

# THE Radio Constructor

RADIO  
TELEVISION  
AUDIO  
ELECTRONICS

VOLUME 15 NUMBER 11  
A DATA PUBLICATION  
PRICE TWO SHILLINGS

## June 1962

### **A Family Radiogram**

- Light Dependent Resistor Control Circuit ● Transistor Calibration Oscillator
- "Revilo-4" Pocket Transistor Portable Receiver
- Folding Bench ● All-Band AM Tuner ● Reducing Radio Luxembourg Fade
- Differential A.C. Voltmeter
- AF Frequency Calibration by Oscillograph





# SCOTTISH INSURANCE CORPORATION LIMITED

38 EASTCHEAP · LONDON · EC3

## TELEVISION SETS, RECEIVERS AND TRANSMITTERS

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A "Scottish" special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

- (a) Loss or damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.
- (b) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.
- (ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

The cost of Cover (a) is 5/- a year for Sets worth £50 or less, and for Sets valued at more than £50 the cost is in proportion. Cover (b) and (ii) costs only 2/6 a year if taken with Cover (a) or 5/- if taken alone.

Why not **BE PRUDENT AND INSURE** your installation—it is well worth while **AT THE VERY LOW COST INVOLVED**. If you will complete and return this form to the Corporation's Office at the above address, a proposal will be submitted for completion.

NAME (Block Letters).....

If Lady, state Mrs. or Miss

ADDRESS (Block Letters).....

J/B

# PANEL-SIGNS TRANSFERS



## SETS AVAILABLE

- 1 RECEIVERS AND AMPLIFIERS. Five sheets containing one large tuning scale, twelve control panels and white wording and symbols. 3s. 6d. postage 3d.
- 2 TEST EQUIPMENT. Five sheets containing two Medium scales, twelve control panels and white wording. 3s. 6d. postage 3d.
- 3 WORDING—WHITE. Wording for Receivers, Amplifiers, Transmitters, Test Equipment and other Radio Apparatus, and Station Names. Five sheets, over 750 words and symbols. 3s. 6d. postage 3d.
- 4 WORDING—BLACK. Wording for Receivers, Amplifiers, Transmitters, Test Equipment and other Radio Apparatus, and Station Names. Five sheets, over 750 words and symbols. 3s. 6d. postage 3d.

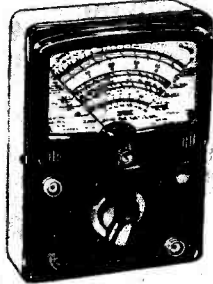
**DATA PUBLICATIONS LTD**  
57 MAIDA VALE · LONDON W9

## SUPERB COMMUNICATION RECEIVERS

**AMERICAN AR8D RECEIVERS.** Fresh release of these renowned sets. 14 valves, 6 wavebands, covering 500 kc/s-32 Mc/s. Incorporate every possible refinement and have internal A.C. mains pack for nominal 115/230V. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. **ONLY £35** (add carriage 30/- and 50/- deposit on returnable transit case). S.A.E. brings illustrated leaflet.

**MARCONI CR. 100/8 COMMUNICATIONS RECEIVER.** Covers 60 kc/s to 30 Mc/s. Complete with all valves, maker's instruction manual, and internal A.C. power unit for 200/250 volts. **BRAND NEW IN ORIGINAL TRANSIT CASES.** Aerial tested before despatch. **ONLY £35** (arr. etc., 40/-). S.A.E. for full details.

## TEST METERS FOR EVERY PURPOSE & POCKET



**2,000 O.P.V. MODEL TP-10.** Reads A.C. and D.C. volts up to 1,000; D.C. Current to 500mA; resistance to 1 Meg; Capacitance to 1µF; Decibels from -20 to +36; Output jack for Audio Measurements. Size 3½" x 5" x 1¼". **£3.19.6**



**20,000 O.P.V. MODEL TP-55.** Reads Voltage up to 1,000; D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. Current to 500mA; Resistance to 10 Meg.; Capacitance to 0.1µF; Decibels from -20 to +36. Size 3½" x 5¼" x 1½". **£5.19.6**



**30,000 O.P.V. MODEL 500.** Volts to 1,000; D.C. at 30,000 o.p.v.; A.C. at 20,000; 12 Amps D.C. Current; 60 Meg. Resistance; -20 to +56 Decibels; Internal buzzer short circuit warning. Size 3¾" x 6¾" x 2½". **£8.19.6**

All new stock, with leads, prods & internal batteries. 6 mths. guar. backed by full service facilities. Details S.A.E.

**AMPLIFIER TYPE A1413.** Ex-R.A.F. For normal A.C. mains use. 5Z4 rectification with 6V6 output. Input and output jack sockets, gain control, fully fused. 600 ohms output transformer, easily changed for 3 ohms type. Standard rack mounting size 19" x 7" x 6". Used, good condition. **ONLY 59/6** (carriage, etc., 10/6).

**AMERICAN HALLICRAFTERS 6 VOLT VIBRATOR PACK.** Output 300 volts D.C. at 170mA. Designed to run Communications Receivers from 6 volt car battery. Size 6½" x 6¼" x 7¼". Complete with 2 valves 6X5 and instructions, in maker's cartons. **BRAND NEW AND UNUSED. ONLY 29/6** (arr., etc., 3/6).

**12 VOLT AMERICAN DYNAMOTORS.** Deliver 220 volts at 100mA. Size 5½" x 3½" diameter. Ideal for running Electric Shaver, etc., from car battery. **ONLY 32/6** (post 2/6).

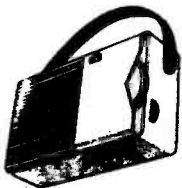
**B.C. 221 FREQUENCY METERS.** The famous American crystal controlled, portable frequency measuring standard. Coverage 125 kc/s-20 Mc/s. With original calibration book. Perfect order. Illustrated details on request. **ONLY £16.**

### PCR COMMUNICATION RECEIVERS

Manufactured by Pye and Philips. One of the Army's most versatile and sensitive sets. RF stage and 2 of IF, using 6 British I.O. type valves. Large 180 degrees Illuminated and Calibrated Dial. Flywheel tuning with locking device. Aerial trimmer. Tone and volume controls. Band switch from panel jacks for speaker or phones. In black metal case, size 17" L x 8" H x 10" D. Model PCR covers 6-18 Mc/s, 200-550 metres and 850-2,000 metres and has internal 5" speaker. REIME reconditioned as new. **£4.19.6.** Model PCR2 has similar L & M waveband coverage. Short wave 6-22 Mc/s, but no speaker. Used but excellent condition. **£5.19.6.** Every receiver aerial tested before despatch. Add 10/6 carr. all models. Designed to operate from bulky EXTERNAL power supply, but any set can be fitted with **BRAND NEW COMPONENTS INTERNAL PACK** for 200/250V a.c. at extra cost of £2.

S.A.E. FOR ILLUSTRATED LEAFLET

### "P.W." 6 TRANSISTOR PERSONAL RECEIVER

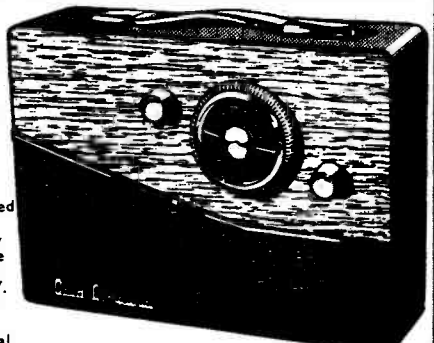


Designed by the technical staff of Practical Wireless: easy to build, using printed circuit and 1st grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speakers. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/6. Newly designed OSMOR Cabinet and reduced price. **TOTAL COST INCLUDING BATTERY AND CABINET NOW £8.10.0.** S.A.E. for 7 transistor version.

### THE "GOOD COMPANION" Mk. 1

THE FINEST COMBINED PORTABLE and CAR RADIO YET DESIGNED FOR THE HOME CONSTRUCTOR

- ★ 750mW output.
- ★ 6 transistors and 2 diodes.
- ★ Full Medium and Long Wave coverage.
- ★ Quality speaker.
- ★ Pre-aligned I.F.T.s.
- ★ Brilliantly styled 2-tone cabinet, size 11" x 8" x 3".
- ★ Very fine tuning with calibrated dial.



- ★ Latest printed circuit. ★ Internal high gain aerial with car aerial socket. Easy to follow construction data (available separately 3/6).

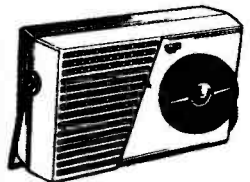
All parts sold separately and full illustrated details will be sent on request. Total Cost **£9.19.6**

OR the Mk. II version, using the latest manufacturing technique—TRANSFILTERS—saving alignment time. Same price.

With alternative luxury cabinet using 7" x 4" speaker, **£10.19.6.** Either type, plus 5/- post and ins. (Battery 3/6 extra.)

### "POCKET 4" TRANSISTOR RECEIVER

Uses miniature speaker, proper tuning condenser, and volume control. Built-in aerial makes unit efficient and portable. Ideal for the beginner. Full medium wave coverage. All components and case for only **42/6** (p. & p. 2/6). Ten-page constructional book free with parts or separately 1/6. S.A.E. for parts price list.



# HARRIS ELECTRONICS (LONDON) LTD

(DEPT. M)  
138 GRAY'S INN ROAD LONDON WC1

Telephone TERminus 7937

Please include carriage costs on ALL items.  
(Open until 1 p.m. Saturdays.) We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

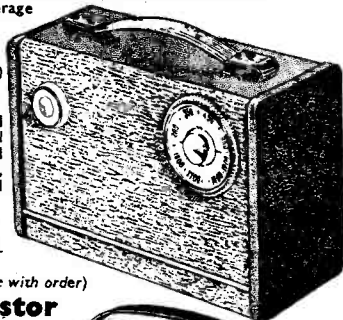
# MINISETS LTD Hatherley Mews London E17

## 6-Stage Portable Transistor Radio

- ★ All parts including transistors direct from manufacturers
- ★ Pre-assembled circuit board ensuring ease of construction
- ★ Full medium-wave coverage
- ★ After-sales service
- ★ Attractive two-tone case 9" x 6" x 4"
- ★ Push-pull output, 350 milliwatts
- ★ 5" high flux speaker
- ★ Built-in Ferrite Rod aerial. No external aerial or earth required
- ★ High performance, many stations received on test

Can be built for **£5.4.0** P.P. 3/-  
Or with long-wave 8/- extra

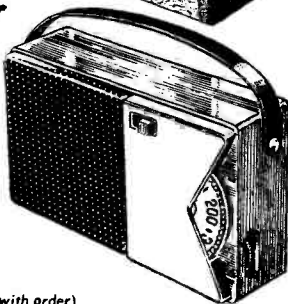
Full instructions 1/6 (Free with order)



## 6-Stage Transistor Pocket Portable

- ★ Can be built for **£4.19.6** P.P. 2/6
- ★ Completely self contained, no aerial or earth required.
- ★ Push-pull output, 250 milliwatts.
- ★ 3" high flux speaker
- ★ Pre-assembled circuit board with simple instructions ensuring easy construction
- ★ High Q Ferrite Rod Aerial
- ★ After-sales service
- ★ Can be supplied with long-wave 6/- extra

Full instructions, price list 1/6 (Free with order)

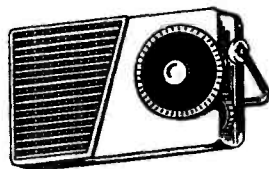


## 3-Transistor Radio (plus 2 diodes)

Total building **70/-** P.P. 2/6

- ★ Pre-assembled circuit board, ensuring easy construction
- ★ Full medium-wave coverage
- ★ Attractive case 5½" x 3" x 1½"
- ★ All components including transistors are brand new and direct from manufacturers
- ★ Ferrite Rod aerial coil, no external aerial or earth required
- ★ 2½" high flux speaker direct from manufacturer
- ★ After-sales service

Send 1/6 for instructions, circuit and price list



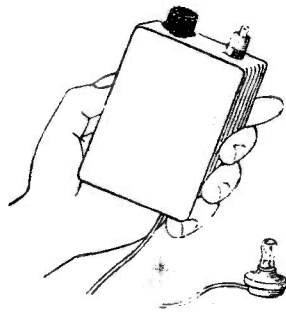
## 2-Transistor Radio (plus 2 diodes)

Ideal for personal listening

- ★ Built-in Ferrite aerial
- ★ Sensitive earpiece
- ★ All parts including transistors direct from manufacturers
- ★ Pre-assembled circuit board and easy-to-follow instructions
- ★ After-sales service

Can be built for **50/-** P.P. 2/-

Full instructions, etc., 1/6 (Free with order)



# NEW !! Transistorised Tape Recorder

FOR ONLY **£6.19.6** P. & P. 4/-

IN ECONOMICAL  
SEMI-ASSEMBLED  
**KIT FORM**

Save at least **£4!**

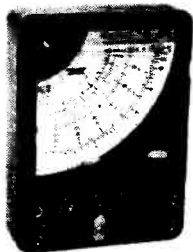
Results comparable with similar built up recorders selling at around 12 gns.

Consists of three transistor amplifier, recordplay, volume control, miniature speaker, forward-stop-rewind-switch, reel of tape and spare reel, motor, attractive coloured case, Mic. and earphone sockets, pick-up coil, mike, earphone and carrying handle supplied. Standard battery operated. Simple to put together in less than one hour. Brand new and guaranteed.



Order early—delivery in strict rotation! S.A.E. for more details

## RELDA METER SENSATION !!



10,000 o.p.v. MULTI-TESTER IN SEMI-ASSEMBLED KIT FORM

Ranges: D.C. voltage: 0-6-30-120-600-1,200V (10,000 o.p.v.). A.C. voltage: 0-6-30-120-600-1,200V (10,000 o.p.v.). D.C. current: 0-120µA, 0-12-300mA. Resistance: 0-20k, 0-2 Meg. (150 ohm, 15k at centre scale). Capacitance: 0.005 to 15µF (at a.c. 6V). Decibels: 20 to ±63Db (600 ohms 1mW, odbm—0.774V). Accuracy: D.C. voltage and current ±2% f.s. A.C. voltage ±4% f.s. Resistance ±3% of total scale length. Size: 4½" x 3½" x 1". Complete with test leads, battery and instructions.

ONLY **69/6** Few only available—rush your order now whilst stocks last!

**Relda Radio** Ltd

Mail Orders to: DEPT. "R"  
32a COPTIC STREET  
LONDON, W.C.1 MUS 9606

Our goods must be seen to be appreciated—a visit to our showrooms at 87 Tottenham Court Road, London, W.1, will be most rewarding!

## This Month's Snips!

- 1. TO OPERATE YOUR RAZOR FROM CAR BATTERY** or suitable for many other uses, we offer Motor Generator 12v. input, 200v. output, which must have cost at least £10 to make, for only 17/6 plus 4/6 post and insurance.
- 2. "SUPER 3"** as described in April issue—we can offer all components separately or complete set, but in our attractive case, 42/6 plus 2/6 post and insurance.
- 3. DON'T MISS THIS VERY SPECIAL BARGAIN.** 6 transistor superhet—everything except speaker and cabinet—proved circuit complete with full instructions and matched set of transistors. 85/- plus 2/6 post and ins.
- 4. CABINET AND PICK-UP.** Cabinet for battery record player. Size approx. 9" x 11" x 5" allows for 7" x 4" speaker and amplifier. Nicely covered two tone. Must have cost at least £2 to make. New and perfect. Offered whilst stocks last 27/6 plus 4/6 post and ins. **COSMOCORD PICK-UP** as illus. with cartridge and headrest. Ready, new and perfect. Suitable for 45 or 33 records. 12/6 plus 2/6 post and ins. **EXTRA SPECIAL OFFER.** Both items if ordered together will be supplied for 37/6 plus 4/6 post and ins.



## MOST POPULAR PORTABLES or CAR RADIOS

"Works better than my 25 gn. '\_\_\_\_\_'!"  
We hear this remark so many times and feel this is why our Companion portables are growing more and more popular.

### The "Good Companion" Mk. II

#### USING TRANSFILTERS

In the "de-luxe" cabinet as illustrated it costs £10.19.6 to build—but what a set! Scan these pages: you will find nothing to compare with its specification. It uses trans-filters instead of I.F. transformers, has variable feedback as well as all the usual features, A.V.C., Push-pull output, Ferrite Aerial, Slow Motion Tuning, etc., etc., and is a very powerful Medium & Long Wave set, conservatively rated at 750mW. Every component used is by a famous maker, such as transistors—Jackson Brothers tuning condensers—Rola-Celestion loudspeaker—Dubilier—T.C.C.—Morganite resistors and controls. Also full after sales service available. **You will definitely be doing the right thing if you buy a Good Companion.**

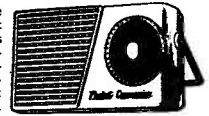


### The "Tremendo Companion"

If you don't mind the battery consumption being a little higher and you want really big output then order The "Tremendo". This has an undistorted output of almost 1 1/2 watts and is probably the most powerful home constructor set available today. Complete building cost of this is £11.5.0 which includes the transfilter (Mk.II circuit) batteries, cost 3/6 (two required).

### The "Pocket Companion"

This is without doubt the most modern and best pocket set available. It uses the very latest I.F. transfilters, Philco R.F. transistors, airspaced tuning condenser in Superhet circuit covering M.W. and L.W. Complete building cost £6.15.0, Battery 2/- Post & Ins. 2/6. Data free with parts or separately 2/6.



### T.R.F. POCKET PORTABLES

Still available as previously advertised, all are complete with cabinet similar to "Pocket Companion".

**THE "PIMPERNEL"**  
Five transistors, 3in. Moving Coil Speaker. 79/6 plus 2/6 postage and insurance.

**THE POCKET "4"**  
Undoubtedly the easiest to build set available, three transistors and one diode. 42/6 plus 2/6 postage and insurance.

**THE SOLDERLESS "3"**  
Two transistors, miniature earphone. Assembled like a Meccano set, ideal for juveniles and beginners. 37/6 plus 2/6 postage and insurance.

## ELECTRONIC PRECISION EQUIPMENT LTD

★ Orders received by post are despatched from our warehouse, Dept. 34, 66 Grove Road, Eastbourne, and to save time, please post your order to this address. Please include enough for postage. Callers, however, should use one of the following addresses: **John Bull**  
520 High Street North Manor Park, E.12      42-46 Windmill Hill Ruislip, Mddx.      266 London Road Croydon      29 Stroud Green Road Finsbury Park, N.4      246 High Street Harlesden, N.W.10

# Premier RADIO

23 Tottenham Court Road London W1 Telephone MUSEum 3451/2 and 309 Edgware Road London W2 Telephone PADdington 6963

## 6-TRANSISTOR POCKET SUPERHET



MAY BE BUILT FOR  
**£7.19.6**

plus 3/6 P. & P.  
PP4 Battery 2/6 extra

Star Features: ★ 6 first grade transistors and one diode. ★ Simple to follow printed circuit.

★ Internal Ferrite rod aerial. ★ Provision for car radio aerial. ★ Full medium & long waveband coverage. ★ Attractive rexine covered cabinet size 7" x 4 1/2" x 2 1/2". ★ Simple point to point instr. supplied.

### The "Petite" PORTABLE



MAY BE BUILT FOR **£7.0.0** plus 5/- P. & P.

Batteries extra

HT 10/- (Type B126) or equiv.  
LT 1/6 (Type AD35) or equiv.

★ Size only 8" x 8" x 4 1/2"

★ Instruction book 1/6

Battery Eliminator, available in component form price 37/6 plus 2/- P. & P.

### WE HAVE BEEN APPOINTED STOCKISTS FOR FULL RANGE OF STERN'S RADIO (Fleet Street)

Famous Mullard Designs such as Type "C" Tape Pre-amplifier and Erase Unit, including separate Power Supply. Complete Kit of Parts ..... £14. 0. 0 or Completely assembled and tested ..... £17. 0. 0

Also available Less Power Supply at £11.15.0 and £14.10.0 respectively.

Stern's Model HF/TR3 Mk.2. Tape Amplifier Complete Kit of Parts ..... £13.14. 0 or Completely assembled and tested ..... £17. 0. 0

Complete Mullard 5-10 Amplifier with Pre-amplifier on same Chassis Complete Kit with Parmeko O/P and Mains Transformers ..... £1.10. 0

Completely assembled and tested ..... £13.10. 0

Complete Mullard 3-3 Amplifier Kit ..... £7.10. 0

Completely assembled and tested ..... £8.19. 6 P. & P. 6/6

Mullard 10-10 Stereo Power Amplifier based on the famous Mullard 5-10 Complete Kit of Parts ..... £18.10. 0

Completely assembled and tested ..... £21. 0. 0

(Control Unit on Main Chassis) Also available with separate dual-channel Pre-amp. Complete Kit for Power Amp. & Pre-amp ..... £26. 0. 0

Completely assembled and tested ..... £30. 0. 0

All components used in these kits are of the highest possible standard and strictly to circuit specifications.

Full descriptive literature available on these products and Circuit Diagrams may be purchased separately.

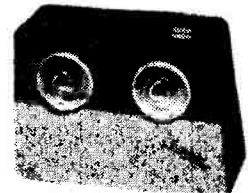
## TRANSISTOR SUPERHET RADIO

May be built for

**£8. 19. 6**

Plus 2/6 P. & P.

PP3 Battery extra at 2/6



Using 6 Transistors and one Diode and internal Ferrite Rod Aerial, with provision for Car Radio Aerial. Full medium and long waveband coverage and 6 x 4 High Flux Speaker. When constructed the Receiver is housed in an attractive two tone case, size 10 1/2" x 7 1/2" x 3 1/2".



### THE "MID-FI" A NEW DESIGN

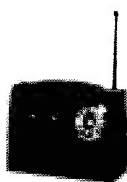
4W AMPLIFIER KIT MAY BE BUILT FOR **95/-** plus 3/- P. & P.

A new circuit for the home constructor requiring a good quality med. powered amplifier for reproduction of records or f.m. broadcasts. Technical spec.: sep. bass and treble controls. Valves: EF86, EL84, EZ80. Voltage adjustment for a.c. mains from 200/250V, 3 or 15Ω imp. Neg. feedback. Size 7" x 5" x 2", overall ht. 5". Silver hammered finished chassis.

# Heathkit

DAYSTROM

## THE FINEST ELECTRONIC KITS IN THE WORLD



RSW-1

**4-WAVEBAND TRANSISTORISED PORTABLE RECEIVER, Model RSW-1.** This model possesses Medium, Trawler and two Short-wave bands and is mid-way between the domestic broadcasting and professional general communications receiver. Ideal and inexpensive for those who wish to listen to world broadcasts, shipping and aviation communications. It is not the set to buy if you wish only to enjoy domestic broadcasting. In a handsome leather case, it has retractable whip aerial and socket for car radio usc.

£216.00



GL-58

**TRANSCRIPTION RECORD PLAYER (STEREO).** Manufactured by Goldring-Lenco. This 4-speed unit is fitted with a G60 pick-up arm. Infinitely variable speed adjustment from 33 $\frac{1}{3}$  to 80 r.p.m. Fixed speed of 16 r.p.m. Its balanced turntable (3 $\frac{1}{2}$  lb) reduces rumble, wow and flutter to very low level. The unique lowering device fitted provides absolutely safe means of placing pick-up on record

£19.12.6



TA-1M

**5" OSCILLOSCOPE, Model O-12U.** Has wide-band amplifiers, essential for TV servicing, FM alignment, etc. Vertical frequency response 3 c/s to over 5 Mc/s, without extra switching T/B covers 10 c/s to 500 kc/s in 5 ranges.

£36.10.0

**DECADE CAPACITOR Model DC-1.** Capacity values 100 $\mu$ F to 0.111 $\mu$ F in 100 $\mu$ F steps.

£6.5.6

**AUDIO SIGNAL GENERATOR, Model AG-9U.** 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's.

£19.19.6



O-12U

**HI-FI SINGLE CHANNEL AMPLIFIER Model MA-12.** 12W output, wide freq. range, low distortion.

£10.19.6

**RESISTANCE CAPACITANCE BRIDGE Model C-3U.** Measures capacity 10pF to 1,000 $\mu$ F, resistance 100 $\Omega$  to 5M $\Omega$  and power factor. 5-450V test voltages. With safety switch.

£8.6.6

**BALUN COIL UNIT, Model B-1U.** Will match unbalanced co-axial lines to balanced lines of either 75 or 300 $\Omega$  impedance.

£4.9.6

**AUDIO WATTMETER, Model AW-1U.** Up to 25W continuous, 50W intermittent.

£14.14.0

**AUDIO SINE-SQUARE WAVE GENERATOR, Model AO-1U.** Covers 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V, distortion less than 1%.

£12.18.6

**AUDIO VALVE MILLIVOLTMETER, Model AV-3U.** 1mV-300v A.C. 10 c/s to 400 kc/s.

£13.18.6

**HI-FI STEREO/MONO PRE-AMPLIFIER, Model USP-1.** Extremely versatile unit. Gain may be preset over a wide range. Input 2mV-20mV. Output 20mV-2V

£6.17.6

**MATCHED HI-FI STEREO KIT**  
We offer as a "packaged deal" the following matched Hi-Fi Stereo Equipment:

4-speed Record Player (RP-1U) ... £12. 4. 0  
6W Amplifier (S-33) ... £12. 8. 6  
Twin Speaker Systems (SSU-1) ... £21. 8. 0

Cost of Units ... £46. 0. 6

At an "all in" price of ... £44. 9. 0

Pedestal Speaker legs £2.2.0 optional ext. £18.10.0.



DC-1



AG-9U



MA-12

Available directly from **DAYSTROM Ltd** Dept. RC6, Gloucester, England

### AMATEUR TRANSMITTER, Model DX-100U.

The world's most popular, compact and completely self contained Amateur Transmitter covers all amateur bands: 160-10 m. 150w D.C. input. Careful design has achieved the stability and high performance for which the DX-100U is noted and no less than 35 disc ceramic capacitors reduce TVI to a minimum.

£71.10.0

**HI-FI AM/FM TUNER, Model AFM-1.** Available in two units which, for your convenience, are sold separately: Tuning hearc (AFM-T1—£5.6 incl. P.T.) and I.F. amplifier (AFM-A1—£19.8.0). Printed circuit board. 8 valves. Built-in power supply.

Total £24.13.6

**HI-FI FM TUNER, Model FM-4U.** Also available in two units as above: R.F. tuning unit (£3.2.0 incl. P.T.) with I.F. output of 10.7Mc/s, and amplifier unit, with power supply and valves (£11.11.0)

Total £14.13.0

**TRUVOX D83 & D84 TAPE DECKS.** High quality mono/stereo tape decks.

£31.10.0

**D83, 2 track, for highest fidelity.**  
**D84 (identical presentation), 4-track, for most economical use of tape.**

£29.8.0



DX-100U



FM Tuner



Truvox D83

## THE BEST QUALITY

### TAPE RECORDING AND REPLAY HI-FI AMPLIFIER

Mono model TA-1M, Stereo model TA-1S. For use with most tape decks. Thermometer type recording indicators, press-button speed compensation and input selection, 3-position bias level and printed circuit construction

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| TA-1M                      | £18 2 6  |
| TA-1M and Collaro "STUDIO" | £30 10 0 |
| TA-1M and TRUVOX D83       | £47 2 6  |
| TA-1M and TRUVOX D84       | £45 5 0  |
| TA-1S                      | £23 6 0  |
| TA-1S and TRUVOX D83       | £52 6 0  |
| TA-1S and TRUVOX D84       | £50 9 6  |

**HEATHKIT ELECTRONIC WORKSHOP, Model EW-1.** This new educational kit will teach and amuse your children, it can make 21 exciting experiments including: transistor radios, burglar alarm, radio or TV silencer, intercom., etc

£7.18.0

### HI-FI EQUIPMENT CABINETS

Our four equipment cabinets meet a wide variety of tastes and requirements: the "CHEPSTOW" was designed for those



The "Gloucester" (open)

who have little floor space, the contemporary "MALVERN" for the Tape and Gram. enthusiast, and the "GLOUCESTER" Mk. I and II for those with traditional tastes. All parts are pre-cut and drilled for easy assembly, and left "in the white". Prices from £11.12.6 to £18.10.0.



DX-40U

**SINGLE SIDEBAND ADAPTOR. Model SB-10U.** May be used with most A.M. transmitters. Less than 3w R.F. input power required for 10w output. Operation on 80, 40, 20, 15 and 10m bands on U.S.B., L.S.B. or D.S.B. **£37.60**



GD-1U

**AMATEUR TRANSMITTER. Model DX-40U.** Covers all amateur bands from 80 to 10 metres; crystal controlled. Power input 75W C.W., 60W peak controlled carrier phone. Output 40W to aerial. Provision for V.F.O. Filters minimise TV interference. **£32.10.0**

**GRID-DIP METER. Model GD-1U.** Functions as oscillator or absorption wave meter. With plug-in coils for continuous frequency coverage from 1.8 Mc/s to 250 Mc/s. **£10.9.6**

Three Additional Plug-in Coils Model 34-1U extend coverage down to 350 kc/s. With dial correlation curves. **15/-**



S-33

**TRANSISTORISED VERSION. Model XGD-1.** Similar to GD-1U. Fully transistorised with a frequency range of 1.8 to 45 Mc/s. **£10.8.6**

**6-W STEREO AMPLIFIER. Model S-33.** 3 watts per channel, 0.3% distortion at 2.5 w/channel, 20dB N.F.B. Inputs for Radio (or Tape) and Gram. Stereo or Monaural, ganged controls. Sensitivity 100mV. **£12.8.6**



"STUDIO"

**COLLARO "STUDIO" TAPE DECK.** The finest buy in its price range. Operating speeds: 1½, 3½ and 7½ i.p.s. Two tracks. "Wow" and "flutter" not greater than 0.15% at 7½ i.p.s. Long Term Speed Stability better than 0.5%. **£17.10.0**

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**ELECTRONIC SWITCH. Model S-3U (Oscilloscope Trace Doubler.)** Enables a single beam oscilloscope to give simultaneous traces of two separate and independent signals. Switching rates approx. 150, 500, 1,500, 5,000 and 15,000 c/s. Sig. freq. response 0-100 kc/s. +1dB. Separate gain controls and sync. output. Sig. input range 0.1-1.8V r.m.s. **£10.15.6**

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VF-1U



UXR-1



S-88



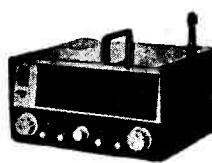
SSU-1



OS-1



V-7A



GC-1U

## AT LOWEST PRICES

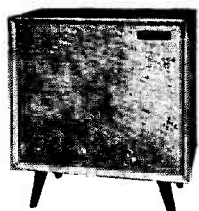
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£53. 9.0  
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THE "COTSWOLD"

**THE "COTSWOLD".** This is an acoustically designed enclosure 26" x 23" x 15½" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32-20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£21.19.0**

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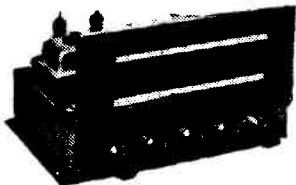
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## ARMSTRONG AF 208 AM/FM RADIOGRAM CHASSIS



★ Full VHF Band (87-108 Mc/s.) and Medium Band (187-570M). ★ 7 Valves ★ 5 Watts Output ★ 15dB Negative Feedback ★ Separate wide range Bass and Treble Controls ★ 2 Compensated Pick-up Inputs ★ Frequency Response 30-22,000 c.p.s. ★ 2dB ★ Tape Record and Playback Facilities ★ Continental Reception of Good Programme Value ★ For 3, 7 and 15 ohm speakers. Send S.A.E. for leaflet.

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Acos Hi-Fi Pick-up for LP, and/or 78, 7", 10" and 12" records. Silent motor, heavy turntable, auto stop. Completely assembled on base plate.  
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Ready built complete with B.S.R. TU9 4-speed Gram Pick-up unit. Handsome portable case. 3-watt amplifier with 2 valves and speaker.

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465 kc/s Stag Tuning Miniature Can. 1 1/2" x 1 1/2". High Q and good band width. Data sheet supplied.

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|-------|-----|-------|------|--------|------|-------|------|
| 1RS   | 7/6 | 6K8G  | 7/6  | EA50   | 1/6  | EZ80  | 7/6  |
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| 6J5   | 3/6 | 35L6  | 9/6  | EL32   | 5/6  | UCH42 | 9/6  |
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| 6J7G  | 6/6 | 80    | 9/6  | EL84   | 8/6  | LUL41 | 9/6  |
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## SETS OF VALVES

|                                |                       |
|--------------------------------|-----------------------|
| DK96, DF96, DAF96, DL96        | 8/6 each or 27/6 set. |
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| ECH42, EF41, EBC41, EL41, E240 | 37/6                  |
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## NEW ELECTROLYTICS

## FAMOUS MAKES

| TUBULAR  | TUBULAR | CAN TYPES     |
|----------|---------|---------------|
| 1/350v.  | 2/-     | 50/350v.      |
| 2/350v.  | 2/3     | 100/25v.      |
| 4/450v.  | 2/3     | 250/25v.      |
| 8/450v.  | 2/3     | 500/12v.      |
| 16/450v. | 3/-     | 8 + 8/450v.   |
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| 25/25v.  | 1/9     | 16 + 16/450v. |
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## COMPLETE RADIO CHASSIS

£4.19.6 post free

4 Mullard valves, 5" speaker, frame aerial. 4 pre-set stations. 1 long, 3 med. wave. Superhet Circuit. Size 9" x 6" x 5 1/2" high. Tested ready for use. 200/250V A.C.-D.C. Mains. Brand New

## DE LUXE MODEL

As above but with illuminated dial. Fully tunable over medium wave 200-550 M and long wave 1,000-2,000 M.

Bargain Price £5.19.6

## MAINS TRANSFORMERS

200/250 AC Post 2/- each

|   |      |
|---|------|
| STANDARD 250-0-250, 80 mA., 6.3 v. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped 5 v. 2 a. and 4 v. 2 a. .... | 22/6 |
| 250-0-250, 80 mA., 6.3 v. 1 a. ....   | 29/6 |
| MINIATURE, 200 v. 20 mA., 6.3 v. 1 a. ....  | 10/6 |
| MIDGET, 220 v. 45 mA., 6.3 v. 2 a. ....   | 15/6 |
| SMALL, 220-0-220 v. 50 mA., 6.3 v. 2 a. ....  | 17/6 |
| STANDARD, 250-0-250 65 mA., 6.3 v. 3.5 a. ....  | 17/6 |
| HEATER TRANS., 6.3 v. 1 1/2 a. ....   | 7/6  |
| 250-0-250, 80 mA., 6.3 v. 1 a. ....   | 10/6 |
| 250-0-250, 80 mA., 6.3 v. 1 a. ....   | 8/6  |
| MULLARD "510" OSRAM "912", 300-0-300, 120 mA., 6.3 v. 4 a. c.t., 6.3 v. 2 a. tapped 5 v. ....                 | 38/6 |
| GENERAL PURPOSE LOW VOLT-AGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. ....             | 22/6 |
| AUTO TRANS. 150 w., 0, 10, 120, 200, 230, 250 v. ....   | 22/6 |
| AUTO TRANS. 500 w., 0, 115, 200, 230, 250 v. ....   | 82/6 |

O.P. TRANSFORMERS. Heavy duty 50 mA. 4/6. Miniature 3V4, etc., 4/6. Small, pentode, 4/6. Multi-ratio push-pull, 7/6. Multi-ratio push-pull 10 w., 15/6. Goodmans heavy duty 10/20 w. 6K push-pull 30/-, Elstone ultra-linear 10 w. 45/-, L.F. CHOKES 15/10 H. 60/65 mA. 5/-; 10 H. 85 mA. 10/6; 10 H. 120 mA. 12/6; 10 H. 150 mA. 14/-

## TELEVISION REPLACEMENTS

Line Output Transformers from 45/- each, NEW Stock and other timebase components. Most makes available. S.A.E. with all enquiries

FULL WAVE BRIDGE CHARGER RECTIFIERS. 2, 6 or 12 v. 1 1/2 a., 8/9; 2 a., 11/3; 4 a., 17/6. Free charger circuit.

CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1 1/2 a., 15/6; 2 a., 17/6; 4 a., 22/6.

