that expressed in gravitational units the acceleration at 10,000 c/s. may be as high as 2000g ( $g = \frac{e f^2}{10}$ ,

where  $e$  = displacement = .0002in. and  $f$  = 10,000 c/s.).

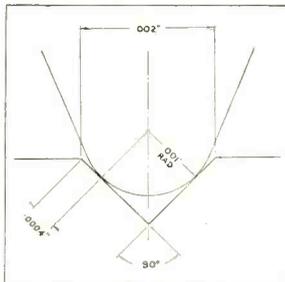


Fig. 1

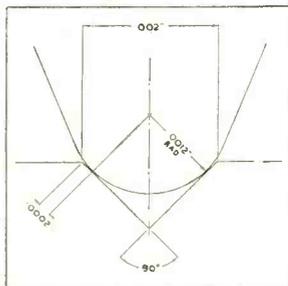


Fig. 2

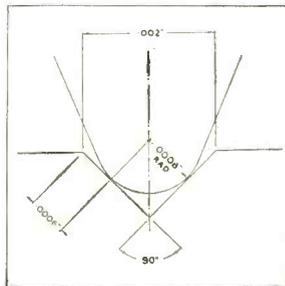
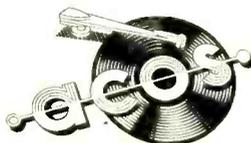


Fig. 3

### 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.



always well ahead

Acos Crystal Devices are Protected by Patents and Patent Applications in Gt. Britain and Other Countries.

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.

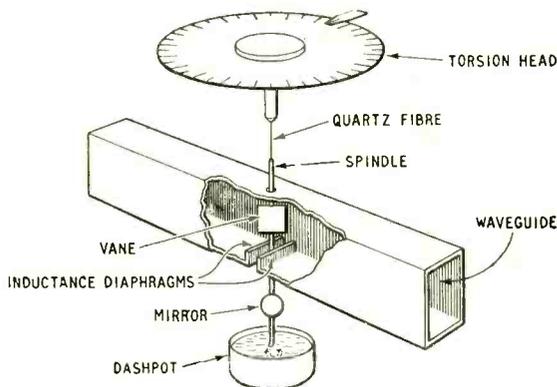
Nearly all new a.c. bridge designs, for all frequencies from power to v.h.f., are based on the use of transformer ratio arms for input or output or both. One of the chief advantages is that an admittance connected across part of a low-leakage transformer winding does not appreciably alter the ratio, 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 has 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 0.01  $\mu$ H 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.

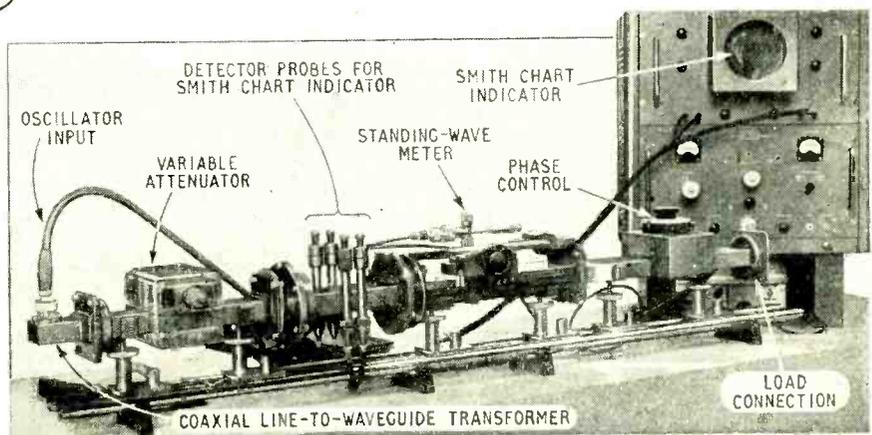
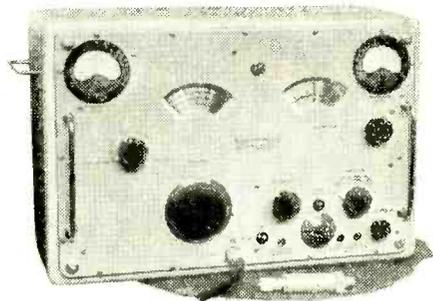
Measuring apparatus for frequencies over 2,000 Mc/s centres on the waveguide "test bench" assembled from a wide variety of waveguide sections and components. Most of the work is based on observance of standing-wave ratio and node positions, and some recent devices have the object of facilitating this. 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

**E**ARLIER 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,  $\alpha$ , 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

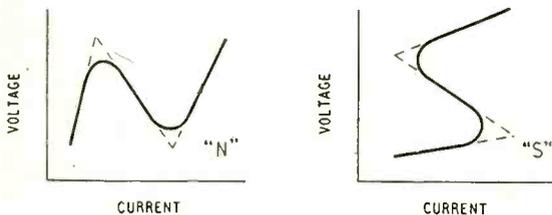


Fig. 1. Characteristics of the two main types of negative resistance.

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

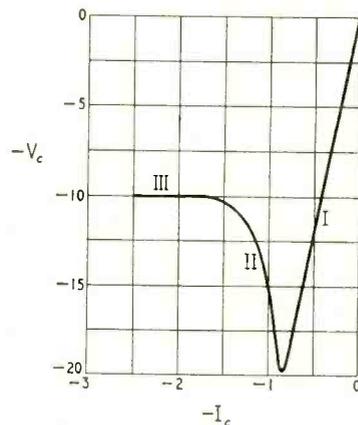
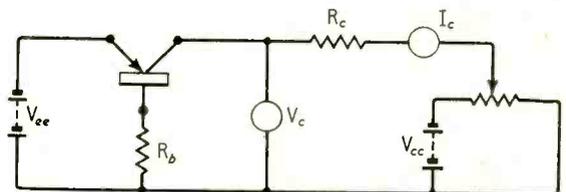
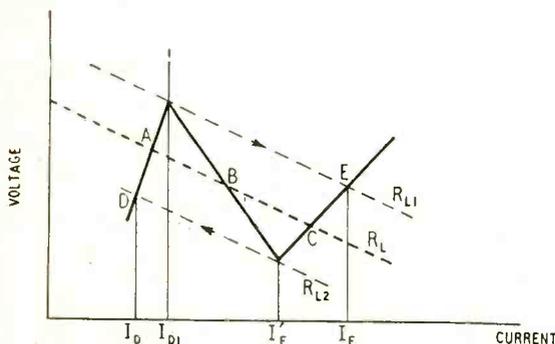
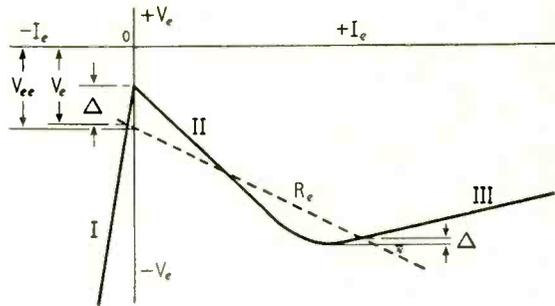
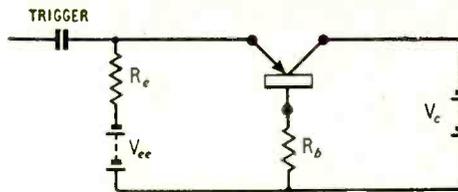
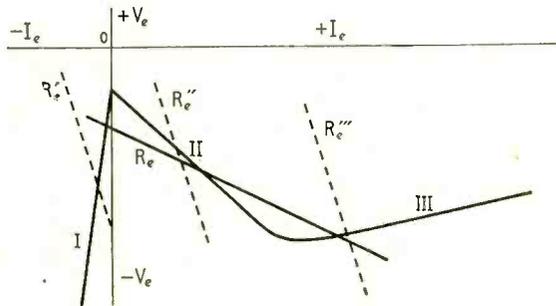
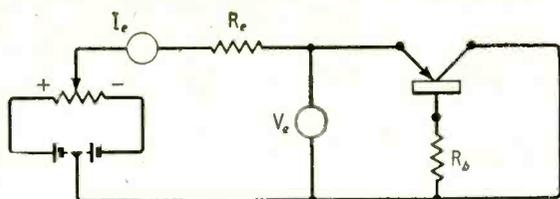


Fig. 3. Collector large-signal negative-resistance characteristic.



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.

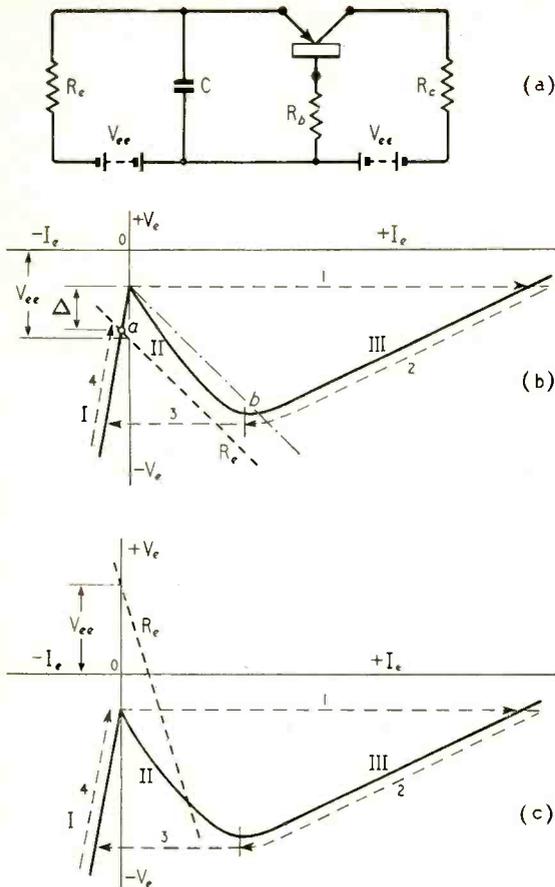


Fig. 6. Monostable and astable characteristics resulting from the addition of capacitor C.

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  $\Delta$ . 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 0.01-0.5  $\mu$ F. 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.

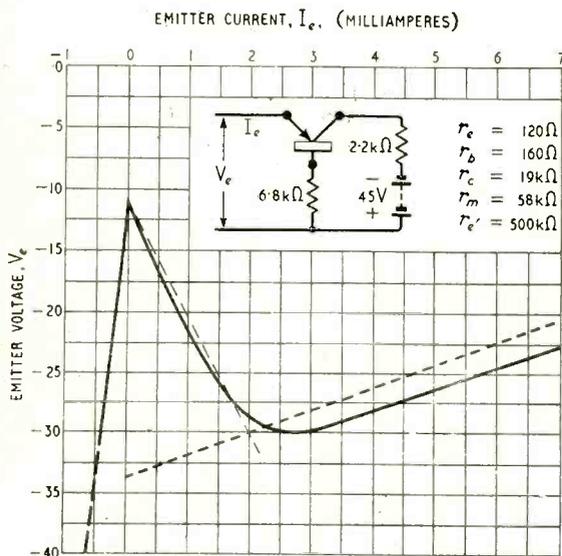


Fig. 7. Basic circuit values and calculated (dotted) and measured emitter negative resistance characteristics, for a Type 1698 point transistor.

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 ( $C \times$  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  $V_e R_b / (R_b + r_c)$ , where  $V_e$  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

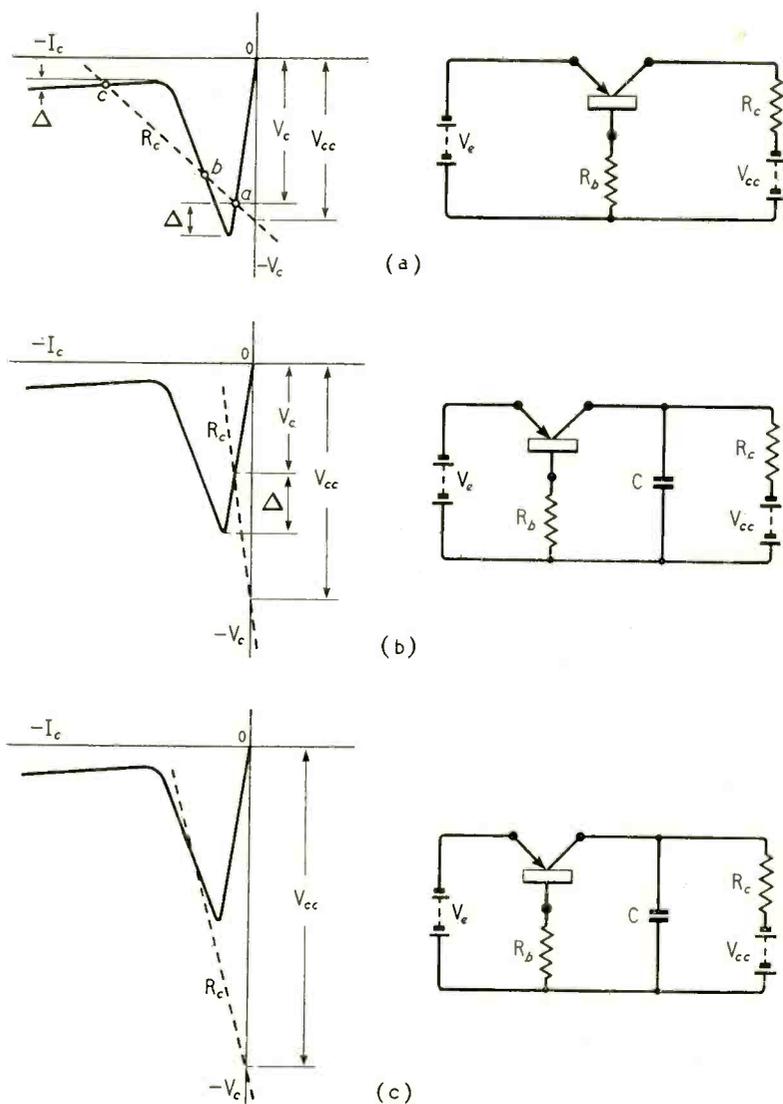


Fig. 8. Collector-connection switching circuits.

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 fall 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.

## 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 x 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 wave-band 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** ("Klemp" Type FW200), 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 ( $8.63 \times 10^6$  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 Arcoelectric 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.

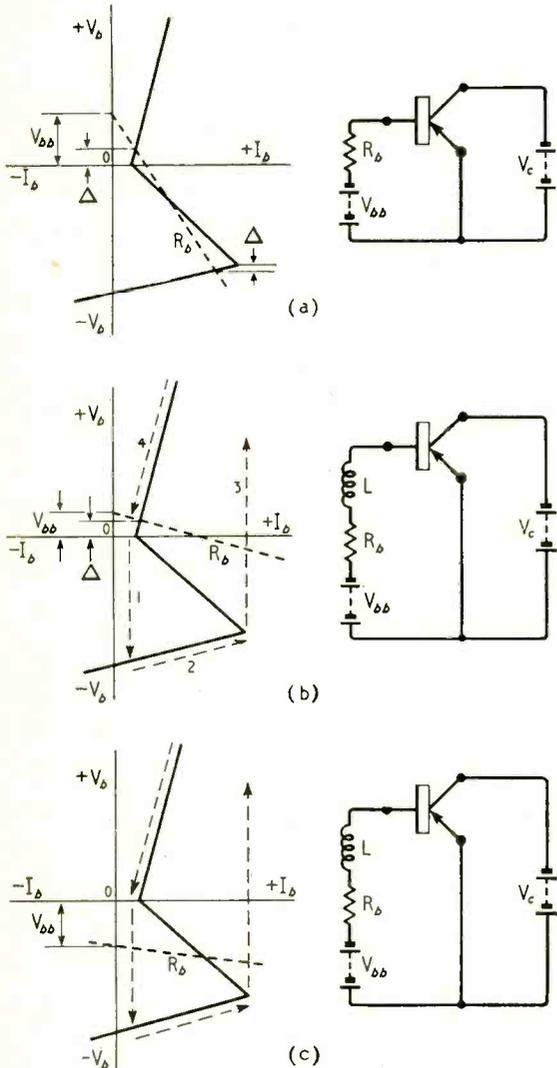


Fig. 9. Base connection switching circuits.

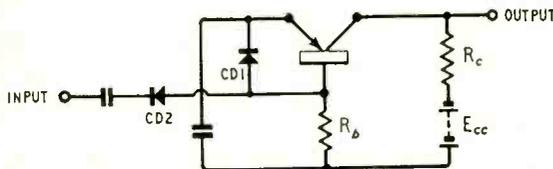


Fig. 10. Addition of diodes to stabilize pulse width and amplitude.

# 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.II, 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.

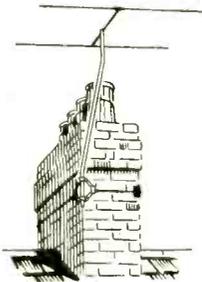
To maintain a low contact resistance under the exhaustive tests described above, considerable attention had to be given to the contact surfaces. After intensive investigation it was found that a gold flash on an appropriate underfinish gave the required durability, together with low contact resistance.

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.

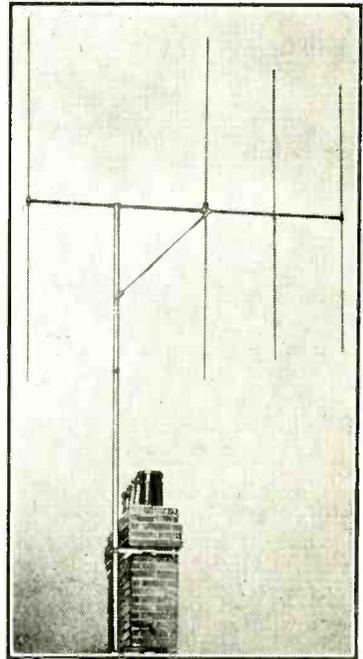
## A Lightning Tip

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.

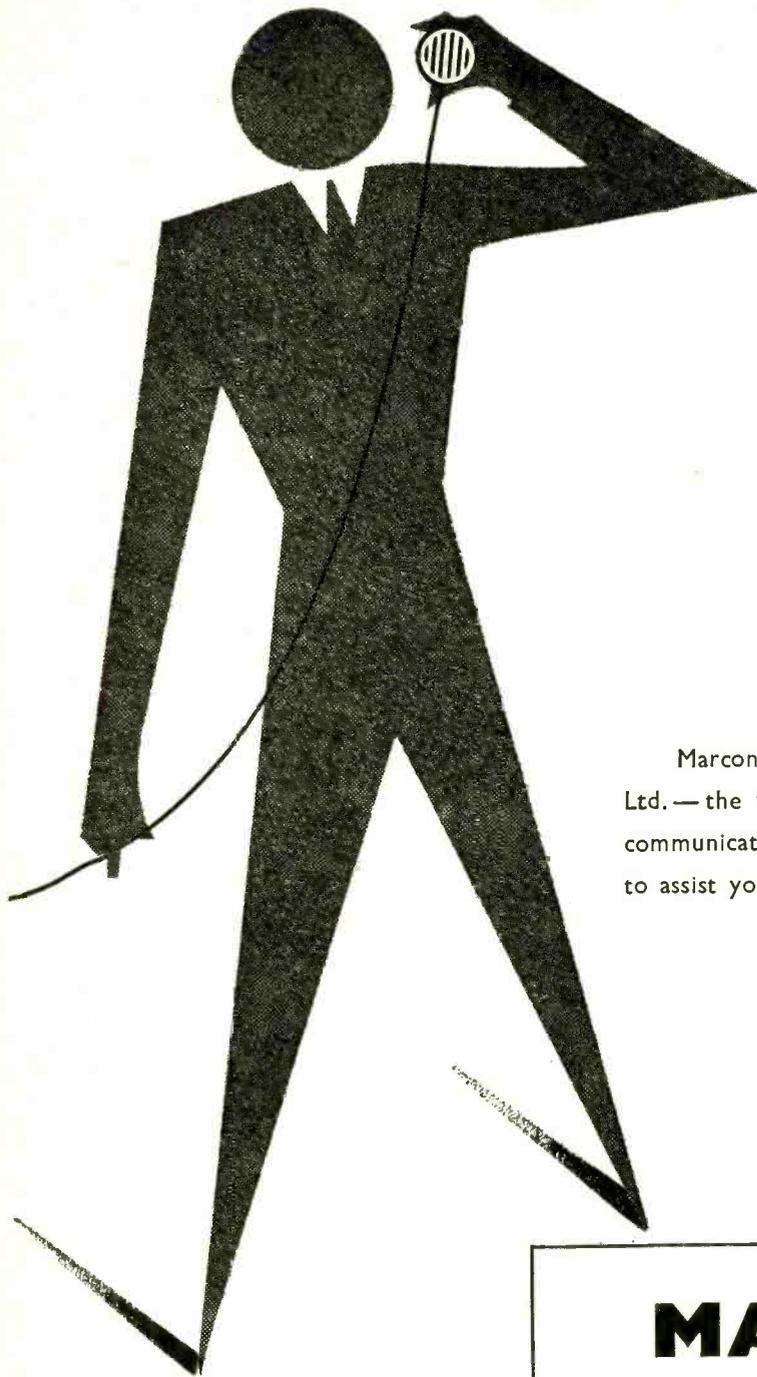
apparently no direct signal, all that the aerial received was reflections and diffusions from the high ground.

## 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

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# 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.

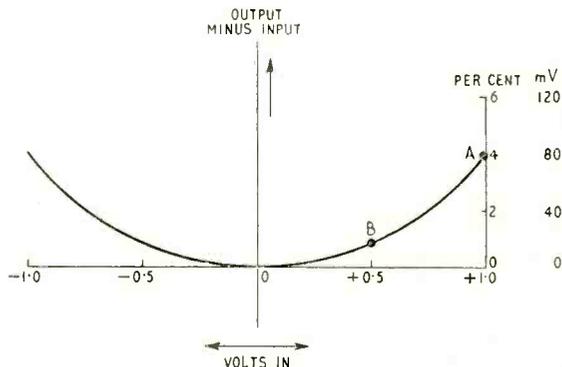
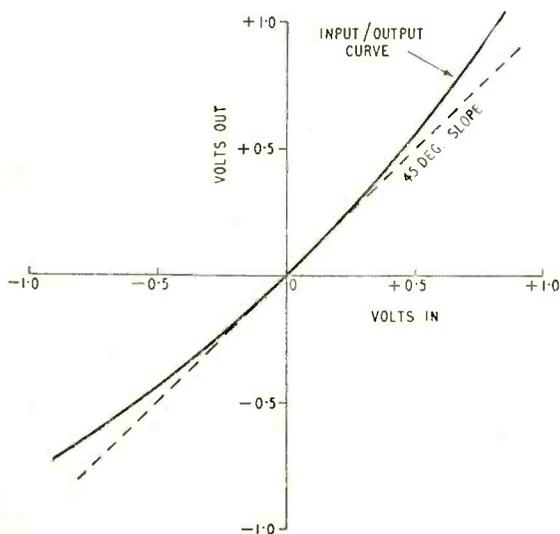
Since distortion components as small as 0.1 per cent can be recognized under good conditions, this method of diagnosis is applicable to amplifiers, oscillators, and the like, which have to meet even the most stringent performance specifications.

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

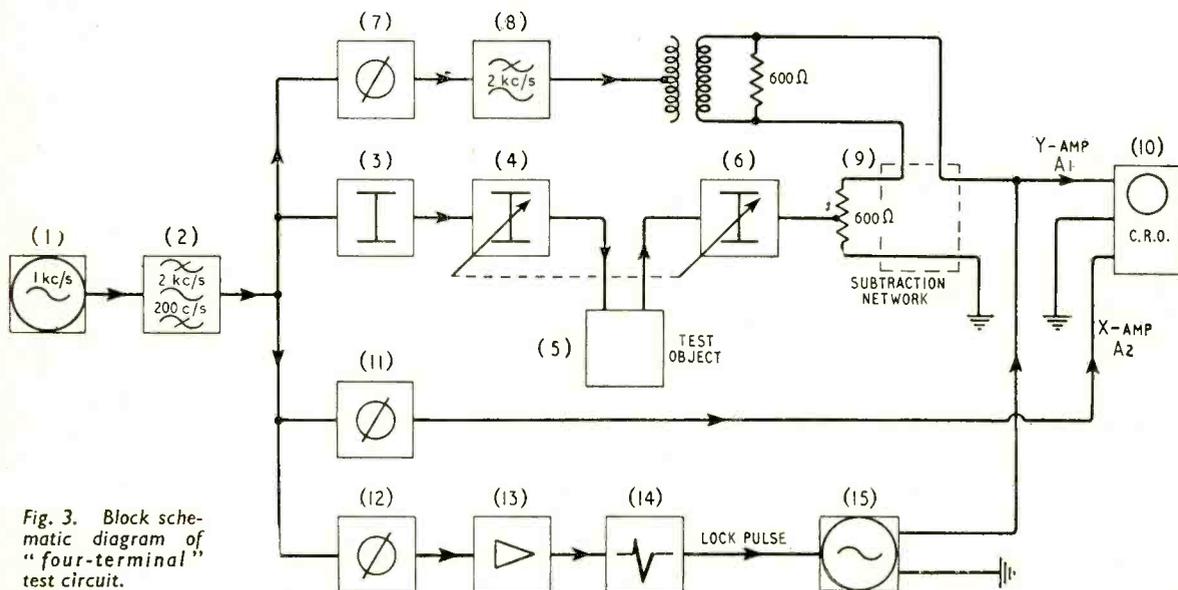
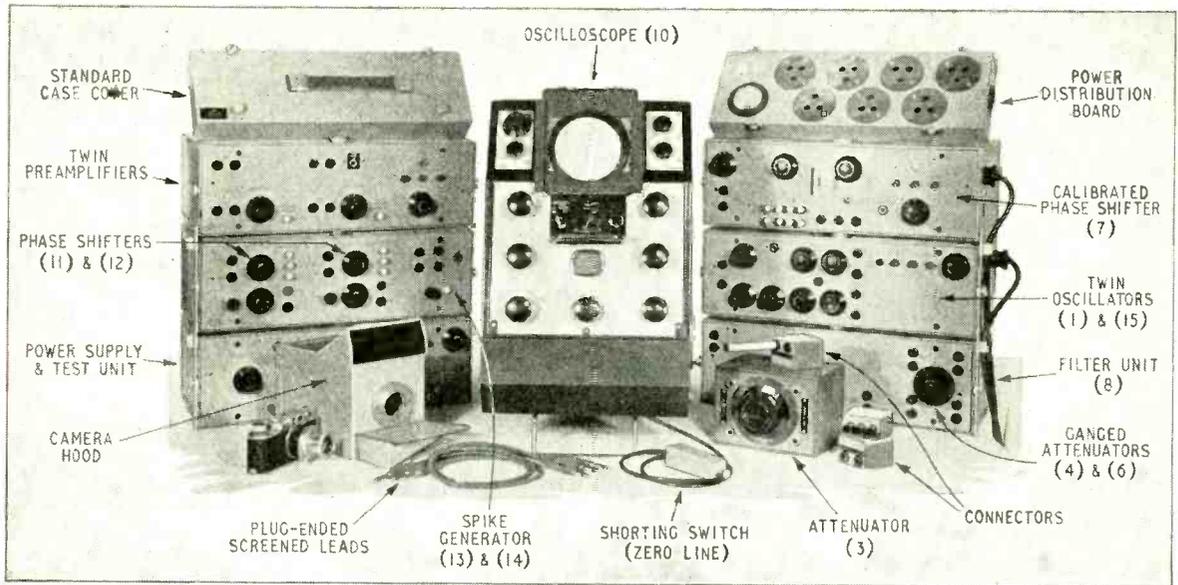


Fig. 3. Block schematic diagram of "four-terminal" test circuit.



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.

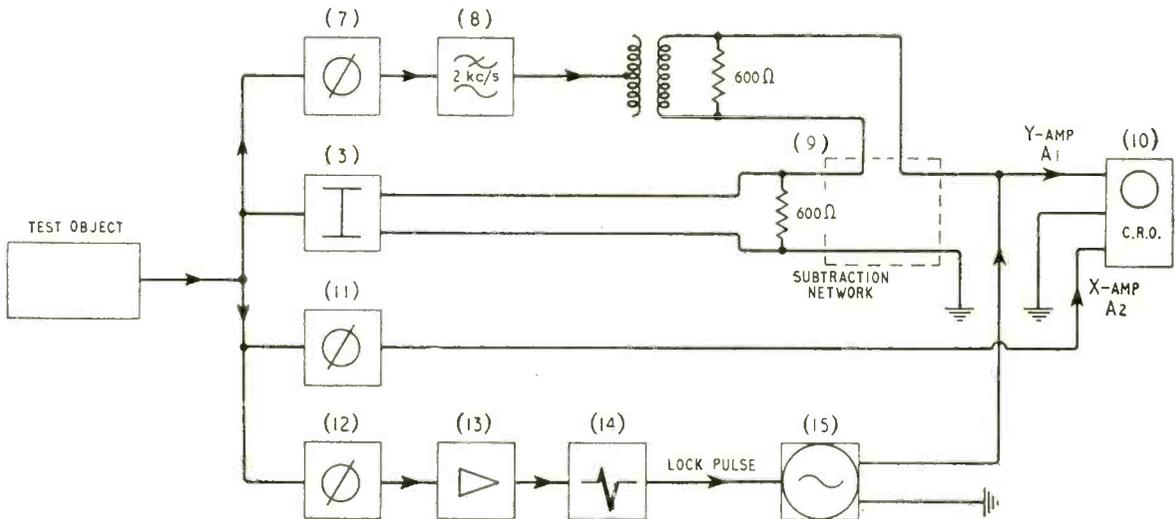


Fig. 4. "Two-terminal" circuit for use when the input to the apparatus under test is inaccessible.

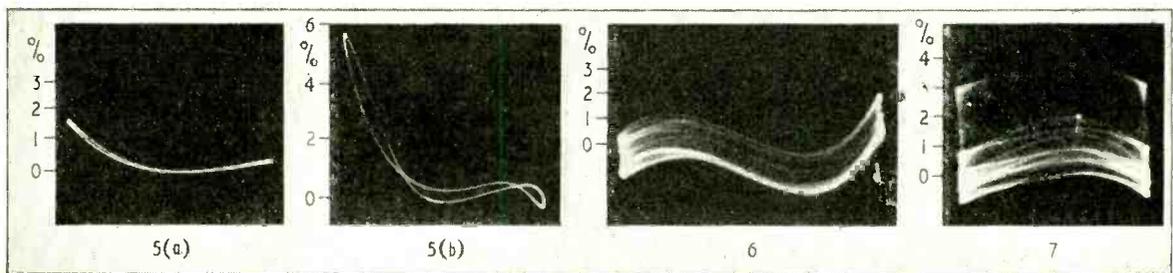


Fig. 5. Single-valve output stage working (a) just below and (b) just above the overload point. Fig. 6. Hum and third harmonic in a push-pull output stage. Fig. 7. Hum at greater level than second and third harmonics (single-valve output stage).

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 2.0V 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.

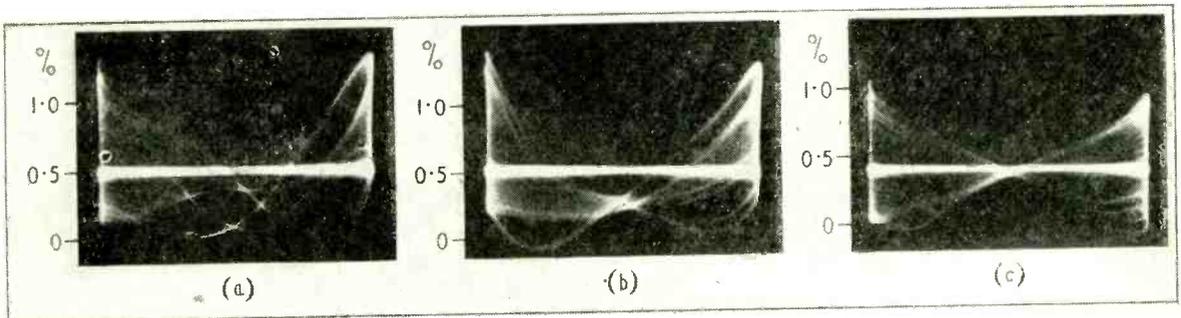
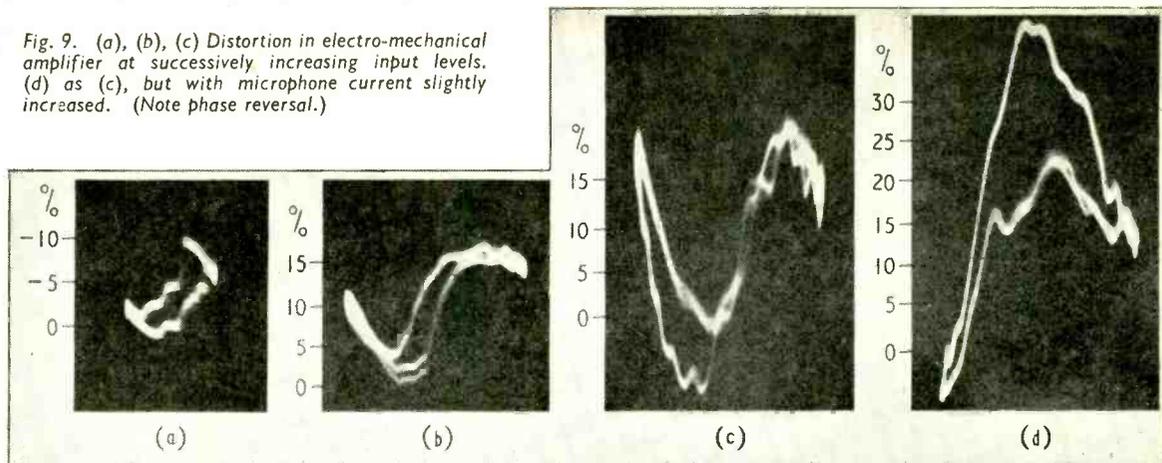


Fig. 9. (a), (b), (c) Distortion in electro-mechanical amplifier at successively increasing input levels. (d) as (c), but with microphone current slightly increased. (Note phase reversal.)



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.

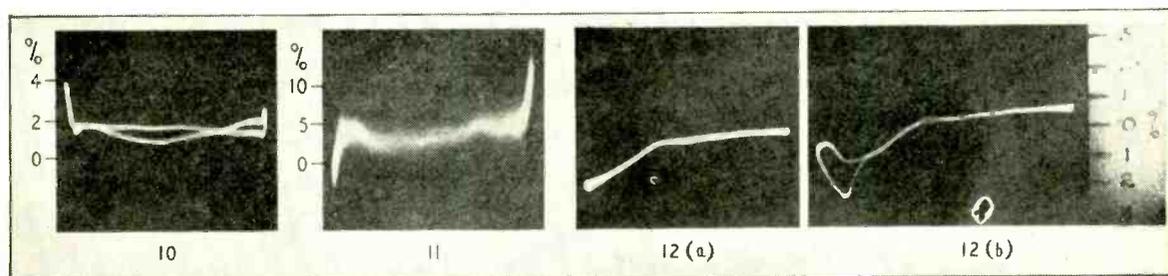
The photographs were obtained with a Leica II camera on Kodak 35mm orthochromatic film R55, with an exposure of  $1\frac{1}{2}$ sec at F/6.3. The brightness of the trace was adjusted for each exposure by the following procedure. The trace was dimmed until only just visible in its weakest part while being 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.

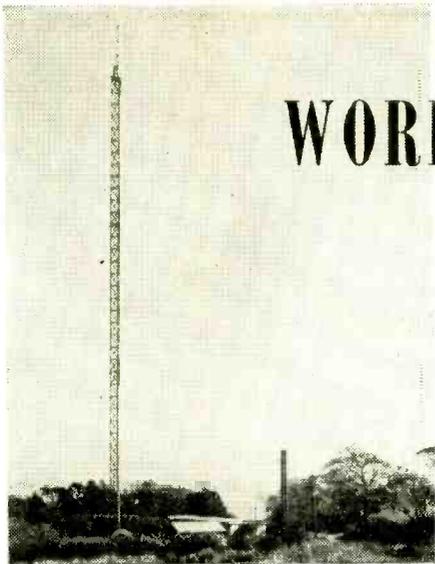
Aerialite, Ambassador, Antiference, Argosy, Automatic Coil Winder, B.B.C., Baird, Balcombe, Belling & Lee, Bernards, Boosey & Hawkes, Bowmaker, Brown Brothers, Bulgfin, Bush, C.W.S., Cole, Collaro, Cosmocord, Cossor, Decca, Dubilier, Dynatron, Econsign, Edison Swan, English Electric, Ever Ready, *Electrical & 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, Marconiophone, 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 & Wearie.

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  $\pm$  two parts in  $10^6$  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 Telcel Telecommunications, Ltd.



**Wilfred Sampson, B.A., A.M.I.E.E.**, has been appointed commercial manager of Telcel 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 exhibitor 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, Redifon 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, transistors 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  $R_{c2}$  of  $V_{c2}$  should be 470 ohms and in Fig. 4 (p. 165, April issue)  $C_{27}$  should be 0.5 $\mu$ F.



**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 (22½ 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+xiii; 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 Annex 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 dis-

tortionless 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 repro-

ducing 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 fly-wheel 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  $\frac{1}{4}$ -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 crase 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.

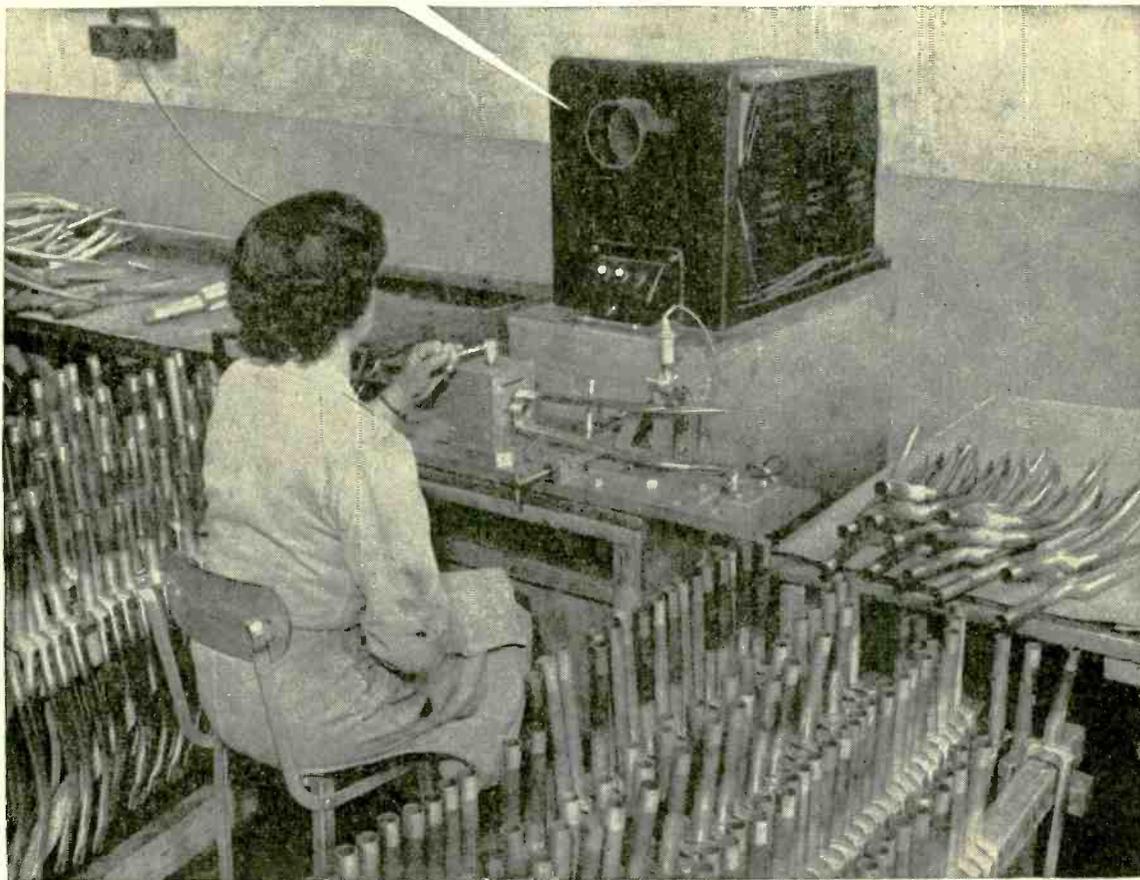
The second method is very suitable if a 500-volt h.t. line is available. A ICP1 type cathode ray tube is used as the indicating device, the oscillator volts being fed across one set of plates whilst the audio output is fed across the other. This gives a rectangular fluorescent area the width of which is proportional to oscillator output and the depth to audio output.

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*In Models 1035 and 1049 the two traces are presented on a flat screen of 90mm. diameter and the amplifiers and time base are so calibrated that measurement of the voltage input as well as the time interval between various significant portions of the Oscillogram is made possible. Permanent records of these traces for subsequent analysis may conveniently be made by attachment of the Cossor Model 1428 Camera.*

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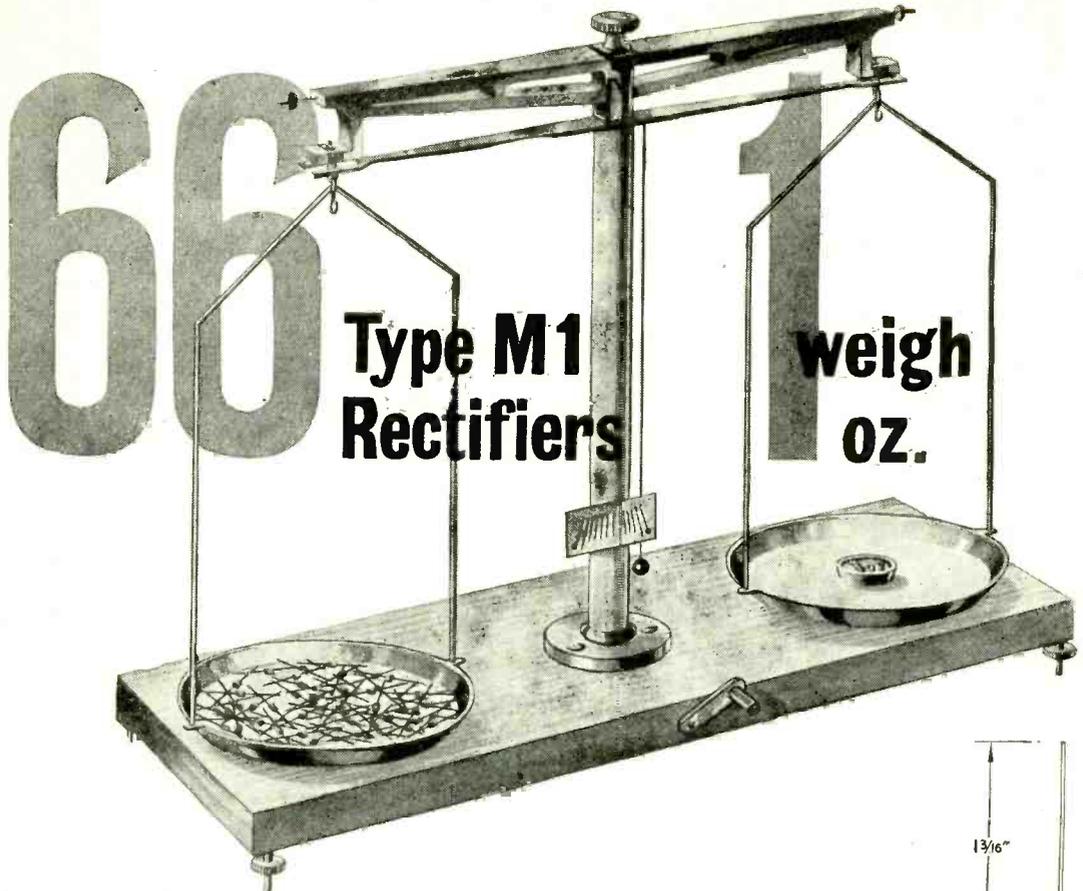
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#### TYPE M-1

For A.F. 2nd detectors. AGC rectifiers. Muting circuits. Contrast expansion and compression. Level indicators. Modulation depth indicators. Limiters. Automatic frequency control.

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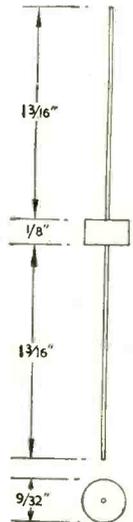
Self Capacitance	22 pF
Forward resistance at 5 V D.C.	10 k $\Omega$
Reverse resistance at 5 V D.C.	1000 M $\Omega$
Maximum peak inverse voltage	68 V
Minimum A.C. input	0.5 V

#### TYPE M-3

Has similar characteristics and application with a maximum frequency of 100 kc/s.

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Self Capacitance	65 pF
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Reverse resistance at 5 V D.C.	45 M $\Omega$
Maximum peak inverse voltage	68 V
Minimum A.C. input	0.5 V



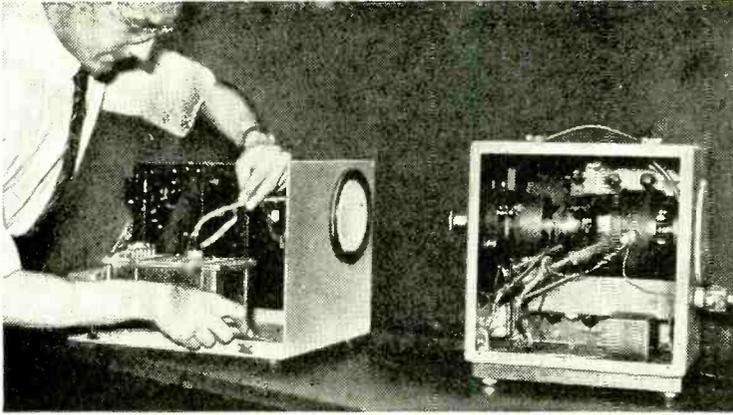
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# Television Standards Converter



## *Mobile Equipment in Holland for the Coronation Relay*

**R**EADERS 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  $\frac{1}{3}$ ths of its original value by the end of one frame period.

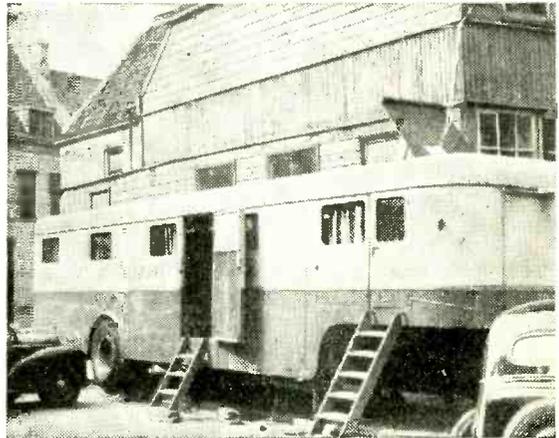
Another important point is that the scanning beam of the camera is arranged to "read" the picture at a more-

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.

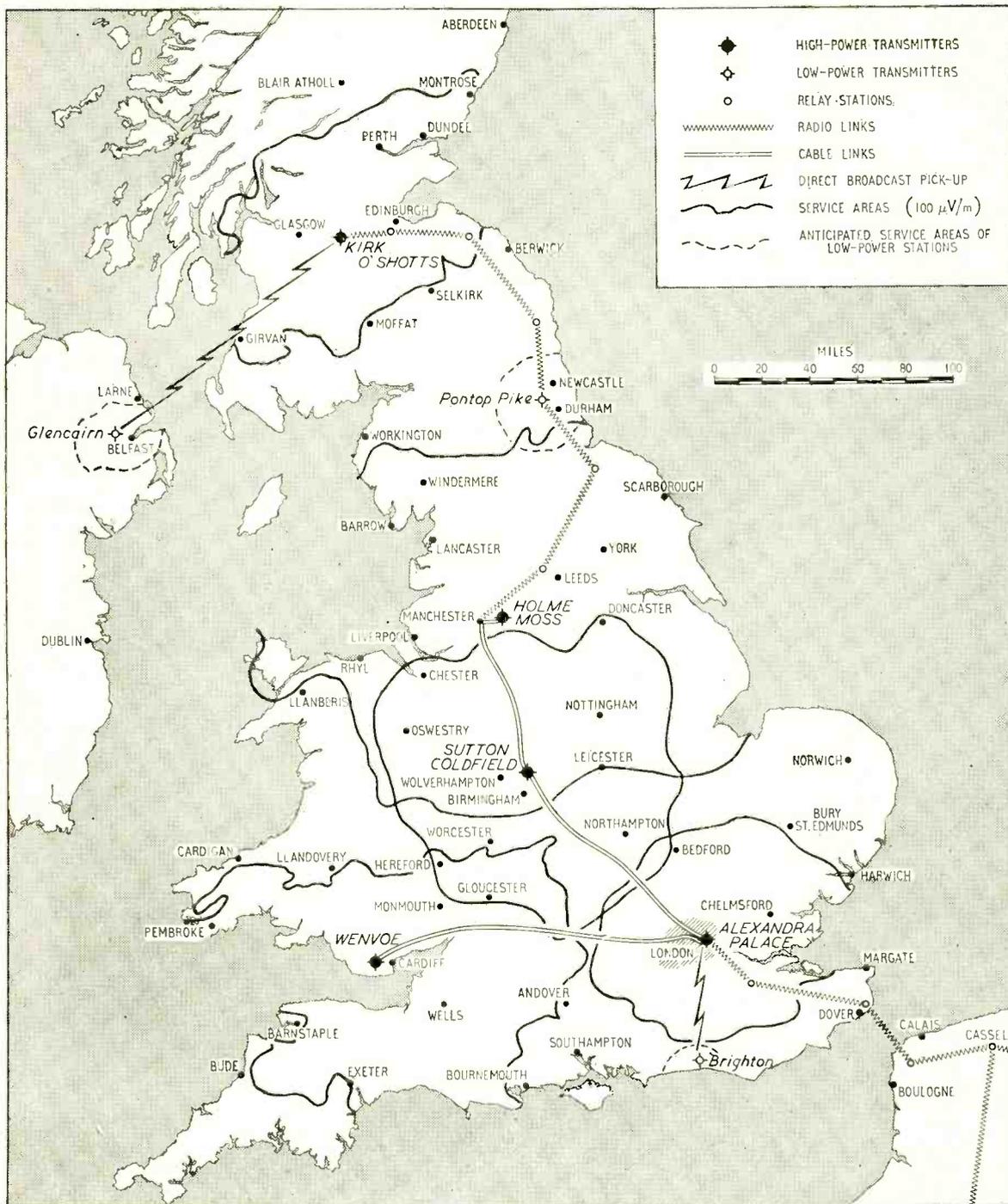
Since the conversion is from a low number of lines to a higher number, it has been necessary to "fill in the gaps" in the 405-line picture by spot-wobbling. Without this device, the scanning lines of the camera would sometimes coincide with those of the 405-line picture and sometimes fall between them, 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 100  $\mu$ V/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.

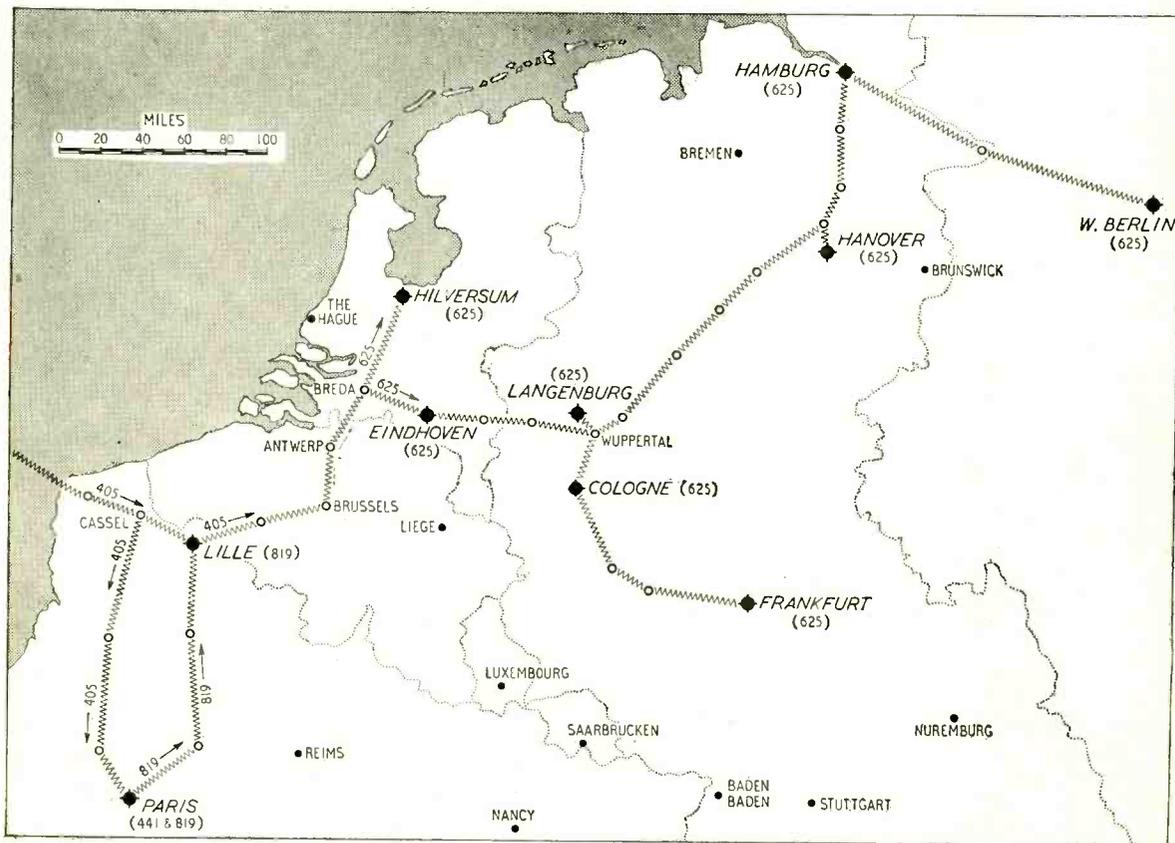
For the continental relay the vision signal will be transmitted from London to France by relay stations provided by Standard Telephones & Cables, Ltd. It will be picked up at a point near Cap Blanc Nez, Calais, and re-transmitted to Cassel. It will be seen from the map that the 405-line signal is carried by the French P.T.T. and Radio-diffusion 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 Nord-westdeutsche Rundfunk 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 ammonium-chloride and zinc into zinc-chloride, ammonia and hydrogen. As the textbooks have it,



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 I 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 0.4V 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  $1.1\text{ V} + 0.4\text{ V} = 1.5\text{ V}$ . 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-

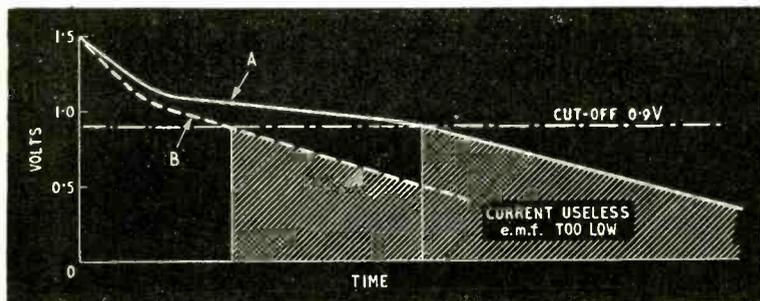
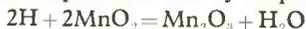


Fig. 1. Curve A shows typical end voltages during intermittent discharge of high-grade cells under ideal conditions of load, temperature and rest periods. A considerable proportion of the ampere-hours potentially available from the zinc in the can is useless, since the e.m.f. is too low. B is the discharge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

ganese-dioxide depolarizer usually employed as:



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  $1\frac{1}{2} \times 2\frac{1}{4}$ -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 sealed 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  $6.3 \times 10^{18}$  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,  $3.15 \times 10^{18}$  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  $6.0234 \times 10^{23}$  atoms. Hence the weight of  $3.15 \times 10^{18}$  zinc atoms is 0.000338 gram; and that is the electrochemical equivalent of zinc. Multiplying by 60 x 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 avail-

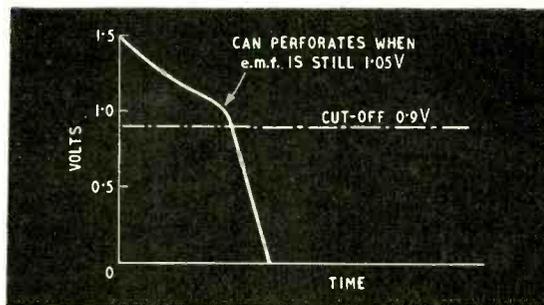


Fig. 2. Discharge curve showing the effects of perforation of the can at a moment when the e.m.f. is still 1.05V.