4 AMP. CAR. BATTERY CHARGER with amp. meter Leads, Fuse Case, etc., for 6 v. or 12 v., 69/6.

## BOOKS (List S.A.E.)

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| 40 Circuits for Germanium Diodes       | 3/-      |
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TINNED COPPER WIRE 16 to 22 swg. 1 lb. 3/- COPPER ENAMEL WIRE 1 lb. 16 to 22 s.w.g. 2/9, 24 to 30 s.w.g. 3/6, 32 to 40 s.w.g. 4/6

CRYSTAL MIKE INSERT 6/6 Precision engineered. Size only 1 1/2" dia. x 1"

ACOS STICK MIKE 39-1 ... 35/- T.S.L. DE LUXE STICK MIKE ... 35/-

SPEAKER FRET. Gold cloth, 17 in. x 25 in., 5/-; 25 in. x 35 in., 10/-. TYGAN, various colours, 52 in. wide, from 10/- ft.; 26 in. wide from 5/- ft. Samples S.A.E. Expanding Metal, Gold, 12 in. x 12 in., 4/-

## BAKER SELHURST LOUDSPEAKERS

12" Baker 15W Stalwart 3 or 15Ω, 45-13,000 c.p.s. 90/-

12" Stereo 12W, 35-16,000 c.p.s. Foamsuspension £6.17.6

12" Baker Ultra Twelve, 20 c.p.s. to 25 kc/s £17.10.0

15" Auditorium, Bass Mk II 35W 20 c.p.s. to 12 kc/s. £18



LOUDSPEAKERS P.M. 3 OHM. 2 1/2 in. 3 in. 4 in. -19/6; 5 in. Rola, 17/6; 7 in. x 4 in., 18/6; 4 in. Hi-Fi Tweeter, 25/-; 8 in. Plessey, 19/6; 6 in. Goodmans, 18/6; 10 in. R.A., 39/-; 12 in. Plessey, 38/-; 10 in. x 6 in. E.M.I. 27/6; E.M.I. 13 1/2" x 8" 45/-; Stentorian HF1012 10 in., 95/-; HF1016, £8. 12 in. R.A. 15Ω45 -.

CRYSTAL DIODES. G.E.C., 2/-; GEX34, 4/-; OA81, OA70, 3/-; Crystal Coils HAX, 3/- CRYSTAL SET BOOKLET 1/- H.R. HEADPHONES, 4,000 ohms, brand new, 15/- pair. Low resistance phones, BA5, 7/6 pair. SWITCH CLEANER FLUID, squirt spout, 4/6 in.

## C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having cathode short circuit and/or C.R. Tubes with falling emission. Full instructions supplied.

TYPE A. LOW LEAKAGE WINDINGS. OPTIONAL 25% and 50% BOOST ON SECONDARY: 2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. WITH MAINS PRIMARIES. 12/6.

TWIN GANG CONDENSERS. Miniature transistor gang 208 and 176 pF, 10/6 each; 365 pF, miniature, 1 1/2 in. x 1 1/2 in. x 1 1/2 in., 10/-; 500 pF standard with trimmers, 9/-; midget, 7/6; midget with trimmer, 9/-

SHORT WAVE. Single 25pF, 50 pF, 75 pF, 100 pF, 160 pF, 5/6 each.

TUNING AND REACTION CONDENSERS. 100 pF, 300 pF, 500 pF, 3/6 each, solid dielectric.

CONDENSERS. 0.001 mfd. 7 1/2" T.C.C., 5/6;

ditto 20 kV, 9/6; 0.1 mfd. 7 kV, 9/6; 100 pF to 500 pF Micas, 6d.; Tubular 500 v. 0.001 to 0.05 μd., 0.1, 1/-; 0.25, 1/6; 0.1/350 v., 9d.; 0.5/500 v., 1/9; 0.01/2,000 v., 1/9; 0.1/2,000 v., 3/6.

CERAMIC CONDENSERS. 500 v. 0.3 pF to 0.01 mfd., 9d. 0.1/30v., 1/3.

SILVER MICA. 109, 5 pF to 500 pF, 1/-; 600 pF to 3,000 pF, 1/6; close tolerance (plus or minus 1 pF), 1.5 pF to 47 pF, 1/6; ditto 1% 50 pF to 815 pF, 1/9; 1,000 pF to 5,000 pF, 2/-.

## 465 Kc/s. SIGNAL GENERATOR

cost 15/- Use B.F.O. Unit ZA 30038 ready to go. SOCKET SIZE 2 1/2 in. x 4 1/2 in. x 1 in. Slight modifications required, full instructions supplied. Battery 8/6 extra 69 v. + 1 1/2 v. Details S.A.E.

## WAVECHANGING SWITCHES

2 p. 2-way, 3 p. 2-way, short spindle ... 2/6  
8 p. 4-way 2 wafer, long spindle ... 6/6  
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6  
3 p. 4-way, 1 p. 2-way, long spindle ... 3/6  
Wavechange "MAKITS". Wafers available: 1 p. 12 wafer, 2 p. 6 wafer, 3 p. 4 wafer, 4 p. 3 wafer, 6 p. 2 wafer. 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-; Additional wafers up to 14, 3/6 each extra.

TOGGLE SWITCHES, s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-; Rotary Toggles, s.p., 3/6, d.p., 4/6.

JACKS. English open-circuit 2/6, closed-circuit 4/6, Grundig-type 3-pin 1/3

JACK-PLUGS. English 3/-, Screened 4/-, Grundig 3-pin 3/6

## JASON F.M. TUNER COIL SET, 29/-

H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s., detector transformer and heater choke. Circuit and component list using four 6AN6, 2/6. Complete Jason FMT kit, Jason chassis with calibrated dial, components and 4 valves, £6.5.0.

VALVEHOLDERS. Pax. int. oct., 4d. EA50, 6d. B12A, CRT 1/3. Eng. and Amer. 4, 5, 6, and 7 pin, 1/7G, B8, B9G, B9A, 2/6. Complete Jason FMT kit with can, 1/6. B9A with can, 1/6. Ceramic, EF50, B7G, B9A, Int. Oct., 1/-; B7G, B9A cans, 1/- each.

# RADIO COMPONENT

Our written guarantee with every purchase. Buses 133 or 68 pass door. S.R. Stn. Selhurst.



## VOLUME CONTROLS

Long spindles, Midget 5K ohms to 2 Meg.  
No. sw. D.P. Sw  
4/6  
Linear or Log Tracks.

## 80 ohm Cable Coax

Semi-air spaced  $\frac{1}{2}$  in.  
Stranded core, 6d. yd.  
40 yds. 17/6; 60 yds. 25/-  
Fringe Quality, Air Spaced 1/- yd.

**EXTENSION SPKR. CONTROL** 10 Ohm 3/-  
**TELESCOPIC CHROME AERIALS** 13in. extending to 43in. 8/6 each. Coax adaptor plug — 1/6 extra.

**RESISTORS.** Preferred values. 10 ohms to 10 meg.  $\frac{1}{2}$  w., 4d.; 1 w., 6d.; 1 1/2 w., 8d.; 2 w., 1/-  
**HIGH STABILITY.**  $\frac{1}{2}$  w. 17/-, 2/-; Preferred values. 10 ohms to 10 meg. Dico 57, 100 ohms to 5 meg. 9d. 5 watt  
**WIRE-WOUND RESISTORS** 1/3  
10 watt/ 25 ohms-10,000 ohms 1/6  
15 watt/ 2/-  
12.5K to 50K 10 w. 2/-

## WIRE-WOUND POTS

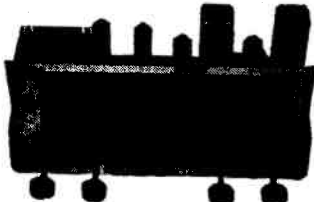
3 WATT. Pre-set Min. TV Type. All values 10 ohms to 25K, 3/-ea.; 30K, 50K, 4/-; Carbon 30K to 2 meg, 3/-

## WIRE-WOUND

4-WATT POTS. Long Spindle, Values, 50 ohms to 50K, 6/8; 100K, 7/6.

**TRIPLEXERS,** Bands I, II, III, 12/6  
**COAXIAL PLUGS, 1/-; PANEL SOCKETS, 1/-**  
**LEAD SOCKET, 2/-; OUTLET BOXES, 4/6**  
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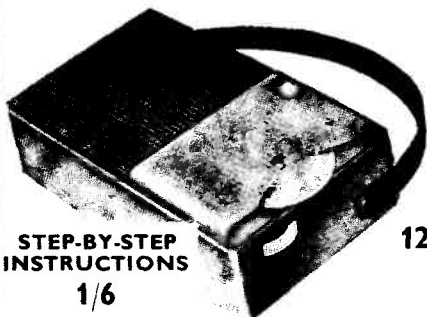
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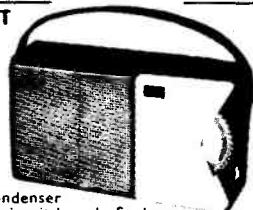
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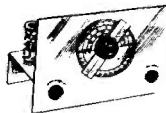
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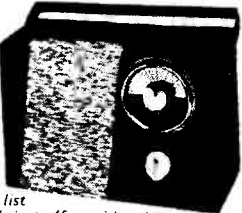
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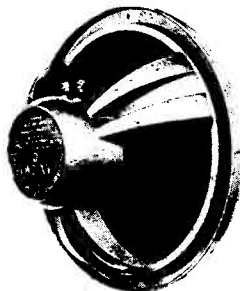


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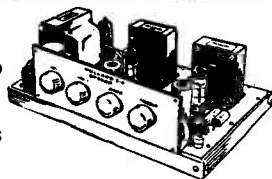
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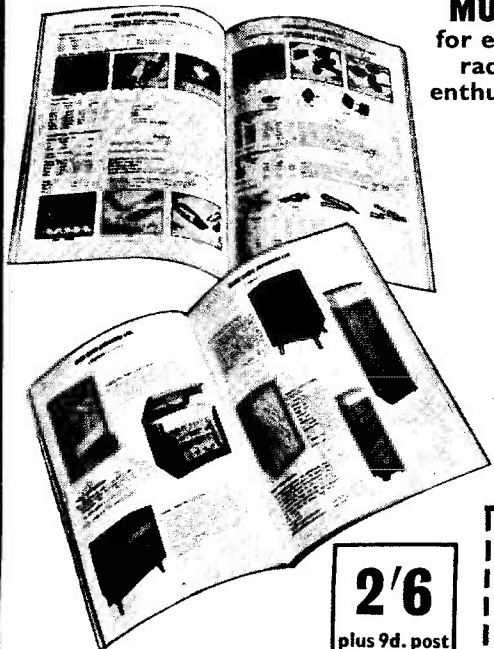
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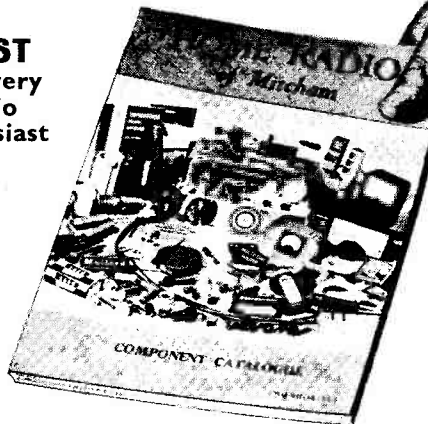
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CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether hand-written or typewritten, lines should be double spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

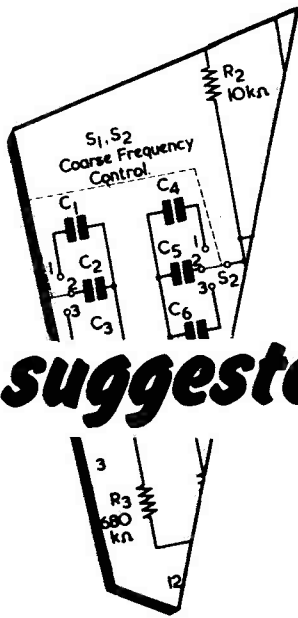
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TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

TECHNICAL QUERIES must be submitted in writing. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

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# suggested circuits

## No. 139 Light Dependent Resistor Control Circuits

The circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential data

AS MANY READERS WILL BE aware, the Light Dependent Resistor (or L.D.R.) is nowadays a common component in domestic television receivers, in which it causes contrast or brightness to be automatically varied to suit the ambient light conditions in which the screen is viewed. However, it does not seem to be generally realised, particularly amongst home-constructors and experimenters, that the L.D.R. can also be employed in a wide range of circuits wherein control of a particular operation is achieved by the appearance or interruption of light. The L.D.R. is, indeed, an extremely attractive light-sensitive device for functions of this type, because not only is it more sensitive than the photo-transistor but it also requires fewer components about it. Further, it can operate from a wider range of supply potentials than the photo-transistor and there is no restriction on polarity.

### The L.D.R.

The L.D.R. is a two-terminal photoconductive cell whose resistance decreases when light falls upon it. A typical photoconductor may have a film of lead sulphide as the light-sensitive resistive element, and this is typical of the units manufactured in America by Infrared Industries, Inc. The L.D.R.'s generally available in Britain are cadmium sulphide types and appear in the Mullard "ORP" range.

An L.D.R. from the Mullard range which is eminently suitable for experimental work is the ORP12. The ORP12 is widely used in television receivers and many service engineers will already be familiar with its appearance and functioning. Also, it is now available to the home constructor.<sup>1</sup> The ORP12 is a

<sup>1</sup> The Mullard ORP12 may be obtained from Henry's Radio Ltd, 5 Harrow Road, London, W.2.

robust encapsulated unit having the appearance and dimensions given in Fig. 1. Connections may be soldered directly to the lead-out wires, but heat conducted to the body during soldering should be kept to a minimum. The use of a heat shunt is, therefore, advisable. Further, the leads should not be bent nearer than 1.5 mm to the seal.

The resistance of the ORP12 varies from 75 to 300Ω in the illuminated condition to 10MΩ or more in total darkness. (It should be noted that some delay will occur before the latter value is reached). Absolute limiting values for voltage and power are as follows: the voltage across the L.D.R. must not exceed 110 volts; and power dissipation in the L.D.R. must not exceed 200mW for temperatures up to 40° C (104° F), 100mW at 50° C (122° F) and 50mW at 55° C (131° F). The permissible power dissipation figure drops to zero at 60° C (140° F). Limiting ambient temperatures are -10° C (14° F) minimum and 60° C (140° F) maximum.

The wide range of resistance variation and the relatively generous voltage and power dissipation limits enable an ORP12 to operate a relay directly. In consequence an L.D.R. light controlled circuit comprises only the L.D.R. itself and the relay.

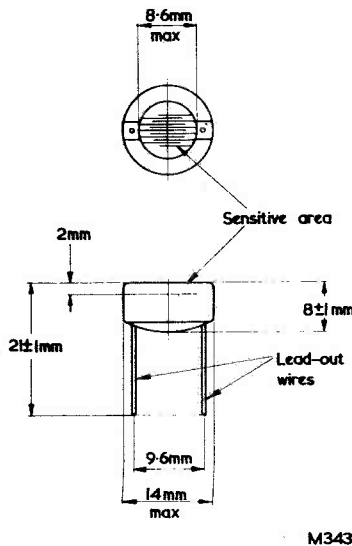


Fig. 1. The dimensions and appearance of the ORP12

### Suitable Component Values

Fig. 2 illustrates a circuit checked

by the writer. In this, the L.D.R. is connected in series with a  $5k\Omega$  relay (RipMax type A30.<sup>2</sup>). For initial tests the relay was adjusted to operate at 1.5mA (7.5 volts across the coil) and the applied supply voltage was 12. The L.D.R. was shielded from ambient light by positioning it inside a cardboard tube. Under these conditions, the relay operated when a bulb mounted in a small torch was held 18in away from the L.D.R. The power dissipated in the bulb was 0.75W.

The relay gave reliable results for the 1.5mA adjustment, but it was felt that a less critical setting would be preferable. In consequence the relay was readjusted to operate at 2.5mA (12.5 volts across the coil) and the supply potential for the circuit was increased to 24 volts. The torch bulb now caused the relay to operate when it was 2ft away from the L.D.R. The 2.5mA setting of the relay allowed very dependable operation, the armature having a wide range of movement with very adequate clearance from the core when it was in the energised position.

For both the 12 and 24 volt supply potentials, the L.D.R. was operated at low power dissipations. Maximum dissipation in the L.D.R. occurs when its resistance is the same as that of the relay coil.<sup>3</sup> When the 24 volt supply potential is used, maximum dissipation occurs in the L.D.R. when its resistance is  $5k\Omega$ ; whereupon it has a potential of 12 volts across it. The dissipation is therefore 29mW only.

Provided that the ambient temperature limitations are borne in mind it would appear safe to operate the ORP12 at a maximum dissipation of 100mW, (this still being half the limiting value for temperatures up to 40° C). A dissipation of 100mW would be given if the supply potential of Fig. 2 were increased to 44 volts. The maximum dissipation in the ORP12 would then occur at a value of  $5k\Omega$  and a voltage of 22, giving a power dissipation of just under 100mW. When L.D.R. resistance had dropped to, say,  $1k\Omega$  with this supply potential, relay current would be in excess

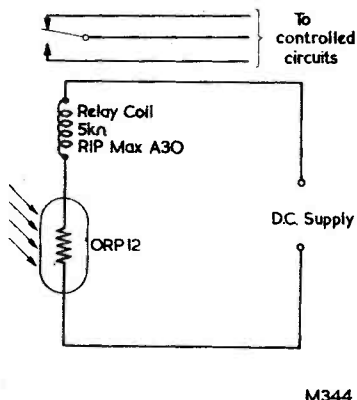


Fig. 2. A working L.D.R. circuit. The voltage of the d.c. supply is discussed in the text

of 7mA. A 5,000 $\Omega$  Post Office relay with light contact loading should operate reliably at this current. It is important to note that, in this instance, the supply potential should not be allowed to rise above

the 44 volt figure just quoted. This is because the power dissipation in the L.D.R. varies as the square of the applied voltage, and a small increase in this voltage results in a significantly larger rise in dissipation.

In the three examples mentioned the voltage across the cell is kept well within the specified maximum of 110 volts.

Relays having coil resistances other than  $5k\Omega$  can, of course, be employed with the ORP12, it being remembered that maximum dissipation in the latter occurs when it has the same resistance as the relay. The requisite supply voltage may then be calculated.

### Sensitivity and Shielding

Due to its inherent simplicity, there is no control of sensitivity in the circuit of Fig. 2. In practice, some control over the amount of light needed to operate the circuit could be made by mechanical adjustments to the relay, but this is rather a clumsy approach.

The writer found that the circuit

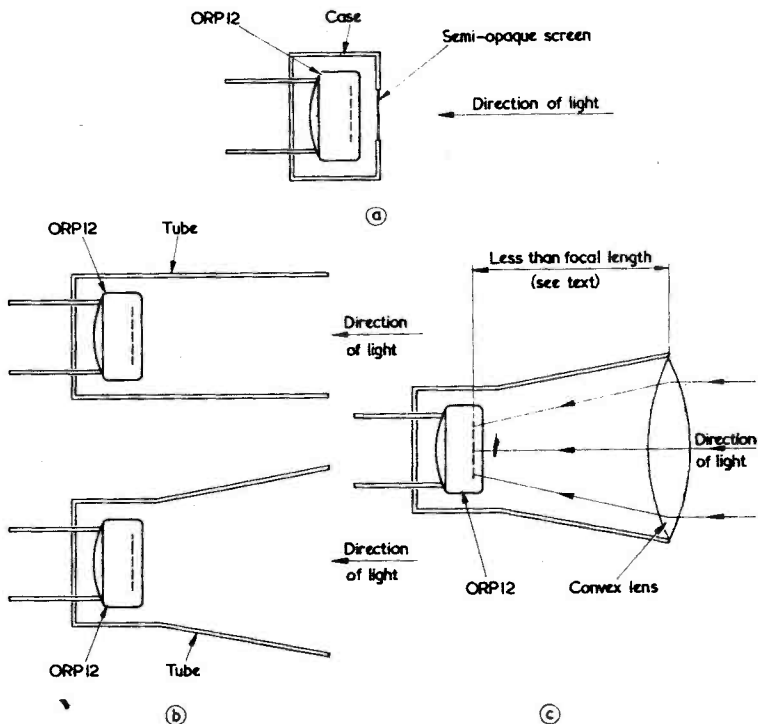


Fig. 3 (a). To reduce sensitivity a semi-opaque screen may be positioned in front of the ORP12  
(b). The effect of the ambient light may be reduced by mounting the ORP12 in a cylindrical or flared tube  
(c). Sensitivity may be increased with the aid of a simple convex lens

<sup>2</sup> This relay is available from Home Radio (Mitcham) Ltd, 187 London Road, Mitcham Surrey, under Cat. No. Z70.

<sup>3</sup> This fact may, perhaps, be more readily appreciated if it is remembered that most accurate matching (i.e. maximum transfer of energy) of a generator to a load occurs when the impedance of the load equals the internal impedance of the generator. In this case it can be assumed that the "generator" is applied to the L.D.R. (which is the "load") and that it has an internal impedance equal to the resistance of the relay coil.

of Fig. 2 had more than adequate sensitivity for most light-control purposes. Normal ambient light caused the relay to operate unless the L.D.R. was shielded, and the fact that an 0.75 watt bulb at 2ft distance was sufficient to actuate the circuit (with the 24 volt supply) indicates a level of sensitivity which would certainly be high enough for most requirements. It is possible, indeed, that sensitivity might be 100 high, with the result that the circuit became too liable to operate from ambient light despite shielding. In this instance, the easiest method of controlling sensitivity would consist of placing a partly opaque screen in front of the L.D.R., as in Fig. 3 (a).

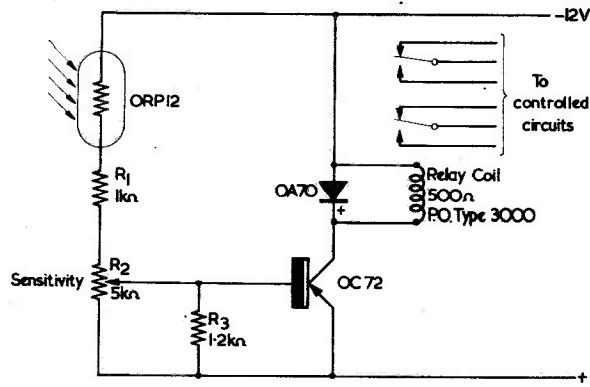
If a transistor amplifier is employed with the L.D.R., sensitivity may be controlled by electrical means, and this point is discussed later.

The simplest means of shielding the L.D.R. from ambient light consists of mounting it in a tube as shown in the examples of Fig. 3 (b). The L.D.R. will then only respond to light reaching it from the desired direction. The inside wall of the tube should be finished in matt black to avoid reflecting ambient light onto the L.D.R.

An increase in sensitivity can be given by mounting a simple convex lens in front of the L.D.R. and tube, as in Fig. 3 (c). A cheap magnifying glass lens is quite adequate here, and it should be mounted so that it is slightly less than its focal length away from the surface of the L.D.R. This spacing is necessary in order to diffuse the light from the lens over the sensitive area of the cell. If the lens were spaced from the cell by exactly its focal length, the source of light would be focussed on to a small part of the sensitive area only, and the desired increase in sensitivity would not be achieved. (The focal length of a convex lens can be found by causing it to focus the image of an electric light bulb on to a piece of paper. The distance between the paper and the lens is then the focal length). The addition of a lens makes the L.D.R. and tube assembly more directional. It was found that the circuit of Fig. 2, using a 24 volt supply, could be actuated by the 0.75W bulb at a distance of 6ft when a lens was added.

#### Applications

The L.D.R. and relay circuit of Fig. 2 has many uses, these including such applications as the operation of garage doors by car headlights, the switching on of lights at sunset, the counting of manufactured units (which break a beam of light) and the remote control of models.



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Fig. 4 An L.D.R. circuit incorporating a transistor amplifier for applications where the L.D.R. is normally illuminated

A particularly attractive application is the control of television receivers by means of light rays. If one or more L.D.R.'s are situated on the front of a television receiver it should be possible to remotely control several receiver functions such as volume, contrast, or brightness, by means of a torch held by the viewer. The sensitivity of the circuit of Fig. 2 is such as to allow reliable actuation by a reasonably powerful torch from a distance of 6ft or so, without the need of a lens in front of the L.D.R. The writer hopes to experiment with this application at an early date, in which case the results obtained will be described in a future article in this series.

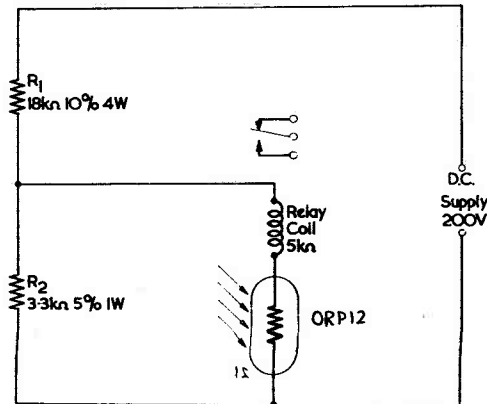
#### An Amplified Circuit

Fig. 4 gives a circuit in which the ORP12 is employed with a transistor

amplifier. When checked, this circuit offered a small increase in sensitivity over that of Fig. 2, in that the relay operated when the 0.75W bulb was held 4 feet away from the L.D.R. The advantages offered by the transistor amplifier are rather marginal, although it does allow the use of a robust standard P.O. relay together with an electrical sensitivity control.

When the L.D.R. of Fig. 4 is in the dark condition the base of the transistor is nearly at the same potential as the positive supply line. The transistor passes little current and the relay is de-energised.

Light falling on the L.D.R. causes its resistance to fall and the base of the transistor to go negative. In consequence, the transistor passes an increased current and the relay energises. Sensitivity is controlled by the 5kΩ variable resistor R<sub>2</sub>, maximum sensitivity occurring when



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Fig. 5 Operating the circuit of Fig.2 from a 200 volt h.t. supply



its slider is at the top end of the track. The 1.2k $\Omega$  resistor R<sub>3</sub> maintains a low base-emitter resistance, and the diode across the relay coil prevents the appearance of high reverse voltages if the relay energising current is suddenly reduced.

The relay employed is a Post Office type 3,000 unit having a 500 $\Omega$  coil and one, or two, contact sets.<sup>4</sup> No more than two contact sets should be used as this increases energising current. Also, a relay having a coil resistance lower than 500 $\Omega$  must not be employed. Care should be taken to ensure that the diode is connected across the coil with correct polarity. Also, the supply voltage should be reasonably

<sup>4</sup> A suitable relay, fitted with two sets of change-over contacts is available from H. L. Smith & Co. Ltd, 287 Edgware Road, London, W.2.

well regulated, a desirable figure being better than  $\pm 2$  volts on 12 volts. The transistor should preferably be mounted on a heat sink.

The L.D.R. suffers maximum dissipation when the slider of R<sub>2</sub> is at the top of the track and its own value is 1k $\Omega$ . Under these circumstances, and assuming zero resistance in the base-emitter junction of the transistor, the L.D.R. has a potential of 6 volts across it. Dissipation, therefore, is 36mW.

The arrangement of Fig. 4 is intended for applications when the L.D.R. is normally in the illuminated condition, the circuit operating when the source of light is interrupted. To avoid high base currents the sensitivity control should not be advanced excessively beyond the point where the transistor bottoms with normal light applied.

### Operating from Higher Potentials

It may be desired to operate the circuit of Fig. 2 from higher potentials than those mentioned up to now. This can be done quite readily by using a fixed potentiometer as shown in Fig. 5.

In Fig. 5 a potential of 200 volts is applied to the fixed potentiometer given by R<sub>1</sub> and R<sub>2</sub>, the L.D.R. and 5k $\Omega$  relay connecting across R<sub>2</sub>. When the L.D.R. is in the dark condition the voltage across R<sub>2</sub> is approximately 26.5 and the current drawn from the 200 volt supply is 8mA. When the L.D.R. is fully illuminated the voltage falls to nearly 20 and the current rises to 10mA. The circuit of Fig. 5 is especially applicable to television receivers, whose h.t. potentials are normally of the order of 200 volts.

## CAN ANYONE HELP?

*Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time*

**Bendix MN26C Receiver.**—R. K. Lloyd, P.O. Box 1164, Lusaka, North Rhodesia, Central Africa, wishes to include a b.f.o. and requires information on the additional wiring, etc., to the diagram on page 375 of the December 1961 issue. Also wanted is information on the diameter and material used for the coil formers called for on page 450, Tables 1 and 2, of the January 1962 issue (R. Astronomy).

\* \* \*

**"Mayfair" Televisor.**—H. J. Johnson, 48 Sudbury Heights Avenue, Greenford, Middlesex, requires lining up details for this televisor.

\* \* \*

**R18 Transmitter and Filter Unit DES8 Video.**—K. R. Craske, 52 Grafton Street, Lincoln, Lincs., wants the operational details and circuitry of these units. All letters answered.

\* \* \*

**Murphy V176C TV and Modulator Unit Type 76.**—P. Birchell, 61 Banbury Road, Stratford-on-Avon, would like to receive the service sheets or circuits of these equipments.

\* \* \*

**R1155 Receiver.**—M. A. Wood, 86 Bradfield Road, Stretford, Manchester, wishes to obtain a copy of the service manual for this receiver. Purchase preferred.

\* \* \*

**R1466 Receiver.**—W. H. Farrance, 18/19 Fish Street Hill, London, E.C.3, wishes to purchase or borrow manual or circuit for this receiver and would also like to hear from any reader who has carried out any conversions on the R1466.

**Control Unit Type 35, No. 7.**—G. Knott, 30 Thorncliffe Avenue, Dukinfield, Cheshire, has recently acquired this surplus equipment which is designed to work from a 12 volt supply and is presumably a process or photographic timer. The unit bears the legend Ref. No. 14A/2205. Can any reader furnish details regarding the function, together with connection details, circuit, etc.

\* \* \*

**Cosser Melody Maker Model 501AG.**—P. Winnett, 64 Terrace Road, Upton Manor, London, E.13, wishes to obtain the circuit diagram of this receiver. Also required are details for converting the Bush BBC type TV24 into BBC/ITV operation.

\* \* \*

**"True-View" 9in Portable TV.**—P. L. Grieveson, 46 Clarence Crescent, Sidcup, Kent, is very anxious to obtain the circuit or service sheet of the TV receiver manufactured by Jack Buchanan Enterprises Ltd, or even a working set.

\* \* \*

**Japanese Transistors.**—D. M. Harrington, 46 Broomfield Avenue, Palmers Green, London, N.13, has recently obtained some of these transistors coded "Hitachi 2SB78-1D" and "Hitachi 2SB76-1E" and would like to receive any details available, also ratings, base connections and British or American equivalents. Also to hand are three transformers designed to match these transistors. One is blue and has five lead-out wires, the second is green and has also five wires whilst the third is red and has four lead-out wires. Any details pertaining to these transformers would be gratefully received.

# Transistor Calibration Oscillator

By G. C. DOBBS

IT IS HELPFUL TO THE SHORT-WAVE LISTENER AND essential to the licensed amateur that an accurate check of receiver frequency can be made. The small, self-contained unit described here provides useful calibration markers for this purpose, and it can be operated externally or built into the receiver. The prototype was, in fact, built into one corner of the author's R107 with just the switch spindle protruding.

The circuit, shown in Fig. 1, is a form of Colpitts oscillator, the capacitive feedback tap being at the junction of the crystal and the capacitor  $C_1$ . The collector is not tuned, an r.f. choke providing the load. The rest of the circuit consists of two resistors only, these providing the necessary d.c. bias. The transistor used was an OC171 which provided harmonics into the 10 metre amateur band, although an OC170 or OC169 could also be employed. Coupling into the receiver was simple. The output was taken via a Philips concentric trimmer to the r.f. stage where the wire was simply wrapped around a cathode lead, the trimmer being adjusted for best injection. When used externally, the unit may be coupled via a suitable capacitor to the aerial input.

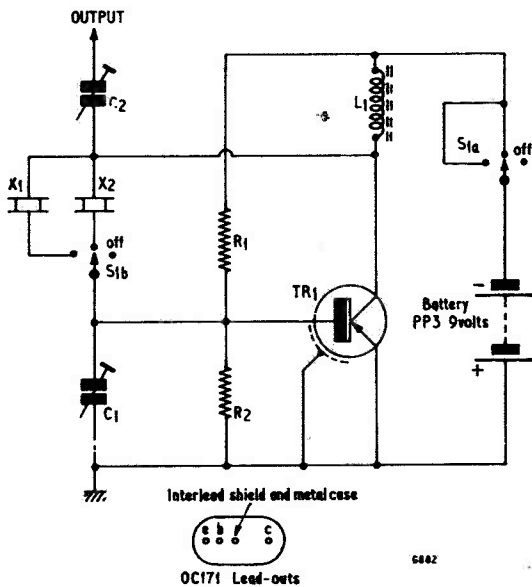


Fig. 1. Circuit diagram of the transistor calibration oscillator

The construction was straightforward, all the components including the 9 volt battery being mounted on a 3in square piece of  $\frac{1}{8}$ in Paxolin. The layout is shown in Fig. 2. The r.f. choke was held by two Terry clips, and the battery was retained by an aluminium bracket. Other components were mounted by pushing each wire to be connected through a  $\frac{1}{8}$ in hole, cutting off the excess and soldering, a blob of solder being left to retain the components. A two-pole three-way switch was employed so that two crystals could be used, together with an "off" position on the same switch.

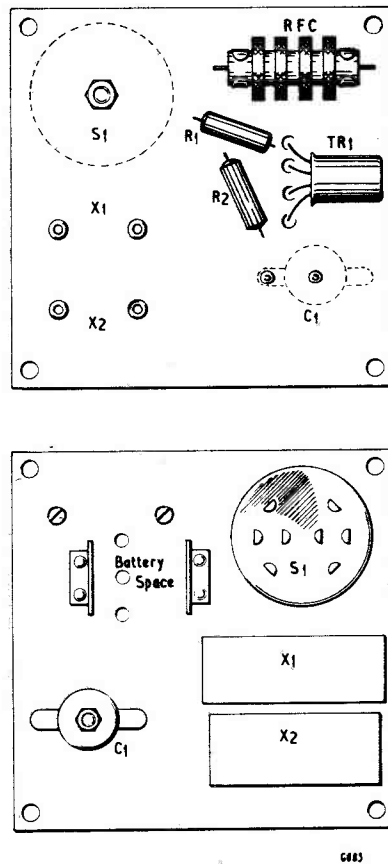


Fig. 2. Showing the component layout on either side of the Paxolin board

The oscillator was bolted to the receiver front-plate through two  $\frac{3}{4}$ in stand-offs, the switch spindle protruding through a  $\frac{1}{4}$ in hole.

The choice of crystals is left to the constructor. These would usually consist of a low and high frequency standard to provide both narrow and wide marking points. The prototype used 500 kc/s and 3.5 Mc/s crystals, the latter marking the low frequency end of five amateur bands. A 1 Mc/s crystal could be used, and a 100 kc/s crystal could also be tried. 100 kc/s crystals are well known for

their "sluggishness" even in valve circuits, but the one tried worked satisfactorily in the prototype. This may not, of course, hold true for the more "sluggish" crystals.

C<sub>1</sub> does not tune the oscillator but controls the amplitude. It is set for minimum collector current dip, or maximum output, with the low frequency crystal. This unit has given a great deal of useful service, the accuracy being sufficient for amateur use.

### Components List

#### Resistors

R<sub>1</sub> 820k $\Omega$   
R<sub>2</sub> 100k $\Omega$

#### Switch

2-pole, 3-way yaxley type

#### Transistor

OC171 Mullard (see text)

#### Crystals

X<sub>1</sub>, X<sub>2</sub> see text

#### Capacitors

C<sub>1</sub> 3—30pF Philips concentric trimmer  
C<sub>2</sub> 3—30pF Philips concentric trimmer

#### Inductor

L<sub>1</sub> R.F. Choke

#### Miscellaneous

Two "000" Terry clips, two crystal holders, 3in by 3in by  $\frac{1}{4}$ in Paxolin, aluminium bracket, etc.



The illustration shows the X-ray spectrometer in Britain's UK-1 satellite before encapsulation. Four circular modules  $5\frac{1}{2}$ in in diameter form a cylindrical pack 3in deep, and hold the circuitry needed to monitor incident X-rays. Pulses from a proportional gas counter vary in height according to the X-ray energy level, and these are amplified by 72 dB in a low-noise stable gain amplifier. The pulses appear at intervals of  $1\mu$ s or more, and are sorted into five energy bands between 2 and 13 Angstroms by a pulse height discriminator. The five bands are interrogated in sequence at intervals of 1 second, pulses from each interrogation being accumulated in a 15-stage binary counter, whence they are transmitted direct to Earth or stored on magnetic tape if the satellite is out of touch with ground stations.

The modules are based on printed circuits using Formica glass-epoxy copper-clad laminate type C.G.E.33. This is manufactured from sheets of continuous filament glass fabric impregnated with epoxide resin and bonded under controlled heat and pressure.

## X-RAY SPECTROMETER



# Transistor Power Supply Stabiliser

By **NORMAN W. BRIDGE**

B.Sc., A.M.Inst.E., Grad.Inst.P.