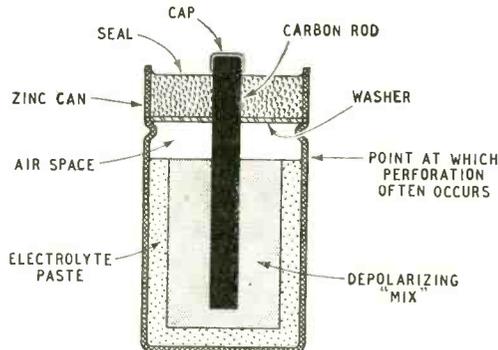


Fig. 3. Construction of modern dry cell. It will be seen that no sac is used. Perforation often occurs in line with the top of the electrolyte paste.

able 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.

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

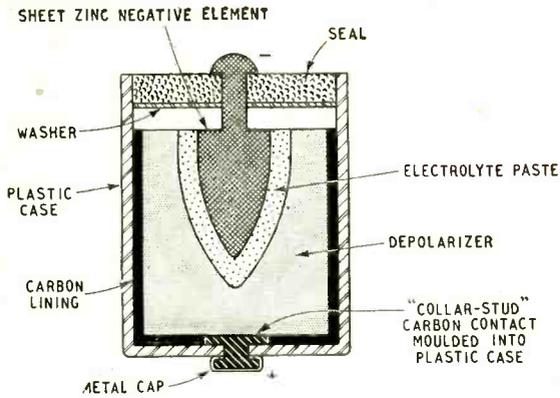


Fig. 4. Suggested "inside-out" cell. Only a small part of the zinc used is now unemployed. By designing the cell so that the carbon forms a lining to the plastic container, the depolarizer is given a much larger surface area on which to act.

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.

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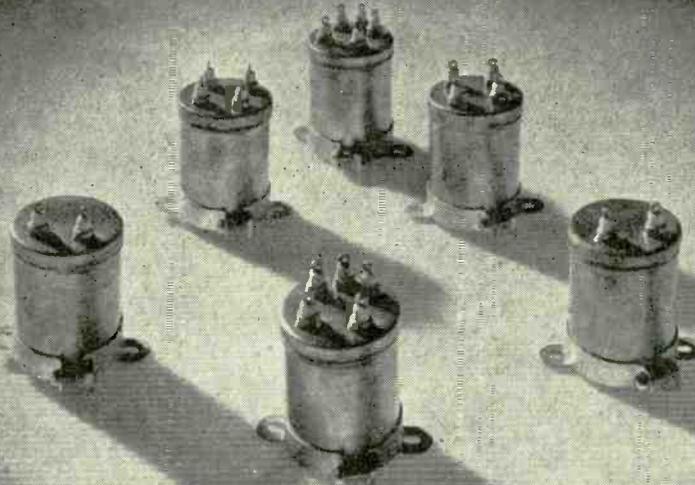
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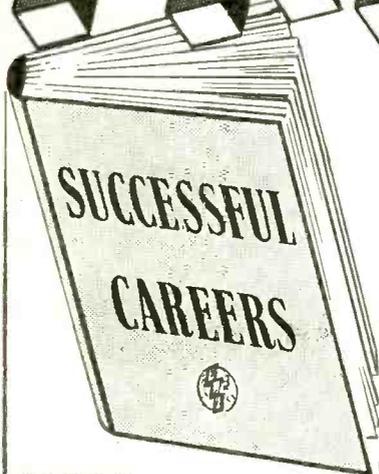
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# MODERNIZING THE

# Wireless World Television Receiver

## Part 2.—Time-Base Circuits

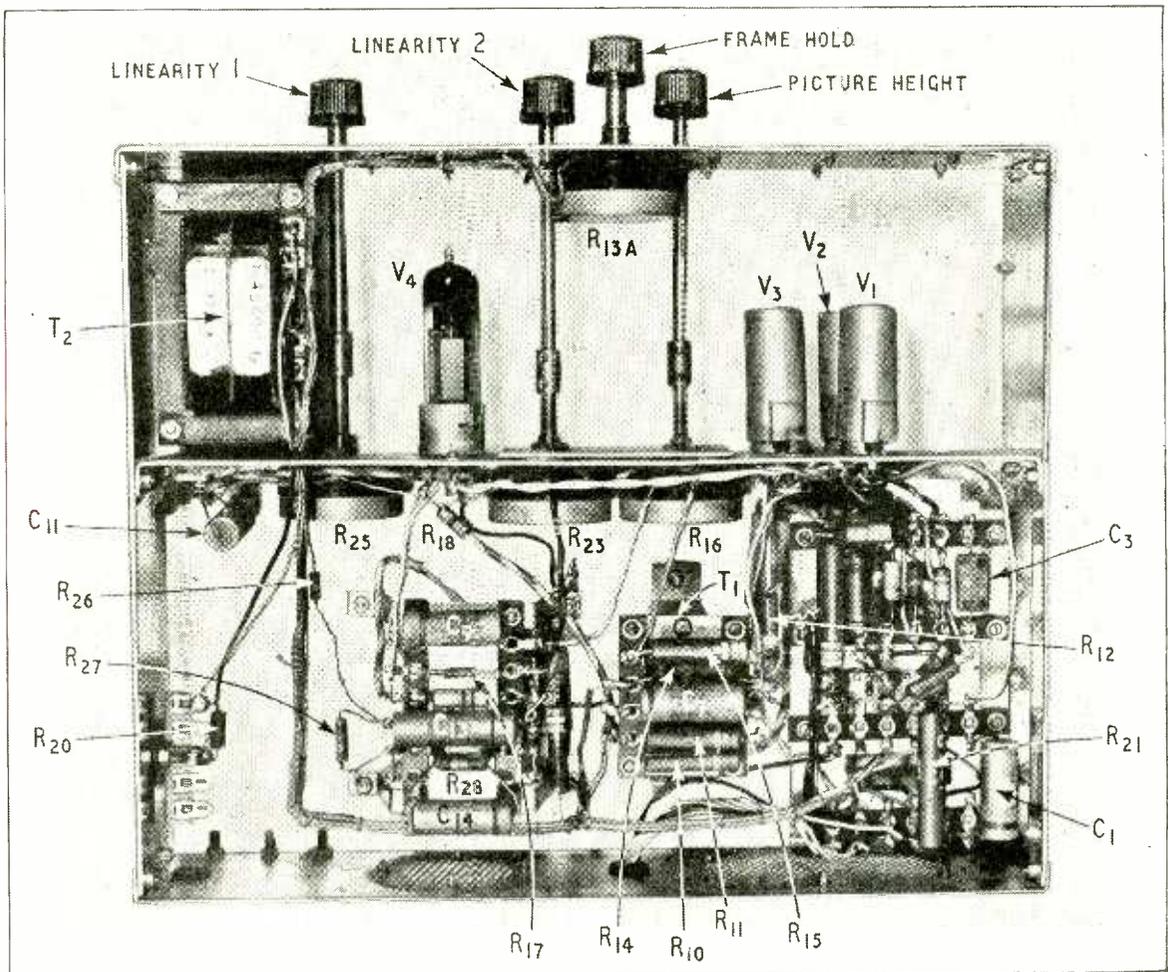
**I**N the original *Wireless World* Television Receiver the frame and line time-bases were built on two separate chassis and the sync-separator circuits were included with the frame time-base. A similar arrangement is adopted for these new time-bases and the sync-separator is included with them.

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  $10\text{-k}\Omega$   $\frac{1}{2}\text{-W}$  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.

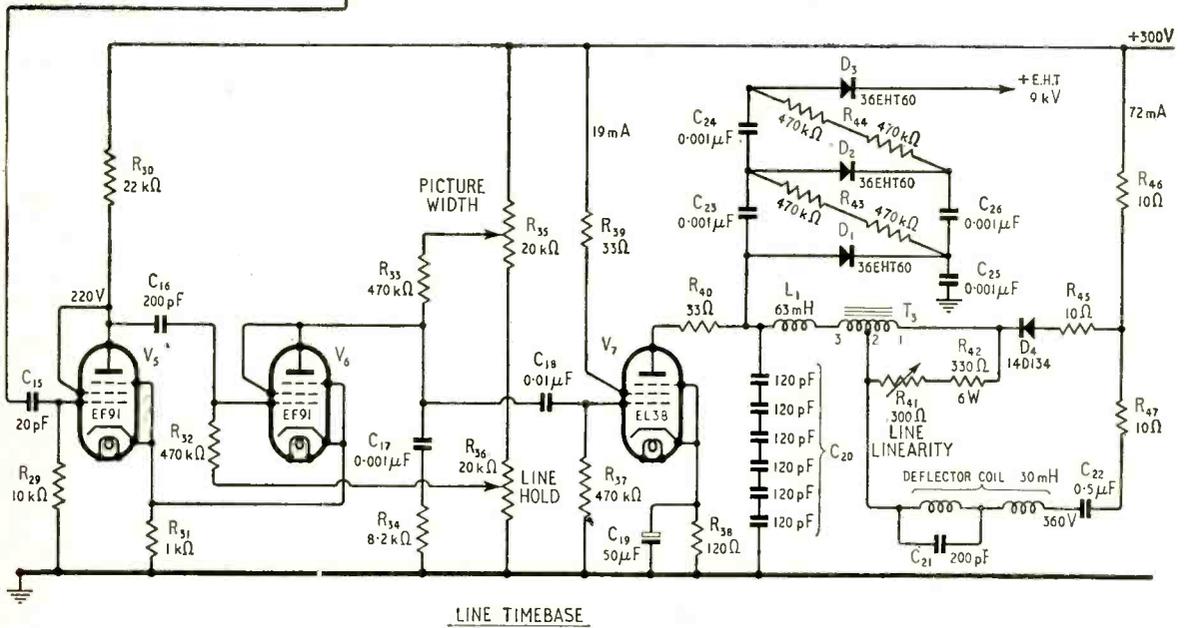
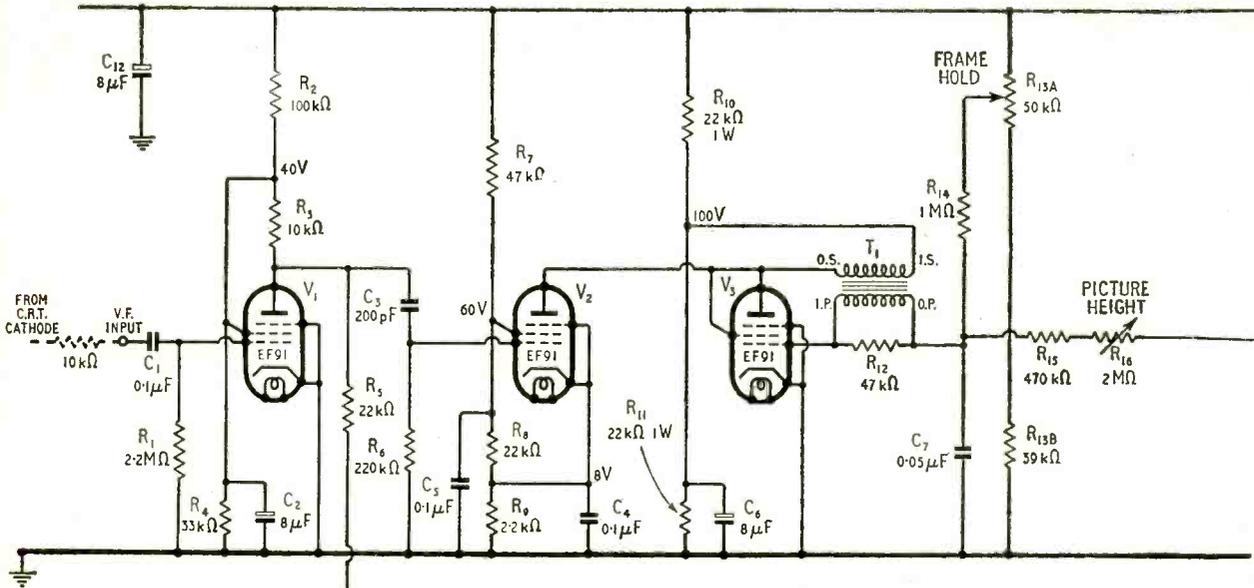
D.C. restoration is effected in the grid circuit in the usual way and the separated negative-going sync pulses appear in the anode circuit. They are applied

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



SYNC SEPARATOR

FRAME



LINE TIMEBASE

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  $V_3$ , 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  $T_3$  and the 150- $\Omega$  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

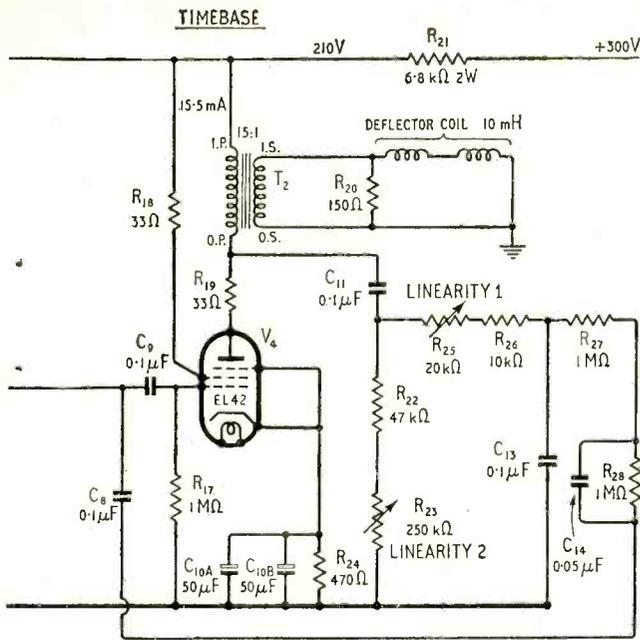


Fig. 1. Complete circuit diagram of the new time-bases. The resistor shown dotted is mounted in the wiring between the tube cathode and the input to the sync separator.  $R_{21}$  is mounted on the deflector-coil assembly.  $R_{45}$ ,  $R_{46}$  and  $R_{47}$  have no circuit function but are included 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  $R_{13}$ ,  $C_7$ , 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.

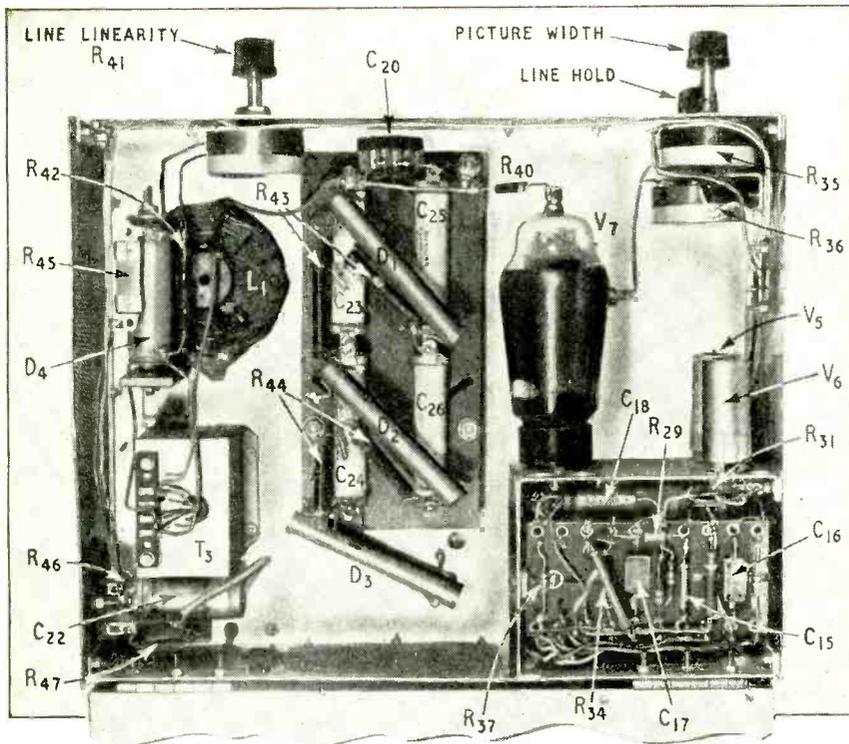
A resistance  $R_{34}$  is included in series with  $C_{17}$  in order to produce a large negative-going pulse on flyback. This is necessary in order to cut off the output valve rapidly and hold it cut off during flyback. The value of this resistance has an appreciable effect on the e.h.t. voltage produced 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  $R_{15}$ ,  $R_{16}$  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  $R_{15}$  or  $R_{16}$ . 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 fly-back 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  $R_{345}$  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,  $R_{31}$  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  $R_{33}$ ,  $C_{15}$  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 k $\Omega$ , 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

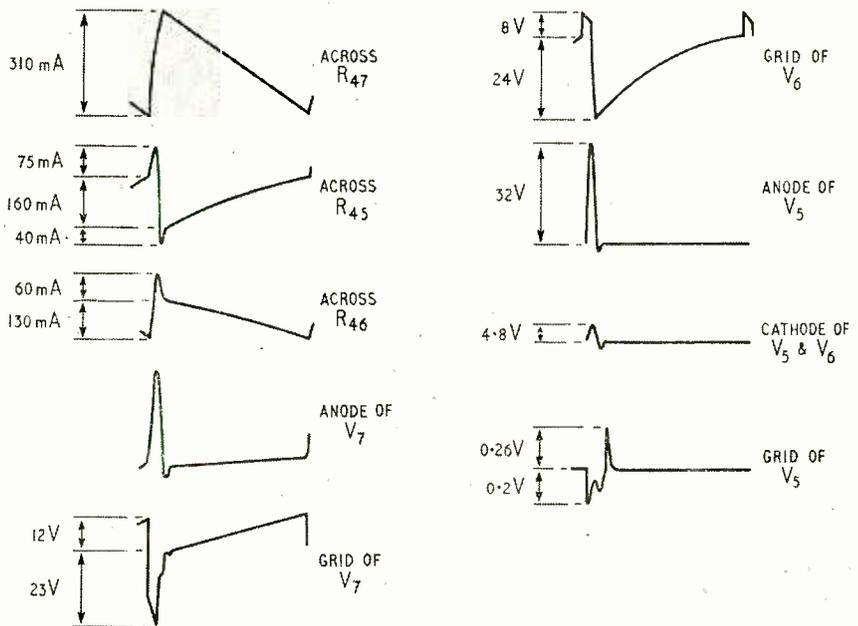
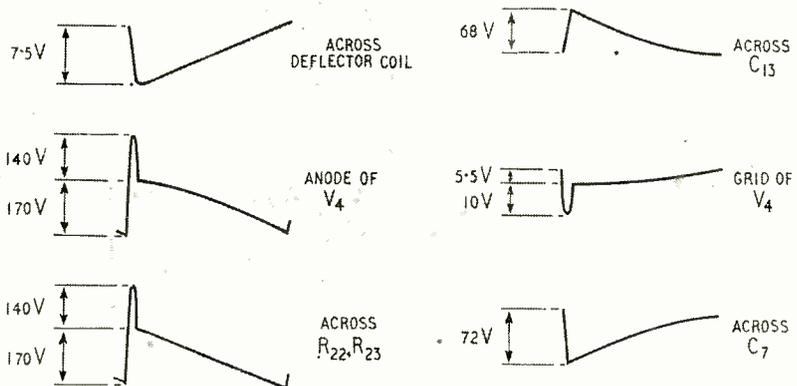


Fig. 2. Waveforms at important points in the line time-base. The current waveforms were measured as voltages across 10- $\Omega$  resistors.

Fig. 3. Waveforms in the frame time-base. A 10-M $\Omega$  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<sub>45</sub>, R<sub>16</sub> and R<sub>47</sub>, 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 <sub>1</sub>	2.2MΩ	½W	Erie
R <sub>2</sub>	100kΩ	½W	Erie
R <sub>3</sub> , R <sub>26</sub> , R <sub>29</sub>	10kΩ	½W	Erie
R <sub>4</sub>	33kΩ	½W	Erie
R <sub>5</sub> , R <sub>8</sub> , R <sub>30</sub>	22kΩ	½W	Erie
R <sub>6</sub>	220kΩ	½W	Erie
R <sub>7</sub> , R <sub>12</sub> , R <sub>22</sub>	47kΩ	½W	Erie
R <sub>9</sub>	2.2kΩ	½W	Erie
R <sub>10</sub> , R <sub>11</sub>	22kΩ	1W	Erie
R <sub>13A</sub>	50kΩ	potentiometer, wire-wound, linear, 5W	Reliance Type T.W./1
R <sub>13B</sub>	39kΩ	1W	Erie
R <sub>14</sub> , R <sub>17</sub> , R <sub>27</sub> , R <sub>28</sub>	1MΩ	½W	Erie
R <sub>15</sub> , R <sub>32</sub> , R <sub>33</sub> , R <sub>37</sub>	470kΩ	½W	Erie
R <sub>16</sub>	2MΩ	variable, linear	Reliance Type S.G./1
R <sub>18</sub> , R <sub>19</sub> , R <sub>39</sub> , R <sub>40</sub>	33Ω	½W	Erie
R <sub>20</sub>	150Ω	½W	Erie
R <sub>21</sub>	6.8kΩ	2W	Erie
R <sub>23</sub>	250kΩ	variable, log-law	Reliance Type S.G./1
R <sub>24</sub>	470Ω	½W	Erie
R <sub>25</sub> , R <sub>35</sub> , R <sub>36</sub>	20kΩ	variable, wire-wound, linear, 5W	Reliance Type T.W./1
R <sub>31</sub>	1kΩ	½W	Erie
R <sub>34</sub>	8.2kΩ	½W	Erie
R <sub>38</sub>	120Ω	2W	Erie
R <sub>41</sub>	300Ω	variable, wire-wound, linear, 5W	Reliance Type T.W./1
R <sub>42</sub>	330Ω	6W	Welwyn
R <sub>43</sub> , R <sub>44</sub> each 2 ×	470kΩ	1W	Erie

#### Capacitors

C <sub>1</sub> , C <sub>4</sub> , C <sub>8</sub> , C <sub>9</sub>	0.1μF, tubular paper, 350 V, Dubilier Type 460
C <sub>11</sub> , C <sub>13</sub>	
C <sub>2</sub> , C <sub>6</sub> , C <sub>12</sub>	8μF, electrolytic, * 500 V, Dubilier Drilitic BR850

C <sub>3</sub> , C <sub>16</sub>	200pF, silvered mica, 350 V, Dubilier Type 635
C <sub>7</sub> , C <sub>14</sub>	0.05μF, tubular paper, 350 V, Dubilier Type 450
C <sub>10A</sub> , C <sub>10B</sub> , C <sub>19</sub>	50μF, electrolytic, 50 V, Dubilier Drilitic BR505
C <sub>15</sub>	20pF, ceramic, Dubilier Type CTD316
C <sub>17</sub>	0.001μF, moulded mica, 350 V, Dubilier Type 635
C <sub>18</sub>	0.01μF, tubular paper, 350 V, Dubilier Type 460
C <sub>20</sub>	6 × 120pF, silvered mica, 750 V, Dubilier Type 635
C <sub>21</sub>	200pF, mica (see text), Dubilier Type 680
C <sub>22</sub>	0.5μF, tubular paper, Dubilier Type 4706B
C <sub>23</sub> , C <sub>24</sub> , C <sub>25</sub> , C <sub>26</sub>	0.001μF, 10 kV, Dubilier Type 411

#### Valves

V <sub>1</sub> , V <sub>2</sub> , V <sub>3</sub> , V <sub>6</sub> , V <sub>6</sub>	EF91 Mullard
V <sub>4</sub>	EL42 Mullard
V <sub>7</sub>	EL38 Mullard
D <sub>1</sub> , D <sub>2</sub> , D <sub>3</sub>	Westinghouse 36 EHT60
D <sub>4</sub>	Westinghouse 14 D134

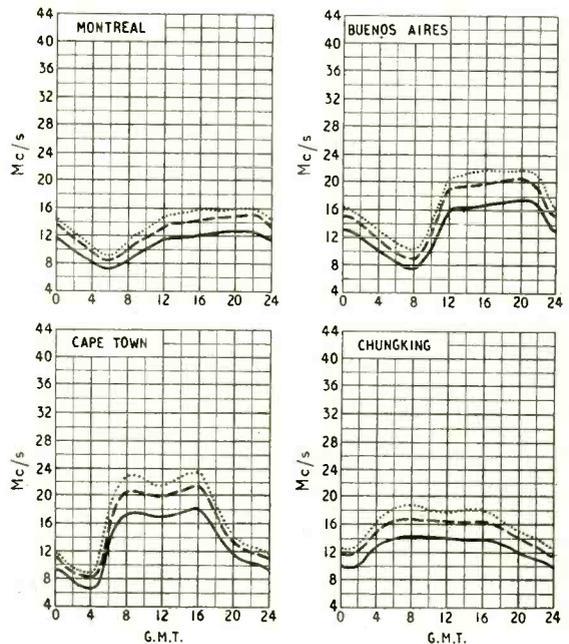
(to be concluded)

## Short-wave Conditions

### Predictions for June

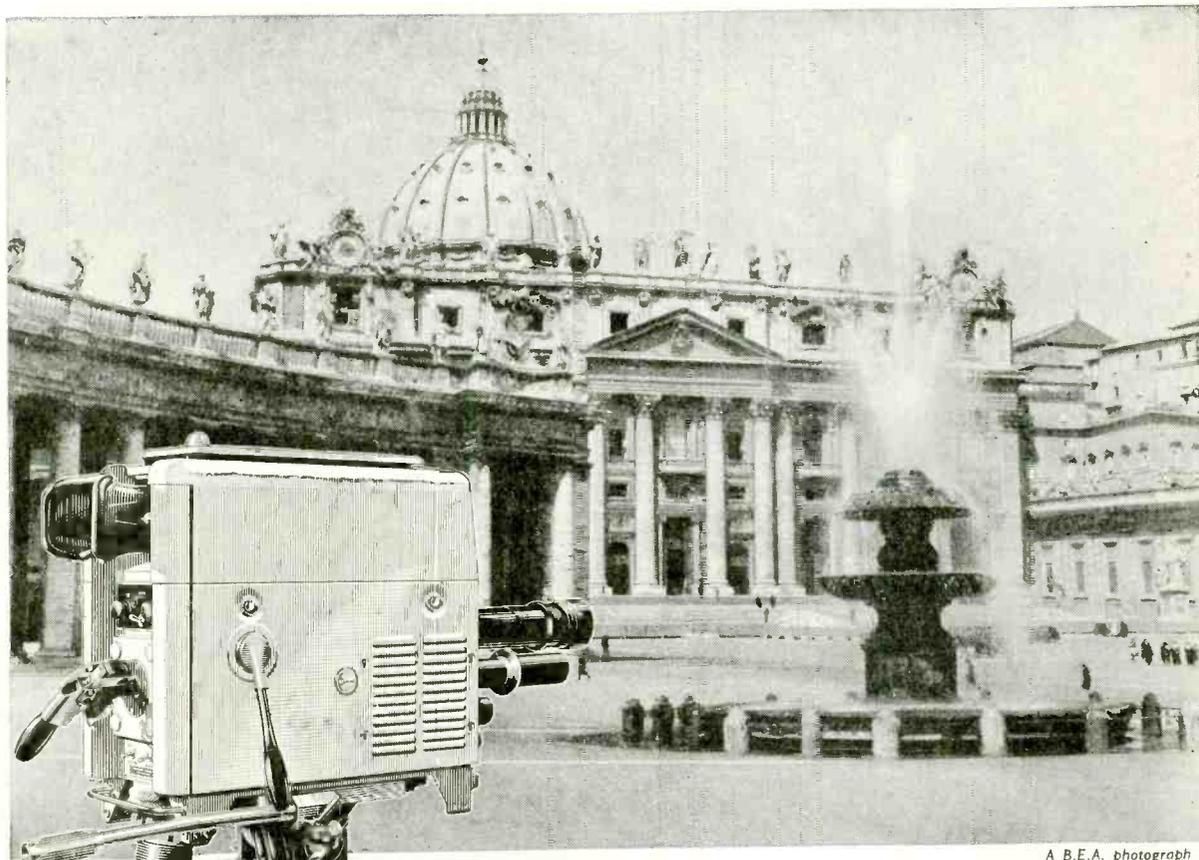
THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during June.