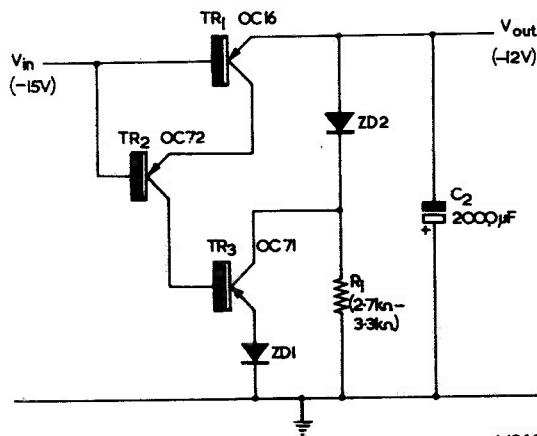
**A** STABILISED POWER SUPPLY USING ONLY SEVEN components for the stabiliser may be made using the accompanying circuit. The component values are not critical and the circuit operates in the following manner.

The supply voltage  $V_{in}$  is dropped to the required output voltage  $V_{out}$  by means of the series transistor  $TR_1$ . An OC16 is shown in the circuit, but any similar large power transistor will do, depending on the output current required. This transistor is driven by an OC72, working as an emitter follower, which uses the input impedance of the OC16 as its emitter load.

The OC72 is, in turn, driven by an OC71 used as a difference amplifier. The reference voltage for this is supplied by  $ZD_1$ , and by using a second zener diode  $ZD_2$  instead of a resistor, any change in output voltage appears entirely between base and emitter of the OC71. Hence maximum control is obtained, and the output voltage given is very nearly the sum of the two zener diode voltages. Therefore, a desired voltage is easily obtained by selecting two suitable zener voltages.

The current through  $ZD_1$  will be practically the same as the OC71 collector current and OC72 base current, but that through  $ZD_2$  must be made about the same value by means of the resistor  $R_1$ . Final smoothing is obtained by  $C_1$ .

In a prototype stabiliser, the change in output voltage was about 50mV for a change in load current from 0 to 1A but the actual value will depend on the current gains of the available transistors, and the type of zener diode used. For an



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output of 1A, and an  $\alpha'$  of 20 for the OC16, its base current, and thus the OC72 collector current, will be about 50mA. If the OC72  $\alpha'$  is 25, its base current, and the OC71 collector current, will be about 2mA; and roughly this current is also passed through  $ZD_2$ , using  $R_1 = 2.7$  to  $3.3k\Omega$  if the zener voltages are both about 6.

If it is necessary to vary the output voltage over a small range, the OC71 base can be taken to the slider of a  $1k\Omega$  potentiometer connected between  $ZD_2$  and  $R_1$ .

The circuit is readily adaptable for a very wide range of load currents and voltages, and is sufficiently stable for most amateurs' purposes.

## BOOK REVIEW . . .

**NEW RTTY HANDBOOK**, First Edition. By Byron H. Kretzman, W2JTP. 192 pages, 6in by 9in. Published by Cowan Publishing Corporation. Price 32s.

This is one of the very few books dealing exclusively with amateur radio teleprinting and, needless to say, it covers the subject very thoroughly indeed. The section on Machines deals of course with models current in the U.S.A. but, in spite of the fact that these are unlikely to be met with in this country, the description of them makes very interesting reading for the RTTY enthusiast.

The section dealing with Receiving Equipment is applicable in this country and many ideas will be gleaned by the reader for improving the receiving side of his RTTY station. The now popular "Twin City" terminal unit is fully described, with chassis layout drawings, as well as the earlier but equally popular W2JAV terminal unit.

Both FSK and AFSK equipment is well covered in the Transmitting Equipment chapter and the RTTY enthusiast will find an interesting selection of tuning indicators, filters, automatic frequency control units, transistorised tuning fork standards and so on in the Accessory Equipment section.

There are chapters on Setting up a Station, RTTY Operation, and so on, all of which contain much useful advice. The RTTY enthusiast will find in this book much information which he cannot readily obtain elsewhere and it is certainly a reference book which should be on his bookshelf.

# B.B.C. TUNING SIGNALS

THE AUDIO SIGNALS PROVIDED BY THE B.B.C. immediately before a transmitter commences to operate are very useful for adjusting audio signal generator frequencies, etc.

The audio tone is normally passed to the transmitter by land line and is derived from an extremely stable crystal controlled r.f. oscillator by frequency division. The stability is better than one part in a million.

A frequency of 1,000 c/s is used on the Home Service and Television sound carrier frequencies, whilst a frequency of 440 c/s is used for the Light Programme and for Network Three (including the Third Programme) frequencies.

Occasionally these accurate audio tones are not conveniently available from the usual source

and a locally derived audio tone is then used. This tone will not, of course, have such an accurately controlled frequency stability and, in order to make this known to the listener, the frequency used is different from those mentioned above. A frequency of 800 c/s is most usually used for a locally derived tuning signal.

When a tuning signal is being transmitted from an a.m. station the depth of modulation of the signal is normally 30%. The B.B.C. f.m. transmitters have a frequency deviation of 19 kc/s whilst either the 1,000 c/s or the 440 c/s tuning signals are being transmitted. (The maximum frequency deviation of B.B.C. v.h.f. transmitters is 75 kc/s.)

## New Burndept Rescue Beacon

Burndept Limited, of Erith, Kent, pioneers in semi-conductor development, have designed a fully-transistorised v.h.f./u.h.f. recovery beacon that is claimed to meet all current N.A.T.O. and foreign air force requirements for personal wear or dinghy stowage. It is also suitable for civil aviation and marine applications.

Service rescue requirements derive from the extreme environmental conditions of supersonic flight, including increased "G" effect and the shock and vibration encountered in ejection parachute drop.

There is also the paradoxical recovery situation in which improvements in flying clothing are increasing the predictable period of survival in rigorous temperature conditions while higher flying speeds are increasing the necessity for positive and continuous directional information.

The new beacon is known as the Search and Recovery Beacon Equipment B.E. 301—S.A.R.B.E. for short.

In keeping with a trend towards smaller and lighter beacons of increased endurance and mechanical strength, it weighs only 2lb 2oz complete with a mercuric oxide battery giving 48 hours endurance at 4° C.

In addition to recording homing ranges of up to 90 miles during trials with an aircraft flying at 10,000 feet, it has successfully undergone such environmental tests as a simulated descent from 70,000 feet in five minutes.

The S.A.R.B.E. B.E. 301 consists of two units connected by a 36in rubber cable and waterproof plug. The first (5½ x 2½ x 1in) comprises the transmitter, tone modulator and self-erecting steel tape aerial. And the second, the standard volume (12.75 cu. in) battery.

Yet although it is lighter and smaller than all valved or "hybrid" (semi-transistorised) beacons previously designed by Burndept, increased endurance for given battery sizes has been achieved without any reduction in the peak radiated power of 400mW which the company consider necessary to meet minimum range requirements under all conditions.

This is due to low supply voltage resulting from the use of transistors throughout.

The S.A.R.B.E. B.E. 301 will normally be supplied as a single-frequency "beacon-only" equipment which radiates a modulated burst carrier of 0.65 seconds duration every three or four seconds without residual power.

Continuous carrier versions are also available and both types can be provided with two-way speech facilities if required.

Operating procedure conforms with N.A.T.O.'s insistence on minimal delay in switching to stand-by or full operation with gloved or numbed hands. The beacon is automatically switched on when the survivor releases the self-erecting aerial by pulling a cord attached to the aerial cover, and continues to transmit without further adjustment for the duration of its battery. It can however be switched off by replacement of the aerial cover without the aerial itself having to be re-stowed.

When the two-way speech is provided, controls are limited to two levers marked transmit and receive. To transmit, the survivor depresses the appropriate lever and speaks into a microphone-loudspeaker unit. To receive all signals within range on the correct frequency, he depresses the other. The set automatically reverts to beacon operation when both levers are disengaged.

The Burndept-designed battery cell has characteristics which have assisted the development of a heavy current pulse technique resulting in good endurance.

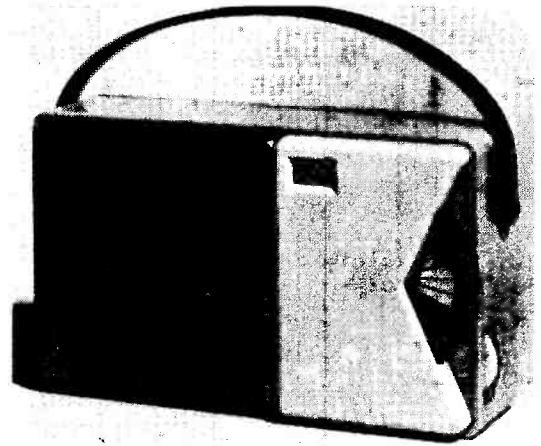
The S.A.R.B.E. B.E. 301 is also supplied with water-activated batteries which quickly develop their full power after immersion.



# The "Revalo-4"

## Pocket Transistor Portable Receiver

Described by P. VERNON



THE "REVALO-4" IS ONE OF A NUMBER OF POCKET transistor portable receivers which have been specifically designed for construction by the beginner and advanced constructor alike. For the latter, of course, such a task is simplicity itself and, for the former, it is straightforward provided the following instructions are carried out in the order to be described. Additionally, construction is made easier for the beginner in that the whole assembly (less the speaker) is mounted—and is therefore capable of being put together and soldered outside the case—on a pre-eyeleted Paxolin board.

When completed the receiver is contained within an attractive two-tone plastic contemporary case having a "gold" speaker grill and an attractive dial. The case is some  $5\frac{1}{2}$  x  $3\frac{1}{2}$  x  $1\frac{1}{4}$  in. and is fitted with a black plastic carrying handle.

The "Revalo-4" is completely self-contained, being fitted with a ferrite rod aerial and a 9V battery power supply. Provision is made for attachment to a car aerial, and an earpiece socket for personal listening is also included in the design. Inserting the earpiece into circuit automatically mutes the 3in. high-flux permanent magnet loudspeaker.

### Circuit

The circuit is shown in Fig. 1 from which it will be seen that four transistors are used in a five stage reflex design. Transistor TR<sub>1</sub> (Mullard OC44) functions primarily as an r.f. amplifier, the resultant r.f. signal being fed, via C<sub>2</sub>, to the diode detector. The rectified signal is then fed back to the ferrite secondary winding and, from there, to the base of TR<sub>1</sub>. The detected audio signal applied to the base of TR<sub>1</sub> is next amplified by the transistor and fed, via the choke L<sub>1</sub> and C<sub>4</sub>, to the slider (centre-tap) of the 5kΩ variable resistor with which is combined the on/off switch. The a.f. signal on the upper end of this potentiometer is then fed into the base of

TR<sub>2</sub>. Regeneration is obtained by feedback from L<sub>1</sub> to the secondary of the ferrite coil. (See under Completing the Assembly.) The amplified a.f. signal appearing across the primary winding of T<sub>1</sub> is then fed, via the secondary winding of this transformer, to the bases of TR<sub>3</sub> and TR<sub>4</sub>; the resultant output being taken from the collectors of these transistors to the output transformer T<sub>2</sub> and thence to the speaker and jack socket. The push-pull output available from TR<sub>3</sub> and TR<sub>4</sub> is some 250mW. The receiver is powered by a Vidormax T.6004 9 volt battery across which is connected C<sub>7</sub>, a 500μF 12 w.v. electrolytic capacitor.

The receiver is tuned over the medium-wave band only by C<sub>1</sub> and connection to a car or external aerial is made via the 5pF capacitor C<sub>8</sub>.

### Preparing the Chassis

In order to avoid excessive heat being conducted to the diode and transistors whilst soldering, it is advisable to apply a small amount of solder to certain numbered tags (see under following paragraph) so that they are thoroughly tinned. Component leads, having been cut to length, should similarly be dealt with, the solder being applied with a fully heated iron.

### Below-Chassis Wiring

In conjunction with the following instructions, see Fig. 2. All tags except 2, 3, 18 and 19 should be prepared as instructed, ensuring that the solder flows evenly and smoothly. Solder into position the diode noting that the red end is connected to tag 17. A pair of pliers should be used as a heat shunt when soldering the diode into position.

The volume control is now fitted to the board. (See Fig. 2.) It will be found that tags B and E of the control will fit into tag apertures 20 and 22 and tag A will slightly overlap the edge of the board.

## Components List

### Resistors

|                 |                               |        |
|-----------------|-------------------------------|--------|
| R <sub>1</sub>  | 1kΩ                           | ¼ watt |
| R <sub>2</sub>  | 4.7kΩ                         | ¼ watt |
| R <sub>3</sub>  | 100kΩ                         | ¼ watt |
| R <sub>4</sub>  | 220kΩ                         | ¼ watt |
| R <sub>5</sub>  | 12kΩ                          | ¼ watt |
| R <sub>6</sub>  | 10kΩ                          | ¼ watt |
| R <sub>7</sub>  | 10kΩ                          | ¼ watt |
| R <sub>8</sub>  | 220Ω                          | ¼ watt |
| R <sub>9</sub>  | 10Ω                           | ¼ watt |
| VR <sub>1</sub> | 5kΩ potentiometer with switch |        |

### Capacitors

|                |                             |
|----------------|-----------------------------|
| C <sub>1</sub> | 200pF variable              |
| C <sub>2</sub> | 47pF ceramic                |
| C <sub>3</sub> | 25μF, electrolytic, 12 w.v. |
| C <sub>4</sub> | 0.1μF paper                 |
| C <sub>5</sub> | 0.1μF paper                 |
| C <sub>6</sub> | 0.002μF paper               |
| C <sub>7</sub> | 500μF electrolytic, 12 w.v. |
| C <sub>8</sub> | 5pF ceramic                 |

### Inductors

Ferrite aerial (R.C.S. Products Ltd.)  
L<sub>1</sub>, L<sub>2</sub> (R.C.S. Products Ltd.)

### Transformers

T<sub>1</sub> Driver type LT44 (R.C.S. Products Ltd.)  
T<sub>2</sub> Output type LT700 (R.C.S. Products Ltd.)

### Transistors

TR<sub>1</sub> Mullard OC44  
TR<sub>2</sub> Mullard OC81D  
TR<sub>3</sub>, TR<sub>4</sub> Mullard OC81 (matched pair)

### Germanium Diode

OA70 or equivalent

Tags B and E of the volume control should now be soldered to apertures 20 and 22. Ensure that tag D of the volume control does not foul tag 16 on the board.

R<sub>9</sub> (10Ω) is now soldered into position between tags 7 and 13, see Fig. 2.

The remainder of the under-chassis wiring, as shown in Fig. 2, should be left until the above-chassis work has been completed.

### Above-Chassis Wiring

One end of a short length of 22 s.w.g. bare tinned wire is now soldered to tag 20 as shown in Fig. 3, the other end of this wire being fixed to tag 21. This wire will be referred to as the positive bar.

Next, solder into position between tags 20 and 6, R<sub>1</sub> (1kΩ) and ensure that a length of systoflex is placed over the long connecting wire of this resistor, having first soldered the black end of C<sub>3</sub> (25μF) to one end of R<sub>1</sub> (tag 6) whilst the red (positive) end is connected to the positive bar. (See Fig. 3.)

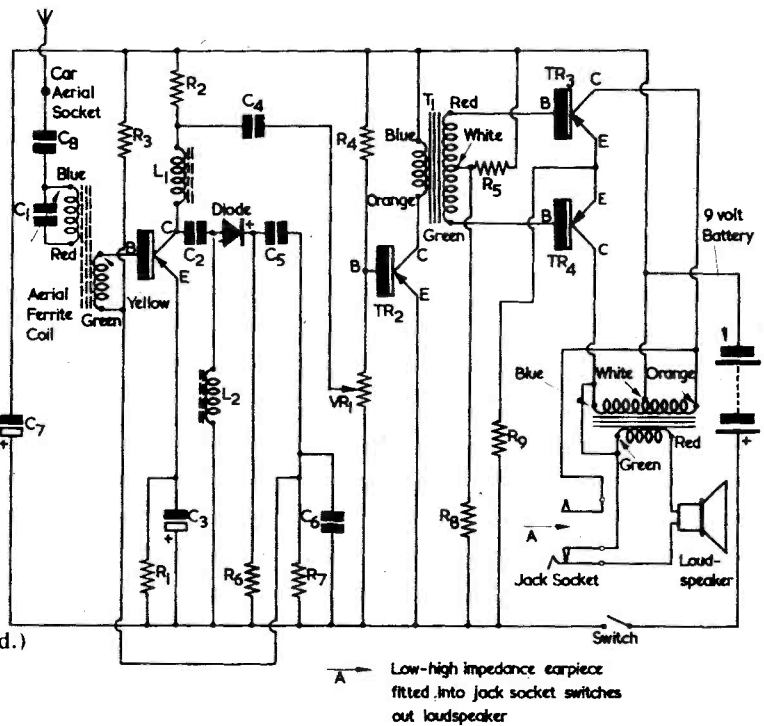


Fig. 1. Circuit of the "Revilo-4" pocket transistor portable receiver

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### Battery

9V type T6004 (Vidormax)

### Miscellaneous

Speaker, output and car aerial sockets, pre-tagged board, dial case, etc. (R.C.S. Products Ltd.)

The choke L<sub>2</sub> should now be soldered into position, one end to tag 16 and the other to the positive bar.

Dealing now with C<sub>2</sub>, one end is connected to tag 16, the other end being soldered to tag 1, sufficient length being left to carry on to tag 2.

Secure C<sub>1</sub> (200pF) to the board ensuring that it does not foul the choke L<sub>2</sub>.

Solder R<sub>6</sub> (10kΩ) between tag 17 and the positive bar, taking care not to cover the adjacent hole in the board. (See Fig. 3.)

Secure into position R<sub>2</sub> (4.7kΩ) between tag 3 and tag 4.

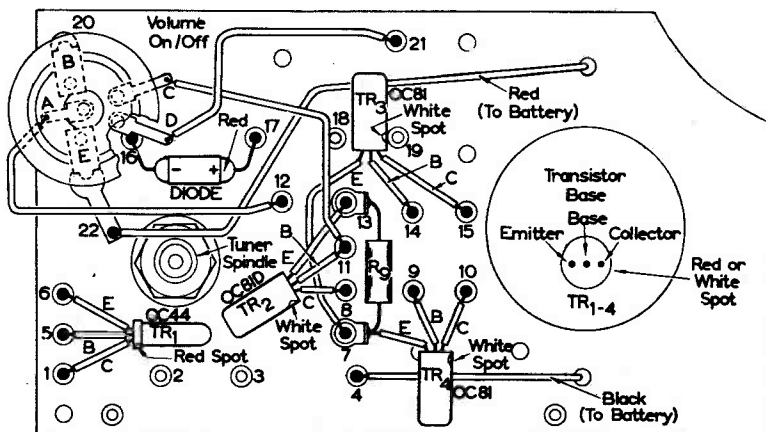
One end of C<sub>4</sub> (0.1μF) is next soldered to tag 3 and the other end to tag 12.

R<sub>3</sub> (100kΩ) is now soldered between tag 4 and tag 18.

Connect between tag 18 and the positive bar R<sub>7</sub> (10kΩ). Ensure that this component does not cover the adjacent hole in the board. (See Fig. 3.)

Connect C<sub>6</sub> (0.002μF) between tag 18 and the

fig. 2. Below-chassis wiring. Note that the numbered tags shown here soldered should be pre-tinned before connecting the components



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positive bar. A space should be left between  $C_6$  and  $R_7$  to enable a short length of p.v.c covered wire to be next connected from tag 13 to the positive bar. Ensure that this latter wire is clear of tag 18.

$C_5$  ( $0.1\mu\text{F}$ ) is next connected between tags 17 and 18.

Connect  $R_4$  ( $220\text{k}\Omega$ ) between tags 11 and 4.

Connect  $R_8$  ( $220\Omega$ ) between tag 19 and the positive bar.

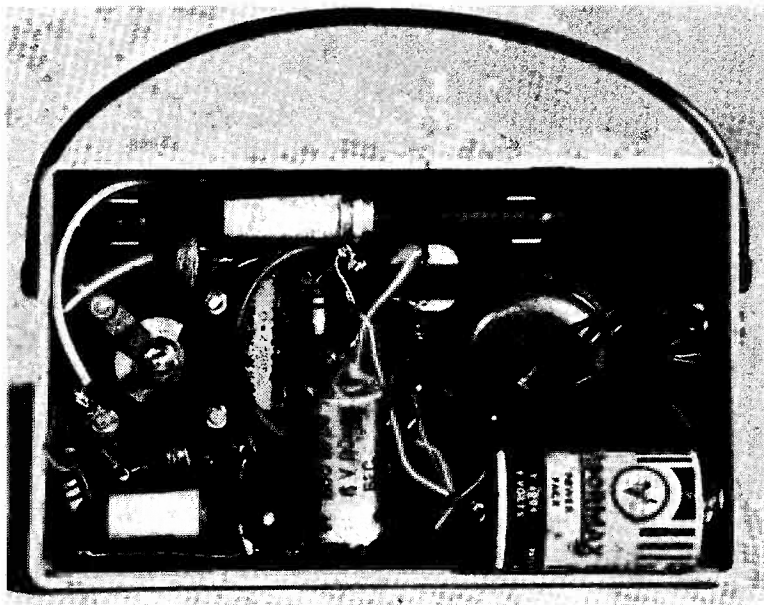
Connect  $R_5$  ( $12\text{k}\Omega$ ) between tag 19 and tag 4.

The red (positive) end of  $C_7$  ( $500\mu\text{F}$ ) is now soldered to the positive bar and its other end to tag 4.

One end of  $C_8$  ( $5\text{pF}$ ) is next connected to the fixed vane solder tag (see Fig. 3) of  $C_1$ , the other end being left free for the time being.

The choke  $L_1$  is next soldered into position. The final position of  $L_1$  is important if best results are to be obtained and consequently the connecting wires of this component should be left fairly long in order that the maximum adjustment is later possible. (See under Completing the Assembly.)

The ferrite aerial coil can now be soldered into circuit. Place the coil into position on the rod and clip the rod into place. See Fig. 3 for correct orientation of the coil. The yellow lead is soldered to tag 5, the green lead to tag 18, the blue lead to the fixed vane tag of  $C_1$ , and the red lead to the copper (moving vane) tag of  $C_1$ . The coil should be so positioned that it is free to move along the rod in order to obtain the maximum response when testing the receiver. Once this position has been found, it



Rear view of the completed receiver



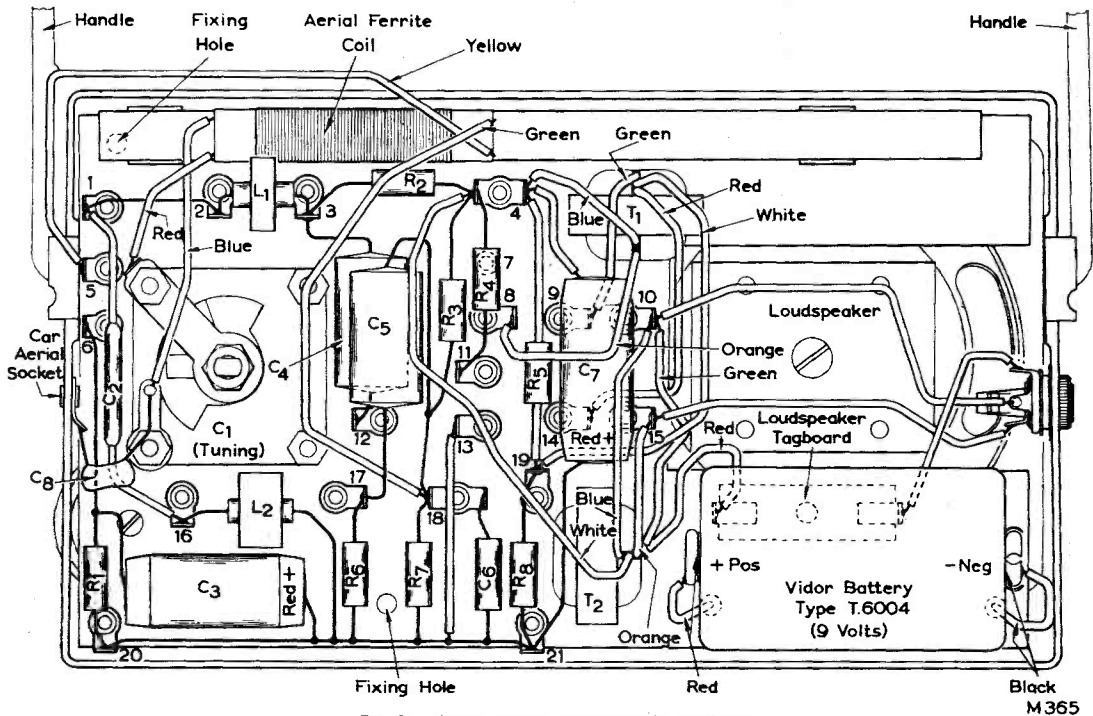


Fig. 3. Above-chassis wiring of the receiver

will be secured with a small amount of Evostick or similar adhesive.

The driver transformer  $T_1$  and the output transformer  $T_2$  are next to be fitted to the board. Note carefully the orientation of these from Fig. 3. The transformers should be affixed with a small amount of Evostick or similar adhesive. ( $T_1$  laminations are covered with a red p.v.c. material.)

Dealing with  $T_1$  first, the coloured leads should be connected into circuit as follows. Blue wire to tag 4, orange wire to tag 8, white wire to tag 19, red wire to tag 14, and green wire to tag 9. All leads should, of course, be cut suitably to length before soldering into the final position.

Concerning  $T_2$ , connect the orange wire to tag 15, the white wire to tag 4, the blue and green wires to tag 10, and the red wire to one tag of the speaker.

Next, proceed with the speaker and phone socket wiring. The remaining speaker tag should be wired to the central tag of the phone socket as shown in Fig. 3. The upper tag of the phone socket should next be soldered, by means of a small length of insulated wire, to tag 15. The remaining tag of the phone socket is then connected to tag 10.

#### Wiring of Transistors

Having completed all of the foregoing tasks, carefully turn over the whole of the assembly so that the under-chassis is visible, as shown in Fig. 2.

Transistors are easily damaged by the application of excessive heat and for this reason it is essential that the following precautions are observed. When

soldering the transistor leads, use a pair of pliers as a heat shunt, holding each lead as near to the free end as possible whilst the soldering process is carried out. Clean the ends of these leads before soldering in order that the joints can be made as quickly as possible whilst effecting an efficient soldered joint. On no account should the heating process be prolonged.

Before soldering the transistors into circuit, the following tag eyelet holes should be tinned and filled with solder: 1, 5, 6, for  $TR_1$ ; 8, 11, 13, for  $TR_2$ ; 7, 14, 15, for  $TR_3$ ; 9, 10, for  $TR_4$ .

Dealing with  $TR_1$ , suitably cut the wires to length and cover with small lengths of systoflex or p.v.c. sleeving and connect the wire nearest the white spot (collector) to tag 1, the centre wire (base) to tag 5 and the remaining wire (emitter) to tag 6.

Wiring into circuit  $TR_2$ , connect the wire nearest the white spot (collector) to tag 8, the centre wire (base) to tag 11 and the remaining wire (emitter) to tag 13, having of course cut the wires to length and insulated them by fitting p.v.c. sleeving or systoflex.

Obtain  $TR_3$ , cut wires to length and fit sleeving, then proceed as follows: wire nearest the arrow or spot (collector) to tag 15; centre wire (base) to tag 14 and remaining wire (emitter) to tag 7.

Lastly, connect  $TR_4$  (having cut wires to length and fitted sleeving) with the wire nearest the arrow or white spot to tag 10, the centre wire to tag 9 and the remaining wire to tag 7.

### Remaining Connections

Using a piece of insulated flex about 6in long, join one end to tag 4. The other end of this wire connects to the battery negative terminal when fitted into the case.

A red wire from tag 22 near the volume control may next be soldered to the positive connector of the battery. Wiring up is now complete.

### Completing the Assembly

Having soldered the battery into circuit, the receiver should be switched on by rotating the volume control, a hissing noise indicating that the circuit is working correctly. Rotate the tuning capacitor  $C_1$  until a station is heard, remembering

that the assembly may require some lateral movement for best results owing to the directional properties of the ferrite rod aerial assembly. Using an insulated screwdriver handle, or better still a plastic knitting needle, push the aerial coil along the ferrite rod until best results are obtained with the required frequency coverage. At the same time alter the position of the choke  $L_1$ , as near to the coil as possible, until optimum results are given. Fix the aerial coil in position on the rod with adhesive.

By means of the bolts, spacers and nuts provided, carefully fit the whole assembly into the case and the tuning scale over the spindle of  $C_1$ . Connect the free end of  $C_8$  to the car aerial socket. The Revilo-4 is now ready for use.

# A FOLDING BENCH

Designed by A. LEE

IT FREQUENTLY HAPPENS THAT THE HOME-contructor or experimenter requires a comprehensive work-bench with built-in test gear and similar equipment, but that sufficient space is not available for this to be installed on a permanent basis. The same problem may be encountered by the amateur transmitter or short-wave listener who requires a comfortable operating table which is completely fitted out with receiver, transmitter, and ancillary gear. This article describes a bench, or table, which offers extensive facilities, but which may nevertheless be very conveniently folded up and disassembled into its constituent parts whenever the need arises. The bench may, similarly, be very quickly assembled when it is required for use. The design is versatile, and allows for partial folding, as well as complete disassembly.

### The Complete Bench

In Fig. 1 the bench is shown completely assembled and ready for use. The diagram illustrates the base section together with cabinets B, C and D, the latter being mounted and opened out into their final positions.

The base section is shown on its own in Fig. 2, which illustrates the legs folded up. In this position the legs are secured in place by a small catch, whereupon the base section can now stand on the four castors indicated as F, these enabling it to be easily pushed around. The legs are shown in the upright position in Fig. 1, and are held firmly in position by bolts and wing-nuts. The lengths of the legs, when in the upright position, raise the base section sufficiently high to allow comfortable leg-room underneath.

Fig. 2 also shows drawer A, this being intended to take tools, manuals, log-books, or any other material associated with the purpose of the bench. There are also two holes indicated by letter E. These are drilled to take  $\frac{1}{4}$ in bolts.

### The Cabinets

The centre, and left and right hand cabinets appear in Fig. 3. The centre cabinet, B, fits on top of the base section as in Fig. 1, and is held in position by two bolts and wing-nuts which pass through holes E in the base section (Fig. 2) and corresponding holes in the centre cabinet. Drawer A has, of course, to be removed whilst the securing bolts are being fitted.

The centre cabinet is fitted with a hardboard panel sunk in by some 2in to allow clearance for and knobs, dials, and switches, etc., which are mounted on it. There is also a drop-down panel which is fixed by two hinges at the bottom. This panel may be lowered as indicated in Fig. 1, and it provides the working surface for the bench. In the down position, the panel overhangs the top surface of the base section, thereby providing a large working area. When it is in the closed, or up, position the panel may be secured by a simple catch or button, whereupon it provides protection for some of the equipment mounted on the hardboard panel behind.



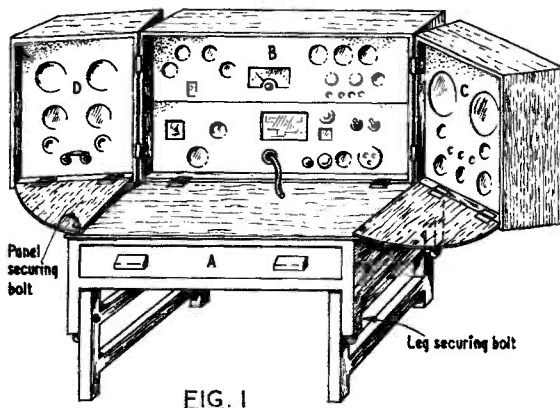


FIG. 1

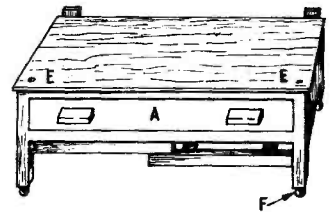


FIG. 2

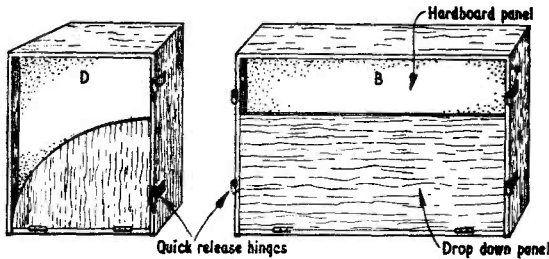


FIG. 3

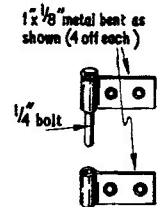


FIG. 4

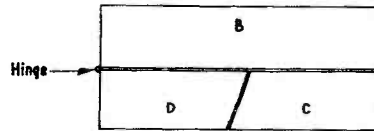


FIG. 5

The left and right hand cabinets, D and C, secure to the centre cabinet by means of quick release hinges. These are shown in detail in Fig. 4. The lower half of each hinge is fitted to the centre cabinet, with the result that the two side cabinets may be readily dropped into position and swung round on the hinges to any desired angle. The hinges can be home-constructed, in which case both halves employ pieces of  $\frac{1}{4}$  in by 1 in strap-iron bent in similar fashion. A  $\frac{1}{4}$  in bolt is fitted to the upper piece of strap-iron and is held in position with a nut, the protruding threaded section engaging with the lower piece of strap-iron. Alternatively, the head of the bolt may be cut off, and the threaded section secured to the upper piece of strap-iron by means of two nuts.

#### Additional Work Surface

Returning to Fig. 3, it will be noted that the side cabinets D and C each have a hardboard panel sunk in by some 2 in in the same manner as has the centre cabinet. Once again, recessing in this manner provides clearance for knobs and switches, etc. The side cabinets also have circular drop-down panels which are hinged in the same manner as is that of the centre cabinet. These circular panels are shown in the open position in Fig. 1, whereupon it will be seen that they not only provide an increased surface but also cause the side cabinets to take up a convenient angle for working. In Fig. 1 the panels are secured by

two securing bolts and wing-nuts which pass through holes in the upper surface of the base section and the drop-down panel of the centre cabinet. (These holes are not illustrated in Figs. 2 and 3.)

If it is not required to completely disassemble the bench, partial folding may be achieved by raising the drop-down panels of the centre and side cabinets, and of then swinging the latter inwards on their hinges as shown in the top view given in Fig. 5. It will be noted that the side cabinets are so dimensioned that they fit snugly against each other and the centre cabinet when folded, and that their adjacent edges are angled. When the cabinets are folded in this manner, the equipment on the hardboard panels is protected against the ingress of dust and dirt.

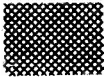
A final point has to do with the raising and lowering of the legs on the base section. It will be found easier to raise and lower the legs if the cabinets are not fitted, this point being especially true if the latter contain heavy equipment. In consequence, the legs should be opened out first during assembly, and closed last during disassembly.



The tenth in a series of articles which, starting from first principles, describes the basic theory and practice of radio

part 10

# understanding radio



By W. G. MORLEY

**I**N LAST MONTH'S ISSUE WE INTRODUCED PRACTICAL fixed capacitors, describing the construction of mica, paper, and plastic film types. We also dealt briefly with ceramic capacitors, pointing out that these components may be classified as high-K or low-K according to the dielectric constant of the ceramic employed. It was stated further that the ceramic dielectric may be formed into a wide variety of shapes to meet particular requirements, and that the ceramics available offer a wide range of temperature coefficients.

We shall now continue with the ceramic capacitor.

## Disc And Tubular Ceramic Capacitors

The two most common ceramic shapes are those of the *disc ceramic capacitor* and the *tubular ceramic capacitor*.

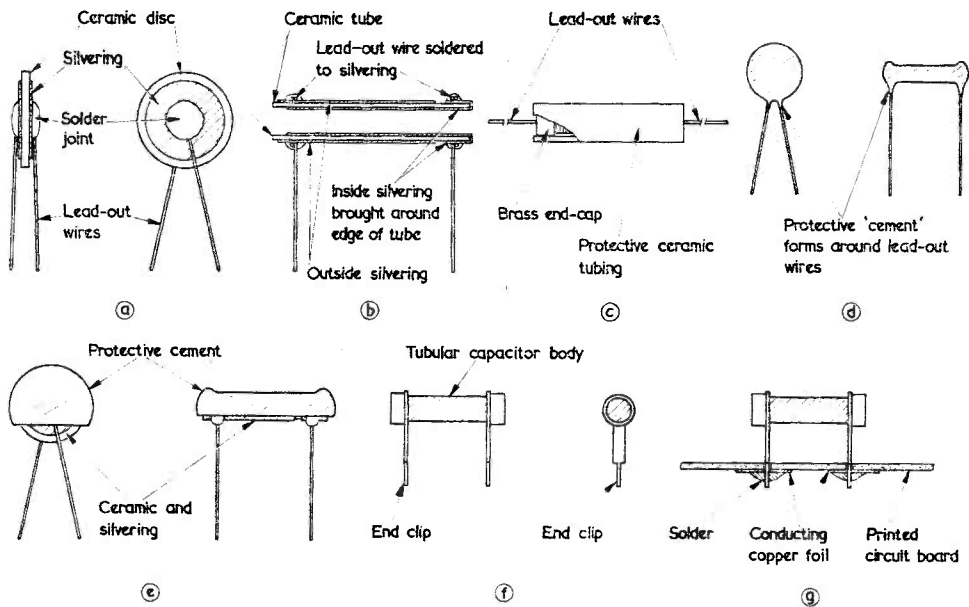
The construction of the disc ceramic capacitor is shown in Fig. 40 (a). The dielectric is a ceramic disc, and the plates consist of two layers of silvering fired on to either side. Lead-out wires are soldered to the silvering and the whole component is then covered by a hard resin or "cement". Since the lead-out wires are anchored only by the solder joint, it is necessary to ensure that there is a high degree of adhesion between the silvering and the ceramic as the former may otherwise be pulled away if the component is handled carelessly. Additional strength is imparted by the resin or "cement" covering; and in some modern disc ceramic capacitors the lead-out wires are so firmly anchored that the wire itself breaks, if subjected to tension, before the silvering fractures.

Tubular ceramic capacitors have the basic construction shown in Fig. 40 (b). In this, one plate consists of a layer of silvering which covers

most of the outside surface. The second plate consists of a layer of silvering on the inside surface, this being continued round one end to the outside. Lead-out wires are wrapped one or more times around the ends of the tube and are soldered to the silvering. The whole component is then covered by a resin or "cement" to provide protection. With the tubular ceramic capacitor there is a mechanical anchorage for the lead-out wires in addition to the solder joint, and these wires are, in consequence, firmly secured to the body of the capacitor.

An alternative construction for the tubular ceramic capacitor employs brass end-caps for connection to the inside and outside silvering. Lead-out wires are fixed to the end-caps and the whole component is sealed in a ceramic tube, as in Fig. 40 (c). This method of assembly was employed to a considerable extent with early tubular ceramic capacitors but has nowadays been largely superseded by the construction shown in Fig. 40 (b).

Both disc and tubular ceramic capacitors are used in assemblies where, because of miniaturised layout or circuit requirements, very short lead-out wire lengths are required between the body of the capacitor and the external points to which it connects. With practical components the length of lead-out wire available may vary from capacitor to capacitor due to variations in the thickness of the protective resin or "cement". The latter tends also to form around the lead-out wire in a manner similar to that shown in Fig. 40 (d). A further requirement is that it is frequently necessary for the leads of disc or tubular ceramic capacitors to be passed through holes in printed circuit boards,



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- Fig. 40 (a). The basic construction of the disc ceramic capacitor  
 (b). Cross-section through a tubular ceramic capacitor  
 (c). An alternative construction for the tubular ceramic capacitor  
 (d). The protective coating tends to form around the legs of ceramic capacitors unless close control is maintained during manufacture  
 (e). The "bare-bottom" technique keeps lead-out wires clean  
 (f). Ceramic capacitors for printed circuits. ("Pluggable" capacitors similar to that shown here are the subject of a Registered Design by Erie Resistor Ltd.)  
 (g). The "pluggable" capacitor soldered to a printed circuit board

whereupon excess resin on the lead-out wires prevents the component from being mounted correctly. If the resin coating on the lead-out wire is sufficiently thin it may pass through the hole in the printed circuit board also, thereby preventing a reliable solder joint to the copper foil. All these difficulties may be overcome by careful control of the application of protective resin or "cement" during the manufacturing process with, perhaps, a lead-out wire cleaning operation later. However, an alternative approach, which has been popular for a number of years, consists of employing the "bare-bottom" method of protection illustrated in Fig. 40 (e). This consists of applying the protective resin or "cement" over part of the capacitor only, the section adjacent to the lead-out wires being completely unprotected. The result is that lead-out wires are completely clean. The fact that the ceramic and silvering are not covered does not reduce the reliability of the capacitor as these are quite capable of withstanding exposure to the atmosphere for normal applications. The "bare-bottom" finish may be employed with both disc and tubular capacitors.

"Pluggable" ceramic capacitors suitable for use in printed circuit boards have been developed by Erie Resistor Ltd., and an example is illustrated

in Fig. 40 (f). As may be seen, this consists of a tubular ceramic capacitor fitted with end-clips having extensions capable of being passed through the holes of a printed circuit board. The extensions may then be soldered as shown in Fig. 40 (g). These capacitors are provided with a protective coating of enamel.

Disc and tubular ceramic capacitors can be made with either low-K or high-K dielectrics. Low-K disc capacitors normally have values ranging from some 3pF to 100pF, high-K types extending the range to around 0.01 $\mu$ F. Typical disc capacitors have diameters ranging from some 0.3 to 0.6 in. according to value. Low-K tubular capacitors have a range of capacitance extending from 0.5pF to around 500pF, high-K types extending this to around 0.02 $\mu$ F. A typical low-K tubular ceramic capacitor having a value of 20pF would have a length around 0.75in and a diameter of 0.3in. A high value tubular capacitor (either low-K or high-K) would, typically, have a length of 1.2in and the same diameter. Working voltages are of the order of 350, 500 or 750.

Low-K ceramic capacitors normally have tolerances on capacitance of  $\pm 20\%$ ,  $\pm 10\%$ ,  $\pm 5\%$ ,  $\pm 2\%$  or  $\pm 1\%$ , although intermediate tolerances may also be encountered. With low value components the tolerance may be expressed in units of

capacitance, e.g.  $\pm 0.5\text{pF}$ . High-K ceramic capacitors are not normally encountered with tolerances of less than  $\pm 10\%$  and those employing dielectrics with very high dielectric constants may have extremely wide tolerances. Typical examples are  $-20\%+80\%$  on nominal value or, even, G.M.V. (Guaranteed Minimum Value) with no indication of positive tolerance. These wide tolerances are not a great advantage, as high-K ceramic capacitors are particularly useful in circuits which only require that minimum capacitance does not fall below a specified figure.

The values and tolerances of ceramic capacitors are frequently printed on them. Alternatively, a colour code may be employed.

#### Other Ceramic Shapes—The Feedthrough Capacitor

A number of alternative dielectric shapes for ceramic capacitors may be encountered, but these all employ the basic construction in which the plates consist of layers of silvering deposited on opposite sides of the ceramic. A fairly common example is shown in Fig. 41 (a), wherein the silvering is deposited on a cup-shaped dielectric.

An interesting development, again due to Erie Resistor Ltd., is illustrated in Fig. 41 (b). In this case the shape is basically tubular, but the outside diameter of the dielectric increases over the top third of the tube. This type of capacitor is connected into circuit by dropping it into a hole in a metal chassis together with a ring of resin-cored solder as in Fig. 41 (c). A centre pin is then dropped into the hole in the ceramic together with another solder ring. The assembly is put into an oven which causes both solder rings to melt, with the result that the outside silvering becomes soldered to the chassis and the centre lead becomes soldered to the inside silvering. See Fig. 41 (d). By taking advantage of this construction it is possible to solder a large quantity of capacitors to a chassis in one automatic operation, and the technique has been extensively employed in television tuner units whose small chassis can be easily raised to the required temperature. As will be seen, the ceramic and silvering of the capacitor are unprotected, as with the lower half of the "bare-bottom" capacitor, although a lacquer capable of withstanding oven temperatures and which does not interfere with the soldering operation may sometimes be applied initially to the units. Also, the outside silvering may sometimes be pre-tinned to facilitate the automatic soldering operation.

The capacitor of Fig. 41 (d) enables a connection to be made both above and below the chassis by way of the centre pin. In consequence, not only does it offer a capacitance to the chassis but it also enables a connection to be taken through the chassis as well. A component of this type is known as a *feedthrough capacitor*. Generally, feedthrough capacitors have the appearance shown in Fig. 41 (e), in which the centre pin is fitted by the capacitor manufacturer as, also, is a metal skirt. The latter may then be soldered to the chassis in normal manner, care being taken to prevent excess heat

which could melt the solder at the junction of the skirt and outside silvering, or the solder joint at the inside silvering. (Many feedthrough capacitors do not, however, have a solder joint between the

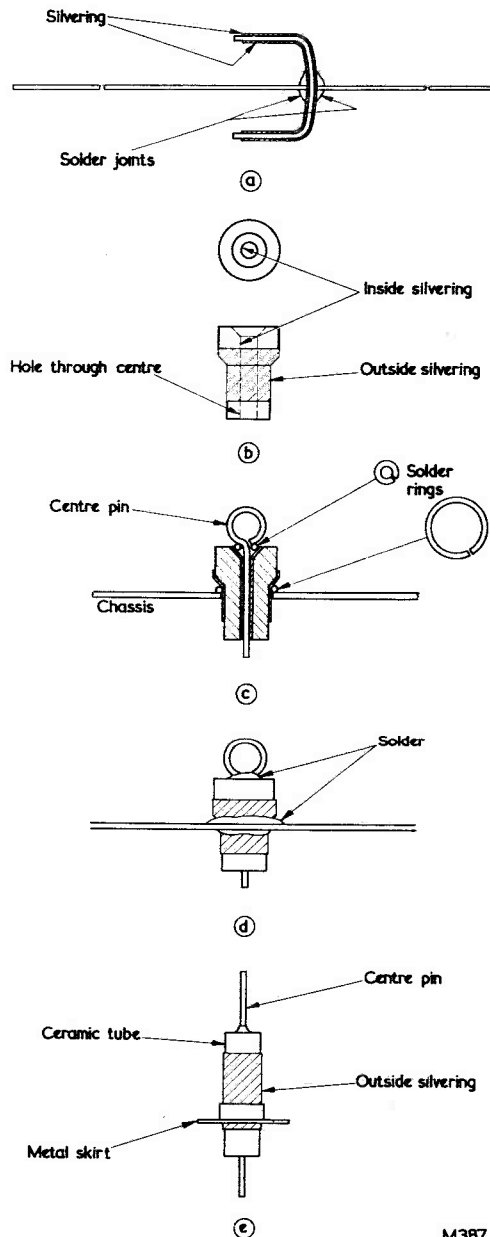


Fig. 41 (a). Cross-section through a capacitor having a cup-shaped ceramic dielectric  
 (b). The Erie shouldered feed-through capacitor  
 (c). The shouldered feed-through capacitor ready for soldering  
 (d). The appearance after soldering.  
 (e). A typical feed-through capacitor

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skirt and the outside silvering, the skirt merely being sprung on to the outside of the tube). The feedthrough capacitor is essentially a tubular component, and offers capacitances ranging from 5pF to 0.01 $\mu$ F.

### Temperature Coefficients Of Ceramic Capacitors

The temperature coefficient of a ceramic capacitor depends upon the ceramic employed. This fact is of particular advantage in certain aspects of radio work because a capacitor whose temperature coefficient is known may be employed to counteract the effects of rise in temperature in other parts of the circuit. By careful control of the ceramic mix used for the capacitor body it is nowadays possible for ceramic capacitors to be manufactured having closely controlled temperature coefficients. However, only the low-K ceramics may be employed for this application.

The standard range of temperature coefficients for ceramic capacitors is P100, NP0, N030, N080, N150, N220, N330, N470 and N750.<sup>1</sup> (It is a convention to prefix the zero coefficient, NP0, with both the letters N and P. Also, a zero appears before the significant figures in N030 and N080 to maintain the three-figure group). Tolerances on temperature coefficient are held at relatively close levels, typical examples being P100 $\pm$ 30% and N470 $\pm$ 15%. Sometimes, ceramic capacitors having temperature coefficients in the range just mentioned are described as "temperature-compensating capacitors".

In circuits where the temperature coefficient of the capacitor is not important it is usual to employ P100 or N750 components.

High-K ceramic capacitors are not employed for temperature compensation as their coefficients vary widely with temperature.

### Electrolytic Capacitors

If a loose roll of aluminium foil is immersed in a suitable solution, or "electrolyte", a very thin film of aluminium oxide will form on its surface when the positive terminal of a battery is connected to the foil and the negative terminal to the electrolyte. See Fig. 42. This film may be several hundred-thousandths of an inch thick only, and it is an insulator. In consequence, an *electrolytic capacitor* is given, one plate being provided by the aluminium foil and the other by the electrolyte, which is capable of passing an electric current. The dielectric is given by the film of oxide on the surface of the aluminium foil.

The dielectric constant of the aluminium oxide is fairly high, at approximately 8 to 9, and since the oxide is also very thin it is possible for the simple electrolytic capacitor of Fig. 42 to have a large capacitance in relation to its volume. A high ratio of capacitance to volume is, indeed, the major advantage of the electrolytic capacitor.

<sup>1</sup> These figures define the change in capacitance in parts per million for a rise in temperature of 1° C. The letter P signifies a positive coefficient, i.e. one which gives an increase in capacitance with rise in temperature, whilst the letter N signifies a negative coefficient. See *Understanding Radio* part 8, April 1962 issue.

In order that an electrolytic capacitor may function correctly it is necessary that a voltage of correct polarity be applied to it to maintain the oxide film. Because of this, electrolytic capacitors are connected into circuits which apply such a voltage continually when the associated equipment is in use. Another important feature of electrolytic capacitors similar to that of Fig. 42 is that, if the polarity of the applied voltage is reversed, the oxide film disappears and the capacitor may break down permanently. In consequence, it is always important to connect normal electrolytic capacitors into circuit with correct polarity. The simple arrangement of Fig. 42 may be described as a *wet electrolytic capacitor* since the electrolyte is a fluid. Wet electrolytic capacitors were used extensively up to some twenty to thirty years ago, but they have now been superseded by the *dry electrolytic capacitor*. In the latter, the electrolyte is held in a semi-liquid state and the disadvantages of the wet type, which had to be mounted vertically to prevent spilling, are overcome.

Dry electrolytic capacitors are manufactured in much the same way as paper capacitors<sup>2</sup>, two strips of aluminium foil being wound up into a roll with paper interposed between. One of the aluminium strips will have previously had an oxide film built up on it, and this strip will be the positive plate of the completed capacitor. The paper between the strips of aluminium foil is highly absorbent. When the capacitor has been rolled, it is placed into a bath containing the electrolyte, whereupon the latter permeates throughout the paper. To ensure complete impregnation of the paper, this process may be carried out under vacuum. When impregnation is complete the two aluminium foils are now separated by the electrolyte, which is held in suspension by the paper. The roll can then be fitted into its housing, lead-out wires or solder tags being connected to the foils.

The capacitor is not yet usable, however, as parts of the aluminium oxide film will have been damaged due to the handling it has received. In consequence, the capacitor has to be "formed" by connecting a source of e.m.f. to it with correct

<sup>2</sup> The construction of paper capacitors was described in last month's issue.

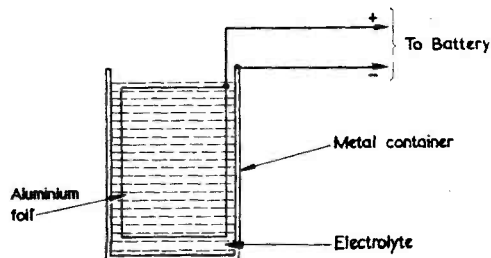


Fig. 42. The basic wet electrolytic capacitor

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polarity. This causes the oxide to reappear at the points of damage, and the capacitor is then ready for use.

The capacitance offered by an electrolytic capacitor depends upon the area of the positive plate, i.e. the foil which has the oxide surface. A considerable amount of development work

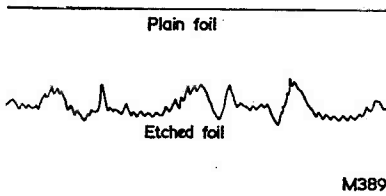


Fig. 43. Cross-sectional view (magnified) of the surfaces of plain and etched foils

has been undertaken in order to increase this area, the most successful process to date consisting of roughening the surface of the positive plate by etching, so that a very large number of "hills" and "valleys" are formed. Fig. 43 shows a cross-sectional view of the surface of a *plain foil* and of an *etched foil*, and it will be seen that the latter has a much greater surface area. Since the oxide dielectric is very thin it can follow the contours of the etched surface and so allow the desired increased capacitance to take effect. Both plain foil and etched foil electrolytic capacitors are currently manufactured, the latter being, in general, significantly smaller than plain foil types of the same capacitance and working voltage.

It is general practice for modern electrolytic capacitors to be housed in aluminium cans, lead-out connections being provided by wires or solder tags mounted in insulated mouldings. Wire-ended electrolytic capacitors are normally single units with a lead-out wire at either end, and are light

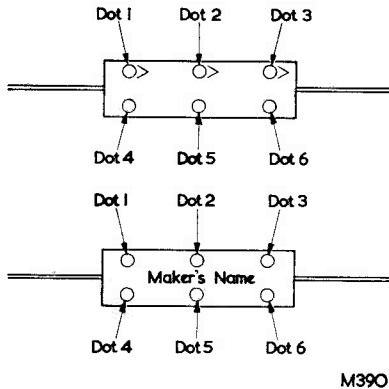


Fig. 44. Mica capacitors employing the six-dot code are marked as shown here

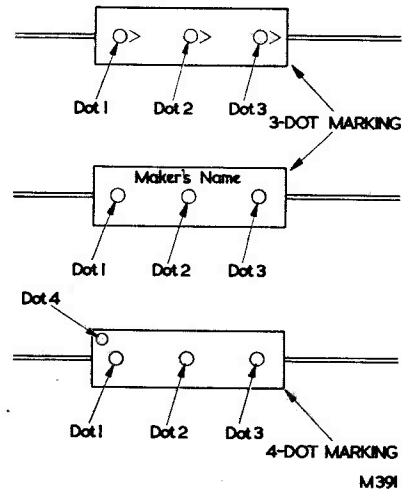


Fig. 45. Three-dot and four-dot markings

enough to be supported in position by the wires themselves. Chassis-mounting electrolytic capacitors usually have lead-out solder tags at one end only and are secured by means of a suitable clip. Frequently, chassis-mounting types have two or more capacitors in the one housing, these having a common negative connection. It is common practice, also, to employ the can itself as the negative terminal for the capacitor.

Electrolytic capacitor values range from one to several hundred microfarads for the higher working voltage types, and up to several thousand microfarads for the lower working voltage types. Capacitances are usually in "round numbers" (i.e.  $25\mu\text{F}$ ,  $50\mu\text{F}$ , etc.), but there is a strong tendency in this country for the higher working voltage types to be manufactured with values in the progression  $2\mu\text{F}$ ,  $4\mu\text{F}$ ,  $8\mu\text{F}$ ,  $16\mu\text{F}$  and  $32\mu\text{F}$ . The values and working voltages of electrolytic capacitors are printed on their housings.

Electrolytic capacitors are low-tolerance components, typical tolerances being of the order of  $-20\%$   $+50\%$  or  $-20\%$   $+100\%$ . Electrolytic capacitors having aluminium foil plates should not normally be operated above  $70^\circ\text{C}$ .

Since the oxide film of an electrolytic capacitor

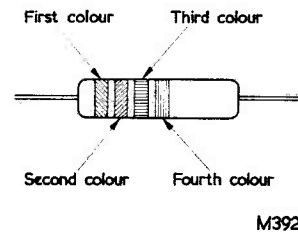


Fig. 46. A colour code used occasionally with small paper capacitors



TABLE VIII  
SIX-DOT CAPACITOR CODE (E.I.A. AND MIL-C-5A)

| Colour | Dot 1            | Dot 2<br>1st sig.<br>figure | Dot 3<br>2nd sig.<br>figure | Dot 6<br>Multiplier | Dot 5<br>Tolerance | Dot 4<br>Characteristic |
|--------|------------------|-----------------------------|-----------------------------|---------------------|--------------------|-------------------------|
| Black  | MIL-C-5A<br>Mica | 0                           | 0                           | 1                   | ±20%               | —                       |
| Brown  | —                | 1                           | 1                           | 10                  | ±1%*               | —                       |
| Red    | —                | 2                           | 2                           | 10 <sup>2</sup>     | ±2%                | —                       |
| Orange | —                | 3                           | 3                           | 10 <sup>3</sup>     | ±3%*               | —                       |
| Yellow | —                | 4                           | 4                           | 10 <sup>4</sup>     | —                  | —                       |
| Green  | —                | 5                           | 5                           | —                   | ±5%*               | —                       |
| Blue   | —                | 6                           | 6                           | —                   | —                  | —                       |
| Violet | —                | 7                           | 7                           | —                   | —                  | —                       |
| Grey   | —                | 8                           | 8                           | —                   | —                  | —                       |
| White  | E.I.A.<br>Mica   | 9                           | 9                           | —                   | —                  | —                       |
| Gold   | —                | —                           | —                           | 10 <sup>-1</sup>    | ±5%                | —                       |
| Silver | Jan<br>Paper     | —                           | —                           | 10 <sup>-2*</sup>   | ±10%               | —                       |

\* not in MIL-C-5A Code.

is formed by electrical action, continuous current is needed to maintain it. This is the *leakage current* of the capacitor and is normally of the order of milliamps or fractions of milliamps. Leakage current increases as the temperature of the capacitor rises.

#### Non-Polarised Electrolytic Capacitors

Some circuits require capacitors having large values, and which may function when the polarity of the applied voltage is reversed. Non-polarised electrolytic capacitors have been developed to meet this application.

A non-polarised electrolytic capacitor may be made in the same manner as the normal component, the only difference being that both the aluminium foils have oxide built up on them before being rolled up. Since there are, in effect, two dielectrics instead of one, the non-polarised construction results in a capacitor having approximately half the capacitance of a normal type of the same dimensions.

#### Tantalum Electrolytic Capacitors

An alternative to aluminium for electrolytic capacitors is offered by the metal tantalum. The

TABLE IX  
SIX-DOT R.M.A. CODE FOR MICA CAPACITORS

| Colour    | Dot 1<br>1st sig.<br>figure | Dot 2<br>2nd sig.<br>figure | Dot 3<br>3rd sig.<br>figure | Dot 6<br>Multiplier | Dot 5<br>Tolerance | Dot 4<br>Working<br>voltage |
|-----------|-----------------------------|-----------------------------|-----------------------------|---------------------|--------------------|-----------------------------|
| Black     | 0                           | 0                           | 0                           | 1                   | —                  | —                           |
| Brown     | 1                           | 1                           | 1                           | 10                  | ±1%                | 100                         |
| Red       | 2                           | 2                           | 2                           | 10 <sup>2</sup>     | ±2%                | 200                         |
| Orange    | 3                           | 3                           | 3                           | 10 <sup>3</sup>     | ±3%                | 300                         |
| Yellow    | 4                           | 4                           | 4                           | 10 <sup>4</sup>     | ±4%                | 400                         |
| Green     | 5                           | 5                           | 5                           | —                   | ±5%                | 500                         |
| Blue      | 6                           | 6                           | 6                           | —                   | ±6%                | 600                         |
| Violet    | 7                           | 7                           | 7                           | —                   | ±7%                | 700                         |
| Grey      | 8                           | 8                           | 8                           | —                   | ±8%                | 800                         |
| White     | 9                           | 9                           | 9                           | —                   | ±9%                | 900                         |
| Gold      | —                           | —                           | —                           | 10 <sup>-1</sup>    | —                  | 1000                        |
| Silver    | —                           | —                           | —                           | 10 <sup>-2</sup>    | ±10%               | 2000                        |
| No colour | —                           | —                           | —                           | —                   | ±20%               | —                           |

oxide film formed on the surface of a tantalum plate is tougher than that given with aluminium, and it has a higher dielectric constant together with a higher leakage resistance (i.e. less leakage current flows). However, tantalum is a hard metal and is difficult to produce in the form of a thin foil.

Tantalum electrolytic capacitors have, nevertheless, been produced in continually increasing numbers over recent years, and they offer especial advantages in low voltage applications because of their small size. Also, the electrolytes employed with tantalum are such that these capacitors may

be employed at higher temperatures than the aluminium type. The problems of producing a thin foil of the metal are avoided by using an alternative form for the positive plate, and this may consist of a mesh of wires, a porous cylinder, or a relatively thick sheet of the metal. The plate is immersed in the electrolyte, and the metal case usually provides the negative connection. Tantalum capacitors are normally made in working voltages up to 150 volts, with capacitances up to some 50 $\mu$ F.

#### Capacitor Colour Codes

A number of colour codes are employed to

TABLE X  
R.I.C. CODE FOR CERAMIC CAPACITORS

| Colour | End Colour Temperature Coefficient | Dot 1 1st sig. figure | Dot 2 2nd sig. figure | Dot 3 Multiplier | Dot 4 Tolerance |                |
|--------|------------------------------------|-----------------------|-----------------------|------------------|-----------------|----------------|
|        |                                    |                       |                       |                  | 10pF or less    | More than 10pF |
| Black  | NP0                                | 0                     | 0                     | 1                | ±2pF            | ±20%           |
| Brown  | N030                               | 1                     | 1                     | 10               | ±0.1pF          | ±1%            |
| Red    | N080                               | 2                     | 2                     | 10 <sup>2</sup>  | ±0.2pF*         | ±2%            |
| Orange | N150                               | 3                     | 3                     | 10 <sup>3</sup>  | —               | ±2.5%          |
| Yellow | N220                               | 4                     | 4                     | 10 <sup>4</sup>  | —               | —              |
| Green  | N330                               | 5                     | 5                     | —                | ±0.5pF          | ±5%            |
| Blue   | N470                               | 6                     | 6                     | —                | —               | —              |
| Violet | N750                               | 7                     | 7                     | —                | —               | —              |
| Grey   | PO30                               | 8                     | 8                     | 10 <sup>-2</sup> | ±0.25pF†        | —              |
| White  | P100                               | 9                     | 9                     | 10 <sup>-1</sup> | ±1pF            | ±10%           |

\* Red for ±0.2pF is not in the R.I.C. code but is used by some manufacturers.

† Some manufacturers use Orange for ±0.25pF.

indicate the values of capacitors, and the most commonly encountered are listed in Tables VIII to X.

American moulded mica capacitors employ a code in which the colours appear as six dots on the case, as shown in Fig. 44. The correct order of reading the dots is indicated by arrows on the housing or by the maker's name (which should be correct way up) as indicated in the diagram. Unfortunately, several codes have been used for these capacitors in the past, and this tends to lead to confusion. Table VIII shows the currently employed E.I.A. and MIL-C-5A codes (previously R.T.M.A. and JAN codes) for six-dot capacitors, and these are very nearly the same as each other. It will be noted that the colours represent the same digits as they do in the resistor colour code,<sup>3</sup>

and that they are read in much the same fashion.

If Dot 1 on the capacitor is black the capacitor is a mica component employing the MIL-C-5A code, whereas if it is white it is a mica component employing the E.I.A. code. Dot 2 gives the first significant figure of the value, Dot 3 gives the second significant figure, and Dot 6 gives the multiplier. All values indicated are in picofarads. Dot 4 gives the "class" or "characteristic" of the capacitor and defines aspects of performance which are outside the present context. For amateur purposes, Dot 4 may be ignored. Dot 5 gives tolerance, and it should be noted that tolerances for ±1% and ±3% do not appear in the MIL-C-5A code.

To take an example, let us assume that we have

<sup>3</sup> See *Understanding Radio*, part 5, December, 1961, issue.

a capacitor coded as follows: Dot 1, white; Dot 2, red; Dot 3, red; Dot 4, brown; Dot 5, orange; Dot 6, brown. Dot 1 tells us that the capacitor is a mica component employing the E.I.A. code; Dots 2, 3 and 6 (red, red, brown) signify a value of 220pF; and Dot 5 indicates a tolerance of  $\pm 3\%$ . For amateur purposes we ignore Dot 4.

The six-dot code may also be employed by some paper capacitors, in which case Dot 1 will be silver, as indicated in Table VIII. Values and tolerances are then read as for mica capacitors.

There is an old colour code, the R.M.A. code, which also employs six dots, and capacitors using this code may sometimes be encountered. If Dot 1 is any other colour than white, black, silver or gold, the old R.M.A. code may be assumed. Table IX gives details. In this case Dots 1, 2 and 3 give the first three significant figures of the value (again in picofarads) and Dot 6 gives the multiplier. Dot 5 gives the tolerance, whilst Dot 4 indicates the working voltage, as shown in the table. As will have been observed, this code offers *three* significant figures in the value instead of the two given by the later codes.

Fig. 45 illustrates moulded mica capacitors employing the three-dot and four-dot code. The three-dot code is employed with capacitors having working voltages of 500 and tolerances of  $\pm 20\%$ . Dots 1 and 2 give the first and second significant figure of the value and Dot 3 the multiplier. If the component is other than  $\pm 20\%$  Dot 4 may be added. This indicates tolerance, using the same colours as Dot 5 in Table IX.

The values of paper capacitors are usually printed on their case, but a colour code is sometimes employed for the smaller types. The colour code normally appears in the form shown in Fig. 46. The value (in picofarads) and tolerance of the capacitor are then read in the same manner as with a similarly coded resistor, the first three colours indicating value and the fourth tolerance.

Ceramic capacitors are frequently colour coded, and the system most commonly employed is illustrated in Fig. 47 and Table X. The first colour in the table is the "End Colour" and this appears either at the end of a tubular capacitor, or to the left of the group on a disc capacitor. Dots 1 and 2 follow, these giving the first and second significant figures of the value (in picofarads). Dot 3 gives the multiplier, whilst Dot 4 gives the tolerance.

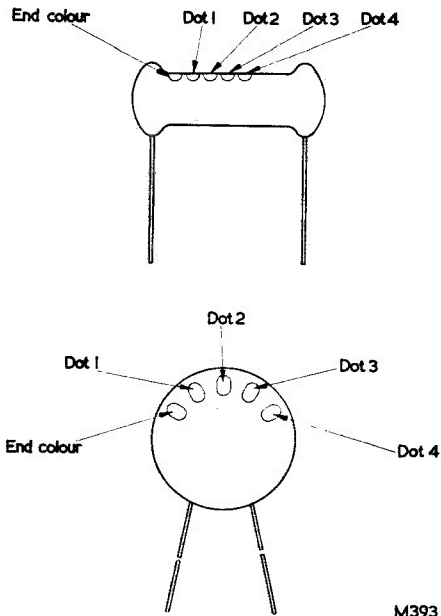


Fig. 47. Ceramic capacitors marked for the R.I.C. code

As an example let us assume that we have a ceramic capacitor with the following coding: End Colour, yellow; Dot 1, yellow; Dot 2, violet; Dot 3, black; Dot 4, green. The end colour indicates a temperature coefficient of N220, and Dots 1, 2 and 3 a value of 47pF. Since the capacitor has a value greater than 10pF, the green Dot 4 shows a tolerance of  $\pm 5\%$ .

An adaptation of this colour code may be encountered with some ceramic capacitors which are manufactured with either P100 or N750 ceramics. These have their values and tolerance printed on them, the printing being white for P100 components and violet for N750 components.

#### Next Month

The writer had intended to commence on variable capacitors in this issue, but it seems that we have already exhausted the available space. In consequence we shall carry on to that subject next month.

## LONGLEAT MOBILE RALLY

Organised by the City and County of Bristol group of the R.S.G.B.

For the fifth Mobile Rally at Longleat on Sunday 17th June, 1962, from 10 a.m. to 6 p.m., the organisers have decided to follow the pattern which made the last four rallies so popular. Probably no other site in the country can match the attractiveness of the Longleat Estate as a venue for an event of this nature. This is an event to suit the family, there being something of interest for everyone. Apart from the opportunity of visiting Longleat House itself, there will be the usual rally attractions. These include various operating contests for the Mobiles, the Concours d'Elegance, a treasure hunt, D.X. balloon race, etc.

Visitors travelling from the Bristol direction are advised to go via Frome, leaving Frome on the Warminster Road—A362—and turning right for Longleat where signposted. This is rather important as there is a one way system operating on the Estate.

The two control stations this year will be G3CHW/A on 1880 kc/s, and G3GYQ/A on 2 metres. Mobiles approaching Longleat are particularly requested to avoid the control station frequencies as far as possible.

# NEWS

and

# COMMENT

Closed circuit television systems are gradually becoming used in all types of activity. Applications in banking, security and traffic control have all been recently reported. Another installation by E.M.I. will be in the All India Telecommunications and Railway Signalling School, Secunderabad, Andhra, and will be used for noting the numbers of railway wagons as they are moved in sidings on the Central Railway, Bombay.

Many readers will have learned of the installation at Westminster of closed circuit TV screens, designed experimentally to supplement the old ticker tape boards. Screens were placed in such places as the tea room and the library of the House. Someone has told Peterborough of the London *Daily Telegraph* "Chief Whip is watching you".

## Hi-Fi Certification

Much concern has been expressed in recent months at the loose description by many manufacturers of their audio apparatus as high-fidelity equipment. Firms who specialise in the manufacture of high quality amplifiers, etc, have been particularly worried at the misuse of the term "high-fidelity" as, in fact, such words were becoming meaningless in the radio sense.

This state of affairs may be remedied in the near future if the many reputable firms making hi-fi equipment apply for, and obtain, the certificate to be granted by the Audio Manufacturers Group of B.R.E.M.A. The Group has issued a very comprehensive specification for Methods of Measuring and Expressing the Performance of Audio Frequency Amplifiers.

There are various clauses which must be complied with by those firms seeking a certificate, e.g. "registration of equipment will be effected only on an undertaking from the manufacturer that all production of the equipment concerned will maintain the performance exemplified by the verified sample, and that any modification to the specification will be notified to the Audio Manufacturers' Group immediately it occurs".

We believe there is the possibility of an approach to the British Standards Institute. We hope to publish an article in a future issue dealing with this subject.

## Amateur Television

The British Amateur Television Club are holding their sixth Amateur Television Convention at The Conway Hall, London, W.C.1, on Saturday, 8th September, 1962, from 10 a.m. to 7 p.m.

The B.A.T.C. is a very enterprising society founded in 1949. Its objects are to inform, instruct and co-ordinate the activities of amateur radio enthusiasts experimenting with television transmission, and to liaise with other enthusiasts engaged on similar work overseas. The club is affiliated to the R.S.G.B., and has more than 450 members of whom about one third reside abroad.

Experiments have been mainly in two directions, r.f. and video. Constructional groups have been formed as the resources required for this type of experimentation are considerable. On the video side, the standards recommended are such that a normal domestic TV set can be used as a monitor, i.e. in the U.K. 200 lines 50 pictures per second sequential, or 405 lines 50 fields per second double interlaced, with waveforms similar to B.B.C.-I.T.A.

Incidentally, the G.P.O. amateur vision licence, costing £2 per annum, does not require a knowledge of the Morse code. The address of the Honorary Secretary is 21 Silverdale, Sydenham, London, S.E.26, from whom further details may be obtained.

## A New Use for Colour TV

Colour television was used at a major fashion show for the first time in Great Britain, when E.M.I. Electronics' colour TV cameras went to Wolsey Vanity Fair Lingerie, at the Dorchester Hotel Ballroom, London, on Tuesday, 1st May.

This was of great advantage to the 400 lingerie buyers, from stores all over the country, who attended the show. It is important that the buyer should be able to see garments in close-up, to study details such as

lace decorations, fit, cut, styling and colour, wherever she may be sitting in the room.

This is not possible when she can only inspect the garments from a distance, but eight 21in colour TV receivers, strategically positioned around the ballroom, ensured a close-up view for everyone.

Opening the show, the George Carden Dancers wore lingerie from the collection—in that way adding substance to the claim that lingerie, which in Victorian times was unmentionable and in the 1930s was mentionable, is now even showable.

## Kenya to have TV

Kenya is to have television before the end of this year and has "bought British" to establish the public service.

Marconi's have been entrusted with the order for the supply and installation of the main items of transmitting and studio equipment. Formal contracts are being placed by Television Network (Kenya) Ltd.

The transmitting equipment will include a 5kW vision transmitter Type BD 372A a 1kW sound transmitter Type BD 324, a 3-stack super-turnstile aerial Type BD 760 (giving an E.R.P. of 15kW), programme input equipment, a filter-plexer, a water-cooled test load, harmonic attenuators and a considerable quantity of other ancillary equipment.

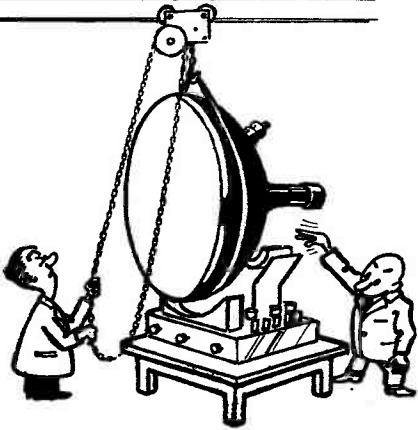
Marconi studio equipment will comprise three Mark IV image orthicon camera channels, four vidicon camera channels Type BD 871, a transistorised sound control console Type BD 968, picture monitors, some master control equipment, film projectors and ancillary equipment. One of the BD 871 camera channels will be used in the announcer's studio and the others for telecine purposes.