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



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# Radio Waves

## *How the Magnetic and Electric Fields Support Each Other*

**D**URING 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,

By

"CATHODE RAY"

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 per-

formed. 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.

### 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 anticlockwise 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

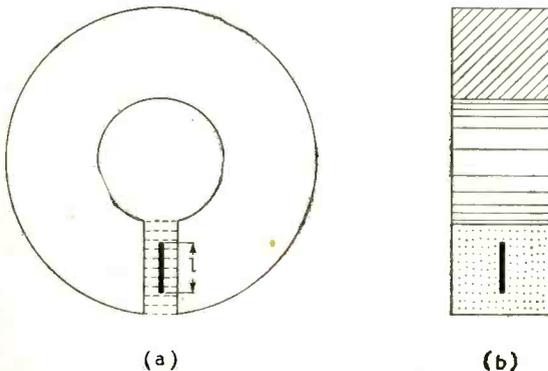


Fig. 1. The basic principle of how electricity is generated in a power station is often expressed something like this, by saying that if a magnetic field is moved across a length of circuit  $l$  an e.m.f. is generated in it, proportional to  $l$  and to the rate at which the field is moved across. Here 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).

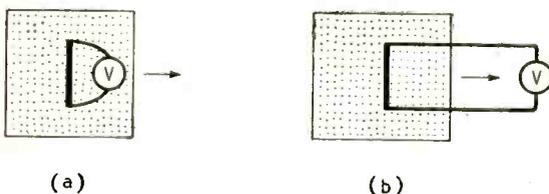


Fig. 2. When an attempt is made to verify Fig. 1, it is necessary to take account of the voltmeter leads. Moving the magnet causes no reading in (a); the arrangement shown in (b) is successful, but the action can at least equally well be explained as change of magnetic field passing through the whole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

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  $\epsilon$ ) is equal to the voltage per metre p.d. set up by the movement of the magnetic field. (If an

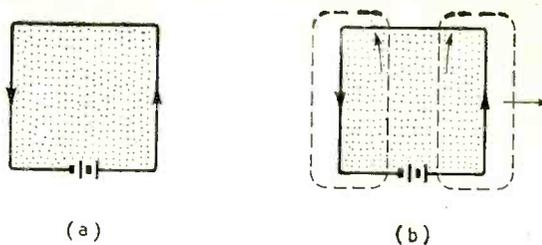
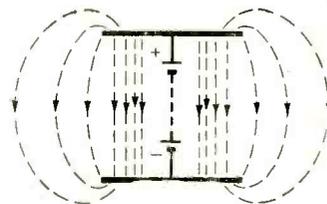


Fig. 3. If a simple loop electromagnet as shown, producing a magnetic field pointing towards the reader, is moved to the right it causes an upward e.m.f.

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.



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 ( $\Phi$ ) 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 ( $\mu$ ). 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  $\Phi$  in this case) is equal to  $\mu I$ . The rate at which  $\Phi$  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  $\Phi$  has been taken away, so if the speed is  $v$  metres per second the rate of change of  $\Phi$  is  $v\Phi$ , and we know this is equal to  $\epsilon$ . So the final upshot is

$$\epsilon = v\mu I$$

### 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 ( $\kappa$ ) of space. The movement of the magnetic field at  $v$  m/s causes it to be charged to  $\epsilon$  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  $l = \epsilon/v\mu$ . So putting these together we get

$$\begin{aligned}\kappa\epsilon v &= \frac{\epsilon}{v\mu} \\ \therefore \kappa v &= \frac{1}{v\mu} \\ \text{and } v^2 &= \frac{1}{\mu\kappa} \\ \text{so } v &= \frac{1}{\sqrt{\mu\kappa}}\end{aligned}$$

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

$$\begin{aligned}v &= \sqrt{\frac{10^7}{4\pi} \times 36\pi \times 10^9} \\ &= \sqrt{9 \times 10^{16}} \\ &= 300,000,000 \text{ metres per second approximately*}.\end{aligned}$$

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

\* The latest estimate is 299,792,000.

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.

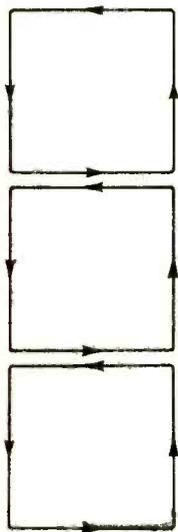
## Procession of Fields

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 anticlockwise. 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.

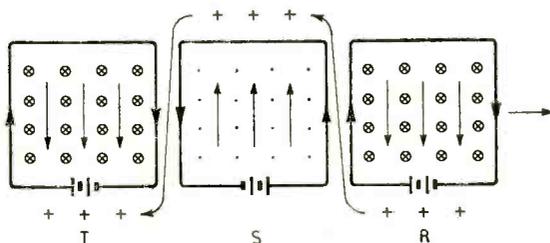
Fig. 6, you remember, was a sample of what we imagined to be a long chain of "links." A pair of them, say S and R, makes up one complete wave, with positive and negative half-cycles. So wavelength is represented by twice the width of one link.

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.



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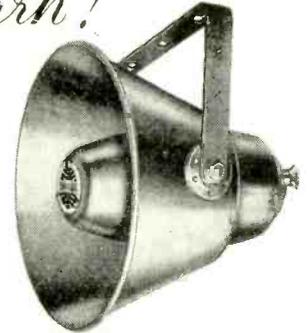
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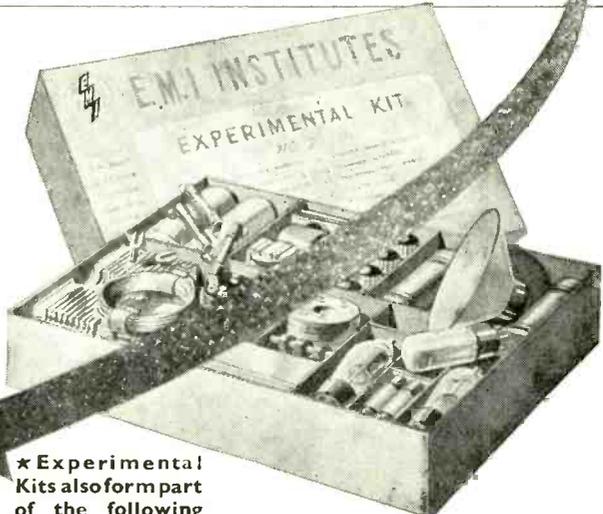
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# Voltmeter Loading

## 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  $20\text{ k}\Omega$  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  $300\text{ k}\Omega$  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.

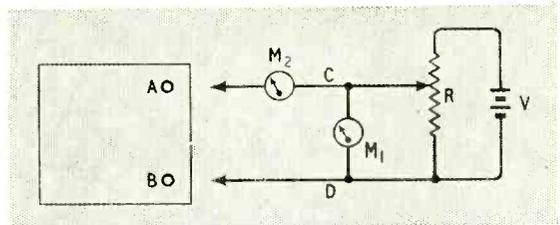
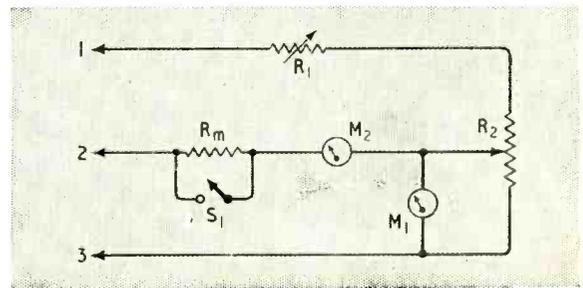


Fig. 1. Basic potentiometer circuit for voltage measurement.

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



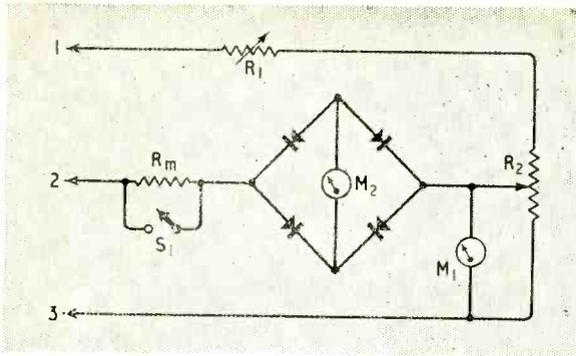


Fig. 3. Circuit for use with a left-hand zero meter for  $M_2$ . The metal rectifiers ensure that the meter deflects one way only irrespective of the direction of the current.

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. Uijtens. 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 phase 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 1g 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. Warfedale 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 bogey.

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 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	
<b>BAND I</b>					
61.75	58.25	Isle of Man	25	6	H
		Channel Islands	5	1.25	H
<b>BAND III</b>					
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

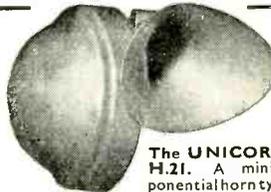
\* Effective radiated power.

H, Horizontal.

V, Vertical.

# Sound Policy

Our policy is to specialise in sound equipment. Sound problems are our problems and we have been solving them for over 25 years. For the usual or unusual in sound amplification install TRIX equipment. Information and advice is always at your disposal.



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# 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 outside 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 ½in × 2½in 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 ½in × 2½in 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



## "WIRELESS WORLD" PUBLICATIONS

	Net Price	By Post
RADIO DESIGNER'S HANDBOOK. F. Langford-Smith, B.Sc., B.E., M.I.R.E., A.M.I.E.E., A.M.I.E., 4th Edition	42/-	43/6
RADIO INTERFERENCE SUPPRESSION as Applied to Radio and Television Reception. G. L. Stephens, A.M.I.E.E.	10/6	10/11
SOUND RECORDING AND REPRODUCTION. J. W. Godfrey and S. W. Amos, B.Sc., A.M.I.E.E., in collaboration with the B.B.C. Engineering Division	30/-	30/8
MICROPHONES. By the Staff of the Engineering Training Dept. B.B.C.	15/-	15/5
ADVANCED THEORY OF WAVEGUIDES. L. Lewin	30/-	30/7
FOUNDATIONS OF WIRELESS. M. G. Scroggie, B.Sc., M.I.E.E. 5th Edition	12/6	13/-
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SHORT-WAVE RADIO AND THE IONOSPHERE. T. W. Bennington. 2nd Edition	10/6	10/10
THE WILLIAMSON AMPLIFIER. 2nd Edition. D. T. N. Williamson	3/6	3/9
BASIC MATHEMATICS FOR RADIO STUDENTS. F. M. Colebrook, B.Sc., D.I.C., A.C.G.I. 2nd Edition	10/6	10/10

A complete list of books is available on application.

Obtainable from all leading booksellers or from

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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 tapings—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

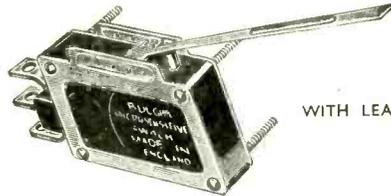
TOWARDS THE END OF MARCH an American friend asked me in one of his letters whether the imminence of the Coronation was producing record sales of television receivers. I replied that sales weren't too bad, except in Scotland, where comparatively few sets were being sold. "Possibly," I added, "the hard-headed 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.

# NEW MINIATURE "M" TYPE MICRO-SENSITIVE SWITCH

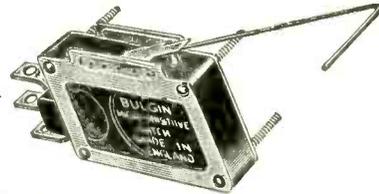
## Rolling-Spring



BASIC TYPE SWITCH



WITH LEAF OPERATOR



WITH WIRE OPERATOR

THE NEWEST addition to the range of Bulgin micro-sensitive Switches are these Miniature "M" type. Manufactured to the usual Bulgin superlative quality, these switches are made with high-grade moulded "Bakelite" bodies, with Styrene type covers, fitted with internal springs of hardened Beryllium-copper alloy and with heavy contacts of pure silver. Bakelite or Stainless-steel operating buttons. Different switching arrangements can be had by fitting the universal detachable plates (Provisional Patents). Further details upon request.

With Stainless Steel operating Button			With "Bakelite" operating Button.		
LIST NO.	Operating Pressure Grams	Breaking Rating (Amperes*)	LIST NO.	Operating Pressure Grams	Breaking Rating (Amperes*)
S.530/A	25-35	At 125 V. = 3.0A. and at 250 V. = 1.5A (A.C. 50~)	S.530/B	25-35	At 125 V. = 3.0A. and at 250 V. = 1.5A. (A.C. 50~)
S.531/A	35-50		S.531/B	35-50	
S.532/A	50-100		S.532/B	50-100	

\*=Surge-current (as from back-E.M.F., etc.) if greater than steady current of circuit. Switching-on surge, if any, should not exceed rating x1.5 max. value, for longest life.

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## 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 1552 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 weekends 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.

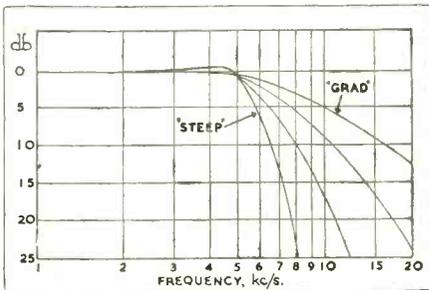
installed in the car when taking particulars for some misdemeanour?

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.

# ★ The HIGHEST ATTAINABLE QUALITY of SOUND REPRODUCTION ★

Representing a unique feedback circuit development, the "Vari-Slope" pre-amplifier gives audibly better reproduction. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5 kc/s, 7 kc/s and 9 kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.



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 VARI-SLOPE

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.

LIST PRICE IN BRITAIN **12 Gns.**

## POINT ONE TL/12 Triple Loop Feedback Amplifier

For laboratory use as a stabilised-gain audio frequency power amplifier. For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pick-up, Radio, Microphone, Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast transmitters. Used with the "Vari-Slope" pre-amplifier and the best available complementary equipment, the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price.

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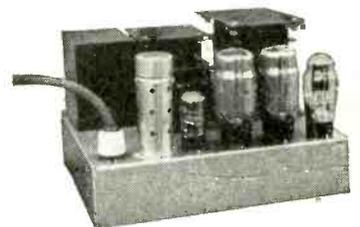
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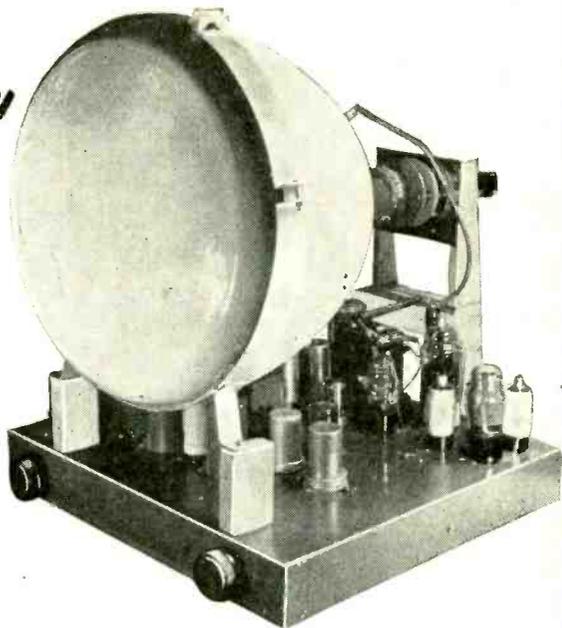
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## ELECTRONIC PRECISION EQUIPMENT LTD

# 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 :

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- 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.

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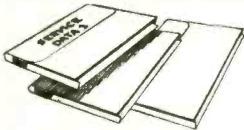
We continually need designs for novel radio and television test sets, servicing instruments, tuning units, pattern generators, etc., particularly those which can be made cheaply from Government surplus and other low priced valves and parts.

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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, V.150M; 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. servicemen 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.

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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.

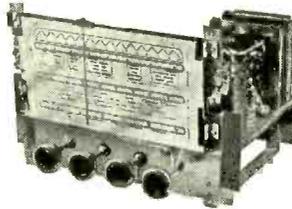
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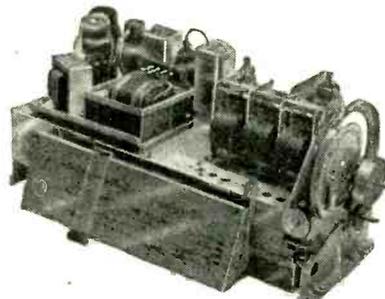
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Both chassis 11 1/2 in. x 7 in. x 8 in. high. Latest type valves: 6BE6, 6BA6, 6AT7, 6BW6, 6X4. A.C. mains operated, flywheel tuning, negative feedback over entire audio section, engraved knobs, fully guaranteed.

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**7 VALVE 5 WAVEBAND RADIO CHASSIS**



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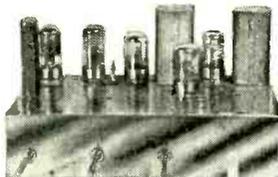
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Less valves and power pack.

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 L.F./A.F. AMPLIFIER**

(For A.C./D.C. working)



This is on an aluminium chassis, size 11 1/2 in. x 7 in. x 3 in. 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

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**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 5 in. 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/APAI 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  
BC.625A R.1132/  
BC.433G 1481 All 1/6  
BC.1206 R.1155 each or  
I.F.F. R.1224A dozen  
12/-.

**ELECTRONIC PRECISION EQUIPMENT LTD.**

**LOW PRICED TEST GEAR, ETC.**

**T.V. SIGNAL AND PATTERN GENERATOR**

Cost of all components, valves, etc., only 29/6.

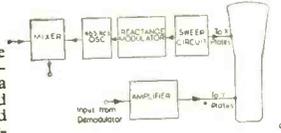
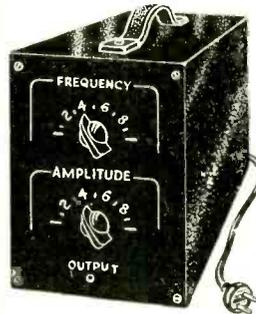
Although this generator can be built and used by any beginner it is at the same time a most useful instrument for the more advanced worker.

It can be tuned to the vision channel and will produce a pattern on the face of the C.R. tube. Alternatively if tuned to the sound channel it will produce an audible signal in the loudspeaker.

Thus its owner will become independent of B.B.C. transmissions and can fault-find or test at any time. It operates entirely from A.C. mains and is quite suitable for use with superhet or straight receivers.

A complete kit of parts (in fact everything except the cabinet) with full constructional and operational data will be supplied for 29/6, plus 2/6 post and insurance, alternatively data is available separately, price 2/6 (credited if you buy the kit later).

**NOTE.** Cabinets as per the illustrated prototype are available price 17/6



**VISUAL ALIGNMENT SIGNAL GENERATOR.**

An interesting article in the October *Radio Constructor* described an instrument which is a combination oscilloscope and signal generator. It is designed to generate a signal into a superhet then permit visual inspection of same signal after passing through the superhet. The article further shows how the instrument could be made for the very low price of £5.

This uses a small tube and is quite a compact instrument, so if it's only use is that of checking the band pass on the I.F. transformers, in a high fidelity receiver, its construction is justified. It can, of course, be used for a variety of different jobs other than the alignment of I.F.'s, in fact, it is a good servicing 'scope.

We can supply a complete kit of parts for £5 containing valves, tube and all components except chassis and case. A re-print of the article from the *Radio Constructor* is available price 9d. The power pack not shown on the block diagram is, nevertheless, included in the kit.

**CONTINUOUSLY VARIABLE MAINS TRANSFORMER**

As described in the "Wireless World," August 1951 issue, this has a primary tapped at 81 v. and four secondaries of 1 v., 3 v., 9 v. and 27 v. respectively.

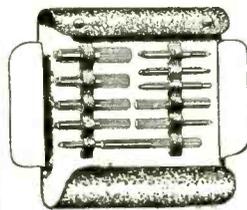
By suitable selection of windings, voltage in steps of 1 v. up to 40 v. can be obtained with isolation from the mains at 100 watt rating, e.g., 20 amps at 5 v. and 2½ amps at 40 v. By adding the primary the voltage can be varied in steps of 1 v. up to 280 v.

This is undoubtedly an essential piece of equipment in all experimental laboratories. Price £3/10/- each.

**TRIMMER TOOL KIT.**

Invaluable for aligning radio or T.V. sets. Kit comprises: 10 precision tools set in polished ebonite and each tool has been carefully designed with the minimum of metal to avoid upsetting the circuits being aligned.

There are ten tools comprising: 4 box spanners, 3 screw drivers and 3 special tools. All packed in strong folding case. Price 35/- complete.



**WELD TYPE WIRE JOINTER**

This jointer melts the wires and causes the metal of each to run together, thus making a strong and permanent weld. It obviously is not intended to replace the soldering iron but nevertheless is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc. In many cases also this method is faster than soldering and there can be a considerable saving of current. Price 9/6. Or complete with enclosed mains transformer 29/6.



**TOOLS, ETC.**

**"Q-MAX" CHASSIS CUTTERS.**

The simplest and quickest tool for cutting holes in aluminium or steel chassis. Comprises die and punch operated by Allen key. A separate die and punch is required for each size.

- 1/4" hole (B7G, etc.) ..... 11/6
- 1/2" hole (B8A, etc.) ..... 11/6
- 3/4" hole ..... 12/6
- Same key fits these three, price 10d.
- 1" hole ..... 14/9
- 1 1/4" hole (Octal base) ..... 14/9
- 1 1/2" hole (English bases) ..... 14/9
- 1 3/4" hole ..... 16/6
- 1 7/8" hole (EF50, etc.) ..... 16/6
- 1 3/4" hole ..... 18/6
- 2 3/32" hole ..... 30/-
- 2 1/2" hole ..... 35/-
- 1" x 1" square hole ..... 23/-
- Same key fits these nine, price 1/3.

**METAL DIVIDERS.**



Really well made for Government workshops. Ideal for marking out on metal chassis. Price 3/6.

**HARMONIC GENERATOR**

A harmonic generator is well worth making up, because it oscillates with a wave form having harmonics extending right into the radio frequencies. To trim a straight set therefore it is only necessary to inject its output into the aerial and adjust trimmers for maximum audio output, similarly with a superhet a great saving of time can be effected.

We will supply this as a kit of parts, with constructional details price 15/- for battery, and 30/- for mains operation; data available separately, price 1/6.

**SPRING LOADED TERMINAL BLOCK**

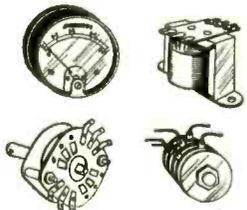


Fully insulated so is ideal for mains, terminal point fitted on bench of workshop or laboratory. Also suitable for temporary hook ups when testing components, etc., will save its cost the first week of use. Price 3/6.



**SPRAY GUN**

Hand operated, ideal to put a good finish on a completed chassis, and for respraying valves etc. (completes the perfect job). Price 15/6 complete with instructions, plus 9d. postage.



**BUILD AN OUTPUT METER**  
Switch, Transformer, meter and rectifier to build a dual range O.P. Meter with instructions. £1/15/-.

**SUNDRIES**

**SPINDLE EXTENDERS & COUPLINGS**



Small type. Solid Brass with two Grub Screw, 7d. each.  
Flexible Type. These also insulate, 2/- each.  
Ordinary Insulated. These have additional spindle moulded permanently and

they extend the control spindle by 1-1 1/4". 1/6 each.  
Bellows Coupling. These are ideal for slug tuning as they extend as well as bend. 1/9 each.

**CLEAR CEMENT.**

Almost instantaneous drying for coil winding and all repairs, 1/6 per tube.



**HARDWARE.**

Service-man's 3 gross assorted nuts

bolts and washers, all useful sizes. Price 6/6. We endeavour to maintain stocks of wood screws, steel and brass round head and counter sunk. Parker Kalon self cutting screws, washers and studs. Send us your orders and enquiries.

**RUBBER GROMMETS.**

1/2", 3/4", 1", 1 1/4", 1d. each.  
3/4", 1", 1 1/4", 11d. each.  
Serviceman's packet of 24 assorted sizes, 2/-.

**CROCODILE CLIPS**

Small instrument, 6d. Large Car Battery type, 9d.



**TERMINAL BLOCKS**

Heavy duty type, 5 way 4in. long x 1in. wide x 1 1/4in. high. 30 amp. rating. Price 1/6.  
Heavy Duty type, 6 way porcelain 15 amp. rating. Price 1/6.  
Heavy Duty type, 5 way porcelain 15 amp. rating. Price 1/3.  
Heavy Duty type, 3 way porcelain 15 amp. rating. Price 9d.

**OCTOPUS CLIPS**

An ideal clip for fixing anything to a rod or pole, this is self adjusting from 1 1/2in. to 4 1/2in. Price 1/- each.



**MILLIBAR BARO-METER, 7/6**

The heart of a barometer is a metal bellows which will expand and contract with the varying air pressure. The aircraft altimeter works on the same principle, a series of gears and lever amplifying the expansion and contraction of the bellows and so works the pointer. We can offer the ex-R.A.F. Sensitive Altimeter slightly faulty but containing the essential bellows, gears, wheels, etc., from which a good barometer can be made. Price only 7/6, plus 1/- post.



**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**

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:

7/.029 3-core flat	2/-
7/.044 twin flat	2/-
7/.064 twin flat	3/3

**MULTICOURED 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:

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 33 1/3%.

**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**

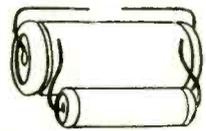
Bakelite, 1/- each or 10/6 doz. Bakelite skirted Batten holder, 1/6 or 15/- doz. Bakelite type threaded for 3/8 in. with HO skirt, 1/6. 10 per cent. discount if bought in dozens.

**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 wave-band 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.

**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. x 8 mfd. 350 v.	3/-
8 mfd. x 8 mfd. 450 v.	3/9
8 mfd. x 8 mfd. 500 v.	3/9
8 mfd. x 16 mfd. 450 v.	4/9
8 mfd. x 16 mfd. 500 v.	6/-
16 mfd. x 16 mfd. 450 v.	6/-
16 mfd. x 16 mfd. 500 v.	7/-
20 mfd. x 20 mfd. 200 v.	4/-
24 mfd. x 24 mfd. 200 v.	4/6
25 mfd. x 25 mfd. 200 v.	4/9
32 mfd. x 32 mfd. 150 v.	4/9
32 mfd. x 32 mfd. 450 v.	6/9
100 mfd. x 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. x 8 mfd. x 8 mfd. 450 v.	3/9

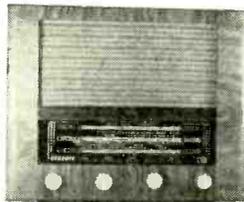
**SPECIAL RADIOGRAM OFFER**

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 Bin. P.M. Speaker. Price £9/19/6 or H.P. £3/7/- deposit. Carriage 7/6 extra.