The transmitting station will be sited at Limuru, some 11 miles north-west of Nairobi (line of sight) and the studios will be in Nairobi itself. The station will operate in Band 1 on lines to C.C.I.R. standards. The service is expected to be in operation by 1st October.

## At Their Own Expense?

The Bulletin of the Association of Broadcasting Staff, the organisation to which many B.B.C. and I.T.A. employees belong, included this little joke in a recent issue. "A legatee who wanted to invest money, was advised that the Director-General of the B.B.C. was able to offer a higher rate of interest than British Railways because he carried more passengers than Dr. Beeching!"

# In your Workshop



This month Smithy the Serviceman and his able assistant, Dick, get down to a serious consideration of u.h.f. tuner units

"I'M QUITE CERTAIN," COMMENTED Dick, "that Picasso doesn't have to use a ruler."

Smithy, bent over the battered and scarred wooden slab which he fondly referred to as the Workshop Drawing Board, abstained from replying.

"Nor," continued Dick, after a moment's further contemplation of the Serviceman's activities, "does he use a ball point pen."

"Picasso," replied Smithy with great finality, "doesn't repair television sets".

Dick considered this statement for a moment, and appreciated its utter conclusiveness from Smithy's single-minded point of view. Frowning, he decided to drop the subject, and he returned to the chassis he was repairing. Meanwhile, Smithy laboured busily at his drawing.

## The Basic U.H.F. Tuner

For several unsuccessful minutes, Dick tried to concentrate on the receiver on his bench. But his curiosity had been aroused, and he turned round once more to the Serviceman.

"Just what is it you're drawing, Smithy?"

"You'll see in a minute," pronounced the Serviceman. "But I will tell you that it is a futuristic creation, and one which I've been intending to present to the Workshop for quite a few weeks."

"Futuristic?"

"That's right."

"And you're going to present it to the Workshop?"

"It will hang," said Smithy, briskly rattling his ruler over the surface of the paper, "on the wall in a position of honour between the inductance and capacitance abacs and the full-sized signed portrait of Jayne Mansfield."

Dick looked impressed.

"This *must* be something," he remarked. "When will it be finished?"

"I'm on the last bit now," replied Smithy.

Carefully, the Serviceman drew a line on his paper, after which he put down his drawing implements with the gesture of a man who has done a job well and who knows he has done it well. He gazed at his work with great satisfaction, then showed it proudly to his assistant. (Fig. 1.)

Dick gazed at it with complete incomprehension.

"Are you sure you've got it right?" he said, doubtfully. "I mean to say, it's not upside-down or anything, is it?"

"Of course it's not upside-down," snorted Smithy.

"Well, what is it?"

"What I have drawn," said Smithy grandly, "is the circuit of the basic u.h.f. tuner unit".

A gleam of intense interest came into Dick's eye.

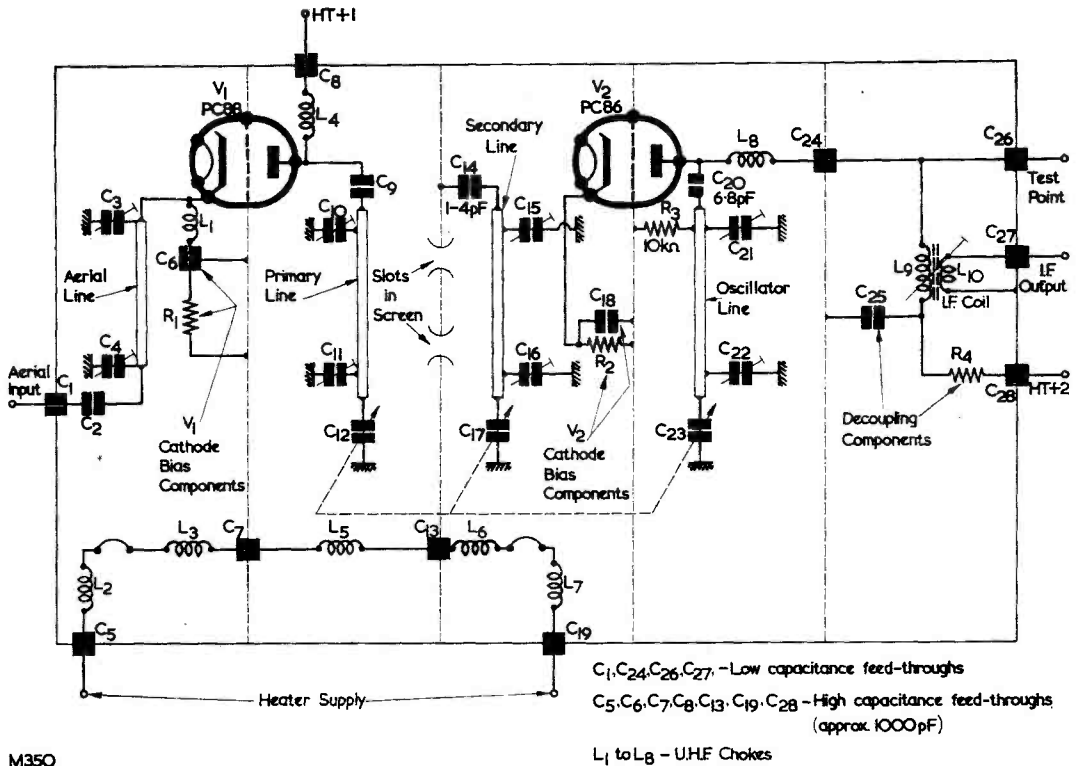
"No kid?"

"No kid," confirmed Smithy. "You've been chasing me for months to give you some gen on u.h.f. tuners. So I'm now going to do just that. Furthermore, I consider the subject so important that we'll drop work right away and get down to a full technical discussion."

Smithy's delighted assistant at once turned to his bench and switched off the equipment plugged into the row of sockets at the rear. He then drew up a chair and settled himself expectantly.

"These are," pronounced Smithy, "early days yet, so far as u.h.f. television in this country is concerned, and so it may be thought that I'm sticking my neck out in talking already about a 'basic u.h.f. tuner'. So I'll give you a bit of background before I get down to the technical details. To begin with, nobody knows exactly what form u.h.f. tuners will take in this country. There are, however, two main possibilities. One possibility consists of using a standard turret tuner with additional u.h.f. biscuits. These biscuits will allow the tuner oscillator to run at a sub-multiple of the frequency which would be required of a u.h.f. local oscillator. This frequency is then multiplied by crystal diodes and fed to the mixer in company with the incoming u.h.f. signal from the aerial."

"Sounds a bit of a bodge to me," commented Dick.



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Fig. 1. The basic circuit of a u.h.f. tuner unit. The i.f. output circuit is illustrated in simplified form. Component values not shown are referred to in the text

"Not at all," said Smithy severely. "It's a properly engineered idea. Quite a few turret tuners on the market today have spare space at the end of the segment drum to accommodate u.h.f. biscuits of this type. The extra space is needed because the u.h.f. biscuits will be bigger than standard Band I-Band III biscuits since they hold more components. They may have more contacts, too. I don't know what performance these u.h.f. biscuits will give and, whilst I don't agree that they represent a bodge, I must admit that I do get the feeling that they are an adaptation rather than a job expressly designed for u.h.f. Anyway, u.h.f. biscuits on a standard turret represent one main possibility for u.h.f. reception."

"What's the other possibility?" "The other possibility," stated Smithy, "is that future television sets will be fitted with a separate u.h.f. tuner which has been designed specifically for the job. This will

have resonant lines instead of coils, it will be tuned by a variable capacitor, and it will have valves which are especially intended for the frequencies covered. And this is where I really stick my neck out, because I'm going to say right now that I think that tuners of this type will be employed in many, if not most, British television receivers of the future. I'm going to say also that I think the design of the resonant line u.h.f. tuner has now become sufficiently stabilised for us to start talking in terms of basic design and functioning."

"You seem pretty certain about all this," commented Dick.

"I feel as confident as one can be about things of this nature," replied Smithy. "Don't forget that there have been quite a few straws in the wind recently. For instance, Sydney S. Bird & Sons Ltd had leaflets available at last year's R.E.C.M.F. Exhibition which described the new 'Cyldon' u.h.f. tuner type U.T. This

leaflet included a circuit diagram of the tuner, which is very similar to the basic design I've drawn out here. Also, the functioning of the stages is identical. Further, there is an article in the February issue of *Mullard Technical Communications* which describes a tuner that is, once again, basically the same as that I've drawn out. What is more, the tuner described in the article is a modification of a Philips tuner which is already established, the modification consisting of changing the PC86 r.f. amplifier in the Philips tuner to a PC88."

Smithy stopped and felt around in his pockets. After a moment he pulled out a flat tin, extracted a very tiny cigar, and carefully lit it. A rich and expensive aroma filled the Workshop.

"Added to the facts I've just mentioned," continued Smithy, "there is the point that tuners of the basic type I'm referring to represent the most commonsense engineering

approach to u.h.f television reception that exists up to now. So I think it's quite safe to assume that their basic design has stabilised in just the same way as basic Band I-Band III tuner design has stabilised."

"You seem to have given this quite a lot of thought," commented Dick.

"I have," admitted Smythy. "And that's because I consider it important that service engineers should get reliable gen on new innovations well in advance. This is, in fact, why I'm giving you all this information now."

Dick looked impressed.

"I must admit," he said, "that I find this rather exciting. O.K. Smythy, let's hear all about the television tuner of the future!"

### Resonant Lines

Smythy puffed contentedly at his little cigar and settled himself more comfortably.

"Right," he said. "Now let's begin by taking a perfunctory butcher's at the nature of the animal our tuner has to handle. We're already familiar with Band I-Band III tuners, and we know that Band I is 41 to 68 Mc/s and that Band III is 174 to 216 Mc/s. We refer to Bands IV and V, the new Bands, as u.h.f. Of these, Band IV covers 470 to 582 Mc/s; and Band V covers 606 to 960 Mc/s. Which is, as you will admit, pretty high for domestic entertainment purposes."

"I'll say!" exclaimed Dick.

"Blimey, I've already considered it a feat just working on Channel 11!"

Smythy chuckled.

"960 Mc/s," he said, "corresponds to a wavelength of approximately 1ft. Just think of getting up on to the roof to erect a half-wave dipole which is only 6in long! Going back to Band III for a moment, I don't need to remind you that some of the higher channel coils in Band I-Band III tuners often have one or two turns only. When you get into Bands IV and V, coils become pretty hopeless as tuning elements and it's easier to work with the inductance given by straight lengths of conductor instead."

"You mean," queried Dick, "that the inductance of a straight conductor is sufficiently high at these frequencies for it to be looked on as a coil?"

"That's about it," confirmed Smythy. "Although I should add that you will still find conventional coils used as u.h.f. chokes. Such coils will not, however, be employed in tuned circuits. For those we need the straight conductors."

"Having said that," continued Smythy, "we can now get down to considering the tuner circuit I have been at such pains to draw out. As you can see, it employs two triodes, both of which have their grids at chassis potential. The first triode is a PC88 and it functions as a grounded-grid r.f. amplifier. The second triode is a PC86 and it functions as a self-oscillating mixer."

"There seems to be," volunteered Dick, who had been studying Smythy's diagram closely, "a lot of screening in this circuit."

"There is," agreed Smythy. "The screening causes the tuner to be divided into five separate compartments. The aerial input is applied to the left-hand compartment and feeds, via our first tuned circuit, to the cathode of  $V_1$ , the grounded-grid r.f. amplifier. As you may see, the tuned circuit includes the straight conductor which I mentioned just now, and which I've drawn as a rod. To be more accurate, we should refer to this conductor as a 'line' or as a 'lecher line'. Now, since the grid of  $V_1$  is at chassis potential, it is possible to make this integral with the screen between the first and second compartments, with the result that the anode circuit is completely screened away from the cathode circuit."

"This seems pretty reasonable so far," commented Dick.

"Actually, it's not too hard all the way through," replied Smythy, "provided that you don't get put off by the use of lecher lines instead of coils. Now the anode of  $V_1$  feeds into what is called the primary tuned circuit, this consisting of a line having two trimmers and a variable capacitor hung on to it, and which I'll explain in greater detail shortly.

The variable capacitor is one section of a three-gang component, and this tunes the resonant circuit nearly all the way through Bands IV and V."

"No channel changing?"

"None at all," said Smythy. "With a tuner of this type you tune in your station with a variable capacitor just as you do on the medium-wave band."

"The aerial input circuit doesn't have a variable capacitor connected to it," objected Dick.

"I know it hasn't," replied Smythy. "The aerial input circuit is more or less aperiodic over Bands IV and V. However, the resonant circuit in the anode of  $V_1$  is tuned, and it resonates at signal frequency."

"You said that the resonant circuit is tuned through nearly all of Bands IV and V," said Dick. "Why can't it tune all of the two Bands?"

"I'm not too certain about that," replied Smythy. "The range given by present tuners seems to extend from 470 Mc/s up to 800 Mc/s or so. Perhaps a little further development is needed to get up to 960 Mc/s. Anyway, we're getting off the main subject, which is that of following the signal through the tuner. How far had I got?"

"To the resonant circuit," replied Dick helpfully, "in the anode of  $V_1$ ."

"Oh yes," said Smythy, "the primary tuned circuit. The primary tuned circuit is coupled to the secondary tuned circuit in the next compartment by a method which I shall describe later. The secondary tuned circuit consists of a line with another two trimmers tacked on to it, plus the second section of our three-gang variable capacitor. The secondary tuned circuit resonates at signal frequency. O.K. so far?"

"Not quite," replied Dick, frowning. "What I don't understand is that the secondary tuned circuit is not connected to the mixer valve in any way."

"It isn't connected," said Smythy, "but it is coupled. The coupling is given by a wire which travels parallel to the secondary line and which connects between the cathode of  $V_2$  and its bias resistor and decoupling capacitor,  $R_2$  and  $C_{18}$ .

## IN YOUR WORKSHOP . . .

Enquiries are often received from readers who require back issues of the magazine in which specific subjects were dealt with by Smythy and Dick. May we remind those who are interested that our Indexes, which are issued at the completion of each volume, contain a complete analysis of the subjects covered during a year.

Indexes to Volume 11 (August 1957 to July 1958), Volume 12 (August 1958 to July 1959), Volume 13 (August 1959 to July 1960) and Volume 14 (August 1960 to July 1961) are available at 9d. each, including postage, etc. Readers are advised to ascertain the availability of back numbers before ordering.



This wire has inductance and it couples to the tuned line in much the same way as, at lower frequencies, a coupling coil would couple to a tuned coil."

"I'm with it now," said Dick excitedly. "Since this wire couples to the secondary line it causes the signal frequency on this line to be applied to the cathode of  $V_2$ ."

"You are," remarked Smithy, "fully with it. So we now have the situation where we are applying signal frequency to the mixer,  $V_2$ . You will note that, here again, we have a layout which enables the grid to complete the screening between the third and fourth compartments of the tuner. Having fed our signal frequency into the mixer, we next have to get the latter to oscillate. The oscillator tuned circuit for  $V_2$  is given by the line in the fourth compartment, together with two more trimmers and the third section of the three-gang. The latter tunes the oscillator circuit over Bands IV and V, and this runs higher than the signal frequency by the intermediate frequency. Which is, of course, what you get in any conventional superhet mixer."

Smithy stopped as he perceived that Dick's face was wearing a look of agonised perplexity.

"What's up?"

"It's the oscillator circuit," complained Dick. "I've been prepared to accept tuned circuits using lecher lines up to now, but I'm completely stuck with this oscillator. All you've got is a triode to whose anode you connect a length of line together with a few odd trimmers and capacitors. And it oscillates!"

Smithy grinned.

"It is a bit of a shaker at first," he chuckled, "but I can assure you that it does oscillate. And very reliably too. This will be another thing I'll explain in more detail later on. For the present, just assume that it does oscillate."

"Okeydoke," said Dick equably. "We'll leave it as a mystery for the time being."

"Fair enough," said Smithy. "Now, churning around inside our self-oscillating mixer are both the signal frequency and the oscillator frequency. In consequence, the intermediate frequency must be present at the anode. And so it is. We take this intermediate frequency through the u.h.f. choke  $L_8$  and apply it to an i.f. tuned circuit in the fifth and final compartment. In practical tuners, this i.f. tuned circuit will very probably vary considerably according to different makers' ideas and requirements, and I've shown it here as a simple tuned transformer

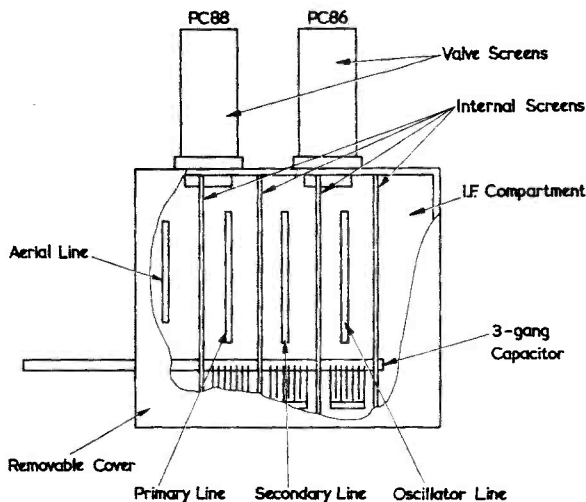


Fig. 2. Practical layout for a u.h.f. tuner, showing the internal screens. It is possible for the order of compartments to be reversed, the i.f. compartment appearing at the front

having a low impedance secondary. There will also be a test point immediately after  $L_8$ , its function being to allow the manufacturer of the tuner to get an i.f. output for wobbulator display.

"And that," concluded Smithy, "is your basic u.h.f. tuner!"

"You make it sound very simple," said Dick, "but there's a terrific amount of detail I don't understand. Also, you haven't mentioned the heater circuit."

"The heater circuit is pretty easy," replied Smithy. "The heater wiring has, of course, to pass through the compartments to enable the conventional series string to be set up. It is important to ensure that the heater wiring doesn't carry signal voltages from one compartment to the next, and so you insert chokes in it at any point where such unwanted couplings are likely to occur. As a further precaution, the heater wiring passes also through feed-through capacitors. These would, I should guess, be of the common-ordinary 1,000pF variety. So far as the service engineer is concerned, the heater circuit could be a possible cause of instability if a feed-through capacitor went open-circuit or a choke had some of its turns shorted out. Apart from that, however, it isn't of great consequence to us."

#### Practical Layout

"I can appreciate that," said Dick.

"What about the practical layout of the tuner?"

Smithy drew up his drawing board and proceeded to scribble on a sheet of paper.

"The practical layout will look something like this," he remarked, when he had completed his quick sketch. (Fig. 2.) "As you can see, it is pretty similar to the circuit diagram. We have the five compartments, each separated from each other by a metal screen. The metal cover, which I've shown mostly cut away, completes the screening and makes each compartment virtually watertight. The valves stick out at the top of the case, and do not appear in the middle of the layout as they do in the circuit. However, their effect is just the same because the internal screens go right up to the centres of the valve sockets, with the cathode pin on one side and the anode pin on the other. Also, the grids of the valves connect to a number of pins, thereby allowing a really reliable connection to chassis to be made. Indeed, the PC88 has no fewer than five grid pins, all of which connect to chassis. My sketch doesn't show trimmers. These would normally be of the ceramic type in which the adjusting screw is at chassis potential and passes down a threaded ceramic rod, and they would be mounted at convenient points on the side of the case furthest away from the cover. In some tuners the partitions may not be straight up

and down, as I've shown here. They may instead be sloping, so that the aerial input and i.f. output circuits can be squeezed into a small space and thereby reduce the overall volume of the tuner. Also, a reduction gear for the three-gang capacitor could be fitted in the front compartment, if this was desired."

### The Primary Circuit

"All this", said Dick, "seems quite simple and easy to understand. Now what about some details on the various sections of the circuit? Can you give me a bit more dope on those lecher lines, for instance?"

"Certainly," said Smithy. "A good one to start off with is the primary tuned circuit. Now, the resonant lines in these tuners are usually of the order of half a wavelength long, which means that if you have a peak positive voltage at resonant frequency at one end you have a peak negative voltage at the

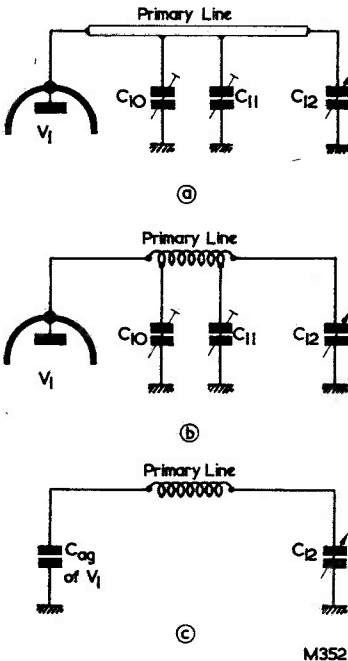


Fig. 3. (a). The primary tuned circuit

(b). The effect given by looking upon the primary line as a coil

(c). When the  $C_{ag}$  of  $V_1$  is considered, the primary line can be seen to enter a pi tuned circuit

other end. This isn't very different from what you get with a coil in a tuned circuit and so it is quite in order, so far as simplified explanations are concerned, to look upon the lecher lines as coils. The primary tuned circuit, on its own, looks like this. (Fig. 3 (a).) I've removed  $L_4$ , which is just a u.h.f. choke, because all it does is pass h.t. to the anode of  $V_1$ . Also  $C_9$ , which has a low reactance at u.h.f. Let's see what the circuit looks like if we re-draw the line as a coil. (Fig. 3 (b).) Do you notice anything?"

"Wait a minute," said Dick, eagerly. "It seems very familiar to me—isn't it a pi tuned circuit?"

"Nothing more and nothing less," confirmed Smithy. "All we've got to do is add the  $C_{ag}$  of  $V_1$  to the circuit and forget the trimmers for a moment and we're back to our old friend, the pi resonant circuit! (Fig. 3 (c).) The inductance, which in this case is the line, is tuned by the series combination of  $C_{12}$  and  $C_{ag}$ . Since  $C_{12}$  is a variable, the circuit can be tuned over a wide range of frequencies."

"Well, that's simple enough," remarked Dick. "What about the two trimmers? Come to that, why do you need two trimmers anyway?"

"You need two trimmers", said Smithy, "so that you can align at the top and bottom of the band of frequencies covered. When you're at the low frequency end of the band,  $C_{12}$  inserts maximum capacitance and minimum reactance. At the same time,  $C_{ag}$ , which has a low capacitance, inserts a high reactance into the tuned circuit. Small variations in  $C_{ag}$  will, in consequence, have a considerable effect on the resonant frequency. We can't vary  $C_{ag}$ , of course, but we can slap a trimmer across it and use that to align the resonant frequency to the required figure."

"I think I'm with this," said Dick slowly. "When you're at the bottom end of the band  $C_{12}$  has maximum capacitance. A trimmer would then have maximum effect if it was connected across  $C_{ag}$  rather than across  $C_{12}$ . Because of this, you use a trimmer at the valve end of the line to align at low frequencies."

"You've got it," confirmed Smithy. "At the high frequency end of the band you have an opposite effect. This time  $C_{12}$  inserts minimum capacitance into circuit. You've already set up the trimmer at the valve end of the line so, to get your required alignment, you slap a second trimmer across  $C_{12}$ , which now has a low capacitance, and align with this second trimmer."

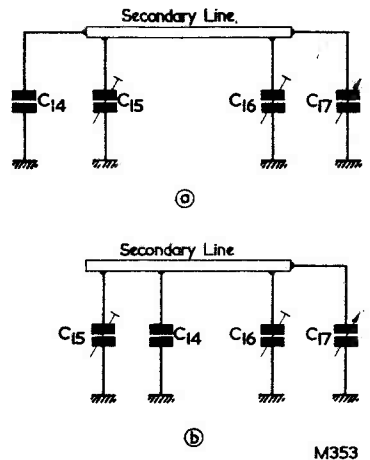


Fig. 4. (a). The secondary tuned circuit

(b).  $C_{14}$  may sometimes be tapped into the line, as shown here

"Well, that's knobby," remarked Dick. "It's almost the same as trimming and padding on medium and long-waves! At the low frequency end of the band you adjust the trimmer at the valve end of the line and, at the high frequency end, you adjust the trimmer at the tuning capacitor end. Dead easy, isn't it?"

"Most things in electronics", pronounced Smithy, "are easy when you get down to basic."

"Why", asked Dick, "are the trimmers tapped slightly along the line instead of being connected to their ends?"

"That", replied Smithy, "is not quite so easy! I would guess that they are tapped in a little in order to ensure good overall tracking between the three sets of tuned circuits."

"What value would the trimmers have?"

"They'd be pretty low," said Smithy. "Different manufacturers will, of course, use different values, but I should imagine that the trimmers would be similar to the sort of thing you find in present-day Band I-Band III tuners. You know, 0.5 to 5pF, or thereabouts."

"What about the value of  $C_{12}$ ?"

"It will vary according to tuner manufacturer."

"Yes," persisted Dick, "but what value would it have, approximately?"

"Well," said Smithy guardedly, "from what I've seen, from manufacturers' illustrations and such-like, I would guess that the maximum

capacitance of  $C_{12}$  would be around the 50 to 60pF mark. The other two sections of the three-gang would have the same capacitance, of course."

"50 to 60pF," mused Dick. "Quite high, then."

"There is a wide range to cover, you know," Smithy reminded him. "And don't forget that the tuning capacitor has to operate in series with the low capacitance between the anode and grid of the valve."

### The Secondary Circuit

Smithy broke off and selected another Lilliputian cigar.

"You like those, don't you?" said Dick chattily.

"They're not bad," replied Smithy. "Better for you, of course."  
"Of course."

There was a pause for a moment.

"They say that full-size cigars", remarked Dick, "are rolled on the thighs of Havana bathing beauties."

"Are they?" said Smithy, interested. "What a peculiar custom."

"That cigar of yours", continued Dick in the same chatty vein, "doesn't seem to be drawing very well."

"I think it's sprung a leak," replied Smithy.

He examined the cigar carefully. Incautiously, he bent it experimentally in the middle, whereupon he found himself holding the two halves. Dick seized one of these.

"Well, that's a swiz," he said. "It's all flakes of tobacco in the middle which are just held together by a couple of thicknesses of leaf on the outside. Blimey, that cigar wasn't rolled, it was *swept* together!"

"It doesn't pay", said Smithy severely, "to look too closely at things of this nature. Let's try another one."

Gingerly he took another cigar from the little tin and carefully lit it. This functioned satisfactorily and, once more, a rich and expensive aroma pervaded the atmosphere of the Workshop.

"They don't half smell good," commented Dick. "What you want to do is to make yourself a whacking great imitation cigar with a spot of red Day-Glo at the end and a hole down the middle. You could pop those little cigars into it, smoke them all day long, and everyone would think you were rolling in lolly!"

Smithy considered this idea in silence for a moment.

"No, I think I'd better not," he said very seriously. "After all, it

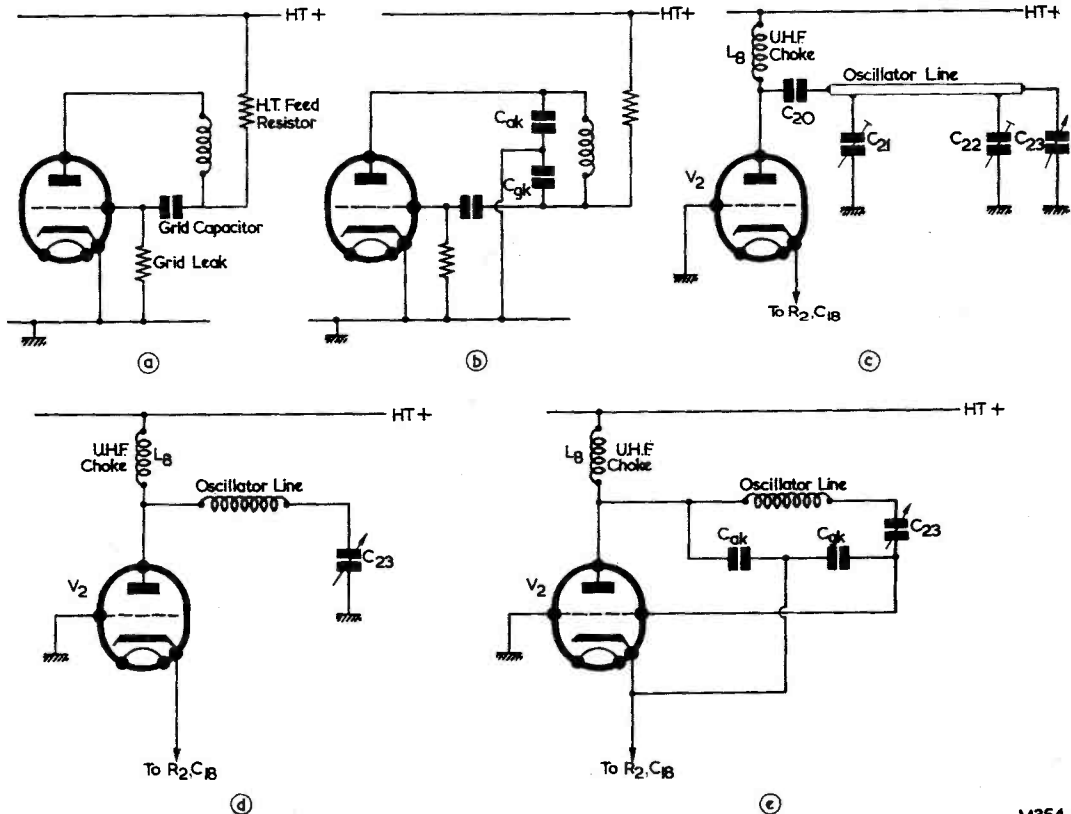


Fig. 5 (a). A typical Band I-Band III oscillator circuit  
 (b). Adding the  $C_{ak}$  and  $C_{gk}$  of the valve demonstrates that the circuit is a Colpitts  
 (c). The basic u.h.f. oscillator circuit  
 (d). Replacing the oscillator line by a coil  
 (e). Adding the  $C_{ak}$  and  $C_{gk}$  shows that the u.h.f. oscillator is also a Colpitts

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would be rather in the category of vain show, wouldn't it? And I don't believe in vain show."

Dick decided to change the conversation. He was never quite certain whose leg was being pulled when Smythy was in one of these moods.

"We've discussed", he said brightly, "the primary resonant circuit of our basic tuner. What about the secondary resonant circuit?"

"It's pretty well the same," said Smythy. "Once again you've got the line, complete with trimmers at top and bottom. (Fig. 4 (a).) The upper end of the line doesn't connect to a valve electrode and so a small fixed capacitor,  $C_{14}$ , provides the necessary capacitance down to chassis. In some tuners  $C_{14}$  might appear further down the line. (Fig. 4 (b)), this being done presumably to improve tracking. I would guess that some tuners might not have  $C_{14}$  at all, the required extra capacitance being provided by giving  $C_{15}$  a larger value."

"How do the primary and secondary circuits couple together?"

"That's one of the points," said Smythy, "I was going to explain later. The favourite scheme seems to consist of having slots in the screen between the two tuned circuits. I've indicated these, incidentally, in my original drawing. (Fig. 1.) The slots allow sufficient capacitive coupling between the two tuned circuits to enable them to function as a bandpass pair."

"As a bandpass pair?" said Dick, astonished. "But that's exactly what you have, with coils, between the r.f. amplifier and mixer of a Band I-Band III tuner!"

"That's right," grinned Smythy, "and that's exactly what you have, with lines, between the r.f. amplifier and mixer of a Band IV-Band V tuner!"

"Well, I'm dashed," exclaimed Dick. "This u.h.f. tuner business is much simpler than I thought it was going to be."

"I know it is," said Smythy, "and it's the simplicity of the basic tuner we're considering, combined with its commonsense engineering approach, which makes me so certain that it represents a stabilised design. Of which, as I say, we will see plenty of practical examples in the future."

But Dick's thoughts had turned to a different matter.

"If you've got slots in the screen," he queried, "how do you adjust the coupling between primary and secondary?"

"So far as I know," said Smythy, "you can't. Apparently, bandwidth can be varied by adjusting the

mixer loading, and an easy way of doing this would consist of moving the wire between the cathode of  $V_2$  and its bias resistor and capacitor closer to or further away from the secondary line."

"What sort of response do you get from the primary and secondary tuned circuits?"

"The usual bandpass response," replied Smythy, laconically. "Double-humped and flat within 2 to 3dB over 8 Mc/s or so."

"And this is achieved over the entire tuning range?"

"Oh yes," replied Smythy. "Apart from the trimmers at either end of the lines there are other tracking adjustments as well. For instance, you can have split tuning capacitor vanes whereupon you adjust the segments of the outside vanes for correct tracking as you tune across the range. I should add that all these adjustments, tracking and so on, would be carried out at the factory where the tuner was made, of course."

### The Oscillator

"Well, I think that's cleared up all my major queries," remarked Dick, "apart from the oscillator. That really is a shocker!"

"No, it isn't," said Smythy, "it's pretty simple really. A good approach is to start from something you already know which, in this instance, is a conventional Band I-Band III oscillator. (Fig. 5 (a).) How does that work?"

"It's just a Colpitts," said Dick, taking a sheet of Smythy's paper and scribbling on it. "All you do is to add the  $C_{ak}$  and  $C_{gk}$  to the circuit (Fig. 5 (b)) and these two capacitances give you a capacitive tap into the tuned circuit and, therefore, the Colpitts oscillator set-up."

"That's very nicely explained," commended Smythy, retrieving his paper. "Now I'll show you what happens with the u.h.f. tuner oscillator circuit. As it stands, and ignoring the i.f. coil, it looks like this. (Fig. 5 (c).) The next step is to show the line as a coil and it will make life easier here if we drop the trimmers as well. We can also lose  $C_{20}$  because its reactance at u.h.f. is quite low. (Fig. 5 (d).) O.K."

Dick examined Smythy's sketched circuit diagrams closely.

"Yes," he said. "There seem to be no snags so far."

"Right," continued Smythy. "All I now have to do is to add the  $C_{gk}$  and  $C_{ak}$  (Fig. 5 (e)), whereupon, hey presto, we've got a Colpitts oscillator again! Mind you,  $C_{23}$  is now in series with the coil, but its relatively

low reactance, compared with  $C_{gk}$ , won't upset the Colpitts operation."

"Well," commented Dick, "it certainly is a Colpitts after all! But I'm still not happy about it."

"In what way?"

"Well," said Dick, "for instance the grid is earthed."

"So what? You've still got the  $C_{ak}$  down to the cathode."

"But that's earthed, too."

"No, it's not," said Smythy. "The cathode's floating. It's floating on the end of the wire which connects to  $R_2$  and  $C_{18}$ . That piece of wire offers quite a high impedance at u.h.f., you know."

"Of course it does," exclaimed Dick, light breaking in. "I can see it all now. You know, Smythy, that's quite an oscillator circuit!"

"It is ingenious, isn't it?" said Smythy. "I should add one further point about it incidentally. You'll note that the lowish-value capacitor  $C_{20}$  couples the anode of the oscillator to the top of the line. This capacitor doesn't affect the oscillator action. Its function, instead, is to reduce changes in capacitance at the anode when the oscillator variable capacitor is adjusted. Such changes in capacitance would tend to detune the i.f. coil."

"Incidentally," said Dick, as a sudden thought struck him, "what is the i.f. output of the tuner?"

"The same as the receiver i.f.," replied Smythy. "The associated Band I-Band III tuner will probably have a biscuit which is tuned to receiver i.f. The output of the u.h.f. tuner would then go into this biscuit and be applied to, say, the Band I-Band III mixer grid. This offers a very simple method of switching in the u.h.f. tuner. However, there are plenty of other possible ways of coupling the u.h.f. tuner output into the receiver."

"What's the test point after choke  $L_8$  for?" asked Dick, returning to Smythy's basic circuit diagram.

"For factory alignment," explained Smythy. "To examine the r.f. response curve of the tuner, it's necessary to feed an output at i.f. into the factory wobblator scope. You've got to get at this output before it hits the i.f. coil in the tuner, or the latter will modify its shape on the scope."

"But," objected Dick, "the i.f. coil is still in circuit if you use the test point."

"That's true," said Smythy, "but that's partly because I've only shown a simplified i.f. circuit in my sketch of the basic tuner. There would probably be some means of reducing the effect of the i.f. coil in a practical tuner, either by using a more compli-

cated circuit or by damping the coil out in some way. Even with my simplified circuit you can still overcome the effect of the i.f. coil."

"How's that?"  
 "By the simple process", said Smithy, "of feeding h.t. to the mixer anode via the test point and a suitable external load instead of via the i.f. coil."

#### The Aerial Circuit

"That seems", commented Dick, "to have pretty well cleared up everything. There's only one point outstanding, and that concerns the aerial circuit. Despite the wide range of frequencies covered, the

aerial circuit doesn't have a tuning capacitor at all."

"Ah yes," said Smithy. "We referred to that earlier, didn't we? The aerial circuit is mainly aperiodic, although there is a pi coupling which matches the aerial to the cathode of the grounded-grid r.f. amplifier at the higher frequency end of the band. The trouble here is that the input impedance of the grounded-grid triode is so low that whatever tuning arrangements you had would be pretty broad in response anyway. At any rate, there is no attempt to use a variable tuning capacitor in the aerial stage or any tuner unit that I've heard about myself. Such a

circuit would be quite possible of course but, as I say, it does not seem to be used in current tuners."

Smithy stubbed out the remains of his cigar.

"And that," he said, rising and looking at his watch, "is that. There's five minutes to go before packing-up time, and I think we could usefully employ those in sticking my basic tuner unit diagram up on the wall."

Without further ado, Dick produced a hammer and a box of tacks and commenced, under Smithy's supervision, to fix the diagram to the wall. The Workshop had now officially entered the U.H.F. Age.

## TRADE REVIEWS . . .

### LEARN

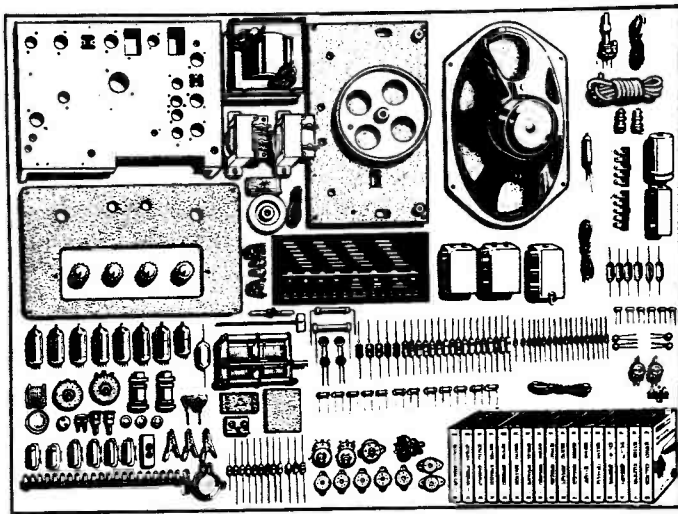
#### Whilst You Construct

If you are a beginner and wish to know more about radio and TV, etc., *Radiostructor* provides one of the finest practical courses in electronics training available today. Each course is supplied complete with a set of picture book manuals and the specially designed training kits, which are also provided, are retained by the student.

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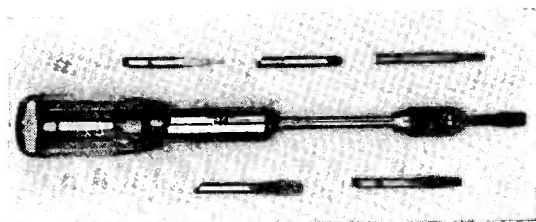
The illustration alongside shows some of the components issued with the main *Radiostructor* course.

An exciting colour brochure providing complete details is available direct from *Radiostructor*, Reading, Berks.



#### NEW RATCHET TURNSCREW WITH SIX INTERCHANGEABLE BITS

The illustration below shows the latest addition to the Guys (Handtools) Ltd comprehensive range of turnscrews which we feel would be of interest to our readers.



This extremely handy tool, which we have inspected and tested, is basically a ratchet turnscREW having an overall length of 9in. It is fitted with a spring loaded quick release chuck and a magazine pattern handle containing six bits for use with slotted screws, Phillip's type screw and an awl.

The ratchet mechanism can be set to drive or withdraw screws and it can be locked in a third position allowing the tool to be used as a rigid screwdriver. The finish is chromium-plating on the barrel, shaft and cap, with nickel-plated bits and chuck, and amber "tenite" handle. Available as extras are BA nut driving heads in sizes 2BA, 4BA and 6BA priced at 2s. 9d. each, these being very useful for the radio and home handyman.

The price (retail) of this well-made and robust tool (model R96 individually carded) is 18s. 9d. The address is Guys (Handtools) Ltd., 13/17 East Dulwich Road, London, S.E.22.

By  
D. BELL

Part Two

# Zener Diode Stabilised Power Supplies

THE POWER SUPPLY MADE BY THE WRITER ENABLES a Grundig "Cub" transistor battery-operated tape-recorder to be supplied from 240V a.c. mains without the internal batteries being in circuit. The supplies required are  $-6V$  at 280mA and  $-9V$  at 11mA, the positive lines of both supplies being common. In the recorder the  $-9V$  supply is obtained by adding a 3V battery in series with the 6V battery.

## The Circuit

The circuit of the power unit is shown in Fig. 8 and is extremely simple in design. The component requirements are all fairly flexible excepting the zener diode which supplies the motor; this must be capable of dissipating 2W and a 5W VR525A, VR575A or VR625A is recommended. The actual voltage required for the supply is 6V, supplied by the VR625A, but the writer used an available VR525A, a 5.25V nominal diode.

The recorder has a centrifugally operated speed regulating system, this employs a centrifugal switch which, when the speed falls below a pre-determined level, closes and increases the current to the motor

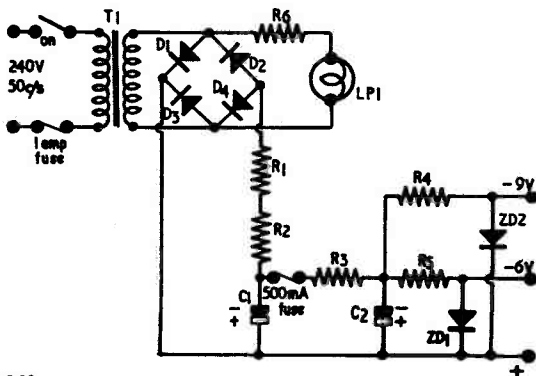


Fig. 8. Circuit diagram of power unit

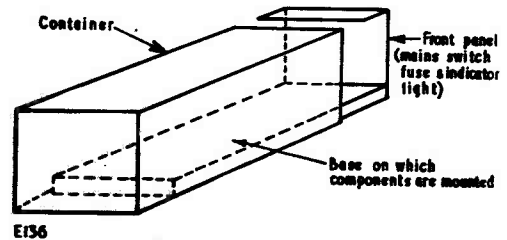


Fig. 9. Method of chassis construction

and therefore increases the speed. The switch opens at another pre-determined level with the result that the current in the motor oscillates between two levels. This allows the motor to operate at a battery voltage lower than nominal.

A mains transformer with a 50 volt secondary was used by the writer, again because it was available. However, a transformer output of between 20V and 50V would be satisfactory. The higher voltage gives better regulation and allows the inclusion of several stages of smoothing, thereby reducing the hum level, whilst still being low enough to keep the power dissipation in the overall voltage dropping resistor within reasonable limits (about 13W).

A selenium bridge rectifier can be used or alternatively, to reduce chassis size to a minimum, semi-conductor power diodes. Construction can be varied to suit individual tastes and requirements, but the writer produced his own unit in a 9 x 3 x 3in aluminium case. (Fig. 9.) The mains switch, fuse and indicator light were mounted on the front panel, all the remaining components being attached to the base plate. Ventilation is essential and can best be achieved by cutting holes or slots in the sides of the case.

As was explained earlier it is advisable to bolt the zener diodes to a heat-sink. Fig. 10 shows the construction of the diodes. The threaded end is the

E85

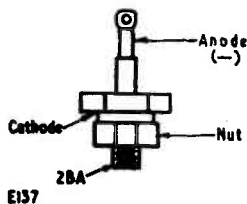


Fig. 10. Zener Diode construction

cathode, and this is connected to the positive of the supply (in this instance the positive is common and therefore the diodes can be bolted directly to the chassis). The anode is the solder-tag end and is connected to the appropriate series resistor.

When using semi-conductor-power diodes for rectifying the secondary output voltage they can be mounted on a piece of Paxolin to provide insulation. Again, the large end is the cathode.

### Testing

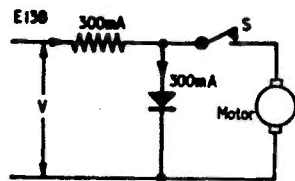
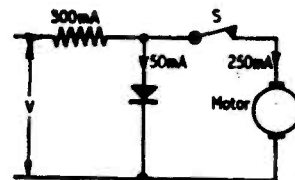
The zener diodes have a spread of stabilising voltage, the range of which is shown in Table II.

TABLE II  
AEI (BTH) Series

| Diode Type  | Reference Voltages (at 20mA) | Slope Resistance (at 20mA) |
|-------------|------------------------------|----------------------------|
|             | Volts                        | Ohms                       |
| VR35 .. ..  | 2.9-4.1                      | 17.2                       |
| VR425 .. .. | 3.9-4.6                      | 16.0                       |
| VR475 .. .. | 4.4-5.1                      | 14.4                       |
| VR525 .. .. | 4.9-5.6                      | 12.8                       |
| VR575 .. .. | 5.4-6.1                      | 5.8                        |
| VR625 .. .. | 5.9-6.6                      | 1.8                        |
| VR7 .. ..   | 6.4-7.6                      | 1.5                        |
| VR8 .. ..   | 7.4-8.6                      | 1.5                        |
| VR9 .. ..   | 8.4-9.6                      | 1.6                        |
| VR10 .. ..  | 9.4-10.6                     | 2.5                        |

The voltage output can be adjusted by monitoring with a meter and in the case of ZD<sub>1</sub> adjusting the series resistor R<sub>5</sub> until the voltage is set to the required value.<sup>1</sup> To increase the voltage output, increase the current in the diode by reducing R<sub>5</sub> and, to reduce the voltage, increase R<sub>5</sub>. Care must be taken when increasing the current in the diode that the maximum power dissipation is not exceeded—it must be remembered that this is a maximum when the motor is switched OFF. On no account should the current in the diode exceed the value of 800mA.

<sup>1</sup> In this particular application the required value may be below the normal 6 volt output of the power unit.—EDITOR.



E139

Fig. 11 (a). Motor on

Fig. 11 (b). Motor off

The action of ZD<sub>1</sub> in Fig. 8 is as follows. When the motor is running with switch S closed, as in Fig. 11 (a), the motor current is approximately 250mA and the diode current is 50mA. When the motor is switched off all the current, necessary to maintain the output voltage constant, passes through the diode, as in Fig. 11 (b). The diode must be capable of dissipating the watts developed; in this

case  $VI = \frac{6 \times 300}{1,000} = 1.8W$ , which is well within the

5 watt rating of B.T.H. zener diode ZR525A.

### Components List

#### Resistors

- R<sub>1</sub>, R<sub>2</sub> 33Ω 6 watt wirewound resistor
- R<sub>3</sub> 22Ω 6 watt wirewound resistor
- R<sub>4</sub> 68Ω  $\frac{1}{2}$  watt carbon resistor (value may require adjustment)
- R<sub>5</sub> 27Ω 6 watt wirewound resistor (see text)
- R<sub>6</sub> 680Ω 5 watt wirewound resistor (this is the value required with a 6.3V 80mA bulb)

#### Miscellaneous

- T<sub>1</sub>—240V 50 c.p.s. primary, 50V 400mA secondary
- D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub>, D<sub>4</sub>—Full-wave bridge rectifier 100V 320-400mA or 4 Mullard OA210 power diodes or B.T.H. GJ3M, GJ5M or GJ6M or International Rectifier 5E4
- C<sub>1</sub>, C<sub>2</sub>—50μF 50WV
- ZD<sub>1</sub>—VR525, VR525A, VR575A or VR625A —A.E.I. or B.T.H. zener diodes<sup>2</sup>
- ZD<sub>2</sub>—VR9—manufacturer as ZD<sub>1</sub>
- Switches, fuse (500mA) and fuseholder to suit.

(conclusion)

<sup>2</sup> Some of these diodes may provide an output lower than the nominal 6 volts.—EDITOR.

Cover Feature

# A FAMILY RADIOGRAM

PART 1

by A. S. CARPENTER

*In this article, our contributor introduces a comprehensive radiogram which is especially intended for family entertainment. A particular feature of the instrument is that it may be fitted into a ready-manufactured cabinet, thereby ensuring professional presentation with the minimum of carpentry. The present article fully describes the amplifier unit and its power pack; and details of the tuner unit and general assembly will be given in the concluding article which appears next month*

THE AVAILABILITY OF VARIOUS BLANK CABINETS of contemporary styling solves the constructor's problem of housing his home-constructed equipment elegantly.

Much home-built gear is of good design and is well made, but does not always please others because of its external appearance. In purchasing a ready made cabinet extra expense may be involved, of course, but it enables the home constructor to finish up with an article which is superior to that of his uninitiated neighbour.

The monaural radiogram to be described in this and the succeeding article was constructed recently and has already provided a great deal of listening pleasure. Built into one of the Nordyk equipment cabinets manufactured by Record Housing, it is attractive in design and appearance, and its small physical size—20in wide by 16in deep by 14in high (excluding legs)—makes it acceptable in the smallest of living rooms. A separate loudspeaker enclosure is used and this is a desirable feature.

## Requirements

A radiogram built specifically for family use needs to be of simple form and a conglomeration of knobs is undesirable. (2) Only essential controls should be fitted. It is probably true to say that a great many families enjoy listening to a wide variety of records including "pops", and if teenagers are apt to gather round, a good "beat" is often demanded together with the facility for fitting a pile of their favourites to the control spindle. This makes the use of an autochanger necessary. Although hi-fi fans usually abhor autochangers—which frequently have a Manual play position anyway—there is something to be said in their favour in that they can handle discs less clumsily

than some ham-fisted humans! This radiogram utilises a Monarch 4 speed autochanger type UA8, although a single player or an alternative make may be fitted if preferred.

The Nordyk cabinet is made with two slots so that any type may be slid in on its motor board as required. In this case the lower slot is used to provide spindle clearance and to make sufficient space available for the radio tuner.

On the radio side one has to choose a tuner type from the following list:

- (1) A.M. superhet
- (2) F.M. superhet.
- (3) A.M. t.r.f.
- (4) Dual a.m./f.m. superhet.

Where the family requires to listen to Radio Luxembourg occasionally the list may be generally shortened to types (1) and (4), and of these type (1) is likely to prove simultaneously the more simple; (3) efficient and inexpensive. It is also necessary to provide an audio output from the tuner which is comparable to that provided by the pick-up.

A valve a.m. tuner unit is used here as opposed to a transistorised version since considerable heat, which is the enemy of transistors, is dissipated by the main amplifier and power pack. Conventional a.m. superhet tuners are often said to be noisy and apt to produce a whistle but this is unjust criticism. Often the blame lies with the user who fits neither aerial nor earth leads and expects good results. A well-built a.m. superhet tuner is sensitive and, although better quality is obtainable from a v.h.f. type, one is limited to B.B.C transmissions with the latter and cost differences are not inconsiderable. However, the general arrangement of the radiogram permits a different type of tuner to be fitted or experimented with, if desired, without disturbing the gram set-up in any way.



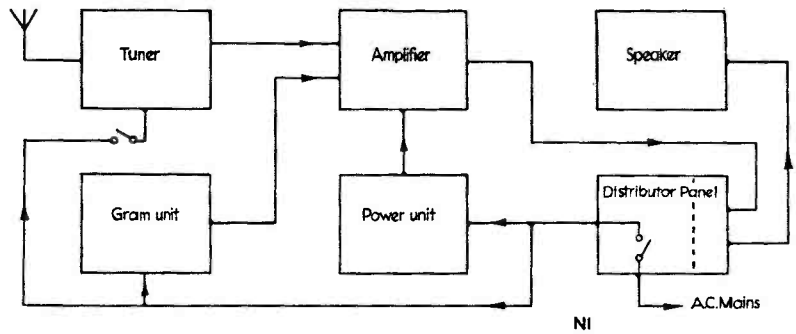


Fig. 1. Block diagram of the layout

### The General Set-Up

It is fairly easy to make the separate sections of a radiogram, but problems arise usually over interconnection and switching. Differing values of load, etc. have to be considered. Also, it is wasteful to keep the tuner operative when the gram is in use and sometimes the tuner heaters are left in circuit with h.t. supplies cut down to starvation level. In the present instance the tuner is entirely self contained and is provided with a panel warning lens and on/off switch of its own. The tuner in this radiogram can in fact be removed entirely, whereupon it will in no way affect the gram function, main amplifier or power pack. (It should be pointed out that some readers might find the tuner suitable for use on its own with different or already existing equipment).

Unit interconnection is by means of a distributor panel (to be described next month) which carries the mains on/off switch, connecting block and other components, and which is mounted on the back of the cabinet. A block diagram showing the overall plan is given in Fig. 1, where it will be observed that mains supplies are connected to the distributor panel and conveyed via the switch to the gram unit motor, the amplifier power pack and radio tuner. Signals are fed from the gram or tuner into the amplifier and selected as desired. These pass to the distributor panel where the external speaker enclosure leads are plugged in.

Two warning lens are fitted, one to the radio panel as mentioned earlier and one, for the amplifier, to the front of the cabinet. Hum and noise levels are so low that it is necessary to fit these in order to ensure that the equipment is switched off after the last record has been played.

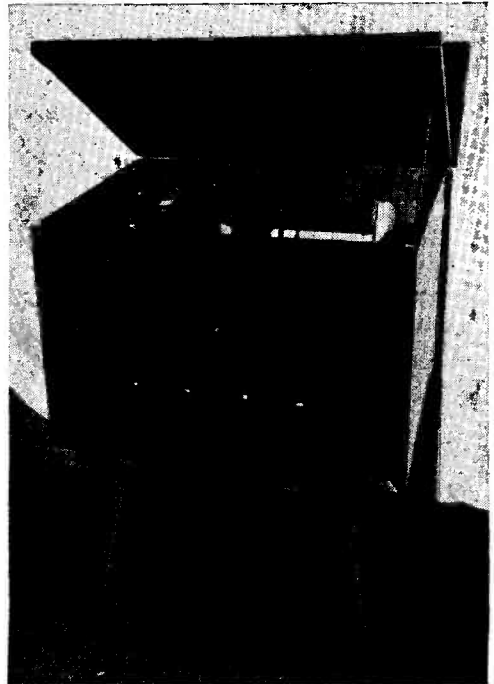
### Positioning of Units

As may be seen from the illustration the tuner (which is 4½ in high) stands on the motor board (to the left of the turntable). The main amplifier and its power pack stand in the compartment below the motor board, the control spindles projecting through from there. The front warning lens is fitted so that the bulb illuminating it is flush with the top of the motor board inside, so

doing double duty by illuminating the player deck. The lid may be closed when the apparatus is in use but it is desirable to fit thin felt or rubber cushions to prevent it excluding a small air flow that is required for cooling purposes. Holes are provided in the cabinet bottom, from whence cool air is converted upwards. A slot has also to be cut in the hardboard back panel to further assist in this respect. These points are dealt with in greater detail next month.

### The Amplifier

It is beneficial to cater for an audio output considerably greater than that which will normally be required, since distortion will occur if the



General view of the radiogram (with lid held open at a convenient angle by a ruler for photographic purposes)

## Components List

Resistors—(1W 20% except where stated)

|     |  |
|-----|--|
| R1  | 1MΩ  |
| R2  | 22kΩ                                       |
| R3  | 2.2kΩ                                      |
| R4  | 100kΩ 10% HS                               |
| R5  | 270kΩ                                      |
| R6  | 22kΩ                                       |
| R7  | 3.3kΩ                                      |
| R8  | 47kΩ 10% HS                                |
| R9  | 2.2kΩ                                      |
| R10 | 22Ω  |
| R11 | 1MΩ  |
| R12 | 1.2kΩ                                      |
| R13 | 33kΩ 2% HS                                 |
| R14 | 33kΩ 2% HS                                 |
| R15 | 12kΩ 1W                                    |
| R16 | 270kΩ 5%                                   |
| R17 | 270kΩ 5%                                   |
| R18 | 2.2kΩ                                      |
| R19 | 2.2kΩ                                      |
| R20 | 270Ω 1W                                    |
| R21 | 270Ω 1W                                    |
| R22 | 180Ω                                       |
| R23 | 1kΩ for 3.75Ω output<br>2kΩ for 15Ω output |
| R24 | 180Ω                                       |
| VR1 | 500kΩ log.                                 |
| VR2 | 250kΩ lin                                  |
| VR3 | 1MΩ log.                                   |
| VR4 | 100Ω wirewound                             |

## Capacitors

|     |                       |
|-----|-----------------------|
| C1  | 150pF mica            |
| C2  | 820pF mica            |
| C3  | 0.05μF, paper         |
| C4  | 300pF ceramic or mica |
| C5  | 3,000pF mica          |
| C6  | 100μF electrolytic 6W |
| C7  | 50μF electrolytic 6W  |
| C8  | 150pF silver mica     |
| C9  | 0.05μF paper          |
| C10 | 0.05μF paper          |

|     |                         |
|-----|-------------------------|
| C11 | 0.05μF paper            |
| C12 | 100μF electrolytic 50WV |
| C13 | 100μF electrolytic 50WV |
| C14 | 1,000pF mica            |
| C15 | 1,000pF mica            |
| C16 | 1,000pF mica            |
| C17 | 32μF electrolytic 350WV |

## Output Transformer

See text for specification  
Type T1044 (Southern Technical Supplies, 83  
Station Road, Portslade, Sussex) or equivalent

|        |       |
|--------|-------|
| Valves | ECC83 |
| V1     | EF91  |
| V2     | EF91  |
| V3, 4  | EL84  |

## Switch

|        |              |
|--------|--------------|
| S1, S2 | 2 pole 2 way |
|--------|--------------|

## Sockets

|   |                             |
|---|-----------------------------|
| 1 | coaxial socket              |
| 1 | twin socket, non-reversible |

## Plugs

|   |            |
|---|------------|
| 1 | octal plug |
|---|------------|

## Tagstrips

|   |                                 |
|---|---------------------------------|
| 1 | 6-way none earthed              |
| 1 | 6-way, left hand tag earthed    |
| 1 | 5-way, second from left earthed |

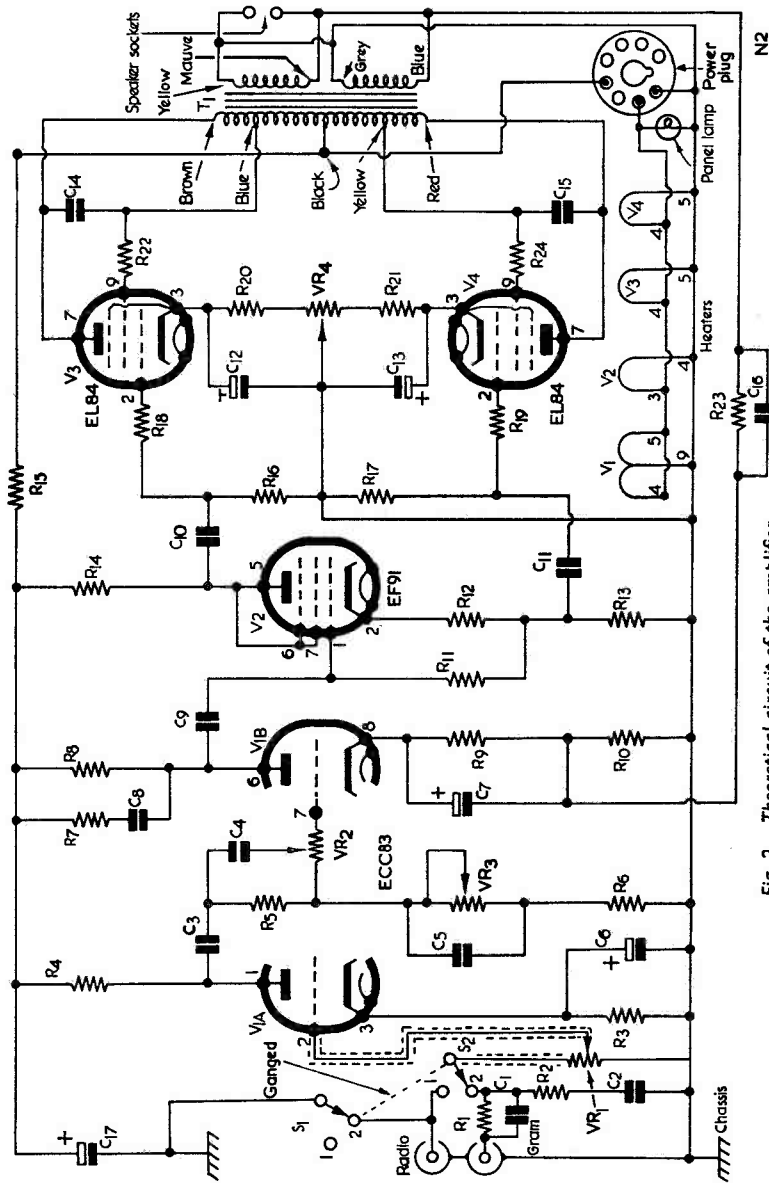


Fig. 2. Theoretical circuit of the amplifier

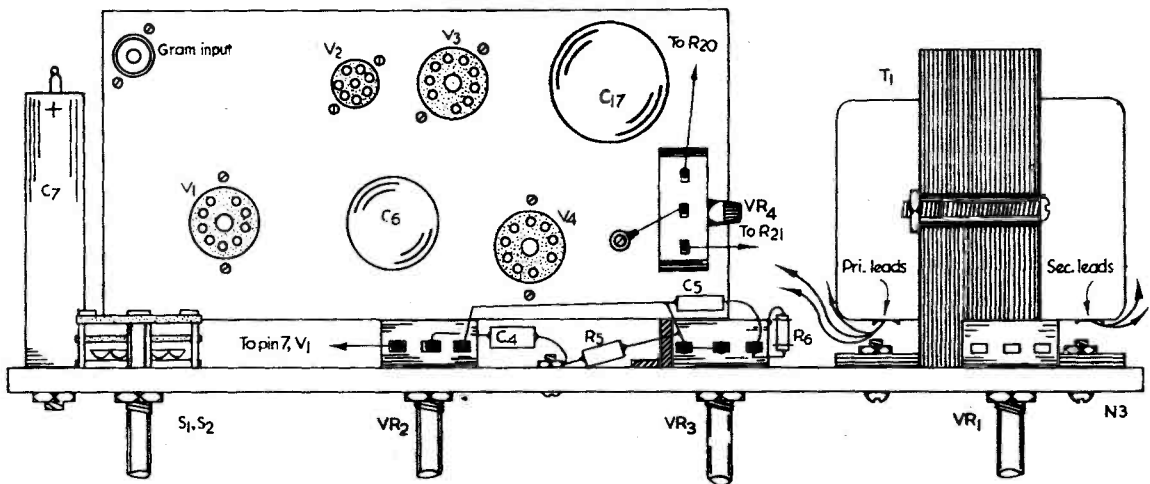


Fig. 3. The amplifier above-chassis layout.

available power is inadequate for sudden peaks. Here an output in the region of 10 watts is aimed at, and makes necessary a push-pull output stage which is operated under ultra linear conditions. The theoretical circuit diagram is given in Fig. 2. The screen taps for the output valves are made at 43% points in the primary winding and a means of current balancing is provided. Four valves are used and comprise: EL84 (2), EF91(1), ECC83 (1).

The output valves are balanced by adjusting VR<sub>4</sub> until zero d.c. voltage appears across the output transformer primary under no signal conditions. In the circuit diagram, these valves are fed from a conventional phase splitter which is in turn fed by one half of an ECC83 via a tone control network. Cut and boost is catered for and the controls are: VR<sub>2</sub>—Treble and VR<sub>3</sub>—Bass, continuously variable controls being preferred. Component values here are such that the prototype controls find themselves set to mid-travel for most of the time. A moderate amount of negative feedback is applied from the output transformer secondary to V<sub>1(b)</sub> cathode and this, together with

grid and screen stoppers in the output valve circuits, assists in maintaining stable conditions.

The input from the appropriate gram or tuner socket is selected by S<sub>2</sub> and applied to the control grid of V<sub>1(a)</sub> via the volume control VR<sub>1</sub>. A simple rotary switch is utilised for S<sub>1</sub>S<sub>2</sub>, one section short-circuiting the radio socket to chassis to prevent breakthrough should the tuner be left switched on whilst the gram is in use. Only modern microgroove records exist in the writer's collection so a simple filter is used at the gram input to provide frequency correction, and to present a sufficiently high input impedance to the pick-up (which is a crystal type) to prevent low frequency attenuation. The input sensitivity is of the order of 100mV allowing for a tone control network insertion loss of 20dB so that attenuation of the gram signal is desirable. Components R<sub>1</sub>, R<sub>2</sub>, C<sub>1</sub>, C<sub>2</sub> in conjunction with VR<sub>1</sub> perform the required tasks.

High fidelity (in its purest form) is not aimed at here specifically, since this would necessitate much more ambitious equipment. The quality obtained is, however, extremely pleasing to listen to, as might be expected.

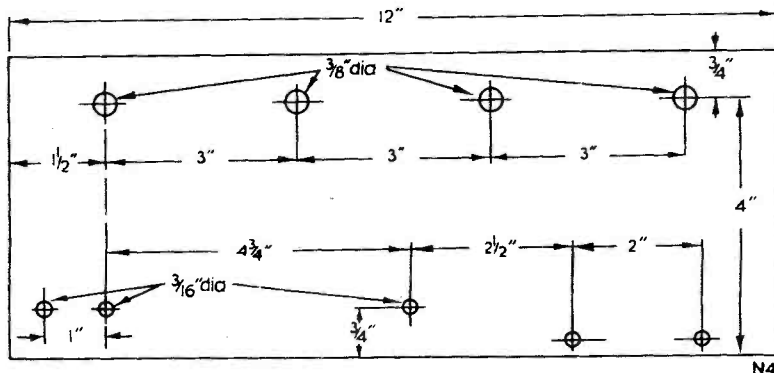


Fig. 4. The amplifier control panel.

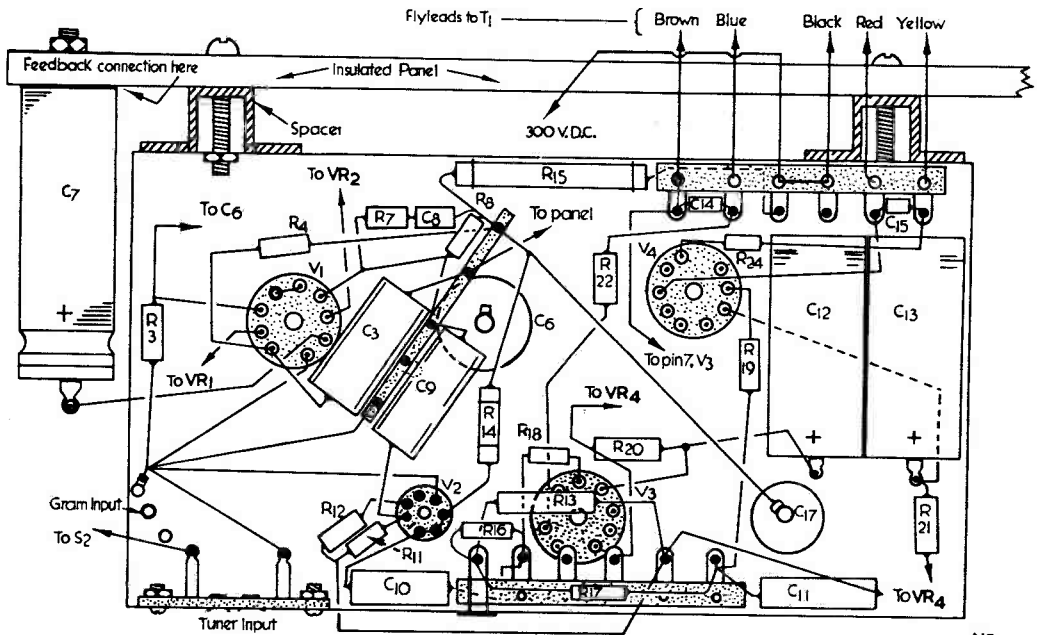


Fig. 5. The amplifier below-chassis layout

Power connections are made to the power pack by way of a standard International Octal plug.

### The Output Transformer

This is built on generous lines and is a Mullard "5-10" model. The suppliers' specification is as follows:

Primary impedance 8,000 $\Omega$

Primary inductance at 10V, 50 c/s—70H

Leakage inductance, Primary to Secondary—20mH

Rated output—12.5 watts

Taps for ultra linear operation at 43% of primary.

Secondary windings may be connected series fashion for an output impedance of 15 $\Omega$  and in parallel for 3.75 $\Omega$  operation. All terminations are flying leads. Fig. 2 shows the secondary windings connected in parallel for 3.75 $\Omega$  output impedance.

For 15 $\Omega$  output impedance the grey and mauve leads are connected together, the output being taken from the yellow and blue leads. The value of R<sub>23</sub> is increased to 2k $\Omega$  for 15 $\Omega$  operation.

### Mechanical Details—Amplifier

Since the four control knob spindles project through the face of the cabinet it is desirable to mount them in a way which is inoffensive to the eye. They are, therefore, mounted on a panel which allows a symmetrical layout to be achieved. This panel needs to be rugged as it has to carry considerable weight, and that employed in the prototype comprised a vintage piece of  $\frac{1}{4}$ in thick ebonite. The controls are fitted to this panel as are also the chassis (which is only  $6\frac{1}{2}$ in wide), the output transformer and C<sub>7</sub>. The latter is thereby isolated from the chassis for feedback connection purposes.

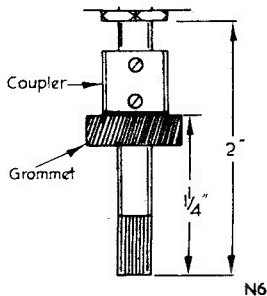
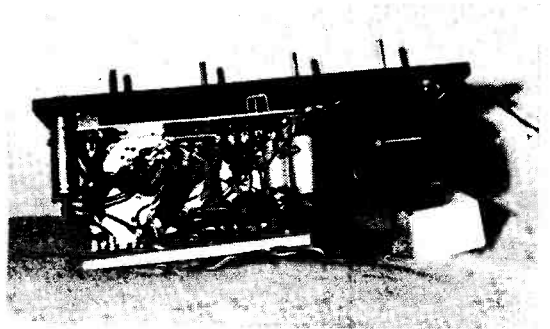


Fig. 6. Amplifier control spindle arrangements



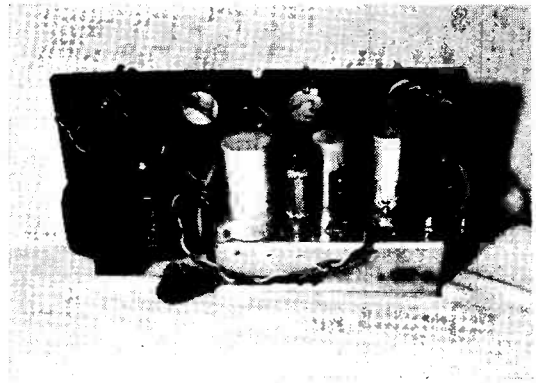
Below-chassis view of the amplifier

The output transformer is fitted on its side (see Fig. 3). The overall height is thus kept at a minimum and sturdy spacers hold the chassis clear of the panel so that the potentiometers cannot foul  $V_1$  or  $V_4$ <sup>1</sup>.

The precise locations of the above-chassis components can be seen in Fig. 3. The tuner input socket is mounted on the rear flange of the chassis (see Fig. 5) and consists of a twin socket such as is used for TV twin feeder. Coaxial sockets may be used in both positions if preferred and may be mounted in the same plane although, as placed here, no incorrect connection can be made. Panel dimensions are given in Fig. 4, and chassis dimensions in Fig. 7.  $VR_4$  is mounted above the chassis on a small L-bracket.

An inspection of Fig. 5 will show the below-chassis layout of the amplifier, the output transformer not being included for purposes of clarity.

<sup>1</sup> If a metal panel is employed instead of the ebonite panel used in the prototype, C<sub>7</sub> terminals and the junction of C<sub>4</sub> and R<sub>5</sub> will of course have to be insulated from it. A metal panel would also automatically connect the output transformer shroud to chassis. With the ebonite panel it would be preferable to bond the output transformer shroud (a connection being taken from one of its mounting nuts) to the chassis by means of a length of wire. With the ebonite panel, potentiometer covers should also be connected to chassis.—EDITOR.