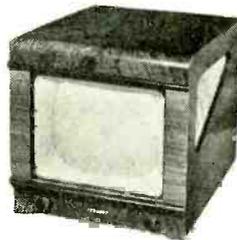
**TABLE MODEL RADIO**

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.

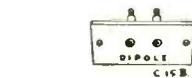
**"MIDGETRONIC" Radio Cabinet**

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.



**.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.

To ensure receiving prompt reply, please enclose stamped addressed envelope, when writing for additional details.

**ELECTRONIC PRECISION EQUIPMENT LTD**

**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. Due to Purchase Tax no kit of parts for this will be made available, but 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.

**HIGH VOLTAGE VALVE HOLDERS**



For four or five pin valves. Price 2/9 each.

**2 1/2in. TUBE MOUNTING**

This comprises metal cased moulded rubber tube mounting, front escutcheon, 4 screws and Perspex window with engraved cursor lines, 5/- complete.

**V.C.R. 139**

Tube base with mu-metal screen, 4/6.

**MU-METAL SHIELD**

For 6in. tube V.C.R.97, etc., 10/- per pair.

**6in. TUBE MOUNTING**

Shock proof rubber mounted and adjustable, i.e., tube may be turned, with tube holder, 4/6 each.

**HIGH VOLTAGE**

Insulated spindle couplers, 1/6 each.



**AUTOMATIC D.C. STARTER**

For remote control of D.C. motor between 1 and 3 kw., adjustment for 100v. or 230 v.

Unused and in first-class condition, complete with metal and wired glass cover. Price on request.

**6KV. EHT FOR 35/-**

6KV. R.F. EHT kit, comprises 2 valves, mains transformer, condensers, coil formers and wiring instructions. Price 35/- complete. Data available separately, price 2/6.

**SPECIAL LOW PRICES**

**AMPLIFIER UNIT A 1134A**

This is a 2-stage intercom and Tx pre-amplifier with transformers, etc. Easily modified as gram amplifier or dictaphone, etc. Complete with 2 2 v. valves, QPP and Triode. Price only 9/6, plus 1/6 post and packing. Circuit diagram, free with unit, or separately, 1/6.

**MORSE OSCILLATOR UNIT**

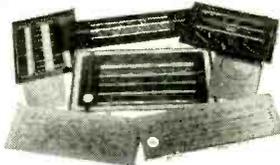
Variable note and variable output, fitted with jack for external modulation, complete with 2 2 v. valves. Price 8/6, plus 2/- post and packing.

**STOP PRESS**

Weymouth miniature Coil Packs at half price. Long, Medium and Short wavebands with gram position. Size, 3 1/2in. x 3in. x 1 1/2in., single hole fixing.

Limited quantity, price 22/6, plus 1/6 post. 12 for £12, post free.

**RADIO DIALS AND SCALES**



Note.—Type A. Pointer moves from side to side.  
Type B. Pointer moves up and down.  
Type C. Pointer rotates centrally.  
Type D. Pointer rotates in semi-circle from bottom centre.

Minimum dial openings are quoted to help you if you cannot find the right size listed, and the figures indicate to what size the dial could be cut down.

Post and packing charges. Owing to the fragile nature of these dials, 2/- extra must be included to cover post and packing.

Quantity Prices. Where 12 or more of one type are required discount is 25 per cent.; 144 or more, 33 1/3 per cent. (there are no carriage charges on quantity orders).

**GLASS DIALS**

Type	Glass Size		Min. Dial Opening	Wavebands	Colours	Price	List No.
	in.	in.	in. in.				
A	12	6 1/2	8 1/4 x 4 1/4	M., S1, S2, S3, S4.	4	3/6	C73A
B	6	7 1/2	5 1/4 x 6 1/2	M., S1 & S2	3	3/6	C74A
B	4 1/2	11	2 x 6	L., M. & S.	3	3/6	C77A
A	13 1/2	3	7 1/2 x 2 1/2	L., M. & S.	3	3/6	C78A
C	3 1/2	3	2 1/2 x 3	L. & M.	2	1/6	C81A
A	8	5	7 x 4 1/2	L., M. & S.	3	4/6	C83A
B	6	7	5 1/2 x 5	L., M. & S.	2	2/6	C84A
B	9	7	5 1/2 x 5	M., S1 & S2	3	3/6	C85A
A	6	7 1/2	6 1/2 x 5 1/2	L., M. & S.	1	2/6	C88A
D	6	5 1/2	5 1/2 x 3 1/2	L. & M.	2	2/6	C90A
B	7 1/2	7 1/2	6 x 5	L., M. & S.	3	3/6	C91A
D	6	5 1/2	5 1/2 x 3 1/2	L. & M.	2	2/6	C92A
B	7 1/2	7 1/2	6 x 5	L., M. & S.	3	3/6	C93A
A	8	3	7 x 2	L., M. & S.	3	2/6	C94A
B	5	8 1/2	4 x 6 1/2	L., M. & S.	3	3/6	C95A
B	7	7 1/2	6 x 5	L., M. & S.	3	3/6	C96A
A	11	4 1/2	6 x 5	M., S1, S2	3	3/6	C97A
B	4	10	3 1/2 x 2 1/2	L., M. & S.	3	2/6	C98A
C	5	4 1/2	4 x 5	L., M. & S.	3	3/6	C99A
A	5	4 1/2	3 1/2 x 2 1/2	L., M. & S.	3	2/6	C100A
C	5	6 1/2	4 1/2 x 5	L., M. & S.	3	3/6	C101A
C	5	6 1/2	4 1/2 x 5	L., M. & S.	3	2/6	C102A
C	5	6 1/2	4 x 4 1/2	M., S1 & S2	3	2/6	C103A

**Metal, Fibre and Card Dials**

A	10 1/2	3 1/2	8 x 2 1/2	M., S1, S2, S3 & S4.	Metal	2/6	C75A
C	4	5 1/2	3 x 3	L. & M.	Fibre	1/6	C82A
C	3	3	2 1/2 x 2 1/2	L. & M.	Card	9d.	C86A
D	5 1/2	5	4 x 2 1/2	L., M. & S.	Card	9d.	C87A

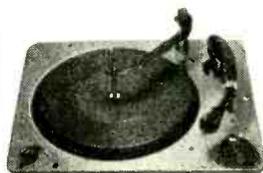
**EXCEPTIONAL I.F. TRANSFORMERS**

Ferro enclosed and cored, 465KC adjustable, very high Q and gain. Ideal for car radios, personnel sets, etc. Dimensions: 1 1/2in. high x 1in. dia. Price 8/6 per pair.

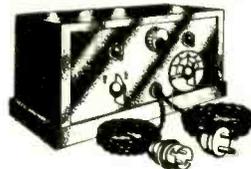
**THIS MONTH'S SNIP**

Owing to a fortunate bulk purchase we are able to offer .1 500 v. Tubular Condensers at 7/6 per dozen. These are not Government surplus but are recent manufacture of one of our most famous condenser firms and have been stored in air-tight tins.

**COLLARO AUTO-CHANGER**

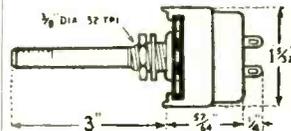


Last year we purchased a large quantity of the Collaro Auto record changers type RC/511, 3 speed, suitable for all types of records with the latest crystal pick-up, but these have been selling very rapidly, and it may well be that unless you buy one this month you will not be able to again, at this special price. We urge you, therefore to order right away, the price is 11 gns., plus 7/6 carriage and insurance.



**ELECTRONIC TIMER**

With this instrument processes which operate over a specified time can be controlled automatically, e.g., in photography use it to control exposures, etc. The instrument can be set to any length of time from a fraction of a second up to three minutes, and it can be made to switch the appliance on or off. Circuit diagram and instructions, 2/3. Complete kit of parts, including valves, mains transformer, power pack, sensitive relay, potentiometer and metal case, 69/6.

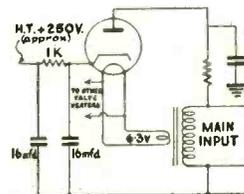


**VOLUME CONTROLS**

We carry a full range of standard-size volume controls from 2K to 2 meg. Prices are: less switch, 3/-; Single pole switch, 4/-; double pole switch, 5/- . We can also supply midget-type controls, less switch, 4/-; single pole switch, 5/9; double pole switch, 6/6. Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.

**SHORT WAVE TUNING HEART**

Coil Pack, 2 gang condenser, IF transformers and calibrated scale for frequency coverage of 13-37 metres, 37-100 metres and 200-500 metres. Price 39/6 complete with circuit diagram.

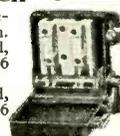


**A POWER PACK FOR 15/-**

Efficient power supply, O.K. for operating a receiver, amplifier, instrument or other device requiring up to 60 mA. at approx. 250 v. Parcel consists of filament transformer, rectifying valve, smoothing resistor and 16 x 16 mfd. 350 v. electrolytic condenser. Note the filament transformer will supply enough current to operate 3 or 4 other 6.3 valves.

**M.E.M. SWITCH FUSES**

10 amp. all Porcelain 250 v., 6/- each.  
15 amp. Ironclad, 10/6 each, plus 1/6 post.  
30 amp. Ironclad, 16/6 each, plus 2/6 post.

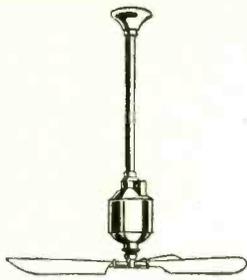
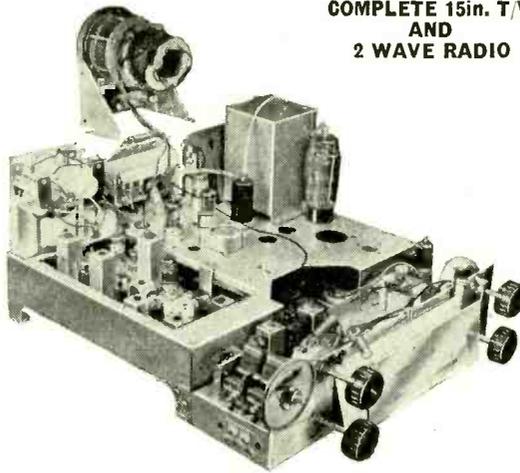


**ELECTRONIC PRECISION EQUIPMENT LTD.**

**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**



**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.



**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:

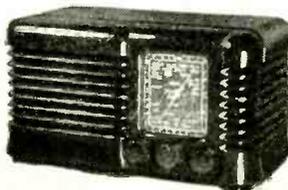
1. 15in tube, type 85K.
2. Moulded rubber mask.
3. Tube clamping ring.
4. Special ion trap.
5. Sundries, plugs, etc.
6. Blue print showing connections and method of fixing tube, ion trap, etc.

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)**

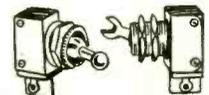
S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	2/-
20	1/4	2/2
22	1/5	2/4
24	1/6	2/6
26	1/7	2/8
27	1/8	2/9
28	1/8	2/10
30	1/9	3/-
31	1/10	3/1
32	1/10	3/2
33	1/11	3/3
34	1/11	3/4
36	2/-	3/6
38	2/2	3/10
40	2/4	4/2

**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/-.

**ELECTRONIC PRECISION EQUIPMENT LTD.**

**EX-GOVT. VALVES**



CV2654



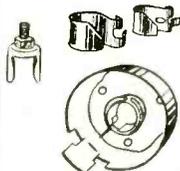
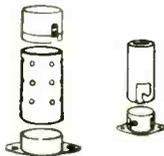
CV1090



CV2579

- CV12 CV1037
- CV13 CV1047
- CV18 CV1051
- CV19 CV1053
- CV20 CV1054
- CV22 CV1055
- CV31 CV1056
- CV32 CV1057
- CV37 CV1060
- CV43 CV1061
- CV45 CV1061A
- CV51 CV1062
- CV53 CV1065
- CV54 CV1066
- CV57 CV1074
- CV63 CV1075
- CV65 CV1078
- CV67 CV1090
- CV71 CV1091
- CV72 CV1092
- CV73 CV1094
- CV74 CV1095
- CV82 CV1101
- CV85 CV1102
- CV92 CV1104
- CV93 CV1105
- CV115 CV1106
- CV117 CV1107
- CV118 CV1108
- CV120 CV1110
- CV129 CV1111
- CV133 CV1118
- CV138 CV1120
- CV147 CV1124
- CV148 CV1125
- CV158 CV1126
- CV160 CV1127
- CV177 CV1128
- CV185 CV1129
- CV187 CV1133
- CV188 CV1135
- CV193 CV1136
- CV210 CV1137
- CV271 CV1139
- CV321 CV1141
- CV327 CV1147
- CV534 CV1152
- CV594 CV1170
- CV619 CV1175
- CV621 CV1187
- CV634 CV1191
- CV640 CV1197
- CV656 CV1199
- CV659 CV1284
- CV665 CV1300
- CV668 CV1306
- CV686 CV1310
- CV702 CV1311
- CV704 CV1366
- CV755 CV1367
- CV773 CV1368
- CV779 CV1449
- CV781 CV1481
- CV849 CV1504
- CV849 CV1508
- CV852 CV1573
- CV895 CV1653
- CV922 CV1755
- CV1000 CV1913
- CV1018 CV1943
- CV1020 CV2539
- CV1023 CV2579
- CV1025 CV2679
- CV1029 CV2710
- CV1031 CV2941
- CV1032 CV2945
- CV1033 CV3581
- CV1035 CV3793

**VALVE HOLDERS, ETC.**



Type	Paxolin		Amphenol		Ceramic	
	s	d	s	d	s	d
British 4-pin	6	—	—	—	9	—
British 5-pin	6	—	—	—	9	—
British 7-pin	6	—	—	—	9	—
British 9-pin	9	—	—	—	—	—
UX 4-pin ..	6	—	—	—	1 6	—
UX 5-pin ..	6	—	—	—	9	—
UX 6-pin ..	7	—	—	—	—	—
UX 7-pin ..	8	—	—	—	—	—
Large UX7	—	—	—	—	1 0	—
Diode B3G	6	—	8	—	—	—
B7G	6	—	8	—	10	—
B8G Octal	9	—	—	—	—	—
B8A	1 3	—	1 6	—	—	—
B9A (Noval)	1 3	—	—	—	—	—
B9G	1 0	—	1 0	—	—	—
B12A (Duodece)	1 3	—	—	—	—	—
Int. Octal ..	6	—	9	—	1 6	—
Mazda Octal	6	—	9	—	—	—
8-pin side contact ..	—	—	2 6	—	—	—
Jumbo 4-pin	—	—	—	—	3 6	—
4-pin Hivac	9	—	—	—	—	—
5-pin Hivac	9	—	—	—	—	—
5-contact Acorn ..	—	—	—	—	1 6	—

**VALVE SCREENING CANS**

Description	s		d	
	1	3	1	6
Suitable for standard size valves consists of three parts, bottom plate, main body and spring top	—	—	1	3
B7G fixing base and top screen with spring ..	—	—	1	6
Screen for octal G.T. Valves	—	—	—	6

**VALVE RETAINERS**

Type	s	d
Spring type for EF50 ..	—	3
Threaded type for EF50 ..	—	6
General type for all valves, consists of a silk cord and two springs ..	—	3

**VALVE TOP CONNECTORS**

Type	Plain		Screw'd		Insulated	
	s	d	s	d	s	d
British 1/2 in. top ..	1 1/2	—	9	—	1 6	—
American 1/2 in. type	1 1/2	—	9	—	1 6	—
Screw to clip adaptor (for modern equivalents) ..	—	—	—	—	—	6

*To ensure receiving prompt reply, please enclose stamped addressed envelope, when writing for additional details.*

**EX-GOVT. VALVES American TYPES**



- 2B26 807 8011
- 2C34 813 DET12
- 4C27 830B DET19
- 3D6 832 RK20A
- 6J6 860 RK28A
- 35T 866 RKR72
- 54 Gammatron 866A RL5
- 259A 923 RL7
- 714AB 954 RL18
- 717A 1616 RX235
- 717A 1625 TZ0520
- 723AB 1629 VT90
- 801 4064B VT114
- 803 4074B VTX3
- 805 4328A WE3A



**EXPERIMENTERS VALVE SNIP**  
CV1147, High Current Thyatron, filament 5 v. at 5 amp. peak plate voltage 1,000 v. peak plate current 12 amp. A limited quantity of these are available at 20/- each.

**THERMAL DELAY SWITCH**  
Hermetically sealed with 4-pin base, the operating voltage is 6 v. with a delay of 1 minute. Price 12/6

**TUNGAR VALVE RECTIFIERS**  
Replacement for many home and industrial chargers: 1 amp. type 68502. Price 9/6.  
3 1/2 amp. type 68507. Price 12/6.

**MERCURY VAPOUR RECTIFIERS**  
CV2946 max current 1.8 max. 1,000 v. Price 6/6.  
VU29. max current 2.5 amps., max. 2,000 v. Price 9/6.  
BD10. max. current 25 amps. max. 1,000 v. Price £6/10/-.



**ELECTRONIC PRECISION EQUIPMENT LTD.**

*Post orders should be addressed to:—*

**ELPREQ HOUSE (Ref 2), HIGH STREET, WEALDSTONE, MIDDX.**

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**42-46, WINDMILL HILL, RUISLIP, MIDDX.**

Phone: RUISLIP 5780  
(Half-day, Wednesday),

**152-153, FLEET STREET, E.C.4.**

Phone: CENTRAL 2833  
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*Immediate delivery - of course*

## **VALVES !! TUBES !!**

RECEIVING, TRANSMITTING, MAGNETRONS, KLYSTRONS,  
CATHODE-RAY TUBES, PHOTOCELLS, ETC.

*First Grade Quality - British and American Make - No Dollar Expenditure Involved*

**LARGE QUANTITIES & GREAT VARIETIES**

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MORE ROOM FOR YOU

MORE ROOM FOR US TO SHOW YOU

THE BEST IN THE ELECTRONIC FIELD

# **TELE-RADIO (1943) LTD.**

For brilliant, high-fidelity sound recording  
the **GRUNDIG** 2-speed tape recorder

**P**USH 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 : 7½ in. per second, 50-10,000 c/s. 3¼ in. per second, 50-6,000 c/s.



**Price 80 gns.**  
including condenser mike. H.P.  
Terms available.

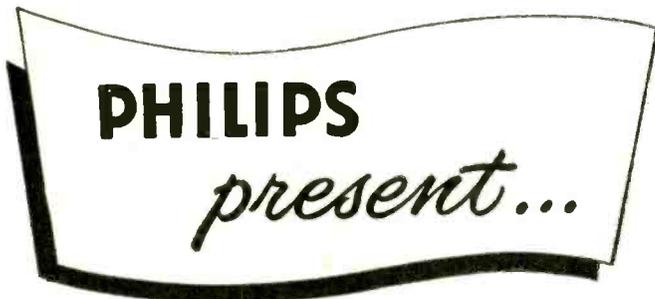
- ★ Condenser microphone—as sensitive as the human ear.
- ★ Mixer unit—to mix up to 4 different recordings at once.
- ★ Remote controls—hand or foot operated.
- ★ Two-way telephone recorder—without alteration to G.P.O. handset.
- ★ As compact and portable as a suitcase.

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.**



**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  
3 V to 300 V at 20 Kcs = 1.9 M.ohm, < 6 pf

*Specially recommended for A.F. work and vibration investigations.*

INDUSTRIAL X-RAY EQUIPMENT · ELECTRONIC APPARATUS  
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WELDING PLANT AND ELECTRODES · MAGNETIC FILTERS  
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GENERATORS · RADIO AND TELEVISION RECEIVERS



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INDUSTRIAL DEPARTMENT

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Export enquiries welcomed.

Immediate delivery from stock.

Prompt attention to post orders.

### TAPE RECORDERS

<b>SOUNDMIRROR</b>	
New Table, Twin Track	£69 10 0
New Portable, Twin Track	£74 10 0
<b>SCOPHONY-BAIRD</b>	
New Model Mk. 2	£68 5 0
<b>SIMPHONIC</b>	
New Model IA	£83 0 0
<b>GRUNDIG</b>	
2-speed press-button control	£84 0 0
<b>WIREK</b>	
Portable Battery Model	£55 0 0

### RECORDING TAPE

<b>GRUNDIG</b>	
L.G.H., 1,200ft.	£2 0 0
<b>SOUNDMIRROR</b>	
Paper Tape, 1,200ft.	£1 5 0
<b>FERROVOICE</b>	
Spare Spools	£1 2 6
E.M.I. H.60, 1,200ft.	£1 15 0
E.M.I. H.60, 600ft.	£1 1 0
E.M.I. H.65, 1,200ft.	£1 15 0
E.M.I. H.50, 1,200ft.	£2 8 0
<b>SCOTCH BOY</b>	
1,200ft.	£1 15 0
600ft.	£1 1 0
Spare Spools, 1,200ft.	£4 3 3
Spare Spools, 600ft.	£3 3 3
E.M.I. H57, 3,250ft.	£6 0 0
<b>SIMPHONIC</b>	
As advertised	£1 15 0

### RECORD REPRODUCING EQUIPMENT

<b>B.S.R.</b>	
3-spd. (Crystal T/O. hds.)	£9 4 11
3-spd. (with 2 GP20 hds.)	£10 8 8
3-spd. (with 2 Decca hds.)	£12 17 8
3-spd. Auto-mixer	£16 10 3
<b>GARRARD</b>	
R.C.80, less Head	£15 3 3
R.C.75A, less Head	£13 10 0
S.201.B Variable 3-spd. Transcription	£22 14 8

<b>CONNOISSEUR</b>	
3-spd. Deck	£21 16 3

<b>GOODMANS</b>	
Axiom 150 Mk. 2	£13 11 5
Axiom 60	£11 10 0
Axiom 101	£6 12 1
Axiom 102	£9 18 1

<b>WHARFEDALE</b>	
W.12.CS	£13 3 3
Golden 10 C.S.B.	£8 6 7
Super 5 and 8 CS/AL	£6 13 0
Bronze 10in.	£4 12 9
Bronze Bin	£3 4 0
W.B. Crossover Unit	£1 6 6
W.B. Tweeter Unit	£3 15 0

### TEST GEAR

<b>AVO</b>	
Model 8	£23 10 0
Model 7 (latest)	£19 10 0
Uniminor	£10 10 0
Electronic Meter	£40 0 0
Wide Band Sig./Gen.	£30 0 0
Valve Characteristic Meter	£60 0 0
D.C. Minor	£5 5 0
10kV. Multiplier for Model 8	£2 5 0
Carrying Cases for Models 7, 8 and 40	£3 0 0

<b>ADVANCE</b>	
H.1 (Sig./Gen.)	£25 0 0
E.2 (Sig./Gen.)	£28 0 0
J.I. New Model	£35 12 0

<b>COSSOR</b>	
Double Beam 1035	£93 10 0
Double Beam 1047	£132 0 0

**TAYLOR**  
ALL NEW TAYLOR TEST GEAR IN STOCK AND AVAILABLE ON H.P. Send S.A.E. for Catalogue and Terms.

<b>PICK-UPS</b>	
<b>ACOS</b>	
G.P.20 (Std. or L.P.)	£3 6 1
Spare heads for above	£2 0 0
G.P.30 L.P./Std.	£3 6 1
<b>DECCA</b>	
XMS, Magnetic	£6 9 5
<b>CONNOISSEUR</b>	
Super Lightweight, L.P./Std.	£9 8 6
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### VALVES

We are one of London's largest stockists — Please write for requirements.

### MICROPHONES

<b>ACOS</b>	
Mic 22 (Crystal)	£6 6 0
Mic 22 (head only)	£4 10 0
Mic inserts for above	£1 9 6
Mic 16 (Crystal)	£12 12 0
Mic 30 (Crystal)	£4 4 0

### SOUNDMIRROR

M/C with T/F	£7 7 0
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### LUSTRAPHONE

M/C with T/F.C.51	£5 15 6
M/C less T/F.C.51	£5 5 0
Heavy Table Base for above	£1 1 0
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### RESLO M/C (Low Imp.)

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(Mic), 3 extensions	£3 12 6
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Point 1, TL12	£28 7 0
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Q.25 in Cabinet	£48 10 0
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WEARITE 2A (limited stock), with complete instructions for Associated Amplifier, £35 0 0, carriage extra.

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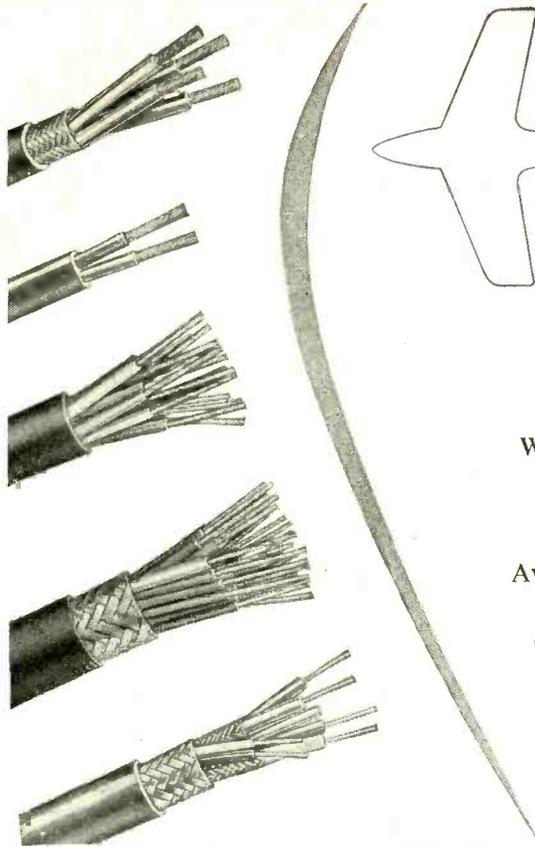
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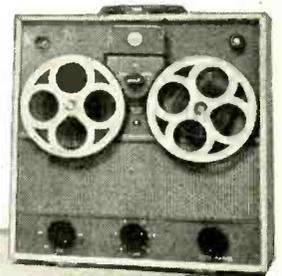
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The one you require enclosed if available in a dozen assorted of our best choice. **10/6**



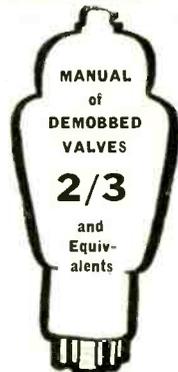
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Connects to radio or gram. Talk over your own radio, room to room. Easy to fix. Two mikes make 2-station house phone in your own home. Order to-day. **12/6** Post 1/6



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All-in-one Radiometer A.C./D.C. Tests everything in Radio. Complete with Test prods. **29/6** Post 1/6.



**AMPLION TEST METER**  
1,800 ohm per volt on all D.C. and A.C. ranges, 10 v., 100 v. and 500 v. D.C. and A.C. 50 mA. and 500 mA. A.C. Resistance up to 200,000 ohm (3,000 ohm centre scale), with self-contained battery, 5,000 volt range with a separate H.T. test prod (9/6 extra). Supplied with test prods. Multi-colour scale easily readable. **£5** POST FREE.



**Universal Minor £10. Model 7 and 40 Avometers, £19. Electronic Testmeter, £40. AVO model 8 in stock, £23.**



**"Demobled Valves Manual" 2/3**  
Giving Equivalents of British and American Service and Cross Reference of Commercial Types with an Appendix of B.V.A. Equivalents and comprehensive Price List. We have still some Valves left at very old Budget Rates (33%) which are actually sold at the old price.

If yours is a Valve Problem—Bulls are most likely to solve it. Please write us.

**TAYLOR Montrose 7-range Multi-meters, A.C./D.C.**  
3 amp precision M/I movement. 0-6-30-150-300 volt. 0-30 mA.—300 mA. **50/-** Post 1/-.



**EASY TERMS ON ALL TAYLOR METERS**  
Terms up to 10 months and very near Cash Price. Please ask for full List, Terms and Proposal Form.

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**CONDENSER TESTERS & RECTIFIER UNITS**  
Plugs straight into A.C. mains. 200/240 v., and is indispensable for examination of condensers. Very slight and intermittent leakages which cannot be discovered by conventional instruments can be traced by this unit. Complete. Supplies are becoming limited. Post 1/- **39/6**

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Paint STRIPPING made easy with our foolproof electric tool. Easy and faster. Clean and safe. Old paint comes off like MAGIC. Cost 1d. per hour. A.C./D.C. Complete with long cable. Guaranteed. List 47/8 Post 1/3 **OUR PRICE 37/6**



**Magic Plates** as described in April—few left at **30/-**.

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IMMEDIATE DELIVERY FROM STOCK  
**"VIEWMASTER"**  
SPECIFIED COMPONENTS  
(London — Sutton Coldfield — Holme Moss — Kirk-O-Shotts — Wenvoe — Newcastle — Belfast.)  
Send for Stage I now—price £3/2/3, post free. Complete Kits, Stage-by-Stage and Single Components Supplied. "Viewmaster" Construction Envelopes ..... 7/6 ea.  
**NEW LANE TAPE TABLE, £17/10/-**, plus 10/- carriage and packing.  
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**ALUMINIUM CHASSIS:** 6 x 4 x 2 1/2 in., 4/9; 8 x 6 x 2 1/2 in., 6/4; 10 x 7 x 2 1/2 in., 7/7; 12 x 8 x 2 1/2 in., 9/6.  
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**CLEAREX 6in. ENLARGERS** (for VCR97, etc.), 17/6.  
Terms: C.W.O. or C.O.D. over £2. Over £2 post free, otherwise please add 1/- post and packing.  
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**LATEST FERRANTI ARI5 HIGH-POWER CAR RADIO.** 12 volt Medium and long wave. Guaranteed brand new condition. Complete with control heads and leads. Unfortunately these sets are less the flexible drives. Purchased from the estate of a late dealer. List price £37/10/-. 4 only. Price £15 each. Absolutely perfect.

**TELEVISION AERIALS.** From the same source. Small quantity of Antiference PD5RM Dipole and Reflector, with 10ft. metal mast and chimney lashing equipment. For Holme Moss. Listed currently at £7. Our price £4 each, carr. 4/-.

**I155 AC POWER PACK AND OUTPUT STAGE.** With built-in LS. See previous issues for full details, £7/10/-, carr. 3/6.

**G.E.C. VHF RECEIVERS** complete with 10 valves. Ex-Govt. As used by police. Used but guaranteed in excellent condition. Valves comprise ZA2's, 954's or EF50's in HF and 1st Det. stages. Det I9 in local oscillator, KTW63's in three IF stages, D63 Det and AVC, LF H63, Output KT63, Noise suppressor D63, Power requirements 6v 3a, 270v 80ma, 78.5-82 Mc/s. Intermediate frequency adjustable 8.3-9.8 Mc/s. Oscillator Crystal controlled (No crystal included). Sensitivity 3 microvolts for 50mw audio output. Input impedance 72 ohms. Housed in Grey enamel steel case with lid 10 x 8 x 7in. Weight 22lbs. Note the amazingly low price, 49/6 plus 5/- carr.

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**OXYGEN MASKS.** 6D/643 and 6D645. Type G. Brand new. Individually boxed. £12/10/- per 100.  
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**AMERICAN AIRCRAFT CABIN HEATERS.** Brand new. Type ABV-50D-H7-B. Makers "Surface Combustion" Columbus. 50/- each.

**H. P. RADIO SERVICES LTD.**  
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Tel.: Aintree 1445 Established 1935

# 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.

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**NOTE THESE OUTSTANDING FEATURES**

- ★ TWIN-TRACK RECORDING WITH UNIFORM RESPONSE.
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- ★ LIGHTWEIGHT PRECISION BALANCED SPOOL.
- ★ FERROVOICE SPOOLS KEEP WEAR, TEAR AND ROTATION NOISE TO A MINIMUM.

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*The Tape YOU will ultimately use*

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**22'6**  
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G.E.C.  
QUARTZ CRYSTAL  
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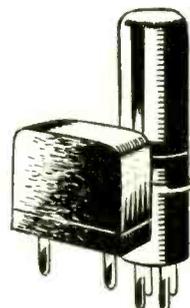
From take-off to touch-down, the safety of the aircraft is dependent on trouble-free radio contact being maintained. The components used in the radio equipment must be the best obtainable.

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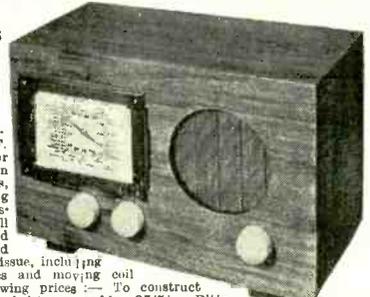
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ESTABLISHED 25 YEARS

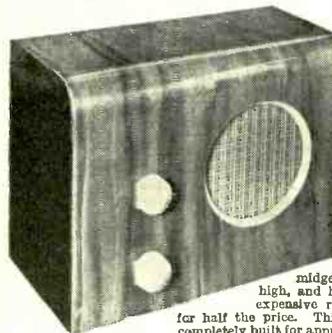
**THE "Wireless World" 3-Valve Set**



A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.

**A MIDGET 4-STATION "PRE-SET" RECEIVER**  
A complete Kit to build a 4-station "Pre-set" Superhet Receiver for A.C. mains operation.

The set is designed to receive any three stations on medium waveband and one on long wave, each station being received by the turn of a rotary switch—no tuning being necessary. It is of midget size, being 8 1/2 in. x 4 1/2 in. x 7 in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price. This Receiver, as illustrated, can be completely built for approx. £9/9/-. The complete assembly instructions, including component layout and component price list, are available for 1/9



A Midget 4-valve Superhet Portable Set covering medium and long wavebands. Designed to operate on A.C. mains 200/240 volts, or by an "Aldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Aldry" Battery Superhet Personal Set which can then be accommodated in the attaché case as illustrated (size 9 1/2 in. x 4 1/2 in. x 7 1/2 in.), this is attractively finished in lizard, maroon, dark green or blue oxide, or (b) as a combined Mains/Battery Superhet Portable Receiver, for which a polished wood cabinet is available to accommodate both Mains Unit and Batteries together. Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound frame aeriels, fully aligned L.P. transfs. and drilled chassis, etc.

**A MAINS OR BATTERY PORTABLE KIT**



Overall size of assembled chassis 5 1/2 in. x 4 in. x 2 1/2 in. Unit if required, can be completely built for approx. £10 (plus Mains Practically layouts and complete price list of Components. Attaché case available separately, 37/6.

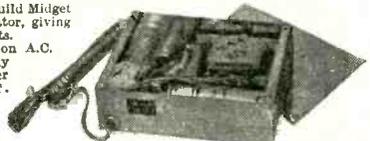
long and medium wavebands. We are able to supply all of the components to build this set, as designed and specified in the Feb. 1950 issue, including the drilled chassis, Valves and moving coil speaker, etc., at the following prices: To construct complete chassis, less dial and drive assembly, £5/5/-. Ditto including dial and drive assembly, £6. To construct the complete set, including dial and drive assembly and cabinet, £7/3/6. Overall size of cabinet is 7 1/2 in. x 3 1/2 in. x 1 1/2 in. A reprint of the designer's article, giving circuit and assembly instructions (this is available separately for 9d.) together with a practical component layout is included with each of above assemblies.

**"PERSONAL SET" BATTERY ELIMINATOR**

A complete Kit of parts to build Midget "Aldry" Battery Eliminator, giving approx. 69 volts and 1.4 volts.

This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 69 volts.

The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4 1/2 in. x 1 1/2 in. x 3 1/2 in. Price of complete Kit with easy-to-follow assembly instructions, 42/6. In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled unit 7 in. x 2 1/2 in. x 1 1/2 in. Price 47/6.



**THE "MINI-TWIN" 1-VALVE BATTERY SET**

A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption.

Drilled chassis and practical diagrams make it the ideal set for the beginner to build.

The complete chassis, including valve, can be built for 37/6, the attractive plastic case is 9/6, and suitable headphones 14/9. The complete assembly instructions, layouts and a component price list, are available for 1/6. This Receiver also performs excellently without modification, as a tuning unit, and in addition, with simple modifications for which a complete diagram is provided makes a first-class pre-amplifier for pick-up or microphone.



**TWO BATTERY PORTABLES (a) THE "MINI TWO-THREE"**

An "Aldry" Battery Portable of midget size, 6 1/2 in. x 4 1/2 in. x 3 1/2 in., designed to cover medium waveband 190-559 metres, with use of short trailer aerial. The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.

Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up IT4-IT4-DL94.

The 2-valve set can be completely built for £4/3/6 (less case), and the 3-valve for £5/3/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 1/9 for the assembly instructions: they include simple and complete practical component layouts and diagrams, which enable the most inexperienced constructor to successfully build either set. All components are available for separate sale, a price list being supplied with assembly instructions.



**(b) THE "MINI-FOUR"**

A 4-valve Battery Superhet Receiver designed to receive 4 pre-set stations, three on medium waveband and one on long wave to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary. It is of midget size, being only 4 1/2 in. x 6 1/2 in. x 4 1/2 in. when completely built and is very easily assembled from diagrams supplied.

Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is £9/10/- (or less valves for £8/7/6). Attractive carrying case finished in blue leatherette, 16/9. Complete constructional data with a blue print, which shows the practical component layout and wiring diagram, together with an individual component price list, is available separately, 1/6. Our battery eliminators (illustrated above) available in kit form are suitable for use with this set.

**THE FAMOUS "SHAFESBURY" RIBBON MIKE**

Incorporating internal line transformer having transformation ratio from ribbon impedance up to 500-600 ohms... reduced from 10 gu. to 26. A special line to grid, 500-600 ohms transformer, also available for 25/-.

**DENCO I.F. LINER**

For accurately giving 465 Kc. and 1.6 Mc. I.F. channels and associate circuits. Battery operated, small and completely self-contained, 59/6 (plus battery 1/8).

**THE "WIRELESS WORLD" MIDGET A.C. MAINS 2-VALVE RECEIVER**

We can supply all the components to build this set, including valves and moving coil speaker, for £3/10/-. including designers' complete building instructions (these are available separately for 9d.).

**THE VIEWMASTER TELEVISOR**

We have had very considerable experience in assisting customers to build this TV and can supply a SPECIFIED COMPONENTS EX-STOCK. The assembly instructions showing practical layouts and price list are available for 7/6 for London, Sutton Coldfield, Holme Moss, Kirk-o'-Shotts and Wenvoe. Complete television price list is contained in our general STOCK LIST at 9d., including Haynes, etc., components.

**THE DENCO ULTRA MIDGET SUPERHET COIL TURRETS WITH A ROTARY TURRET ACTION**

Type CT9 consists of a four station "pre-set" unit from which any three stations on medium waveband and one on long wave can be received by a turn of the turret switch. Price 39/6. Type CT10, is a 3 waveband coil pack incorporating a fourth switch position for "Gram. Complete coverage is, long waveband 700-2,000 metres, medium waveband 190-570 and short wave 15-50 metres. Price £23/6. A complete receiver circuit and all necessary data is included with each turret. These can be supplied separately for 6d.

**HOME CONSTRUCTORS A CAR RADIO RECEIVER FOR £12.0.0**

A design of a 5 Valve Superhet Receiver, employing an R.F. Stage for 6 or 12 Volt supply. Send 2/6 for the complete set of Assembly Instructions, CIRCUITS, LAYOUTS, and POINT-TO-POINT WIRING DIAGRAMS, together with a complete component Price List.

THIS IS NOT AN EX GOVT. RECEIVER, IT IS A NEW DESIGN EMPLOYING NEW COMPONENTS.

**PICK-UPS**

Cosmocond "G.P.20," for standard records, £3/5/9 interchangeable (G.P.19) head for L.P. records, £2. Decca lightweight "turnover head" type, for L.P. and standard records, £3/12/6. Goldring, Standard, lightweight Magnetic, 33/. Cosmocond "Acos" G.P.30, turnover crystal type. For Standard or L.P. Records, £3/5/9.

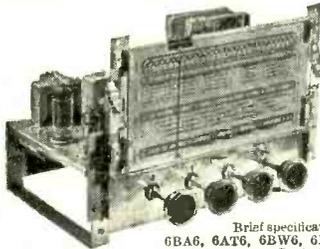
**BATTERY CHARGER KITS**

All kits incorporate metal rectifiers and are for use on A.C. mains 230-250 volts. All kits include an easily followed wiring diagram. All prices include a TAPPED RESISTOR and a five-position SELECTOR SWITCH to enable the charging rate to be varied. For 6 or 12 volt batteries at max. 1 amp., £1/18/9 (excluding Resistor and Switch, £1/5/9). For 6 or 12 volt batteries at max. 1 1/2 amps., £2/4/- (excluding Resistor and Switch, £1/8/9). For 6 or 12 volt batteries at max. 2 1/2 amps., £2/14/6 (excluding Resistor and Switch, £1/19/6). For 6 or 12 volt batteries at max. 4 amps., £3/2/6 (excluding Resistor and Switch, £2/7/3).

Send 9d. for our STOCK LIST it shows hundreds of RADIO AND TELEVISION COMPONENTS and many KITS OF PARTS for both Sets and Battery Chargers. When ordering please include approx. cost of Post and Packing.

**TWO COMPLETELY ASSEMBLED "ALL-WAVE" SUPERHET CHASSIS**

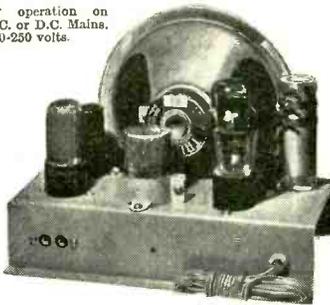
(a) MODEL B.3. A 6-valve 3-waveband superhet Receiver.  
 (b) MODEL B.4. A 5-valve 6-waveband (4 bandspread) Superhet Receiver.  
 Both Receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent, clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.



Brief specifications: Model B.3.—Valve line up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel-type); (3) wavechange and gram; (4) tone (3-position switch operative on gram and radio).  
 Negative feedback is employed over the entire audio stages. Chassis size: 11 x 7 1/2 x 8 1/2 in. high. Dial size: 9 1/2 in. x 4 1/2 in. Price, complete and READY FOR USE, excluding speaker, £12/12/-. (Carr. and Pkg. 7/6 extra).  
 Model B.4 employs a similar valve line up as the B.3, but covers 6 wavebands. Short wave 11-16, 16-25, 22-23, 31-46 and 43-120 metres, and medium wave 187-550 metres. The first four short bands are bandspread. The controls employed are as used on the B.3 model, but the tone control operates a six-position switch, having three additional positions for varying bass and treble on gram reproduction. Negative feedback is employed over the entire audio stage. Size of chassis and that is as given for B.3. Price complete and READY FOR USE, excluding speaker, £15/15/-. Carriage, packing and insurance 7/6 extra.

**A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER**

for operation on A.C. or D.C. Mains. 200-250 volts.



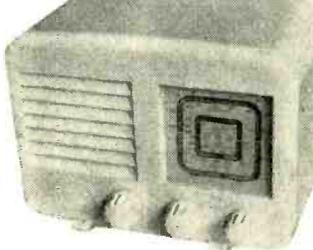
This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.  
 A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 2 1/2 in. x 5 1/2 in. x 7 in. and valve line up 25Y5-beh7-25L6.  
 Price of complete kit, including drilled chassis and valves, 24/2/6, plus 6 1/2 in. P.M. (which fits on chassis), 16/-. or 5 in. P.M., 13/6.  
 Price of fully assembled chassis ready for use, 25/5/- (plus cost of speaker).  
 Copy of assembly instructions and components price list available for 1/3.

**A 5-VALVE "ALL-WAVE" SUPERHET RECEIVER**

For use on A.C. Mains 200 to 250 volts.  
 This small attractive Receiver, embodying modern circuit technique, is designed to cover Short, Medium and Long wavebands, and incorporates the following outstanding features:

- A superhet circuit designed for high efficiency on all three wavebands.
- A 3 1/2 in. P.M. Speaker accurately matched for good quality reproduction.
- The latest range of new 6-volt B.V.A. miniature valves.
- Built-in frame aerial with provision for external aerial for distant stations.
- A white plastic cabinet of very attractive appearance overall size 7 1/2 in. x 6 1/2 in. x 6 1/2 in.
- THE RECEIVER AS ILLUSTRATED CAN BE BUILT FOR APPROX. £10/10/-.

Send 2/6 for the fully descriptive stage by stage assembly and wiring diagrams, with which complete price details are given.



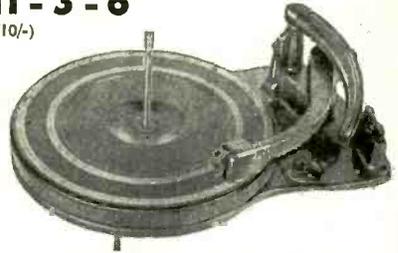
**A GENUINE SPECIAL OFFER !**

**PLESSEY 3-SPEED AUTO CHANGE UNITS**

Brand New in maker's Cartons, complete with mounting instructions.

**£11 - 3 - 6**

(Normal price is £23/10/-)



**MODERNISE YOUR OLD RADIOGRAM FOR**

**£25**

(plus 10/- carriage and insurance)

with the very latest equipment. We will supply the 3 waveband chassis on the left with the Plessey auto changer on the right, complete with 10" speaker for £25 (£28/7/6 with the 6 waveband chassis). This is less than half the price of comparable commercial three speed auto radiograms.

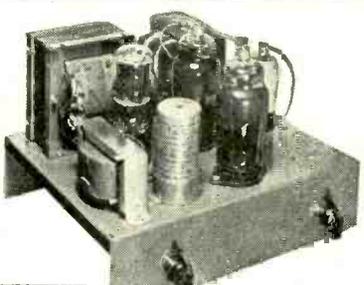
- These units will auto change on all three speeds, 7 in., 10 in. and 12 in.
- They play MIXED 10 in. and 12 in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 16 in. x 12 1/2 in. with height above 5 1/2 in. and height below baseboard 2 1/2 in.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

Please add 7/6 packing, carriage and insurance.

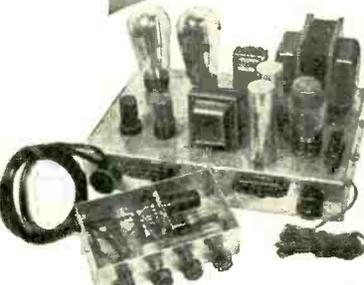
**!! AMPLIFIERS !!**  
**TWO COMPLETE KITS OF PARTS**

A 6-8 watt QUALITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, incorporating a simple arrangement to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.  
 The overall size of the assembled chassis is 10 in. x 8 in. x 7 1/2 in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, 26/17/6. Price of assembled chassis, supplied ready for use, 29/12/6. Full descriptive leaflets are available separately for 1/-.



A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Pre-amplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 x 4 x 2 1/2 in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV., 6.3 volts at 2 amps and 30 mA H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, £14. Complete specification and layout, 2/- We can also supply completely assembled and ready for use at £17.

THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THE COST.



**A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT**

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume/Mixer Control.



It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long playing, without recourse to pick-up correction. The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier.

Response characteristics are given in 12-watt amplifier advt.  
 The unit measures only 7 in. x 4 in. x 2 in., including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (68N7 and 6J5), £3/16/6. Complete assembly data is available separately for 1/-. Completely assembled and ready for use, 25/5/-.

**STERN RADIO Ltd.**

**109 & 115, FLEET STREET, E.C.4**

Tel.: CENTRAL 5812-3-4

**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 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.** 1/2-1/2 watt, 3d. each. Virtually all standard values in stock. Nearest value supplied, unless otherwise stated. (PorG)

**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. (PorG)

**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.** RMI, 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. 2 A., 6/- 6 v. 1 A., 4/6. 12 v. 2 A., 12/6. 12 v. 2 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 3/8 in. x 2 3/8 in. with opening 6 3/8 in. x 1 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, 1/8 in. diameter, 80 ohms, 9d. per yard. (P)

**CONDENSER CLIPS.** Vertical mounting, 1 1/2 in., 4d.; Horizontal mounting, 1 1/2 in., 4d.; Double, 3/8 in., clips, 4d. (G)

**BELLINGAND 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 3 COAXIAL PLUGS AND SOCKETS.** 1/- per pair, complete. (G)

**4-WAY MOULDED PLUGS AND SOCKETS** 2/6 per pair. (G)

**ZINC PLATED CHASSIS.** 13 1/2 x 6 x 2 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 5 in. 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. 5 in. green screen, electrostatic focussing and deflection. Callers only. Price 17/6 each. (G)

**FLEX CONNECTORS.** 2 1/2 x 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, air-spaced pre-set, 1/3 each; 75 pF, air-spaced, 2 in. 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, amphenol, 9d.; B9G, pax, 6d.; B9G, ceramic or siliconised polystyrene, 6d.; B12A, pax, 9d.; UX4, pax, 6d.; UX4A, 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 1/2 in., 5d. each. Other sizes 6d. each. (P)

**SWITCHBOARD METERS.** 6 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)

**TAPE RECORDER OSCILLATOR COILS.** 6.3 mH, 45 kc/s, for high impedance heads only. Price 6/9 each. (P)

**TELEVISION MAGNIFYING LENSES.** 6 in. clear, 19/6; 9 in. clear or filter, 50/-; 12 in., 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 mfd., 750 v., 1/9. (U)

**OIL FILLED CONDENSERS.** 1 mfd. 600 v., 3/- (G)

**AERIAL FILTER UNIT.** No. 112. 10P/13089 2/- each. (G)

**ALADDIN 3/8 in. COIL FORMERS.** Ex-Govt. wound. No slugs or cores. 2/- per doz. Includes 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)

**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 3/8 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. Tex. 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., 3/8 in. diam. x 3/8 in., 1/- each (M); 1 mfd. 150 v., 3/8 in. diam. x 1/2 in., 1/3 each (M); 2 mfd. 250 v., 3/8 in. diam. x 2 1/2 in., in Neoprene sleeve, 1/9 each. (M)

**TYANA SOLDER GUNS.** Weight 30 oz., for 220-230 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; midjet type for lightweight or high fidelity pick-up. Price 2/9 each. (P)

**MIDJET 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)

Garland Bros

**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 2 1/2in., 5/- each; two-sided with two straps, 12in. x 4in. x 2 1/2in., 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)

**ELECTROLYTIC CONDENSER OFFER.** Tubular cardboard cased, with wire ends, 8 mfd., 4/5 v. wkg., 525 v. surge, 2/- each. (P)

**RECTANGULAR KNOBS.** Size 1 1/2in. x 3/4in., with gold indicating spot; to fit standard 1/4in. spindles. Price 6d. each. (G)

- BOOKS FOR RADIO ENGINEERS**
- Mullard Valve and Service Reference Manual 5/-
  - Mullard Amateurs Guide to Valve Selection 1/6
  - Osrnam 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)

**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. (b) 0.027400µF. (d) 0.040710µF. (e) 0.055820µF. (g) 0.087460µF. (h) 0.108435µF. (G)

**ENGRAVED KNOBS.** 1 1/2in. 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)

**T.R.F. COILS.** Medium and long wave, aerial and H.F., 6/- per pair; with reaction winding, 6/9 per pair. (P)

**TOROIDAL CERAMIC POTENTIOMETERS.** 260 Ω 50 w., 6/6. 17k. 100 watt, 8/6. (G)

**MAGNETIC TAPE.** Scotch Boy MCI-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) 15 1/2in. x 10in. x 5 1/2in.; 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 5 1/2in. 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, 1/4in. diameter, 6d. per yard length. (M)  
**LITZ WOUND INDUCTORS.** 199 micro Henry, wound on Aladdin 1/4in. coil former (no iron dust core). Price, 2/6 per half-dozen. (G)

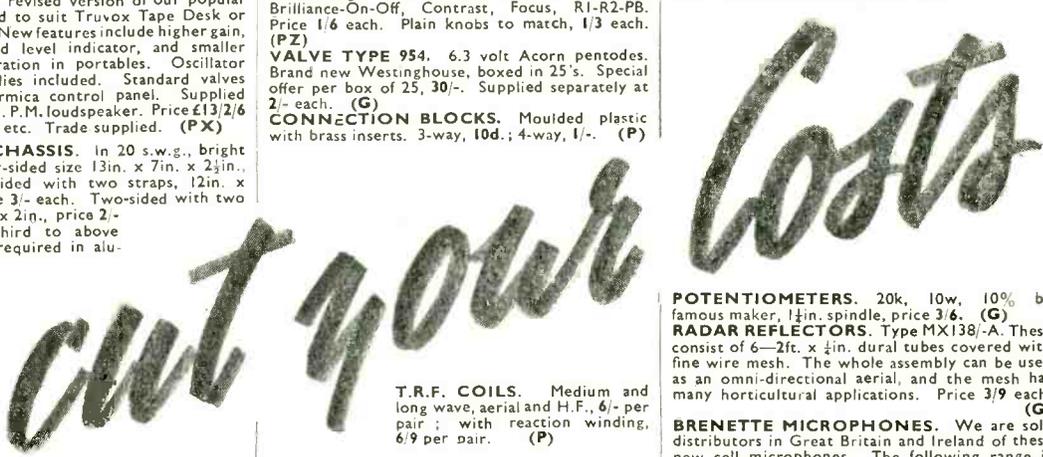
**ELECTRO-MAGNETIC CONTACTORS.**

Energised at 9-14 volt, 1/2 Amp; maximum switched, current 40 Amps. In bakelite case. Price 2/9. (G)

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**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 chrome 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)

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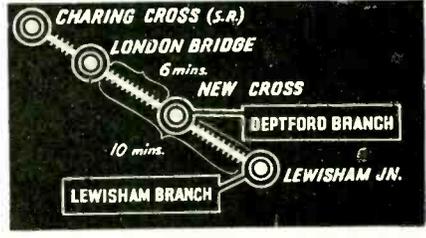
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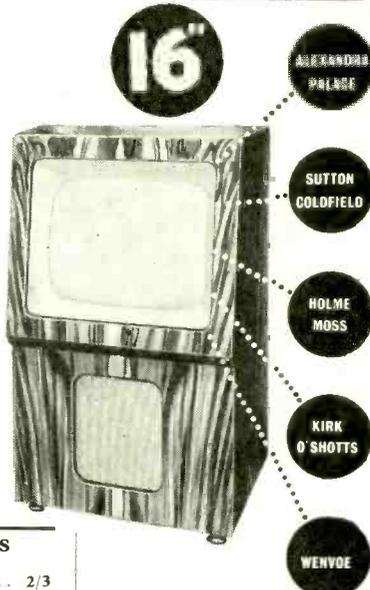
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Perfect ..... £12/19/6.  
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Frame blocking oscillator transformer, Plessey, 10/6  
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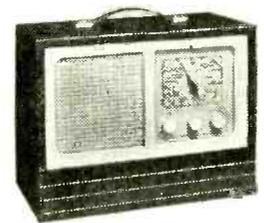
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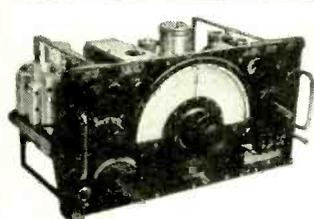
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**R1132 RECEIVERS.** New. boxed, with all valves, £3/19/6. Carriage 10/-.