Above-chassis view of the amplifier

Note the rugged  $\frac{1}{2}$  in spacers. Two simple tagstrips are bolted to the front and rear flanges and another is fitted close to  $V_1$ . These act as anchors for most of the wiring since the tight layout and small chassis does not allow tagboards to be fitted. It should be noted that none of the tags in the strip adjacent to  $V_4$  are at chassis potential, and that an additional tag or mounting bracket is required with

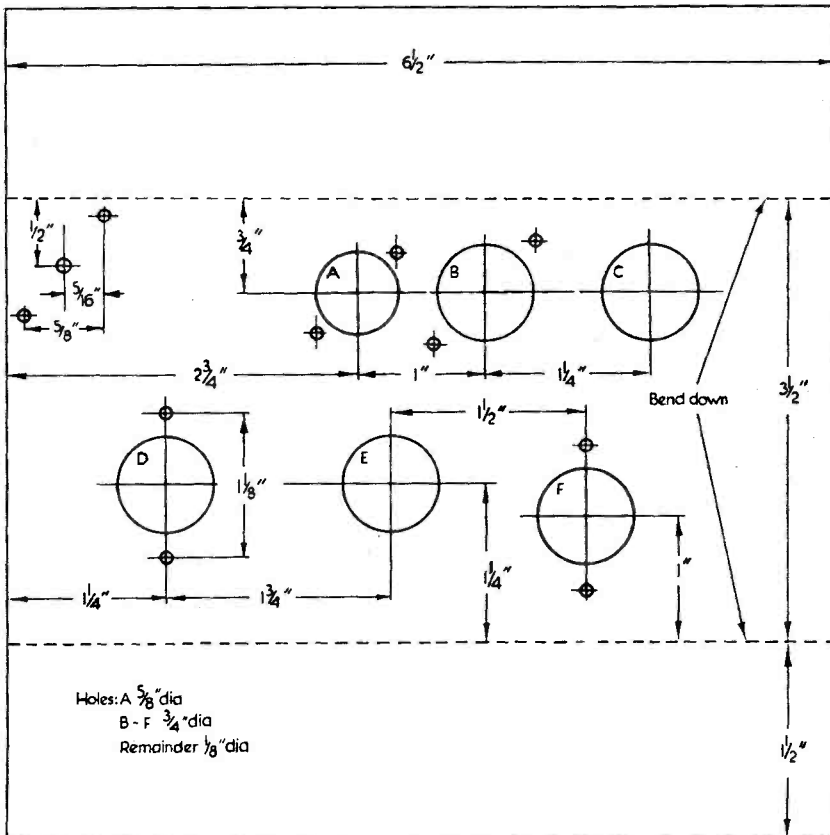


Fig. 7. Dimensions of the amplifier chassis with main drilling details. The aprons are bent down, away from the reader.

N7

## Components List (Fig. 8 (a))

### Resistor

$R_1$  33 $\Omega$  1 watt

### Capacitors

$C_{1(a)(b)}$  32 + 32 $\mu$ F, electrolytic, 450WV

$C_2$  0.02 $\mu$ F, 250V a.c. working

### Valve

$V_1$  5Y3GT

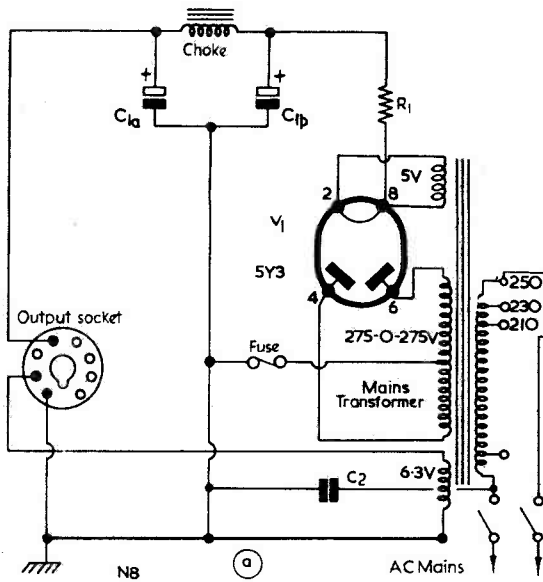
### Mains Transformer

Primary 210, 230, 250V

Secondary 275-0-275V at 85mA, 6.3V at 2.5A, 5V at 2A

### Choke

10H, 85mA



### Fuse

0.15A bulb

### Sockets

2 International Octal

### Miscellaneous

Chassis (to suit components)  
Output socket bracket  
Wire, etc., etc.

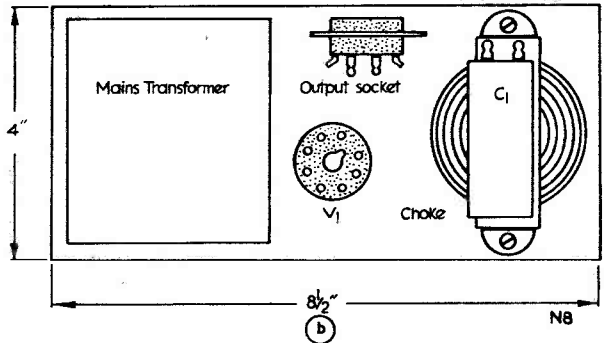


Fig. 8. (a). Circuit diagram of the amplifier power pack (on/off switch is fitted to distributor panel) and (b) layout of the power pack

this strip. The extreme left-hand tag of the strip adjacent to  $V_3$  provides mounting. Mounting is similarly provided by the second tag from the left in the strip adjacent to  $V_1$ . Spire clips retain  $C_{12}$  and  $C_{13}$ .

Much of the amplifier wiring is also shown in Fig. 3 and 5. Heater wiring is not shown, however, but consists of the usual tightly twisted pair of leads. Wiring of the amplifier should be carried out in the normal manner, both Figs. 3 and 5 and the circuit diagram of Fig. 2 being consulted as applicable. It should be noted that a 3-way power cable is connected to the appropriate points in the amplifier, this providing h.t. positive, heater and chassis connections from the power unit. The 3-way cable is terminated in an octal plug having the pin connections shown in Fig. 2.

Coloured primary winding leads emanate from the output transformer base as shown in Fig. 3 and are connected to the tag strip indicated in Fig. 5.

The secondary winding leads—also colour coded and connected to suit the particular speech coil in use—are anchored to the front panel to simplify external connection.

Conventional wiring techniques are employed and practically all chassis returns are made at the input socket to avoid undesirable chassis currents. Where a direct connection is made a heavy copper lead is taken therefrom to the common earthing point.

The use of a control panel necessitates stringing out the controls rather more than is usual, therefore all leads associated with the controls are of screened cable to prevent hum. All four controls need long spindles and these can be made to act as locking devices for the chassis. A glance at Fig. 6 will show how this is done. A standard coupler is slid over the spindles which control the selector switch and  $VR_1$  and a rubber grommet is fitted to each as shown. When the amplifier is fitted into the cabinet the spindles project through the holes provided (which

need to be located and cut very carefully) until the grommets touch the woodwork. Two more grommets are then placed over the outermost spindles and the control knobs brought up to them and secured. The cabinet front is then sandwiched between the grommets which prevent scratching and also act as cushions.

#### The Amplifier Power Pack

In the original a rather bulky mains transformer is used in conjunction with a 5Y3GT valve rectifier and provides an h.t. rail voltage of 320V. The conventional circuit arrangement and layout is shown in Fig. 8 (a) and (b) respectively. Push/pull amplifiers are not infrequently fed from the RC mains smoothing filters these days but here an l.f. choke is used in conjunction with  $C_{1(a)}$  and (b). Resistor,  $R_1$  is fitted for surge limiting purposes and a small fuse—a 0.15A torch bulb—is inserted as a safety measure in case a short circuit should develop on the h.t. line.

The problem of height arises due to the shallowness of the cabinet below the motor board and a drop-through mains transformer is essential if a metal chassis is used. In the prototype an upright mounting type is used and the height problem is resolved by building the pack on a plywood baseboard—a method reminiscent of bygone days! An International Octal valveholder is also fitted for power supply transmission and to receive the plug from the amplifier. The capacitor  $C_2$  is useful in effectively earthing the whole equipment; and it is vital to use a component of adequate rating here.

The 2-pole on/off switch shown in Fig. 8 (a) is not contained in the power pack but is fitted to the distributor panel.

#### General Requirements

Accompanying this month's article is a Components List showing General Requirements. This specifies the principal parts needed for the radio-gram, including the cabinet and auto-changer. It will be noted that the legs can be supplied separately. The manner in which they are fitted to the cabinet is discussed next month. Also discussed next month is the engraving required for the knobs.

#### Components List

##### (General Requirements)

- 1 4-speed Monarch Auto-changer type UA8 (Birmingham Sound Reproducers Ltd)
  - 1 Nordyk Equipment Cabinet (record housing)<sup>2</sup>
  - 1 Set of legs for cabinet (record housing, or to suit individual choice)
  - 1 Signal lamp assembly, Bulgin type D197, red lens
  - 1 Bulb 6.3V, 0.15A
  - 1 Coaxial plug (connection to amplifier)
  - 1 Non-reversible twin plug (connection to amplifier)
- Oddments plywood, screened cable, mains lead, connecting wire, etc., etc.

<sup>2</sup> The cabinet should be purchased uncut except that the gram unit may be fitted to the motor board as described.

## Marconi's and Welsh Independent Television

### TRANSMITTING AND STUDIO EQUIPMENT

Marconi's Wireless Telegraph Co. Ltd. are supplying and installing a considerable amount of equipment for the new independent television service for west and north Wales which is scheduled to begin later this year.

For the Independent Television Authority, the Company are providing two transmitting stations, one at Bryn-y-chain in Caernarvonshire and the other in Flintshire.

The installation at Bryn-y-chain consists of two 500 watt (peak vision) Band III translators in parallel, with two further translators also in parallel to act as standby equipment. This installation is designed for fully remote control and will be operated unattended.

The station in Flintshire will use two 500 watt (peak vision) Band III transmitters in parallel to carry the programme service, with a second pair as standby. The signals will be radiated from a Marconi 16-stack (twin 8) aerial array supported on a 750ft mast.

Wales (West and North) Television Ltd., who will be providing the programmes, have ordered a substantial quantity of studio equipment from Marconi's. The order includes a number of vision and sound distribution amplifiers, a transistorised synchronising pulse generator, a uniselector master control switching system (the latter specially designed for the client), and ancillary equipment.

The studios will be in Cardiff and the programme service will cover south-west, west and north Wales—the first to cater for Wales only—and will bring independent television to many parts of the country for the first time. Wales (West and North) Television Ltd. plan to transmit a considerable number of programmes in Welsh as well as in English.

Installation began early this summer and the service is expected to start in September.

# AN ALL-BAND

# AM TUNER

By B. W. Hollinshead

- A simple tuner unit which will be especially attractive to the beginner

WITH THE V.H.F. SERVICE COVERING THE MAJORITY of Great Britain, it is natural that most enthusiasts will have taken advantage of the undoubtedly fine quality of reproduction that an FM tuner coupled to a high class amplifier offers. However there must be a number of readers who do not use an FM tuner, probably because the fairly high initial cost and the limited programme material available on the v.h.f. service has led them instead to turn to the often much maligned AM tuner to feed their amplifiers.

The choice of AM tuners lies between the superhet and the straight t.r.f. Many enthusiasts will prefer the latter on the grounds of the higher quality of its output which can, in some cases, approach that of an AM tuner. Other points in favour of the t.r.f. are its ease of alignment and relative simplicity, the latter contributing also to a low

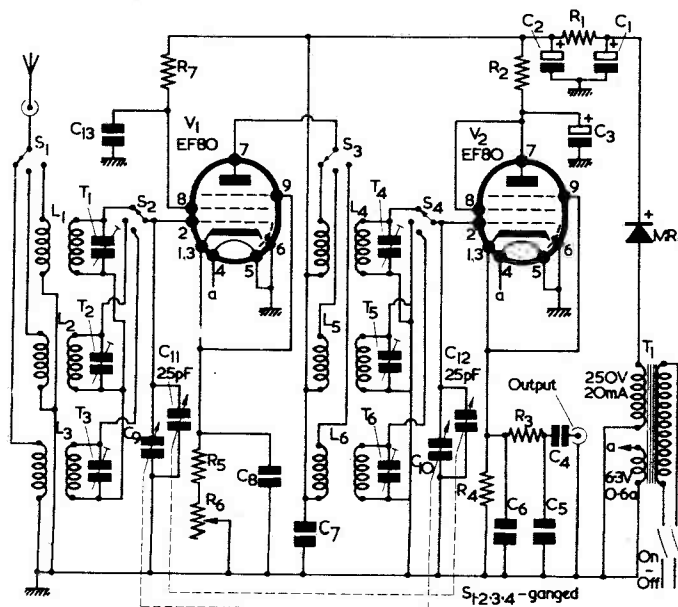
initial cost. The writer had built several such tuners over the past two years with various detectors and coil arrangements and the circuit described here is a development of these.

## Circuit

No originality is claimed for the circuit which covers long, medium and short-wave bands, see Fig. 1. The r.f. stage uses the high slope pentode EF80 (or its equivalents such as the 6BW7). EF80's are cheap and readily obtainable and the high slope gives the tuner a fair degree of sensitivity. A  $1k\Omega$  potentiometer inserted in the cathode circuit of the r.f. valve acts as a volume control, and a 2-pole on/off switch incorporated with the control serves as a mains switch.

Another EF80 is used in the  $V_2$  position as an infinite impedance detector. This arrangement

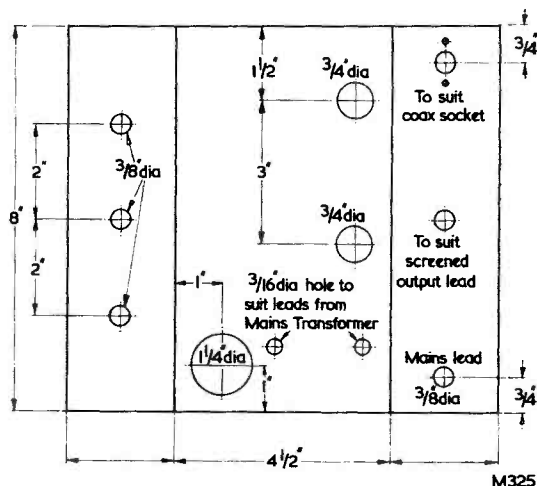
Fig. 1. Circuit diagram of the All-Band A.M. Tuner



M324



Fig. 2. Chassis drilling details



has the advantage of imposing very little damping on its grid tuned circuit, thus enabling tuning to be made very sharp. Also, the choice of an EF80 here cuts the cost as one spare valve only is required for replacements. The load is the  $47k\Omega$  resistor  $R_4$ , and the filter consists of two  $200pF$  capacitors,  $C_5$ ,  $C_6$ , and the  $22k\Omega$  resistor  $R_3$ . These components are mounted on a piece of  $\frac{1}{8}$  in Paxolin measuring  $1$  in by  $1\frac{1}{2}$  in, the leads being passed through holes drilled in the Paxolin and soldered. The  $0.1\mu F$  capacitor  $C_4$  is for d.c. blocking and should not be omitted.

The coils are small dust cored types which have a high "Q" and are very efficient. Six in all are required to cover the long, medium and short-wave bands. Shipping band coils may replace the long-wave coils if the Light programme is available on the medium-wave band. A fourth position on the switch used in the prototype could also be used for adding this band if required. To facilitate tuning on the short-wave band an ex-Government  $25pF$  variable twin-gang capacitor was connected in parallel with the main  $500pF$  tuning capacitor, the smaller component being mounted below the

### Components List

#### Resistors (all $\frac{1}{2}$ watt unless otherwise stated)

|       |                             |
|-------|-----------------------------|
| $R_1$ | $1k\Omega$ 2 watt           |
| $R_2$ | $22k\Omega$                 |
| $R_3$ | $22k\Omega$                 |
| $R_4$ | $47k\Omega$                 |
| $R_5$ | $180\Omega$                 |
| $R_6$ | $1k\Omega$ pot, with switch |
| $R_7$ | $33k\Omega$                 |

#### Valves

|               |  |
|---------------|--|
| $V_1$         | EF80 Mullard   |
| $V_2$         | EF80 Mullard   |
| $T_1$         | Primary 2.0V, Secondaries 250V 20mA, 6.3V 0.6A "Converter" transformer |
| $MR_1$        | 250V, 30mA, contact cooled   |
| $S_{1,2,3,4}$ | 4-pole, 3-way, 2-bank (4-way used in prototype)                        |

#### Coils

|       |           |
|-------|-----------|
| $L_1$ | Osmor QA9 |
| $L_3$ | " QA7     |
| $L_5$ | " QHF8    |
| $L_2$ | " QA8     |
| $L_4$ | " QHF9    |
| $L_6$ | " QHF7    |

#### Capacitors

|                   |  |
|-------------------|--|
| $C_1$             | } $32+32\mu F$ , electrolytic, 350 w.v. (see text) |
| $C_2$             |  |
| $C_3$             | $8\mu F$ , electrolytic, 350 w.v.                  |
| $C_4$             | $0.1\mu F$ , 350 w.v.                              |
| $C_5$             | $200pF$  |
| $C_6$             | $200pF$  |
| $C_7$             | $0.1\mu F$ , 350 w.v.                              |
| $C_8$             | $0.1\mu F$ , 350 w.v.                              |
| $C_9$             | } $500pF+500pF$ variable                           |
| $C_{10}$          |  |
| $C_{11}$          | } $25+25pF$ variable                               |
| $C_{12}$          |  |
| $C_{13}$          | $0.1\mu F$ , 350 w.v.                              |
| $T_{1,2,3,4,5,6}$ | $50pF$ trimmers                                    |

#### Valveholders

B9A (two)

#### Miscellaneous

Coaxial sockets (2), grommets, screened lead, mains lead, nuts, bolts, etc.

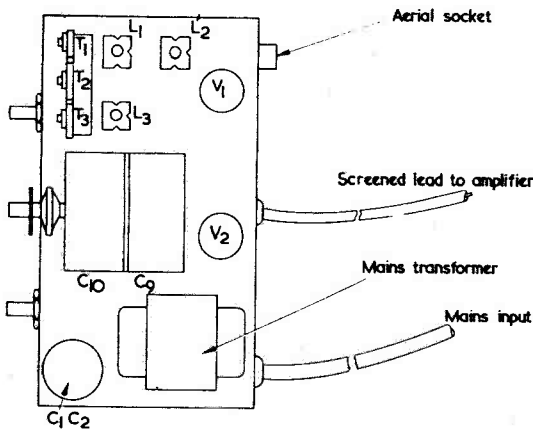


Fig. 3. Above-chassis layout

chassis to obtain a symmetrical layout. Epicyclic reduction drives were fitted to both. The 4:1 reduction ratio thus obtained proved very useful and an elaborate slow motion drive was deemed unnecessary.

### Power Supply

The tuner was self powered for convenience, this being the writer's practice with all his tuners. However, if sufficient spare power is available from the power supply of the main amplifier there is no reason why this should not be used instead, whereupon the power supply in the tuner can be dispensed with. The space thus saved could result in a chassis smaller than that specified. The heater current for the two EF80's is 0.6A and the h.t. requirements some 15 to 20mA. A double wound mains transformer with a 250 volt secondary was used in the prototype, this being the type sold for converters. This ensures complete isolation from the mains supply. A small half-wave contact cooled rectifier is required and smoothing is provided by a double electrolytic capacitor and a 1k $\Omega$  2 watt resistor. A 32+32 $\mu$ F capacitor was used in the writer's model for C<sub>1</sub> and C<sub>2</sub>, this component being to hand at the time, but a 16+16 $\mu$ F type would serve equally well.

### Chassis

The tuner is built on a chassis of 16 s.w.g. aluminium measuring 8in by 4½in with 2in side pieces. The dimensions and positions of the principal components are given in Figs. 2, 3 and 4, although it should be pointed out that different components might require slight rearranging according to their dimensions.

The chassis is initially marked out, scored and bent, sharp corners being removed with a file. The holes for the valveholders, electrolytic capacitors and the various controls are drilled and these components are next fitted. The contact cooled rectifier is mounted below the chassis, care being

taken to ensure that no burrs remain to prevent good thermal contact being made with the chassis, which acts, of course, as a heat sink. The trimmers were removed from an old superhet and consisted of banks of three, this allowing for easy mounting in the positions shown. If individual trimmers are employed, these will need to be fitted to suitable brackets. The coils are too small to allow easy mounting of trimmers on their tags.

### Wavechange Switch

The wavechange switch used in the prototype is a 4-pole, 4-way type having two wafers, the fourth position not being used. Ex-Government switches having 3-poles and 3-ways are obtainable quite cheaply and could easily be used here. To avoid any instability through interaction between the aerial and detector switching, an aluminium screen 2in square is cut, drilled, and fitted on spacers between the two wafers, thus ensuring effective screening. It is advisable to solder lengths of wire to the tags on the switch and code these before mounting as, by doing so, some awkward soldering can be avoided. The front wafer is used for the detector switching and the rear for aerial switching. The leads from the rear wafer should pass through the chassis to the aerial tuned circuits by way of holes immediately above the wafer, thereby ensuring that minimum lead lengths appear below the chassis. The connection between the fixed vanes of C<sub>9</sub> and C<sub>11</sub> should pass separately through the chassis by the shortest possible route.

### Wiring

P.V.C. insulated wire is used for connecting up and it is advisable to start with the power supply. The mains lead is taken through a ¼in grommet at the rear of the chassis, via the switch on R<sub>6</sub>, to the 3-way tagstrip shown in Fig. 4, the mains earth being taken to the anchoring tag. The

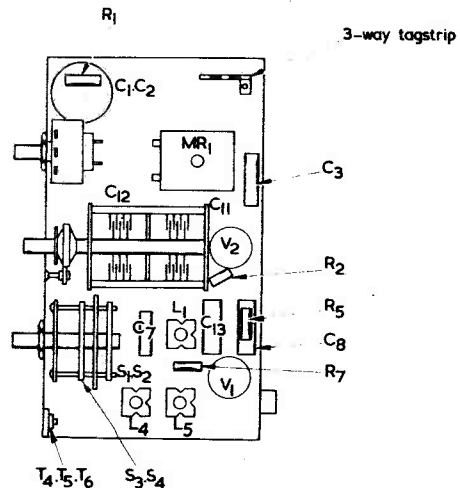


Fig. 4. Below-chassis layout

primary leads of the mains transformer are also taken to this tagstrip. One side of the h.t. winding and one side of the heater winding are connected to a 4BA solder tag fitted under one of the transformer securing bolts. As will be seen from the circuit diagram, resistance capacitance smoothing is used, the low current consumption making a choke unnecessary. Care must be taken to avoid incorrect connections to the metal rectifier.

Although no miniature components were employed in the prototype, no trouble was experienced in mounting them near the valveholders. The EF80 has an internal screen connected to pin 6 and this should be earthed, together with one side of the heater supply, to a solder tag mounted under one of the valveholder securing nuts. Two cathode pins are available on each valve and these should be connected together.

As the coils are on polystyrene formers care must be taken in soldering the leads to their tags. Soldering should be carried out quickly with a hot iron, as prolonged application of heat will cause the polystyrene to melt.

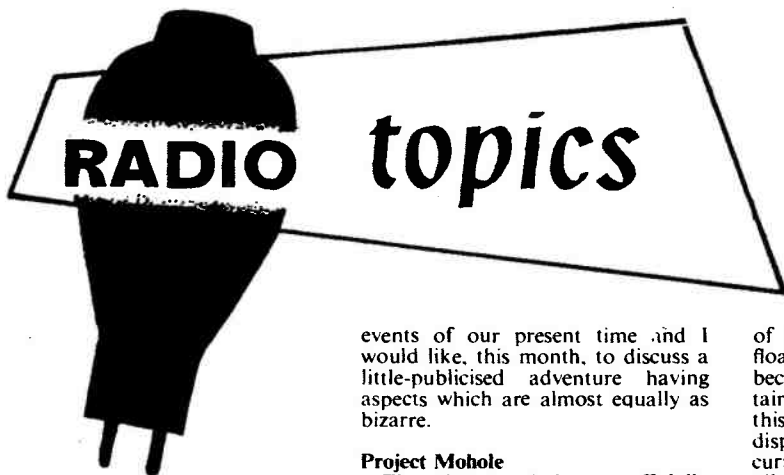
The a.f. output from the tuner can be taken out either via a coaxial socket, or by screened lead through a grommet fitted in the rear of the chassis. The screening of the cable is connected to chassis near the point at which it passes through. When the wiring has been completed, it should be thoroughly checked for errors and also for h.t. short-circuits to chassis. If all is correct, the tuner

can be connected to an amplifier and a good aerial and switched on.

#### Alignment

The alignment of the tuner is very simple and requires no test instruments. As each band has its own coils and trimmers, it can be separately dealt with. On tuning in a station at the low wavelength end of the band (i.e. vanes of the tuning capacitor fully open) the trimmers are adjusted for maximum volume. Next tune in a station near the other end of the scale and adjust the coil cores with an insulated tool for best reception. It is advisable to carry out these adjustments with the vanes of the 25–25pF variable capacitor fully meshed. The operation is repeated for each band. The use of the 25–25pF variable capacitor will be found advantageous, not only on the short-wave bands but also for really accurate tuning on the other bands.

In conclusion, the writer would like to say that this tuner, together with a good aerial, should give a very creditable performance in most areas. It will be noticed that a coaxial socket is used for the aerial input socket in the prototype. This is because the writer has found that, on the advice of G.P.O. engineers, a screened down lead from the aerial is very useful for cutting down whistle from neighbouring TV sets when listening to the Light programme on the long-wave band. Readers can, of course, make arrangements to suit their own aerials and location.



By **RECORDER**

**W**E LIVE, THESE DAYS, IN A world in which the fantastic has become commonplace. Satellites whirl around us, missiles hurtle off into the depths of the Universe, and we accept these things as part and parcel of our everyday life. But Space research on its own does not provide all the outlandish

events of our present time and I would like, this month, to discuss a little-publicised adventure having aspects which are almost equally as bizarre.

#### Project Mohole

The adventure is known officially as Project Mohole, and its object is to obtain a sample of the substance of the Earth. That sample lurks some 18,000 feet below the bottom of the ocean, at a point where water depth itself may be as much as 12,000 feet. The sample will be obtained by drilling, and the drill "string" will be operated from a floating oil rig whose position is controlled by a pilot to an accuracy

of 200 feet in any direction. The floating rig cannot be anchored because no anchor cable can maintain positional stability as high as this. Anchor cables are ruled out by displacement stresses due to ocean currents and their own weight. The pilot, in consequence, will maintain the rig in position by reference to marker buoys and to radar and sonar displays, continually correcting drift by bringing into operation directional propellers as required.

The deepest hole drilled on land is over 25,000 feet, but this was from a stable derrick mounted on solid ground. With the Mohole project the drill string does not find a solid surface until it reaches the

bottom of the ocean. Below this, such oil-drilling operations as casing (lining the hole with heavy steel pipe cemented to the sides), logging (checking the nature of the material being drilled by lowering measuring devices) and coring (the removal of samples of the material) have to be carried out whilst the hole is subject to the immense pressures of the water above.

The preliminary story of the Mohole is told in *A Hole In The Bottom Of The Sea* (Weidenfeld & Nicolson, 25s.) by Willard Bascom, who is Director of the Project. *A Hole In The Bottom Of The Sea* is a fascinating book, not only because it covers all features of the venture with the single-minded certainty that it will succeed, but also because of the descriptions of the ingenious manner with which existing techniques from almost all sciences, ranging from seismology to closed circuit television, will be bonded together for one single purpose.

#### AMSOC

Project Mohole will have to solve engineering problems which, up to now, have never before been approached or even considered. In this respect alone it is an enterprise which captures the imagination. But when I referred earlier on to its bizarre aspects what I had mainly in mind was the history of its inception, as described by Willard Bascom. The project has been fostered from the beginning by a scientific society which deliberately sets out to be the direct antithesis of any similar body in the world. This is the American Miscellaneous Society, or AMSOC. AMSOC has no officers, no constitution and no bylaws. Also, there are no publications, formal meetings, or subscriptions. There isn't even an official roll of membership! It is affiliated with the Committee for Co-operation with Visitors from Outer Space and the Society for Informing Animals of Their Taxonomic Positions. The only attempt at organising the Society has been the setting up of five divisions, these being Etceterology, Phenomenology, Calamitology, Generalogy, and Triviology. And there is one strict unwritten rule. Copies of all correspondence relating to the Society must be sent to its Central Files in Washington—where the filing cabinets resemble incinerators!

It is this incredible fellowship which controls the Mohole project. And which will spend an estimated 30 to 50 million federal government dollars in the process.

#### The Purpose

What is the purpose of the project? The answer to this is that it is to find out what material the Earth is made of. At the time being geophysicists can only guess at the nature of this material, and this is done by reasoning from the evidence given by shock waves through the Earth and from other data. Man's feelers have so far penetrated only to the deepest oil well of 25,000 feet, and this is but  $4\frac{1}{4}$  miles into a sphere whose diameter is of the order of 8,000 miles. Below the Earth's crust, as we understand it to date, there is a sudden change in structure known as the Mohorovicic discontinuity. The Mohorovicic discontinuity is at its highest under certain parts of the ocean, these being the points where the Mohole may best be drilled. Below the Mohorovicic discontinuity is the mantle of the Earth; and it is the sampling of this mantle which forms the sole purpose of Project Mohole.

At the present time, experimental drillings have already taken place in 3,000 feet of water off the coast of California, and these have shown the practicability of the project. Preparations for drilling the main hole are now under way and the overall task will take anything from three to seven years.

The project has been described as man's greatest single geophysical investigation, a statement which certainly seems to be no exaggeration. Readers who are interested in a venture which will add to our knowledge without the necessity of leaving the face of the Earth may like to know that a special 25-foot display has been set up at the Geological Museum at South Kensington, this showing a section of the Earth's crust together with details of the Mohole floating rig and drill string. This display will remain at the Museum until the completion of the project, changes being made as progress advances.

#### Soldering Aluminium

The photographs accompanying my contribution this month show two joints made with a new aluminium solder known as Soldalum 121, which is marketed by Industrial (Metallurgical) Services, 138 High Street, Waltham Cross, Herts. One of the photographs illustrates a joint between an aluminium tube and sheet, whilst the other shows a joint between two pieces of  $1 \times \frac{1}{8}$  in aluminium strip. The second photograph also illustrates the result of flexing the two strips to and fro. As may be seen, it is the aluminium

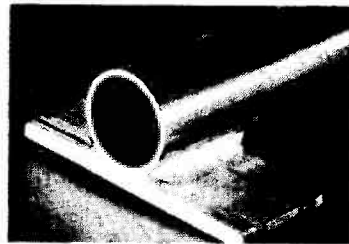


Photo 1. A joint made with Soldalum 121 aluminium solder, which exhibits good strength and high thermal and electrical conductivity.

which has failed and not the lap joint between the strips.

The soldering of aluminium has always been a difficult process, because a very tough oxide film forms on the surface of the metal, especially when it is heated. Fluxes are available to break down this oxide and allow the surface of the metal to be wetted by the solder, but these may tend to be expensive, corrosive, or to emit irritating or even toxic fumes.

Alternative approaches to the problem have included mechanical techniques to remove the oxide film. Typical examples are ultrasonic soldering irons (in which the bit vibrates at ultrasonic frequency) or abrasive pads or brushes.

Industrial (Metallurgical) Services state that, apart from the factor of solderability, methods employed up to now do not take into account the problem of bi-metallic corrosion. When aluminium and solder are joined together and an alloy layer appears along the interface (as should occur in a proper soldering process), the interface or the small volume of intermetallic compound is very susceptible to rapid failure through bi-metallic corrosion. A corrosion path may, in consequence, form between the aluminium and the mass of solder in a very short space of time, with the result that the solder may drop off under low mechanical stress or, even, under its own weight.

Much research into this subject has been undertaken by Industrial (Metallurgical) Services, using accelerated corrosion tests in a hot 3% solution of sodium chloride. Testing in this environment considerably speeds the formation of a corrosive path, and results in the parting of  $\frac{1}{8}$  in butt joints using tin/zinc or cadmium/zinc aluminium solders within 33 hours. It is estimated that, in an ordinary office atmosphere, the same joints would similarly part in 2 to 3 years. Soldalum 121 has been developed partly as the result of the



Photo 2. As a result of flexing the aluminium strip has failed, and not the soldered lap joint

hot salt solution tests and it is claimed to be over 20 times as corrosion resistant as the other aluminium solders just mentioned. It is considered that most joints soldered with the new product will have an expected life of over 20 years, whilst an expected life much longer than this is possible if the finished joint is sealed by painting with a suitable lacquer to exclude any corrosive environment.

Soldalum 121 is a low melting point (325°C) hard solder for aluminium and its alloys, and it

requires no flux. The parts to be soldered are heated and "tinned" by rubbing the solder stick lightly on the surface of the aluminium. A blow torch offers an adequate source of heat, and a Bunsen burner could be used for small joints. Soldalum 121 is now available in triangular sticks or "blowpipe" strips at around 10s. a pound. Industrial Trial Packs may be obtained for 12s. 6d.

#### Some Items of Interest

Brimar are including their new double triode, type ECC807, in their display at the Instruments, Electronics and Automation Exhibition (May 28th to June 2nd). This valve is designed specifically for high gain amplifiers operating from low level inputs. An outstanding feature of the Brimar ECC807 is the low grid hum level of 3 $\mu$ V average, with a maximum of 5 $\mu$ V. Under typical operating conditions each section gives a stage gain of 74.5. (The 12AX7 gives a stage gain of 60.)

An innovation in the transistor radio field is the Sony pocket radio type TRW-621. This incorporates a 7-jewel watch which not only indicates the time but also turns the

radio on and off automatically. The set covers medium-waves only, measures 4 x 2½ x 1in and weighs 7 ounces.

Marconi's Wireless Telegraph Company announce that their "PETA" traffic radar equipment is now in widespread use by the police forces of Britain. Thirty constabularies have purchased Marconi traffic radar, and the majority of the equipments are in day-to-day use. PETA (Portable Electronic Traffic Analyser) equipment is portable and can be easily stowed in the boot of a car. There are no wires trailing across the road and the only power supply required is a 12 volt battery. The equipment shoots a narrow radar beam across the road at an angle of 20° to the side, and the speed of passing vehicles is registered on a meter or as a graphical record. Separate indications are given on all vehicles more than 8ft apart. It is stated that the general police strategy is to use the radar speed check as a deterrent and not as a trap, motorists being usually warned by road signs at county boundaries and, in some cases, by notices on either side of the actual monitoring point.

## EMI'S New Sonar Detects Submarines at Varying Depths

H.M.C.S. *Crescent*, which has recently been visiting U.K. waters, is fitted with a new anti-submarine detection device known as Variable Depth Sonar, by means of which it is possible to detect submarines at considerable depths.

This Canadian equipment, which is one of the first to be produced in the world, is made by EMI-Cossor Electronics Ltd.

The device consists of an asdic transducer which is towed behind the ship and, by varying the length of tow, the depth of the transducer can be controlled.

Until the advent of this device, submarines were able to lie below certain layers of water which, because of their temperature variation, reflected the beam from the surface vessel's asdic set back towards the surface. The submarine could not, therefore, be detected.

With this equipment, however, the asdic transducer can be lowered until it is below the temperature layer beneath which the submarine is lying. Detection is then again possible.

One of the disadvantages of hull-mounted sonars is that they pick up the noise made by the sea water hitting the ship, and this is much accentuated in rough weather. With Variable Depth Sonar, this is no longer the case, since the asdic transducer is well removed from the ship and below the breaking of the waves.

## British Television Equipment for Australia

Two vidicon cameras, manufactured by EMI Electronics Ltd., will soon allow Richmond Tweed TV Ltd.'s new television studio centre at Goonellabah, New South Wales, Australia, to telecast a variety of live programmes.

In this television station, which will be one of the most modern of its kind in the world, filmed shows will be handled by two EMI vidicon telecine machines. These are being provided to give continuity of programme, and the cameras are interchangeable with those in the studio.

The telecine machines and associated cine and slide projectors will be accommodated in the main operational room. The area is to include a main control console, all camera control units, equipment racks and microwave links. The microwave links to carry the programme picture and sound from Goonellabah to the transmitter at Mount Mathieson are the latest high-powered links developed by EMI and are the first of their type to be imported into Australia. The entire studio installation is to be supplied by EMI (Australia) Ltd. and will be closely followed by a similar one at Toowoomba, Queensland.

EMI has already supplied equipment to similar Australian national stations and "country stations".

# Reducing Radio Luxembourg Fade

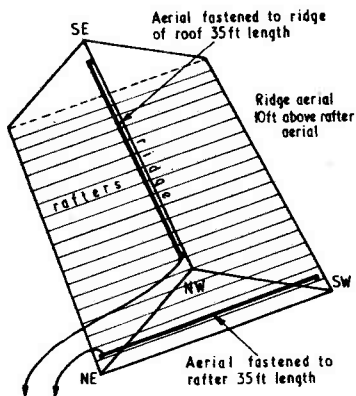
By F. W. STEVENS

AS IS WELL KNOWN, RECEPTION OF RADIO LUXEMBOURG on 208 metres can be marred, especially at night time, by severe fading and distortion. This effect has been described in a recent article,\* which gave comprehensive details of aerial systems designed to overcome the phase discrepancies between ground and sky waves which cause the fading and distortion.