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12 v. 1 a. 6/9    12 v. 1/2 a. 3/6  
6 v. 1 a. 3/11    6 v. 4 a. 18/6  
12 v. 4 a. 18/6

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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  
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Midget Pentode ..... 4/3  
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All less o'trans. new and unused. First quality.  
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**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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Supplied complete with 10 valves.

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Sound-Vision, 18/6. Power-Pack/Time base, 18/6. Support for S.V. chassis, 6/-.

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All suitable for Home Construction T/V.

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**PERSPEX. 13 1/2 x 10 1/2 x 1/2 in.** Neutral shade, slightly marked 5/11 per piece.

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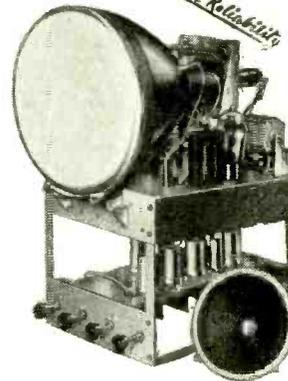
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Plastic case, single bolt fixing, Other high voltage condensers  
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All 200-250 volts c.p.s. primary. Finest quality, fully guaranteed.  
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**Special 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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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. **LASKY'S PRICE £34.19.6** Carriage 10/- extra.

**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: 15 1/2 in. wide, 8 1/2 in. deep, 6 in. high. Circuit available.

Although new, these amplifiers are untested, and may have minor faults. The price has been reduced accordingly to £7/15/- complete with valves. Carriage 10/- extra.

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4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet. Suitable for use as baby alarm. **MASTER UNIT £7/15/-.** Carr. 5/- extra. **Extension Units.** Price 21/- each complete. Carriage 2/- each extra.

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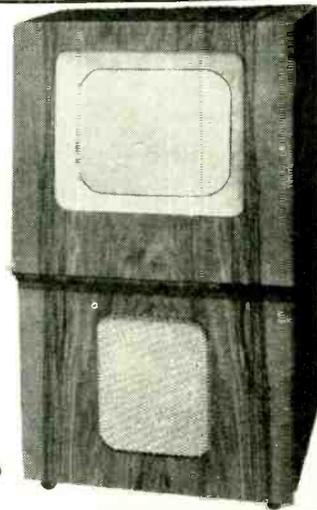
For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster. "Practical Television," "Practical Wireless," and "Wireless World" televisions.

**LASKY'S £8.10.0** PRICE

Carriage 12/6 extra.

Outside dimensions of cabinet 17 1/2 in. x 16 1/2 in. x 32 in. 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 CHAMPION SX20R** by the American Hallicrafter Inc. This super receiver covers 550kc/s to 45Mc/s (850 to 67 metres) without gaps. Has band spread tuning with separate venier dial. Controls include RF and Audio Gain, AVC On/Off, Automatic Noise Limiter, BFO Pitch, Tone and Stand-by switch. Standard mains 200/250 volt A.C. power pack and speaker is built into set and jack provided for 'phone use. Complete with all nine valves and ready for operation. Size of case 18in. x 8 1/2in. x 10in. and the appearance is typical of the well known Hallicrafter design. Each set air tested prior to despatch and demonstrated to callers. Price £21 plus 10/- carriage and packing.

**SKY RIDER DEFIANT SX24** is similar to above but includes crystal IF filter and 5 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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**INDICATOR UNIT 1B2A** contains VCR517, 3-EF50, 1-5U4G and 4-SP61. BRAND NEW (less relay). Price 79/6 plus 7/6 carriage.

**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.

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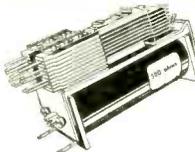
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57/6

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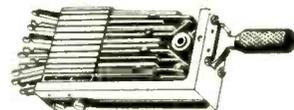
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**ELECTROLYTICS** (Current production. Not ex-Govt.)

Tubular Types		Can Types	
8µF 450 v.	1/11	16µF 450 v.	2/9
8µF 500 v.	2/9	24µF 850 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
<b>Can Types</b>		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. 500 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. Un-drilled Aluminium) Receiver type. 6 x 3½ x 1½ in., 1/11; 7½ x 4½ x 2½ in., 2/9; 16 s.w.g. 10 x 5½ x 2½ in., 3/9; 11 x 6 x 2½ in., 4/3; 12 x 8 x 2½ in., 5/3; 16 x 8 x 2½ in., 7/8  
20 x 8 x 2½ in., 8/11; Amplifier Type, 12 x 8 x 2½ in., 7/11; 16 x 8 x 2½ in., 10/11; 14 x 10 x 3½ in., 13/6; 20 x 8 x 2½ in., 13/6.

**SILVER MICA CONDENSERS.** 5µmF, 10µmF, 15µmF, 20µmF, 25µmF, 30µmF, 35µmF, 50µmF, 120µmF, 150µmF, 180µmF, 200µmF, 230µmF, 300µmF, 330µmF, 400µmF, 470µmF, 500µmF, 1,000µmF (.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 pnc.

**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 INTERCOM. 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 x 6½ x 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.

## 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 K1355 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. Television	67/6
425-0-425 v. 200 mA., 6.3 v. 4 v. 4 a., c.t., 6.3 v. 4 v. 4 a., 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

**COAXIAL CABLE,** 75 ohms, ½ in., 10d. yard-  
**DIAL BULES, 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. Sylvania 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.

**GOLLARO TAPE DESK MOTORS,** shaded pole type, clockwise or anti-clockwise, 29/9 each.

### 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; 0.3 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 6V6 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 cracked 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 7 1/2in. x 6in. Slightly used. ONLY 39/6.

**INDICATOR UNIT TYPE 62A.** Contains VCR97 tube with mu metal screen, 12 valves EF50, 4 of 5P61, 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 5/6).

**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 8 1/2in. long x 6 1/2in. wide x 7 1/2in. 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 televisions 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 EF50. 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.

425-0-425 v. 200 mA, 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., 50/-.

350-0-350 v. 160 mA, 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., 42/6.

350-0-350 v. 150 mA, 6.3 v. 5 a., 5 v. 3 a., 32/6.

250-0-250 v. 100 mA, 6.3 v. 6 a., 5 v. 3 a., 32/6.

Please add 2/- per transformer postage.

**TRANSFORMERS, FILAMENT.** 6.3 v. 2 a., 7/6; 6.3 v. 3 a., 10/6. (Postage 1/-).

**TRANSFORMERS EHT.** Upright mounting. EHT for VCR 97 tube, 2,500 v. 5 mA, 2-0-2 v. 1.1 a., 2-0-2 v. 2 a., 37/6.

EHT 5,500 v. 5 mA, 2 v. 1 a., 2 v. 1 a., 72/6.

EHT 7,000 v. 5 mA, 4 v. 1 a., 82/6. Please add 2/- per transformer postage.

**SPECIAL OFFER.** L.T. Transformers with windings of 5 v.-0-5 v. 5 amps; 5 v.-0-5 v. 5 amps; 5 v.-0-5 v. 5 amps. By using combination of windings will give various voltages at high current. Brand new and unused these have become damaged, but are still usable, the damage being confined to broken fixing lugs, and/or broken bakelite terminal panels. Formerly sold at 35/-, now offered at 22/6 (postage 2/6).

2 1/2in. **SQUARE FLANGE 0-1 M.A. METERS.** Brand new. ONLY 15/-.

10in. **P.M. SPEAKERS** with output trans. Brand new. ONLY 27/6 (postage 2/-).

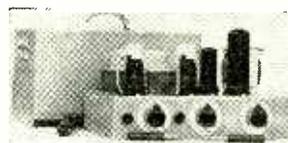
Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only.

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**1070 Harrow Road, London, N.W.10**  
(Nr. Scrubs Lane) Tel.: LADbroke 1734



MODEL AC10E £10/7/6.

**AMPLIFIERS**

Collage general-purpose units. MODEL AC10E, 4 valve, 10 watts. Neg. feedback, £10/7/6. MODEL AC18E, 6 valve, 18 1/2 watt P/P output. Feedback over 3 stages, £15/15/-. MODEL AC32E, 32 watts P/P output. Feedback over 3 stages, £18/18/-. MODEL U10E, for D.C./A.C. mains, 6 valve P/P output. Feedback over 3 stages, £12/10/6. All are COMPLETE WITH CASES and chrome handles. They have a SEPARATE microphone stage. SEPARATE mike and gram. inputs allowing MIXING of speech and music. Input voltages average .003 mike and 3 gram. Outputs match 3, 8 or 15 ohm speakers. MODEL Q6C, 6-valve unit with Bass and Treble controls. P/P output of 9 watts. This amplifier incorporates an 15 section O/Transfr. variable feedback from zero to 25 db. Output input, 3.8 to 230. Complete chassis, £13/19/6. MODEL Q4C, 4 valve 4 watt unit Bass and Treble controls. Variable feedback. O/Imp. 3 to 15 ohm. Chassis complete, £9/15/-. Complete range of accessories available. Send stamp for lists. All amplifiers are ready for use.

**LYONS RADIO LTD.**

**STEEL AERIAL MASTS.** Consisting of 9 tubular sections each 2in. dia. and a mast-head pulley section to give a total height of 33ft. Guy wires are not supplied but three nickers for securing these are included. PRICE £5/15/-, carriage 9/6.

**RECEPTION SETS AEW.1.** These are five valve super-het 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 6X5, 6U7's, 6V6 and 6Q7 or equiv. types. Supplied complete with valves and speaker. Outside of cases are a little soiled otherwise condition is as new and unused. Aerial test-set before despatch. PRICE £11/10/-, carriage 9/6.

**POWER UNITS, TYPE 222.** Neat metal cased units, overall dimensions approx. 9 x 9 x 6in. containing a rotary converter for 24 v. D.C. input and having a twin D.C. output of 300 v. at 30 mA. and 6.5 v. at 3.2 A., carbon pile voltage regulator, a four section filter unit in diecast metal box, wire-wound resistors, relay, jack socket, fuses etc. Can be operated in reverse from D.C. mains or 6 v. A.C. Contents can easily be dismantled providing a fine case in which to build Power Pack, V.P.O. etc. Condition is as new and unused. PRICE 19/6, carriage 4/-.

**INVERTERS.** Known as Motor Generator type 7. Input 22-29 v. D.C. Output 80 v. A.C. at 1,600 cycles, 240 V. A. at unity power factor. Complete with carbon pile voltage regulator and filter unit mounted beside generator on the same base plate. Overall dimensions approx. 9 x 8 x 5in. and weighs only 15 1/2 lbs. In new unused condition. PRICE £5/10/-.

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**L. WILKINSON** WHOLESALE AND EXPORT  
**19, LANSDOWNE ROAD, CROYDON**  
Phone: CRO 0839 Telegrams: "WILCO" CROYDON

**RELAYS — P.O. TYPE 3,000**

**BUILT TO YOUR SPECIFICATION—EARLY DELIVERY QUOTATION BY RETURN—PLEASE STATE RESISTANCE OF COIL REQUIRED AND CONTACT BUILD UP.**

**RACKS.** Standard 6ft. P.O. type for 19in. panels, steel channel sides correctly drilled, heavy angle base.

**TEST SET 205.** Wavemeter range. 3.05 to 3.35 centimetres, built-in oscillator with 9 valves including Klystron type CV.129, etc., in good condition, £25.

**MICROAMMETER.** 0.50 2 1/2 Flush type, contained in Test Set 28. A very sensitive meter. Scaled 0/100. £3/10/- complete.

**VOLTAGE REGULATORS.** Input 230 volt A.C. 21 amps., output 57.5 to 228 volts in 16 steps. With current limiting Reactor. £10.

**VARIAC TRANSFORMERS.** Type 80 CO in brass case, oil filled, 50 cycles, P.200/240 volts 5. 220 volts, 7.5 amps, £7/10/- each. Also an open type, 500 cycles, 180/0-180 volts, 7+7 amps., £12/10/-.



**RELAYS AND KEY SWITCHES**



**LARGEST EX-GOVT. STOCK IN GT. BRITAIN**

Types 600-3000 Relays—Siemens High Speed Also A.C. 400 volts 50 cycles

Uniselector Switches, Telephone Switch-Boards, Telephone Components, Plugs, Jacks, Handsets—Government Contractors.

**JACK DAVIS (RELAYS) LTD. (Dept. W.)**  
**36 PERCY STREET, LONDON, W.1**  
Phones: MUSEum 7960, LANGham 4821

**Primary, 200-250 v. P. & P.** on each, 2/- extra.  
**300-0-300, 100 mA., 6 volt** 3 amp., 5 volt 2 amp., 22/6.  
**Drop thro' 350-0-350 v. 70 mA.,** 6 v. 2.5 amp., 5 v. 2 amp., 14/6.  
**Drop thro' 250-0-250 v. 80 mA.,** 6 v. 3 amp., 5 v. 2 amp., 14/6.  
**Drop thro' 110-110 60 mA.** 6 v. 0.5 amp., 8/6.  
**280-0-280, drop-through, 80 mA.,** 6 v. 3 amp., 5 v. 2 amp., 14/6.  
**Auto-wound, H.T. 280 volts at** 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separates 4 v. 3 amp., rectifier winding 10/6.  
**Auto-transformer, 110 v. 70** watts, 10/6.  
**250-0-250, 80 mA. 6 v. 4 amp., 14/-** Pri. 230 v. Sec. 200-0-200 35 mA. 6 v. 1 amp., 8/6.  
**Pri. 200/250 v. secondary 3, 4, 5,** 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., 13/-.  
**Semi-shrouded drop thro',** 200/250 v. primary; sec. 280-0-280, 200 mA., 6 v. 5 amps., 5 v. 3 amps., 27/6. P. & P. 2/6.  
**Semi-shrouded drop thro',** 270-0-270, 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., 13/6.  
**Semi-shrouded drop thro',** 270-0-270, 60 mA., 6 v. 3 amp., 11/6.  
**Heater Transformer. Pri. 230-** 250 v. 6 v. 1 1/2 amp., 6/-; 2 v. 2 1/2 amps., 5/-; 2, 4 or 6 v. at 2 amps., 7/6; 2 v. 2 1/2 amp. and 6 v. 0.6 amp. E.H.T. insulated, 8/6. P. & P. each 1/-.

**P.M. SPEAKERS** (closed field) with less trans. trans.  
 3in. .... 10/-  
 2 1/2in. .... 15/6  
 3 1/2in. .... 13/6  
 5in. .... 16/6 12/6  
 6 1/2in. .... 16/6 12/6  
 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/-.  
**5in. M.E. field coil 750 ohm** with O.P. trans., 17/6. P. & P. 1/-.

**Extension speaker cabinet,** in contrasting walnut veneers, size 15 x 10 1/2 in. Will take 6 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, 1 1/2 x 9in., 2/-.

**Volume Controls** by famous manufacturer. Long spindle and switch, 1/2, 1 and 2 meg., 4/- each; 50 K, 3/6 each. 1/2 and 1 meg., long spindle double pole switch, miniature, 5/- P. & P. 3d. each.  
 Trimmers, 5-40 pf., 5d.; 10-110 10-250, 10-450 pf., 10d.  
**Twin-Gang .0005 Tuning Con-** denser, 5/-. With trimmers, 7/6. P. & P. 1/-.

**Line Cord.** 3-way 0.3 amp. 189 ohms. per yard, 1/3 per yard.  
**Twins-gang, .0005 with feet,** size 3 1/2 x 3 x 1 1/2 in., 6/6.  
**3-gang .0005, with feet,** size 4 1/2 x 3 x 1 1/2 in., 7/6.

**Television Coils** wound in alican, size 2 1/2 x 1 1/2 in., with former and iron core, 1/- each.  
**Hoover Variable Speed 600-** 1,200 revs. Tape Recording Motor. Silent running, 200/250 v. A.C. Shaded pole with fixing. Weight 5 lb., 27/6. Plus P. & P. 2/6.  
**A.C. Mains 230 v. 4 pole in-** duction motor, originally made as a gram. motor, 9/6. P. & P. 1/6.

**PERSONAL SHOPPERS ONLY.** 9in. Enlarger 17/6, 12in. 27/6.  
**Germanium Crystal Diode,** 2/3 post paid.  
**Television Masks.** White Rubber 9in. with glass, 7/6. Cream Rubber, 12in. with armoured glass, 15/- plus 1/6 P. & P.  
**T.V. Width Control, 3/6.**

## D. COHEN

### RADIO & TELEVISION COMPONENTS

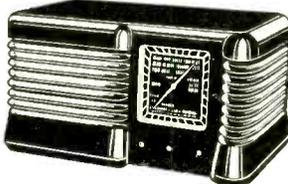
*Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and lists, S.A.E.*

**SPECIAL NOTE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.**

### 23 HIGH STREET (Uxbridge Road)

### ACTON, W.3 Telephone: ACOrn 5901

Hours of Business:  
 Saturday 9—6 p.m. Wednesday 9—1 p.m. Other days 9—4.30 p.m.



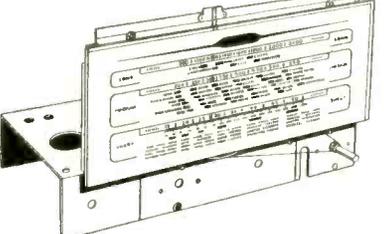
T.R.F. coils 5/6. 3 obsolete Ex-Govt. valves, 3 v/holders, and circuit of an A.C. mains 3-valve plus rec. T.R.F. which can be built for approx. £4, 8/6. Heater trans. 6/-. Volume control with switch 3/6. Wave-change switch 2/-. 32+32 mfd. 4/6. Bias condenser 1/- Resistor kit 2/-. Condenser kit 4/-.

**CABINET** as illustrated, 11 1/2 x 6 1/2 x 5 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

**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 1/2in. x 4 1/2in., size or scale 6 1/2in. x 3 1/2in. 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, £13/10, P. & P. 4/-. This includes 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 1/2 x 8 x 2in., cad. plated 18 gauge, w/h., 1F and trans. cut-outs, back-plate, 2 supporting brackets 3 waveband scale, new wavelength station names. Size of scale 11 1/2 x 4 1/2 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 mA., 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 15x8 1/2 in., complete with 3 wave-band scale size 5 1/2 x 4 1/2 in. 5/- P. & P. 1/6.

**CRYSTAL PICK-UP** by famous manufacturer, complete with sapphire trailer needle and volume control, 23/-. Post and packing on each 1/-.

**EX-GOVT. RECEIVER TYPE B28.** Complete coil unit, 6 bands, 60 kc/s.-420 kc/s., 500 kc/s.-30 Mc/s., 21/- Plus 2/- P. & P. Circuit for above, 4/-.

**VARIABLE selectivity IF Switch** to suit above, 7/6.

**MAINS OR BATTERY SUPERHET PORTABLE COILS.** Medium-wave 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.  
**465 KC. MIDGET I.F.S.** Q 120, size 1 1/2 in. long, 1in. wide, 3/4 in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6. Both these items £1, post paid.

**CONSTRUCTOR'S PARCEL** comprising chassis Bin. x 4in. x 1 1/2 in., with speaker and valve holder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, iron-cored, four valve-holders, 20 K volume control and wave-change switch, 23/-. P. & P. 1/6.

**OUTPUT TRANSFORMERS.** Standard type 5,000 ohms imp., 2 ohms speech coil, 4/9. 42-1 speech coil 2-ohm with extra feed-back windings, 4/3. Miniature 42.1 2-ohm speech coil, 3/3. Multi-ratio 3,500, 7,000 and 14,000 2-ohm speech coil, 5/6. 10 watt push-pull, 6V6 matching, 2 ohm speech coil, 7/-.

**TELEVISION CHASSIS.** Size 9 1/2 x 9 1/2 x 3 1/2 in., 18 gauge steel cadmium plated complete with 5-coil cans size 1 1/2 x 1 in. with iron cored former. These are wound for television frequency, 6/6. P. & P. 1/6.

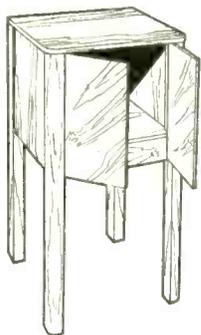
**PUSH-BACK CONNECTING WIRE.** Doz. yds. 1/6, post paid.

**STANDARD WAVE-CHANGE SWITCHES.** 6-pole 3-way, 2/- 4-pole 3-way, 1/9; 5-pole 3-way, 1/9; 3-pole 3-way, 1/9; 9-pole 3-way, 3/6; Miniature type, long spindle, 3-pole 4-way, 2-pole 5-way, 4-pole 3-way and 4-pole 2-way, 2/6 each. P. & P. 3d.

**AMPLIFIER CHASSIS,** 18 gauge cadmium plated steel with transformer and 5 v/holder cut-outs. 1 1/2 x 8 x 3in. 3/-. P. & P. 1/6.

**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 1/2 in. high by 17 1/2 in. wide by 13 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 each. 32 mfd., 350 wkg. .... 2/-  
 16 x 24 350 wkg. .... 4/-  
 4 mfd., 200 wkg. .... 1/3  
 40 mfd., 450 wkg. .... 3/9  
 16 x 8 mfd., 500 wkg. .... 4/6  
 16 x 16 mfd., 500 wkg. .... 5/9  
 8 x 16 mfd., 450 wkg. .... 3/9  
 32 x 32 mfd., 350 wkg. .... 4/-  
 32 x 32 mfd., 350 wkg. and 25 mfd., 25 wkg. .... 6/6  
 25 mfd., 25 wkg. .... 11d.  
 250 mfd., 12 v. wkg. .... 1/-  
 16 mfd., 500 wkg., wire ends 2/3  
 8 mfd., 500 v. wkg., wire ends 3/6  
 8 mfd., 350 v. wkg., tag ends 1/6  
 50 mfd., 25 v. wkg., wire ends 1/9  
 100 mfd. 350 wkg. .... 4/-  
 16+16 mfd. 350 wkg. .... 3/3  
 Ex-Govt. 8 mfd., 500 v. wkg., size 3 1/2 x 1 1/2, 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 1/2 x 4 1/2 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 1/2 x 1 1/2 in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored IF's. 4 x 1 1/2 x 1 1/2 in., per pr. 7/6. Wearite standard iron-cored 465 Kc. IF's, 3 1/2 x 1 1/2 x 1 1/2 in., per pr. 9/6.

**Iron-Cored 465 Kc. Whistle Filter,** 2/6.

**H.R.O. SENIOR RECEIVERS.** With A.C. P.P., 5 coils, £37/10/-, D.S.T. 100 RECEIVERS, as new. Coverage is 7 bands from 30 Mc/s. to 50 Kc/s., £30 each.

**HAMMERLUND BC779B.** Mint condition, rack mtg., £42/10/-.

**HALLICRAFTERS SX28, S27, S20R, S41, S38, etc.** All in perfect condition.

**AR88LF, AR89D, CR100,** from stock. **RI155 RECEIVERS,** new. A.C./D.C. MOTORS, suitable for sewing machines, 47/6 each.

**A.C./D.C. 12 v.-15 v. MOTORS,** long spindle for models, 15/- each.

**20 WATT P.A. RACK MOUNTING AMPLIFIERS,** complete with power pack, 200/250 v. A.C., less valves, £6/10/-. Valves—2 type PX25, 1 MH4 and 1 MU14, £2/15/- per set.

**NEW M.C. MICROPHONES,** hand type, with 12 yds. heavy duty screened cable, £3/15/- each.

**TEST EQUIPMENT.** We hold a comprehensive stock of all test gear multi-range meters at 1,000 o.p.v. and 20,000 o.p.v., valve testers, signal generators, etc.

**4,000Ω EARPHONES, 11/6 pr.**

**10,000Ω POTENTIOMETERS,** large size, by Colvern, enclosed, 8/6 each.

**TYPE 73 and 74 YELLODYNE UNITS** in stock.

**C.R.100 RECEIVERS,** perfect order, £28/10/-.

**MAINS TRANSFORMERS.** Special offer, not ex-W.D., 200/250 v. input tapped. Output 250-0-250 v. at 100 mA., 5 v. 3 a., 6.3 v. 4 a., 21/6 each.

**350-0-350 v. Ellison** at 120 mA., 6.3 v. 5 a., C.T. 5 v. 3 a., 39/-.

All types in stock.

**EVERSHED BRIDGE MEGGERS,** 250 v. Special price, £12/10/- each.

**D.C. A.C. CONVERTERS,** 230 v. D.C. input, 230 v. A.C. output at 140 watts, £9.

**MAGNAVOX 12in. P.M. SPEAKERS,** snip at £5/10/- each.

**G.E.C. 7 WATT V.H.F. MOBILE TX/RX.** Complete with 12 v. rotary p. pack, 30.9, 81.1 and 81.3 Mc/s., special offer, £30.

**EDDYSTONE 640 RECEIVER.** Perfect, at £22.

**EDDYSTONE 504 RECEIVER,** perfect, at £21.

**1/2 F 350 v. METAL CASED TUBULARS,** U.S.A., at 4/6 doz. (minimum 2 doz.).

**H.R.O. COILS.** .46-.96 Mc/s., 14-30 Mc/s., etc., at £2/5/- and £3/5/- per coil.

**LARGE STOCKS OF MOTORS.** A.C./D.C. and A.C., 1/16, 1/12, 1/4, 1/2 h.p.

Your post enquiries welcomed. S.A.E. for reply please. Prices quoted do not include carriage and packing.

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**U.S. NAVY OSCILLOSCOPE UNITS**—Containing 5 BPI. 5in. Tube with fully screened mu shield isolating heater trans. Dozens of H.V. Cond., Resistors, Pots, etc. The finest value offered to date in "Scope" units. "W.W." T/V 'scope circuit included. Price 57/6.

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**VALVES.** 1S4, 8/6; 6AG5, 10/6; 117Z6, 12/6; 6SH7, 6/6; EF50, 6/6; 955, 954, 6/-; SG215, 6/6; Pen 220A, 6/6; TT11, 8/6; VR 150, 10/6; 42, 10/6; CK512AX, 9/-; 9001, 9002, 9003, 7/6; 954-955, 6/6.

**MAINS TRANSFORMERS.** Input 200/240 v. Output 350-0-350 or 250-0-250 volt 80 mA. and 4 and 6.3 v. 4 a. and 4 and 5 v. 2 a. Price 21/6. Input 200/240 v. Output tapped 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 volts, 2 amps. 21/6. All with one year's guarantee.

**D.P.D.T. RELAYS.** Operate at 230/300 volts D.C., 8/6. D.P. make and break, 8/6. We can supply any type of voltage and contacts at varying prices.

**NEW SELENIUM RECTIFIERS.** F.W. 12/6 volt 3 amps., 14/6; 4 amp., 22/6; 6 amp., 30/-; 1 amp., 8/6; 12 v. 100 mA., 3/-; 250 v. 100 mA., H.W., 9/-; 80 mA., 6/6.

**GERMANIUM CRYSTAL DIODES, 3/9.**

**B.C. 603 RECEIVER AND B.C. 604 TRANSMITTER.** 20 to 28 Mc/s. Including 80 crystal, £35, carriage extra.

**VCR97 CRTS.** New and crated. Picture tested, 45/6. Bases, 3/6.

**NEW MAG SLIP TRANSMITTER MOTORS.** Made by G.E.C. 50 v., 50 cycle. Mk. 1—2in., 15/-.

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**CARBON MICROPHONES with Matched Trans., 10/6.**

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**M/C MICROPHONES with matched Trans., 15/-.**

**4ft. ROD AERIALS,** set of three 6/-; Base 3/-.

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In 25 Kc. steps.

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All Carriage paid in the U.K. from Dept. W.W.,  
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33 v. 0.7 a., 24/3; 1 a., 28/-; 1.5 a., 45/-; 2 a., 51/-; 3 a., 52/-; 4 a., 62/-; 5 a., 67/-; all post 1/-.

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**BRIDGE CONNECTED HEAVY DUTY Funnel Cooled, also**

**7 1/2in. SQUARE COOLING FINS.** Revised price, same both types. 17 v. 12 a., 102/-; 20 a., 118/-; 30 a., 164/-; 50 a., £12/15/-; 33 v. 6 a., 91/-; 10 a., 104/-; 12 a., 168/-; 20 a., 188/-; 54 v. 6 a., 120/-; 10 a., 142/-; 7.2 v. 6 a., 154/-; 10 a., 178/-; 100 v. 6 a., £11; 10 a., £12/15/-; all post 1/10.

"WESTALITE" (BRIDGE), 12-15 v. D.C., 1.2 a., 15/10; 2.5 a., 27/8; 5 a., 31/9; 10 a., 54/6; 20 a., 99/6; 30 a., 144/10; 50 a., 257/-; 24 v. 1.2 a., 15/9; 2.5 a., 27/8; 5 a., 51/-; 10 a., 92/7; 20 a., 176/2; 36 v. 1.2 a., 27/8; 2.5 a., 51/-; 5 a., 69/10; 10 a., 130/9; post extra.

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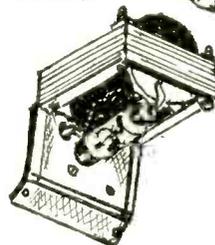
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110-250v. A.C.  
78-33 1/2 r.p.m.

Dual Purpose Sapphire Stylus



Few only at £6.7.6 P. & P. 2/6.



**5-6Kv. E.H.T. TRANSFORMER**

With U22 RECTIFIER

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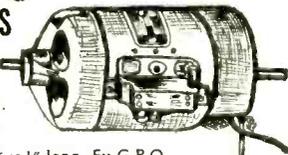
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3,000 r.p.m. 1 1/2 h.p. Size 6 x 3 1/2"

Spindle 5/16 x 1" long. Ex G.P.O. Ideal for 101 uses. Price 27/6 P. & P. 2/-.



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A.C. mains, input 230V. 50 cps. Outputs E.H.T. 2kV. 5 mA. H.T. 350 V. 150 mA. L.T. 6.3V. 10A. and 6.3V. 5A. Fully smoothed and rectified with valves VU120, 5U4G, VR91 (EF50) plus cond., resistors, etc.  
ASK FOR NO. **£4.19.6** CARRIAGE PAID  
X/H947.

## LOOP AERIAL. Type 17. Ref. 10D/16950

This aerial has wiper contacts, a ball race, also spring clip device for mounting. Complete with scale marked 0-350 degrees (no housing). Weight 2½lb.  
ASK FOR NO. **£1.10** POST PAID  
X/H938.

## DIRECT CURRENT GENERATOR

Type 3DG3. Ref. 42U/506  
Output 14/32V. 9 amps. 2,500 R.P.M. ½in. diam. splined spindle 1in. projection. Size 11in. x 7in. x 6in. Weight 31lb.  
Can be used as a Battery Charger or low voltage lighting generator, when driven by a motor or petrol engine.  
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## H TYPE ½ WAVE DIPOLE AERIAL

in original wood case.  
For approx. 50 mcs., Aerial 9ft. 3in., reflector 9ft. 7in., crossarm 4ft. 11½in. All metal construction, tubular spans 10mm. dia. Co-axial downlead 39ft. of 80 ohm. 12 mm. cable. Can be mounted vertically to existing mast or wall bracket.  
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X/E773

## EX-R.N. LOUD HAILER

Made by Ardents. 10/15 watts Output.  
Comprises 4-valve, 3-stage Amplifier, Carbon Hand Mic. and Bell shaped power projection Loudspeaker. With instruction book, less accumulator, designed for 12V. D.C. input.  
A FEW ONLY.  
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## SELSYN MOTOR TYPE 5J/2512.

Ref. No. W325A.  
230 volts A.C. input single phase, torque transmission value 45 lb/in. with ½in. long, ¾in. shaft. Overall 12½in. x 7in. diam. with fixing base.  
ASK FOR NO. **39/6** CARRIAGE PAID  
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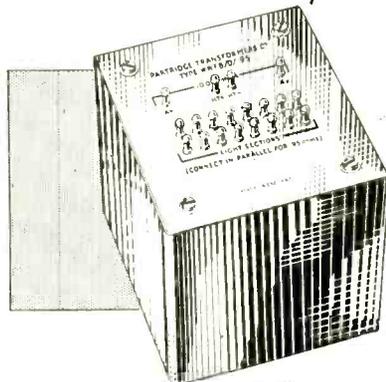
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- 12**-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co. Ltd., Tombland, Norwich. 10065

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- B**AYSWATER radio dealer requires outlet for second-hand TV sets.—Tel. Bay. 4860.
- 358**×Eddystone communications receiver, speaker, 'phones, data; £30 o.n.o.—Box 6737. 11036
- D**YNATRON Merlin console (cost £125, Mar. 1949), perfect condition; £65, or near offer.—Box 6854. 11031
- M**URPHY table television, V204, 15in. £75; Wharfedale Golden 10in speaker, £6; both as new.—Box 6856. 11034
- T**RIPLE diversity receiver, R.201, new condition, every possible refinement.—Harris, Organford, Dorset. 11128
- 11**55 p/pack, 10in speaker, good condition; £7/10 or nearest.—Bain. 63, Castlecroft Rd., Wolverhampton, Staffs. 19934
- 1132A** V.H.F. receiver with power unit and spare valves, all as new; £8 or nearest, trial given.—Box 7073. 11078
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- T**ELEVISION Baited new 12in tube, completely overhauled, chassis only, bargain; £30, o.n.o.—Bexleyheath 8080, 96 Ramillies Rd., Sidcup. 11109
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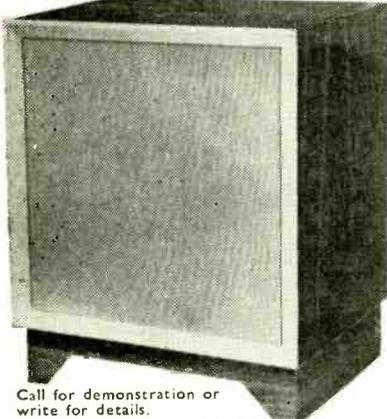
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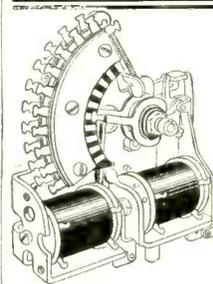
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**MAINS TRANSFORMERS (NEW)**, input 200/250 volts in steps of 10 volts, output 350/0/350 volts, 180 m/amps., 4 volts 4 amps., 5 volts 3 amps., 6.3 volts 4 amps., 45/- each, post 1/6; another 350/0/350 volts 180 m/amps., 6.3 volts 8 amps., 0/4/5 volts 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, input as above, output 4,000 volts 2 1/2 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.

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**ROTARY TYPE RESISTANCES**, stud S/arm type 10 ohms 3 amps, 17/6 each. (Other types in stock please ask for quotation.)

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**FOR** sale, Wearite tape deck, almost new, £30.—Box 7131. 11909

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**36** new unused 1,200ft reels Scotch Boy tape, 27/6 each; a few used once at 25/.—Tel. Mountview 6975. Box 6850. 11029

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**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. 11006

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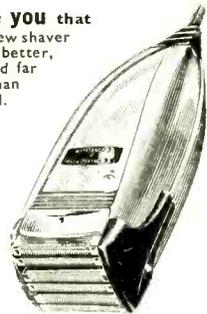
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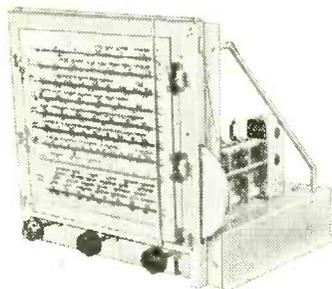
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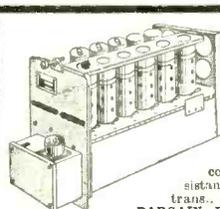
**NEW COMPONENTS**  
 CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new 15/6 post free; Cosmocord Mic-30 hand stand microphones, black or white, £4/4 each, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036]

## COMPONENTS—SURPLUS AND SECONDHAND

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**ELECTROLYTICS**, capacity, voltage, size, type of mounting, price post paid, in that order:  
 400, 6v, 1X2in, lug, 2/3; 250+250, 6v, 1X2in, lug, 2/6; 500+500, 6v, 1X3in, lug, 2/6; 40+40, 150v, 1 1/2in X 2in, clip, 3/4; 40, 150v, 1 1/2in X 2in, clip, 2/6; 20+20, 275v, 1 1/2in X 2in, lug, 3/6; 16+32, 275v, 1X2in, lug, 3/6; 16+16, 275v, 1X2in, clip, 3/6; 32+32, 275v+50mf 25v, 1X3in, lug, 4/-; 60+100, 275v, 1 1/2in X 3in, lug, 5/6; 100, 275v, 1 1/2in X 2in, clip, 3/9; 32+12, 350v, 1 1/2in X 2in, clip, 4/6; 16+16+16, 350v, 1 1/2in X 2in, clip, 5/-; 40+40+20, 350v, 1 1/2in X 3in, lug, 5/-; 16, 350v, 1 1/2in, lug, 2/-; 40+40, 300v, 1X3in, lug, 4/-; 10, 450v, 1 1/2in, lug, 2/-; 16, 450v, 7/8 X 2in, 3/-; 20, 450v, 1X2in, lug, 2/9; 32, 450/525v, 1 1/2in X 2in, clip, 4/-; 16+16, 450v, 1 1/2 X 2in, clip, 5/6; 32+32, 450v, 1 1/2 X 3in, clip, 5/9; 30+30, 450v+20mf 25v, 1 1/2 X 3in, lug, 5/6; 15+15, 450v+20mf 25v, 1 1/2 X 3in, lug, 5/3; 200, 6v, 5/8 X 1 1/2in, clip, 2/-; 100, 12v, 5/8 X 1 1/2in, wire, 1/9; 8, 450v, 1X2in, clip, 2/3; 50, 12v, 3/4 X 1 1/2in, wire, 1/6; 150, 25v, 1 1/2 X 2in, clip, 2/6; 12v, 3/4 X 1 1/2in, wire, 2/3; 350, 25v, 1X2in, clip, 2/6; 16+16, 450v, 1 1/2 X 2in, clip, 4/-; 40+40, 275v, 1 1/2 X 2in, clip, 3/6; 16+32, 450/525v, 1 1/2 X 2in, clip, 5/6; 24+24+16, 350/425v, 1 1/2 X 2in, clip, 4/9; 60+200, 275/350v, 1 1/2 X 3in, clip, 6/4; 1,000, 12v, 1X2in, clip, 2/4; 150v, 6/8 X 1 1/2in, clip, 1/1; 60+100, 350/425v, 1 1/2 X 4in, clip, 6/6; 500, 12v, 1 1/2 X 2in, clip, 2/6; 4, 350v, 3/4 X 2in, 2/-; 6,000, 12v, 1 1/2 X 4in, lug, 4/6; 100+200, 275/350v, 1 1/2 X 4in, clip, 6/6; 8+16+16, 450/525v, 1 1/2 X 2in, lug, 5/9; 32+32, 350/425v, 1 1/2 X 2in, clip, 5/-; 2,000, 6v, 1X3in, clip, 3/3; 8+16, 450/525, 1X2in, clip, 4/3; 2, 450/525v, 3/4 X 1 1/2in, lug, 1/6; 2, 350v, 3/4 X 2in, lug, 1/3; 8, 350/425v, 1 1/2 X 2in, clip, 2/-; all are all cans, some with sieves.

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**TELEVISION SETS** 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.  
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**L**ARGE stocks of ex-Govt. radio equipment to clear.—Box 7140. 11101  
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**BRIDGE-MEGGERS**, by E. & V., 250v, self-contained type accuracy tested, last few, £14.  
**P. B. CRAWSHAY**, 166, Pixmore Way, Letchworth, Herts. Tel. 1147.



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**FREE GIFT OF 8in. P.M. SPEAKER** with either of following two chassis. 6 v. Export model at **£15/15/-**; and 3 valve Home Market model at **£12/12/-**. Both measure 1 1/2in. X 7in. X 8 1/2in., have flywheel tuning, negative feed-back, gram pick-up sockets, and valve line-up 6BA6, 6BE6, 6AT6, 6X4. Also special reduction to 12/6 for a 10in. speaker supplied with either of these.

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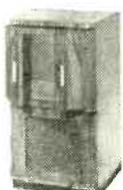
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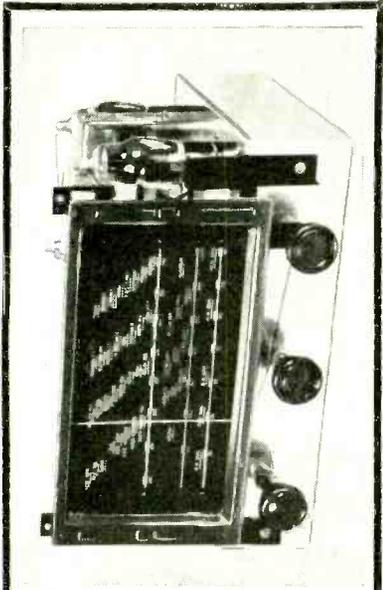


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**SEE** our displayed advert. on page 108 for surplus bargains.—Radio Exchange, Bedford. [0012]

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**P.M. speakers**, all less trans. 2-3 ohm v/coil, 5in 10/6 ea., 6 1/2in 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.

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**K. LOGAN**, Westalley, Hitchin, Herts. [0233]

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**RESPONDER**, 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]

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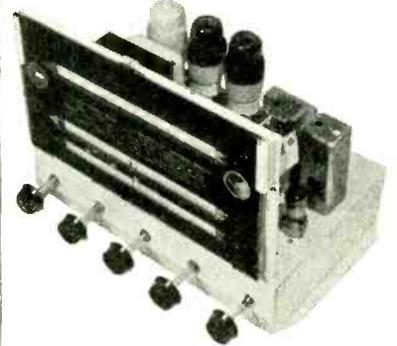
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£17.15.0 plus p.t.

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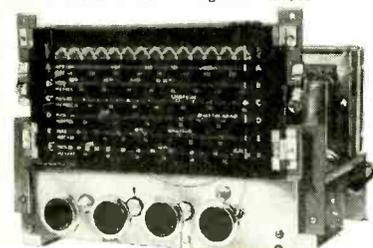
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**WALNUT** radiogram and television cabinets, soundly constructed; stamp details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11. [9591]

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**3. CANDIDATES** must also be educationally qualified to proceed to a University.

**4. FURTHER** details may be obtained from the Secretary of the Admiralty, C.W. Branch (Cadets), Queen Anne's Mansions, St. James' Park, London, S.W.1. [1009]

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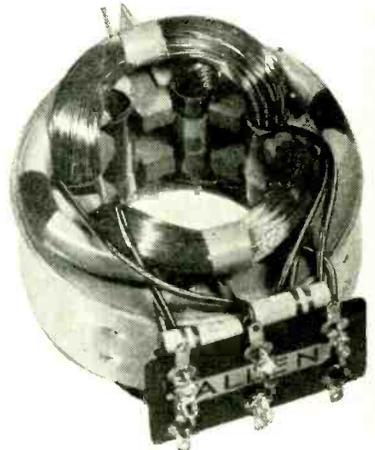
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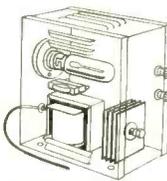
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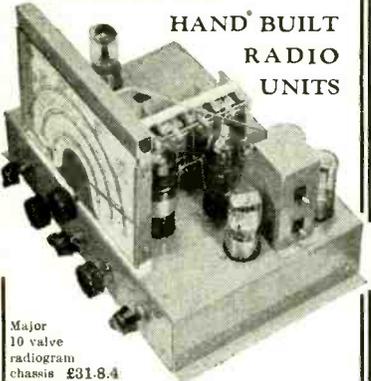
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(1) ELECTRONIC Engineers of degree standard, with at least three years' experience in one of the following: V.H.F. transmitter and receiver design, pulse techniques, aerials, transformers design, servo-mechanisms and electro-mechanical devices.

(2) TECHNICAL Assistants with H.N.C. or C. & G. standard, for development work, electronics, servo-mechanisms and hydraulics.

(3) DRAUGHTSMEN with experience in electronic, electrical, or electro-mechanical design.

(4) JIG and Tool Draughtsmen.

APPLY, quoting reference G.W.1, to Employment Manager, Vickers-Armstrongs, Ltd., Weybridge Works, Weybridge, Surrey.

APPLICATIONS, with certain exceptions, are subject to the approval of the Ministry of Labour and National Service. [1094]

INSTRUMENT mechanics required to serve a research and experimental mechanics at Ministry of Supply, Sellafield.

ALL applicants must have served a recognised relevant apprenticeship.

INSTRUMENT mechanics (Electronic) must have sound theoretical knowledge of electronics (Ordinary National Certificate standard desirable) with practical knowledge of pulse amplifiers, D.C. amplifiers, electronic scalars, discriminations, and general trigger circuits, and in wiring and assembly of electronic apparatus. Experience of test gear and general instrument calibration an advantage.

INSTRUMENT mechanics (physical) must have experience of industrial instruments used in measurements and control of temperature, specific gravity pH and flow knowledge of vacuum techniques and measurement of gaseous properties an advantage.

INSTRUMENT mechanics (general) must have experience of relay circuits and automatic telephone exchange maintenance, knowledge of X-Ray and electrical measuring apparatus an advantage.

RATES of pay for 44-hour 5-day week: 153/1 on entry with early assessment for merit pay; merit pay agreed after first assessment will be applied from date of entry; possibility of advancement to 195/1.

HOUSING accommodation will be available within a reasonable period for married applicants.

APPLY, giving details of apprenticeship, training (including Forces training), qualifications and experience, to Senior Labour Manager, Windscale Works, Sellafield, Cumberland. [9869]

THE ENGLISH ELECTRIC Co., Ltd., Stafford, requires the following personnel for its new factory in the North Staffs area:

1. ENGINEER with experience of magnetic amplifiers; good academic and practical background is essential.

2. ENGINEER with experience on electronic servo control gear and servo analysis.

HOUSING facilities may be available in 12 months; salary up to £1,000 per annum.

APPLY to Department Control Personnel Services, 336, Strand, W.C.2 quoting ref. 1095.

A NUMBER of Qualified Engineers are required for development work on aircraft instruments, the vacancies occur in three sections as follows:—

(a) THE development of special synchro test gear, knowledge of electronic measuring techniques is essential.

(b) THE development of all types of synchro elements and associated equipment, previous design experience on A.C. synchros or precision electro-mechanical devices is desirable.

(c) THE development of moving-coil instruments, previous experience in the design and manufacture of such instruments is essential.

ALL candidates should have a degree or equivalent in electrical engineering, housing assistance may be given in due course to successful applicants.—Apply, quoting reference 13/EN, stating age, experience and salary required, to the PERSONNEL Manager, Smiths Aircraft Instruments, Ltd., Bishops Cleeve, near Cheltenham. [1098]

DECCA RADAR, Ltd., invites experienced electrical engineers to apply for the post of leader of a group to be formed for the production of microwave links.

THE post carries good starting salary, is pensionable, and there are good prospects of expansion in scope.

APPLICANTS must be of British nationality and should be under forty years of age.

WRITE, quoting ref. SRT.B.—The Research Director, Decca Radar, Ltd., The Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey. [0241]

EXPERIENCED TV engineers required for retail service; permanent positions at good salary.—Full details to Shenstones (op. Town Hall), Leyton, E.10. Ley. 1362. [9266]

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**TRANSMITTER-RECEIVERS. No. 18. Mark III.** Brand new, complete in original packing cases. Complete with all attachments. Headphones, aerials, microphones, tappers, etc. and complete set of spares, including duplicate set of valves, £18.

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**QUALIFICATIONS**—age limit, twenty-eight; must have workshop experience; preferably have O.N.C.; must have drawing ability.—Write, giving full details, quoting ref. 171A, to Central Personnel Services, Marconi House, 336 7, Strand, London, W.C.2. 19969

**WANTED**, radio mechanic holding M.C.A., A and B licences; also fully licensed radio operator for duties on Dakota C.47 equipment. Apply Starways, Ltd., Liverpool Airport, Liverpool, 19. 11025

**COMPETENT television service engineer** required, mainly outside work; good rate of pay and assistance given in accommodation; Bedford area; writer service manager.—Box 6992, c/o W.W. 11054

**AIRCRAFT radio mechanics**, skilled in workshop practice, are required by Skyways at Stansted Airport, Essex.—Apply in writing to the Personnel Manager, Skyways, Ltd., 7, Berkeley St., W.1. 11058

**THERMIONIC technical assistant** required; must be keen on industrial electronics; experience of audio equipment; please state experience and salary required to—The Rover Co., Ltd., Lode Lane, Solihull. 19757

**RADIO mechanics** required for development work on test apparatus.—Write, giving full particulars of experience, age, etc., to Personnel Manager, S. Smith & Sons (England), Ltd., Bishops Cleeve, Nr. Cheltenham. 11127

**TECHNICAL assistant** required for commercial work with large company in London area, manufacturing electric telephone equipment.—Write, stating qualifications and details of experience, to Box 6695. 11015

**TV service engineer** wanted by old-estdb. dealer in S.W. excellent resort, will consider good theoretical knowledge substitute for experience, accommodation hard to find for married man.—Gerry, 36, Bank St., Newquay. 11103

**RADIO service mechanics** required by Smiths (Radiomobile), Ltd., for all parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. 10342

**JUNIOR engineers** required for design and technical process engineering of capacitors, previous experience in this field will be an advantage but not essential.—Write giving full details of age, experience and salary required to Box 7150. 11121

**TECHNICAL representative** required by old-established firm to handle electronic acoustic correction equipment from a London H.Q.; excellent scope for ambitious man to develop and expand into completely new field.—Full particulars to Box 7064. 11074

**T/V Junior Engineers** required for the testing of cameras and associated equipment; state details of television experience and education, degree standard not necessary; this work offers good training and prospects in this field.—Apply Box 5184. 19704

**ASSEMBLY wiremen** required, must be first-class, used to small, intricate chassis work.—Apply by letter, stating age, nationality and experience to E.M.I. Engineering Development, Ltd. (Wells Division), Penleigh Works, Wells, Somerset. 11108

**FIRST-CLASS radio and television engineers** required by old-established, expanding business; good salary and prospects; permanent; all leading agencies, including Murphy, Bush, Pye, Ekco, etc.—E. P. Fox, Ltd., East Molesey, Surrey. Molesey 2721. 1042

**BRITISH OVERSEAS AIRWAYS CORPORATION** invite applications from radio maintenance engineers, aged 22 years or over, possessing "A" and "B" licences with radar endorsements for further training at London Airport and eventual overseas service.

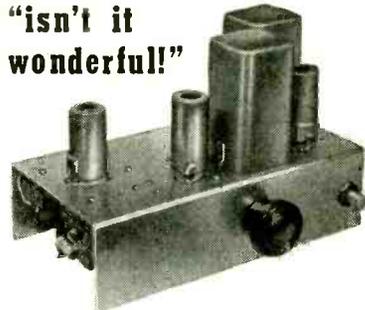
**BASIC salary** whilst at London Airport will be £11/14 p.w. x7/6 to £13/19 p.w. and, when posted overseas, £58/6 p.a. x £19/10 to £703/6 p.a. plus overseas station allowance.

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**EXPERIENCED radio testers and inspectors** required for production of communication and radio apparatus, also instrument makers, wiremen and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. 10238

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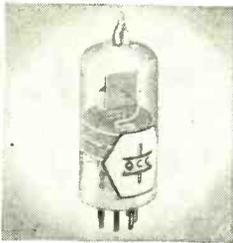
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**R**ADIO and television engineer required, competent man, permanent position.—Apply Maxwell & Sons, Ltd., 45, Hill Rd., Wimbledon. [1011]

**T**ELEVISION radio engineers required one 1st grade, and one 2nd grade, permanent position.—N.C.E.—73, Mill Lane, N.W.6. Tel. Ham. 1118. [1064]

**T**ECHNICIAN, 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]

**M**ESSRS. 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. [19978]

**A**IRCRAFT 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., Haves, Middx. [19849]

**E**XPERIENCED 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. [19792]

**W**IREMEN, 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. [11097]

**G**RADUATES 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. [11014]

**R**ADIO 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. [19791]

**E**LECTRONIC 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. [11059]

**S**ENIOR 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. [11063]

**S**ENIOR 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. [19985]

**D**ESIGNER draughtsman; electronic instruments, or radio, good prospects and salary according to qualifications; prospects of housing assistance to suitable applicant; Saturdays, interviews, if required; near City centre and all amenities; within easy reach London.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [11027]

**E**NGINEER 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. [11131]

**S**ENIOR 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. [11022]

**E**LECTRONIC 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. [11060]

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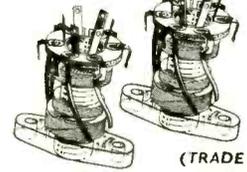
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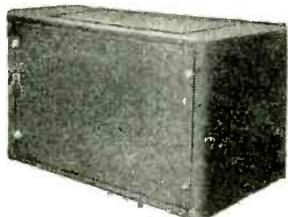
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**TELEVISION** tube engineer, must be fully experienced in all aspects of mass production and test of cathode ray tubes, new project not connected with any existing company. Surrey area.—Write giving age and details of experience to Box 7144. [1119

**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

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**THE De Havilland Engine Co., Ltd.**—Electronic engineer required, interested in physical measurement rather than construction of apparatus, required vibration measurement and analysis on gas turbine engine test cells.—Please write in confidence, stating age and full details of previous experience to the Personnel Officer, The de Havilland Engine Co. Ltd., Stag Lane, Edware, 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 in an 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. [1023

**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 reasonable 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 6571. [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., Longcross, Hatfield Rd., 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

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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 7187. [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/TP, 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, to Personnel Officer, Hilker and Watts, Ltd., Hilker 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, electronic and telecommunications equipment, progressive and permanent appointment.—Please write in confidence, giving details of experience and quoting reference WW/20, to Box 6635. [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]

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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. [1025]

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]

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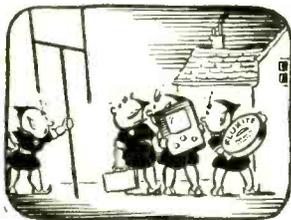
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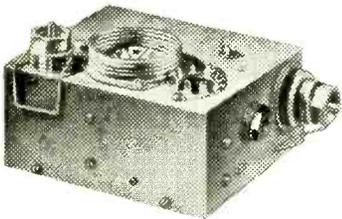
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**THE** General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radio-telegraphy. 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. 19721

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**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. 11070

**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. 19920

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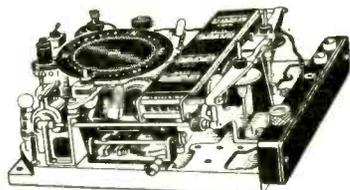
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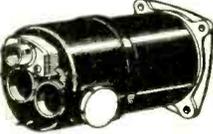
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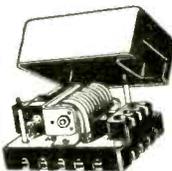
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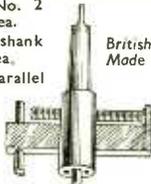
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panel accessories; applicants should be capable  
of sponsoring new components from specifica-  
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**DEVELOPMENT** engineers required in the radio component laboratory of The Plessey Co., Ltd.; applicants 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 W/W/51, should be made in writing, stating full details, to the Personnel Manager, The Plessey Co., Ltd., Ilford, Essex. [1991]

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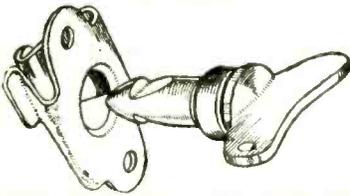
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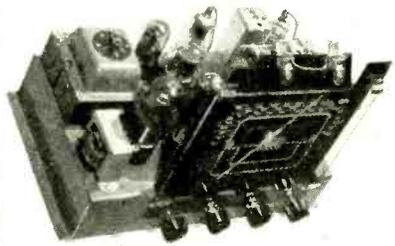
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