The writer, who is situated in Essex, has carried out a large number of experiments with aerial systems to reduce these shortcomings in the Radio Luxembourg signal, the experiments including the use of dipoles and horizontal and vertical aerials employed on their own or in combination. By far the best arrangement has been the simple installation which is described in this article.

## Aerials

Two aerials are employed in the installation, both being fitted in the loft space of a bungalow. These aerials are shown in Fig. 1.

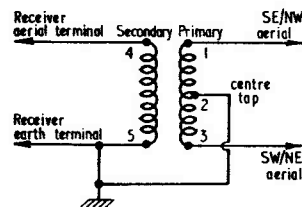


E191

Fig. 1. The aerial installation in the loft space

One aerial runs the full length of the ridge-pole in the roof, and is 35ft long. Its direction is from S.E. to N.W. and it is, in consequence, approxi-

mately in line with the Luxembourg signal. The other aerial is also 35ft long and is stretched along a ceiling rafter. Its direction is S.W. to N.E. and it is broadside on to the signal. This second aerial is 10ft below that fitted to the ridge-pole. Both aerials are suspended between insulators, and down-leads are taken from their N.W. and N.E. ends respectively. These down-leads are each approximately 15ft long, and they connect to the coupling transformer mounted near the receiver.



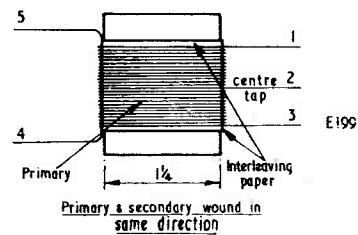
E192

Fig. 2. How the aerials and the receiver are coupled together

## The Coupling Transformer

The aerial coupling circuit is shown in Fig. 2. In this diagram the two aerial down-leads are applied to the two outside ends of the coupling transformer primary, a centre-tap on which connects to a true earth. The secondary then connects to the aerial and earth terminals of the receiver.

The coupling transformer is illustrated in detail in Fig. 3. The secondary is wound on first, and



E193

Fig. 3. The coupling transformer. Winding details are given in the text, and the terminal numbers correspond to those in Fig. 2

\* "Improving Radio Luxembourg Reception" by Gordon J. King M.I.P.R.E., M.T.S., ASSOC. BRIT. I.R.E., *The Radio Constructor*, January, 1962.

comprises 90 turns of 32 s.w.g. enamelled (or cotton covered) wire close-wound in a single layer. The secondary is then covered with a layer of interleaving paper and the primary wound on. The primary winding consists also of 90 turns of 32 s.w.g. enamelled (or cotton covered) wire, and it has a centre-tap at 45 turns. Again, a close-wound single layer winding is used. Coil ends are anchored by any conventional method, and the

windings are connected to the receiver and aerials as shown in Fig. 2.

### Results

As was mentioned above, the installation described here was found to be most successful after a considerable amount of experiment with different aerials had been carried out. It has now been in use for two years and has worked well over that period.

## AF FREQUENCY CALIBRATION BY OSCILLOGRAPH

By G. A. W. PARTRIDGE

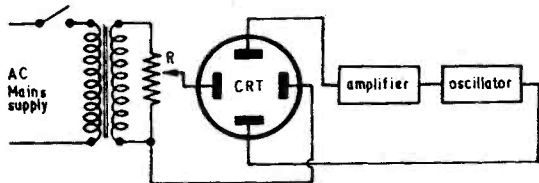
**M**ANY RADIO ENTHUSIASTS HAVE CATHODE RAY oscillographs in their dens and workshops.

Some of these instruments are quite simple, consisting of the cathode ray tube plus a timebase oscillator, an amplifier, and of course the power pack.

Frequency calibration can be carried out on an oscillograph with no timebase. The tube, together with a suitable amplifier and power unit, is all that is required to check the frequency of a.f. oscillators.

Calibration is done by comparing the output of an oscillator with a standard frequency, such as the frequency of the 50 c/s mains supply. This is most reliable these days as the owners of synchronous clocks probably realise.

Fig. 1 shows a simple arrangement using the mains frequency as a standard. A suitable voltage is applied to the horizontal plates from a transformer connected to the mains. The transformer isolates the cathode ray tube from the mains and also supplies a voltage which can be varied by R. The voltage across the horizontal plates is dependant upon the sensitivity and size of the tube. A 1½ in tube may require about 20 volts r.m.s. to produce a line from one end of the screen to the other (Fig. 2). In this case the transformer would reduce the mains voltage to about 100 and R could be about 100kΩ adjusted to give a 20 volt output.



E203

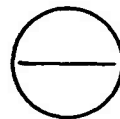
Fig. 1. Using the 50 c/s standard

The a.f. oscillator may have to be connected through an amplifier to the vertical plates if its output is low. The vertical amplifier is usually

built into the oscillograph and is adjusted by turning the knob marked "Vert Gain", "Y Amp", etc.

The procedure for testing the a.f. oscillator is as follows:

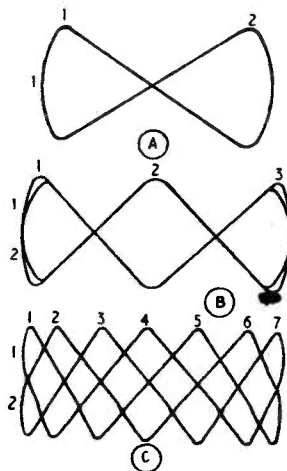
First, adjust R until a line stretches across the screen as shown in Fig. 2. Now turn on the oscillator



E204

Fig. 2. Voltage across horizontal plates only

and adjust the amplifier until a reasonably large waveform moves across the screen. Vary the oscillator frequency until the waveform becomes stationary, and looks something like one of the patterns in Fig. 3.



E205

Fig. 3. Typical frequency patterns

If pattern A results it means that the oscillator is giving a 100 c/s output. Count the number of loops along the top of the pattern, which in this case is 2. Then count the loops on one vertical side, which is only 1.

Now the correct frequency of the oscillator

$$\frac{\text{Number of horizontal loops} \times \text{standard frequency}}{\text{Number of vertical loops}}$$

$$= \frac{2 \times 50}{1}$$

$$= 100 \text{ c/s}$$

The same idea applies to pattern B, where the correct frequency

$$= \frac{3 \times 50}{2}$$

$$= 75 \text{ c/s}$$

On the same standard frequency, pattern C would be:

$$= \frac{7 \times 50}{2}$$

$$= 175 \text{ c/s}$$

A 50 c/s standard frequency will test up to 500 c/s at a ratio of 10 to 1, which is about maximum for this method of comparison.

For higher frequencies it will be necessary to increase the standard frequency. A standard of 1,000 c/s would check from 100 to 10,000 c/s. In

this case a standard oscillator fixed at a convenient frequency would be used as shown in Fig. 4.

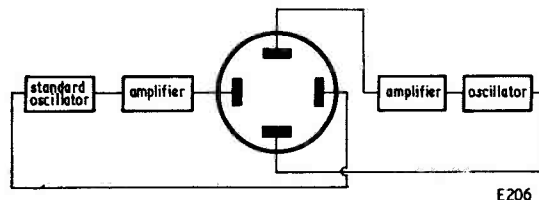


Fig. 4 Using a standard Oscillator fixed at a convenient frequency

Assuming a standard of 1,000 c/s, the pattern in Fig. 3 (c) would indicate a frequency of:

$$= \frac{7 \times 1,000}{2}$$

$$= 3,500 \text{ c/s}$$

R.F. calibration can be done in much the same way providing the amplifiers are able to work on the higher frequencies involved, but in this case calibration is probably much easier with a wave-meter.

NOTE: Standard audio frequencies at 440, 600 c/s, are transmitted by radio station WWV and 1,000 c/s by station MSF. Details are given in the *Radio Amateur Operator's Handbook*.—EDITOR.

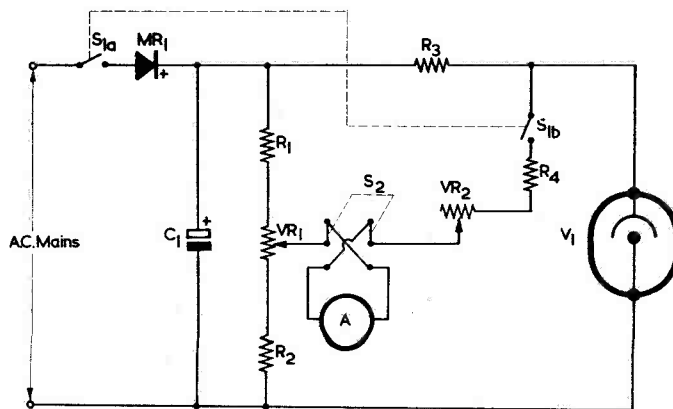
## Differential A.C. Voltmeter

By K. BERRY

THE VOLTmeter DESCRIBED HERE was originally developed to measure small changes in the public electricity supply voltage in the Bournemouth area where the regulation is poor due to an out-of-date and overloaded distribution system.

In the normal type of a.c. voltmeter (either rectifier or moving iron) reading, say, 250 volts full scale, the length of scale from 230 to 250 volts is of necessity quite short and such an instrument is only capable of being read to the nearest 5 volts. It is thus unsuitable for measuring changes in voltage.

Certain types of voltmeter, namely, suppressed zero instruments (reading typically 150-300V) and sub-standard instruments can be read to a greater degree of accuracy, though these





are still vastly inferior to the voltmeter which is the subject of this article.

The differential voltmeter can, with suitable design, show a change in supply voltage (either positive or negative) of any chosen magnitude about any chosen datum voltage.

#### Operation

The circuit of the differential voltmeter accompanies this article. The principle of operation is very simple. The supply voltage to be measured is half-wave rectified by a metal rectifier and stored in a reservoir capacitor. A portion (10mA) of the resultant d.c. is fed via a limiting resistor to a gas-filled voltage regulator tube which is used as a voltage reference source. The remainder of the d.c. (10mA) passes through a potentiometer. The indicating voltmeter is connected between the potentiometer and the voltage reference source. Any change in supply voltage will cause the potentiometer voltage to vary whilst the voltage reference source remains constant, thus the voltmeter connected between the two will indicate a change in supply voltage.

Certain approximations have been

#### Components List

##### Resistors

(All fixed values should be  $\pm 5\%$  and preferably high stability)

- R<sub>1</sub> 10k $\Omega$  2 watt
- R<sub>2</sub> 13.5k $\Omega$  2 watts (two 27k $\Omega$  1 watt in parallel)
- R<sub>3</sub> 11k $\Omega$  2 watt (two 22k $\Omega$  1 watt in parallel)
- R<sub>4</sub> 50k $\Omega$   $\frac{1}{2}$  watt
- VR<sub>1</sub> 2.5k $\Omega$  potentiometer, wirewound
- VR<sub>2</sub> 25k $\Omega$  potentiometer, wirewound

##### Rectifier

DRM1B Standard Telephones & Cables Ltd., or similar

##### Capacitor

C<sub>1</sub> 16 $\mu$ F, 350 w.v., electrolytic (see text)

##### Meter

0-100 $\mu$ A, M/C

##### Switches

- S<sub>1</sub> d.p.s.t. toggle
- S<sub>2</sub> d.p.d.t. toggle

##### Valve

- OA2 Brimar
- VR150/30 Brimar
- 150B2 Mullard
- 150C2 Mullard

made in the design of this instrument and these are now considered.

(1) The d.c. voltage across the reservoir capacitor must vary in a linear fashion with the input voltage. Since this relationship is basically that of a diode anode characteristic this will not in fact be so, except for small changes in input voltage. Fortunately in this application only small changes in voltage occur and the requirement of a linear input/output characteristic is satisfied.

(2) The voltage ratio of the potentiometer (i.e. output voltage over input voltage) must remain constant. This will not be exactly so in this case as the current taken from the potentiometer varies from 0 to  $\pm 100\mu$ A. However, since this is only 1% of the current through the potentiometer, the variation in potentiometer voltage ratio is very small. The effect of this approximation is to lead to a very small degree of error in the meter reading, which can for most purposes be neglected. If this small error is required to be made even smaller the potentiometer bleed current can be increased to, say, 100mA, or the voltmeter could be a valve voltmeter.

The supply on/off switch (S<sub>1</sub>) is a double-pole single-throw switch, one pole of which breaks the supply connection whilst the other pole disconnects the meter circuit. The latter operation is essential because, when the supply is removed, the d.c. voltage commences to decay and the voltage regulator tube is eventually extinguished. When this occurs, the meter (reading only 10 volts full scale) would be left connected across the upper leg of the potentiometer which has a P.D. of about 60 volts across it, causing a heavy current to flow through the meter.

The reversing switch (S<sub>2</sub>) enables the meter polarity to be reversed in order to read both rises and falls in supply voltage.

#### Construction, Components, etc.

The components used are quite straightforward and should present no difficulties. Several voltage regu-

lators are quoted in the component list, but base connections have not been given as they vary from valve to valve. The manufacturer's information should be consulted for the particular valve it is decided to use.

The meter circuit given will measure 240 volts  $\pm 10$  volts. If a greater voltage change is required, say 240  $\pm 20$  volts, the resistors in series with the meter (50k $\Omega$  fixed, 25k $\Omega$  variable) should be doubled in value. To obtain a lower datum voltage, e.g. 200 volts, the 10k $\Omega$  resistor in the potentiometer should be reduced to 5.6k $\Omega$ .

Note that the 11k $\Omega$  and 13.5k $\Omega$  resistors are in fact 2 x 22k $\Omega$  and 2 x 27k $\Omega$  in parallel.

#### Calibration

Having wired the unit, set the 25k $\Omega$  rheostat VR<sub>2</sub> to its maximum value and connect the instrument to a variable voltage supply which is set to the required datum voltage. Switch the supply on and check that the voltage regulator glows.

With S<sub>2</sub> in either position adjust VR<sub>1</sub> (2.5k $\Omega$ ) until the meter reads zero, then increase the supply voltage by 10 volts and having set S<sub>2</sub> to the appropriate position (i.e. for a positive reading) adjust VR<sub>2</sub> (25k $\Omega$ ) until the meter reads full scale. The meter is now ready for use.

For those not fortunate enough to have access to a variable voltage source the 50k $\Omega$  and 25k $\Omega$  resistors in series with the meter should be replaced by a 68k $\Omega$  fixed resistor. The meter will then read approximately + or - 10 volts change in supply voltage.

The use of an electrolytic reservoir capacitor in the circuit should cause no drifts in meter reading for normal applications in the U.K., and such a component should give completely satisfactory results. If it is essential to ensure the highest possible stability and reliability, then the use of a paper capacitor (say 8 $\mu$ F, 350 w.v.) might be advisable.

## Next Month . . .

- The "Highwayman" Car Radio
- 2-Valve Stereo Amplifier

# Constructor Visits The 1962 International Audio Festival and Fair

THE 1962 INTERNATIONAL AUDIO Festival and Fair was held at the Hotel Russell, London, from April 26th to 29th. The keen interest of the public in high fidelity reproducing equipment was amply demonstrated by high attendances. On the Saturday morning (April 28th) several hundred people were already queuing outside the Hotel Russell a quarter of an hour before the exhibition opened.

Inside the hotel, the Festival had the same layout as has been used for Audio Fairs of the past. There were two sections, the first consisting of stands, or booths, on the ground floor, where queries could be handled by the technical staff of the firms concerned. The second section consisted of demonstration rooms on the first, second and third floors of the hotel.

It was noticeable, this year, that congestion in the demonstration rooms was less evident than in previous years. There were less jams around the doors to individual rooms, and this may have been due to planning on the part of exhibitors or to the fact that visitors are now more accustomed to the peculiar requirements of the Audio Fair and are less liable to stand aimlessly in demonstration room entrances. Presentation of reproducing equipment is, also, falling markedly into two different styles. In one, a complete demonstration lasting, say, quarter of an hour is given inside a closed room to visitors who have previously obtained tickets from the associated stand on the ground floor. This enables members of the public to listen to the equipment under best conditions and in maximum comfort. The second method of demonstration is one which has been used very successfully in the past by H. J. Leak and Co., and consists quite simply of a single set-up of equipment which plays continually in an open room. In the H. J. Leak display a large sign told visitors what the equipment was, whilst another stated that all queries would be handled at the booth on the ground floor. Other manufacturers used this scheme

in more or less the same form sometimes employing illuminated signs to indicate which of several sets of equipment were being employed. It is difficult to state which of these two methods is the better; and, of course, neither can be very successfully applied to such things as tape recorders, in which the public is just as interested in ease of manipulation as in quality of reproduction.

## Tape Recorders

The smallest and lightest tape recorder at the Festival was the Stuzzi MemoCord. This measures  $4\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{1}{2}$  in, weighs 11 ounces and has an overall playing time of 1 hour. It may be employed as a completely portable instrument with an integral microphone/loudspeaker built into the case. Alternatively, an external lapel microphone or loudspeaker may be plugged in. Telephone pick-up attachments are also available. An interesting feature is a remote control facility which enables the tape to be "back-spaced" over several words by a typist who has missed part of a recording during playback.

To obtain its playing time of 1 hour, the MemoCord employs quarter track recording on  $\frac{1}{2}$  in tape. A single track is exhausted after 15 minutes' running and the head assembly is then transferred to the next track and the tape run in the opposite direction. Selection of track is achieved by a four-way gate selector lever which raises or lowers the head assembly, reverses the drive motor if required, and applies erase voltage to the requisite head when recording. The head assembly comprises three units, these consisting of a central record/playback head with an erase head on either side. Thus, whichever way the tape is running it encounters an erase head before the record/playback head. Both erase and bias voltages are d.c., being obtained from the motor supply cell. Frequency response is from 400 to 3,000 c/s, and tape speed is approximately 1.3 i.p.s. The amplifier employs two OC75's and an OC72,

these being powered by a PP3 9 volt battery. The motor is powered by a D15 Penlight cell. To enable the position of the tape to be evaluated it has numbers printed on the non-coated side in rather the same manner as the numbers on a spool of photographic film. These numbers are viewed through a window in the side of the case. Re-wind may be effected by the internal motors or manually. The external microphone is a moving coil type whilst the integral microphone/loudspeaker employs a diaphragm construction similar to that of a headphone. The writer found that reproduction with the MemoCord was quite satisfactory for speech. With the lapel microphone, speech was picked up at adequate level from a distance of 6 feet.

Another miniature tape recorder, the Fi-Cord 1A, is now replaced by the Fi-Cord 202. This is a larger unit than the 1A, but it has added features including provision for operation from the mains. The Fi-Cord 202 measures  $9 \times 6 \times 4\frac{1}{2}$  in, and weighs  $6\frac{1}{2}$  lb including mercury batteries. Speeds are  $7\frac{1}{2}$  and  $3\frac{1}{2}$  i.p.s., frequency response being flat within  $\pm 3$  dB from 50 to 12,000 c/s at the former speed. A built-in tape position indicator and recording level meter are provided.

## Reverberation

Bird songs in stereo were the first thing to catch the attention of the writer on visiting the demonstration room of Grampian Reproducers Ltd. These had been obtained with the aid of two Grampian Parabolic Reflectors directed, at a slight angle to each other, to the source of sound. The Grampian Parabolic Reflector is well-known to recorders of sound in nature and it resembles a radar antenna dish with provision for mounting a microphone at its focal point. The diameter of the reflector is 24 in.

Also to be seen in the Grampian demonstration room was this company's new Reverberation Unit. The basic element of this unit is a

reverberation device manufactured by Hammond Organ Company, the device being fitted into a case and provided with the necessary amplifying and mixing circuits by Grampian. Fundamentally, a reverberation unit of this type functions by feeding sound signals into one end of a spring and by means of a transducer. Mechanical vibrations then pass down the spring and may be re-converted to electrical form by pick-up devices coupled to the spring. The greater the length of spring between the transducer and the pick-up device, the greater the delay of the original sound. The reverberation device employed in the Grampian unit has four springs, thereby allowing different degrees of delay to be applied. A four-stage amplifier is fitted, and this brings the input signal to the level required for operating the transducer and also allows mixing of the delayed signals with the input signal. The various delays offered by the four springs are fixed, and the amount of overall reverberation is adjustable by a gain control which handles the delayed signals. The initial delay is 30 milliseconds, with multiple repeats over a 2 second period. The unit may be coupled into any amplifying chain, that demonstrated working from an input of 0.5 volts.

The writer found that the reverberation effect offered by the unit was pleasing in character and was especially noticeable with solo instruments and, in particular, with solo voices. The effect tends to depend upon the amount of reverberation already present on the original sound. The unit may be especially useful for adding reverberation to amateur tape recordings which have little natural reverberation, or to electronic musical instruments. The reverberation system was initially developed, of course, for use with electronic organs.

A simpler reverberation unit was exhibited by Bang and Olufsen of Denmark. This employs two springs, one having a single pick-up device and the other two pick-up devices at different points along its length. The transducer driving the springs is fed from the speaker terminals of the associated amplifying equipment, and the output from the pick-up devices is fed back to the amplifier at a suitable voltage amplifying stage. It was stated that regeneration should not occur owing to the delay between input and output signals. Control of reverberation is effected by a four-position switch, this being either in the "off" position, or selecting one, two, or three pick-up devices.

#### Loudspeakers and Microphones

Newly introduced by Goodmans Industries Ltd. are the Axiom 201 and 301 reproducers, these having truly massive magnet assemblies. The overall diameter of both these speakers is 12½in, and they handle outputs up to 15 and 20 watts respectively. Both are 15-16 ohm units and have fundamental resonances at 35 c/s. A corrugated surround is employed.

The H. J. Leak demonstration featured two "Sandwich" loudspeakers in a stereo set-up reproducing discs played on Leak equipment. The "Sandwich" speaker was introduced at last year's Fair and employs expanded polystyrene ½in thick placed between skins of aluminium foil, giving thereby stiffness several hundred times greater than that of paper cones of equal mass. In consequence, the diaphragm functions as a rigid piston without break-up distortion.

Standard Telephones and Cables showed their new type 4108 Condenser Microphone. This has a printed circuit head amplifier employing a valve type 3A/170G

followed by a TK23C transistor. The reason for the valve input stage is that the type chosen can tolerate an extremely high grid resistance without significant increase in noise level. The transistor functions as a buffer amplifier and eases matching problems. The microphone, complete with head amplifier, measures ½in in diameter by 5½in in length, and its response is from 30 to 15,000 c/s.

#### The Home Constructor

Since some of the equipments on display are available in kit form, the home-constructor is always partially catered for by the Audio Fair.

A stand with particular interest to the home-constructor was that of Mullard Ltd. Mullard exhibited their World Series valves for audio equipment, and offered literature on all products of interest to the amateur, including a leaflet covering the "Twin Three-Three", a stereo amplifier circuit developed from the original "Three-Three" amplifier. Also featured were details of a 10 watt stereo amplifier employing the new ECL86, and a 3 watt tape recording amplifier. A useful leaflet described the possible alterations in amplifier operation needed when changing from half-track to quarter-track heads.

Daystrom Ltd. had a separate exhibition at the Grand Hotel in Southampton Row, this being several minutes' walk from the Hotel Russell. The comprehensive Heathkit range on show included the S-88, a 16 watt stereo amplifier with push-button selection and switched filters; the MA-12 12 watt power amplifier; the S-33 6 watt stereo amplifier with ganged controls and special single end ultra-linear output stages; and the SSU-1, a twin speaker system especially designed for use in applications where space is limited.

## EMI Tape Recorders Aid Oil Burner Research

The greatly increased use of oil heating in factories, hospitals, offices and particularly homes during recent years has been accompanied by corresponding progress towards silencing oil-burning equipment.

The Shell International Petroleum Co.'s Central Laboratories, at Egham, have for some time past sponsored field research into the noise levels produced by domestic and industrial oil burners. This research, which receives the full co-operation of the oil burner manufacturers, uses professional tape recorders supplied by EMI Electronics Ltd.

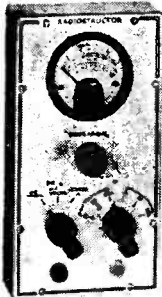
The equipment can record noise intensities from 50 to 130dB. Recordings are subsequently analysed in a half-octave frequency analyser to indicate at which frequencies the noise predominates and to determine corrected loudness values.

Data obtained from this analysis can be used when modifying equipment or developing burner designs for specialised applications.

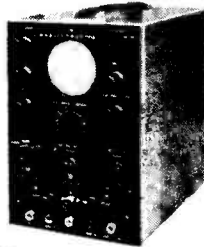
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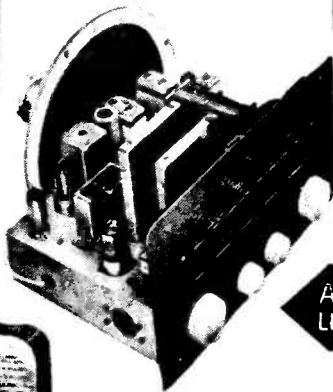
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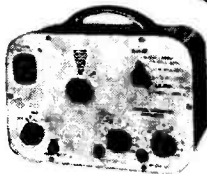
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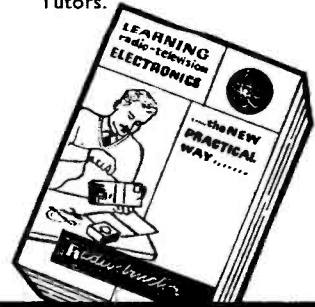


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continued on page 869



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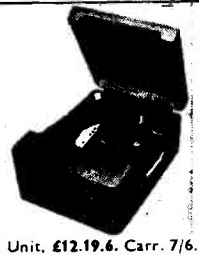
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Ideal gram unit or general audio amplifier. Based on G.E.C. 4 Trans. circuit. 1 watt output in standard 3 ohms speaker. Vol. control and neg. feedback. Chassis size 6 1/2" x 3 1/2" x 1 1/2". Consumption 10mA quiescent—250mA at 1 watt. Sensitivity 6 mV. Freq. response ±3dB 110 c/s-16 kc/s.  
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## SMALL ADVERTISEMENTS

continued from page 867

### PRIVATE—continued

**FOR SALE.** AA-Radar unit-AH, 7-valve, wide band amplifier, 39/6; voice output 4-valve unit, 29/6; wireless transmitter No. 10, soiled, 4-valve 230V a.c. 4½ gns.; mains foot switches, 5/6 each; 100 assorted resistors, 12/6 box; 50 assorted condensers, 14/- box; 25 assorted volume controls, 23/6 box; 250 assorted sleeves and grommets, 4/6 packet; hydraulic pump, 17/6; 20 assorted wafer switches, 12/6 box; Mag slip transmitters-receivers, 14/6 each; 25 assorted printed circuits, 8/-. Prices include postage. B. Enderby, Nussey's Farm, Sutterton, Boston, Lincs.

**WANTED.** Newnes *Radio and T.V. Servicing*, 1960-1961 edition, 45 Chanel Road, Coolock, Dublin.

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**"MEDIUM WAVE NEWS."** Monthly during DX season.—Details from B. J. C. Brown, 196 Abbey Street, Derby.

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**RADIO AMATEUR COURSE.** A postal course for those wishing to take the Amateur Examination. A sound basic training in radio communication. Very reasonable terms. Send for brochure.—Premier School of Radio, 3 Kerry Crescent, Calne, Wiltshire.

**RECEIVER TYPE B.C. 624 CHASSIS**, suitable for conversion 2 metres, new condition, less valves and relay 5/6. Post 4/-.—Arthur Sallis (Radio Control) Ltd. 93 North Road Brighton Sussex.

continued on page 871

# BBC

## SOUND TECHNICAL OPERATORS

are required for operational duties  
at SOUND STUDIOS in LONDON

**DUTIES INCLUDE:** Tape and disc recordings; Tape editing; Testing studio equipment; Programme monitoring; Programme switching and control.

**QUALIFICATIONS:** Male subjects of the United Kingdom, aged 18-26. G.C.E. "O" level in five subjects, including English, mathematics and physics, preferably mathematics or physics at "A" level, or equivalent technical certificates. A technical knowledge of amplifiers, tape recorders, record players and associated equipment. Practical experience in radio or electronic engineering is desirable if over 20 years of age.

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Three-year course leading to College Diploma which exempts from Graduateship Examination of British Institution of Radio Engineers. Minimum age 17 years.

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| 3V4 7/6    | 12AX7 7/6   | EB91 4/6   | KT66 15/-  |
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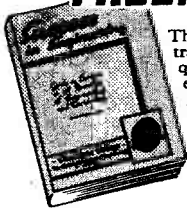
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continued from page 869

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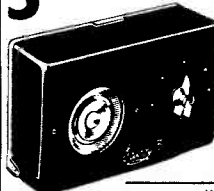
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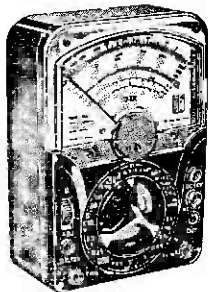
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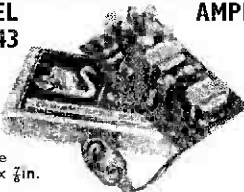
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SUITABLE 2½" SPEAKER, 16/6

## TRANSISTORS

NEW PRICE REDUCTIONS

|            |            |            |
|------------|------------|------------|
| AF117 9/6  | OC83 6/-   | OC139 13/6 |
| AF212 35/- | OC84 8/6   | OC140 29/- |
| AC107 14/6 | OC75 7/-   | OC200 10/6 |
| OC71 5/6   | OC35 18/-  | OC201 31/- |
| OC72 7/-   | OC44 9/3   | OC22 23/-  |
| OC76 7/-   | OC45 8/6   | OC771 29/- |
| OC81 7/-   | OC170 9/6  | OC31 9/-   |
| OC78 7/-   | OC171 10/6 | OC42 9/6   |
| AF102 27/6 | AF115 10/6 |            |

Send for New List of Fully Guaranteed Transistors, Diodes, Zener Diodes, Silicon Rectifiers, etc. All 100% 1st Grade. We stock a semiconductor device for every need.

SPECIAL REDUCTIONS FOR SETS

## TYPE 38, TRANSMITTER RECEIVER

Complete with 5 valves. In new condition. These sets are sold without guarantee but are serviceable.

7.4 to 9 Mc/s. 22/6 P.P. 2/6  
Headphones, 7/6 pair. Junction Box, 2/6.  
Throat Mike, 4/6. Aerial Rod, 2/6.

## CRYSTAL MICROPHONES

- ACOS 39-1. Stick Microphone with screened cable and stand (list 5 gns.), 32/6. P.P. 1/6.
- ACOS 40. Desk Microphone with screened cable and built-in stand (list 50/-), 15/- P.P. 1/6.
- ACOS 45. Hand Microphone with screened lead, very sensitive, 25/- P.P. 1/6.
- 100 C. Stick Microphone with muting switch and screened cable, detachable desk stand, card and neck, 39/6. P.P. 1/6.
- MC 24. Stick Microphone with muting switch and cable, 25/- P.P. 1/6.
- LAPEL. Miniature Mic. With clip. Ideal for recording, 15/- P.P. 1/-.

## 1 WATT TRANSISTOR AMPLIFIER

★ EMI 4-Transistor Amplifier with 7" x 4" speaker, tone and volume controls. Ready assembled. For use with crystal pick-ups. 6-9 volt operated, 89/6. P.P. 1/6.

## BATTERY RECORD PLAYER

★ 6-7½ volt Garrard turntable with crystal pick-up. Plays 45 r.p.m. Ideal for above amplifier.

65/- P.P. 1/6  
★ PORTABLE RECORD PLAYER CABINET for above player and amp., 22/6 for 7" x 4" speaker. P.P. 1/6.

Henry's Radio Ltd

PADdington 1008/9

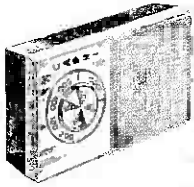
5 HARROW ROAD LONDON W2

Open Mon. to Sat. 9-6, Thurs. 1 o'clock

Send 1/- stamp for Illustrated Price List

★ ★ ★ ★ ★

Please Turn Page



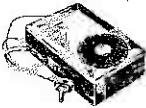
Size only  
 $4\frac{1}{2} \times 2\frac{3}{4} \times 1\frac{1}{2}$  in.  
**Really  
 Pocket  
 Size!**

P.P. 2/-  
 (Battery 2/6)

A new design 6-Transistor Printed Circuit Superhet for Medium and Long Waves. Uses all sub-miniature parts. Sub-min. Mullard Transistors. Quality speaker output, fitted earphone. Record Sockets. Cabinets Red/White or Blue/White with Gold fittings.

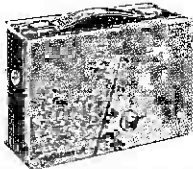
**DETAILS ON REQUEST**

Size  $4\frac{3}{8} \times 3 \times 1\frac{1}{4}$  in.



P.P.  
 1/6

A Three Transistor Two Diode Personal Radio for Medium Waves. Amateur top band and shipping. Quality output on personal 'phone. Fitted air-spaced tuner, vol. control. No aerial or earth. Luxembourg guaranteed.



Medium  
 and  
 Long Wave  
 Portable  
 $8\frac{1}{2} \times 6\frac{1}{2} \times 3\frac{1}{2}$  in.

P.P. 2/6

A 5-Transistor (Mullard) and Diode, Printed Circuit, Medium and Long Wave Portable. Features 5in. speaker Car aerial socket, Mullard transistors and carded components. Excellent results guaranteed. **DETAILS ON REQUEST**

**PUSH-PULL AMPLIFIER**

(over 1 watt peak output).

Uses OC71/OC81D,  
 2—OC81.

$\pm 3dB$  70 c/s to 12  
 kc/s  
 Overall size  $4'' \times 2\frac{1}{2}''$   
 $\times 3''$ .  
 Built on printed  
 circuit.

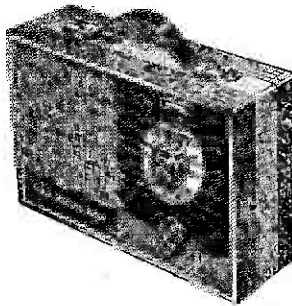
**BUILT & TESTED** P.P. 1/6 OR P.P. 1/6  
**COMPLETE KIT**  
 Ideal for Record Player, Intercomm., Baby Alarm for Tuners, etc.  
 3 ohm output, fully guaranteed, 9 volt operated  
 Descriptive leaflet with uses FREE on request.

A new design pocket size tester for fault finding on valve or transistor radios, T.V., amplifiers, etc. Built-in indicator and batteries with detachable probe, 52/6 P.P. 1/6.

PADddington 1008/9

Open Monday to Sat. 9-6 Thurs. 1 o'clock

**UNBEATABLE IN PERFORMANCE AND APPEARANCE**



Employs the latest techniques. Double tuned I.P.S. AVC and first-grade components are standard features. Excellent tone, sensitivity and selectivity on both wavebands.

**Descriptive Leaflet on Request.**

425mW Push-Pull Output.  
 6 "Tap-Grade" Edison Transistors.  
 New Type Printed Circuit with all Components marked.  
 Full Medium and Long Wave Tuning.  
 High "Q" Internal Ferrite Aerial.  
 Car Radio Adaptation and AVC.  
 Slow Motion Fingersip Tuning with Station Names clearly marked.  
 "Hi-Fi" Quality Speaker.  
 Attractive Rexine Covered Cabinet, Red/White or Blue/White.

**TOTAL COST OF ALL PARTS**

P.P. 3/6



2,000 ohms  
 per volt  
 AC/DC. Size  
 $5'' \times 3\frac{1}{2}'' \times 1\frac{1}{2}''$ .

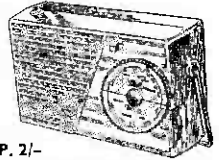
P.P. 1/6.  
 with test leads, battery and instructions.

0/10/50/250/500/1000 volts D.C.,  
 0/10/50 250/500/1000 volts A.C.,  
 0/500  $\mu$ A/10/250mA., D.C.  
 3 ranges resistance 0/10K/100K/1  
 Meg. Capacity and dB ranges.

**FULLY GUARANTEED**

Pocket Soldering Iron, 220/250V A.C./D.C. 30 watts, complete with mains plug, case, etc. Handle unscrews to cover element enabling iron to be carried in pocket, 18/6. P.P. 1/-.

Size  
 $5\frac{1}{2} \times 3 \times 1\frac{1}{2}$  in.  
 Red or Blue  
 with  
 Gold trim



P.P. 2/-

A Five Transistor and Diode Medium and Long Wave Printed Circuit Loudspeaker Radio, with Excellent Results including Luxembourg, guaranteed with full station separation. Supplied with Mullard Transistors and Carded Components. Fitted earphone/record socket.

Full Details and Diagrams On Request  
 Performance will amaze you

**MOBILE TRANSISTOR SHORT WAVE CONVERTER**

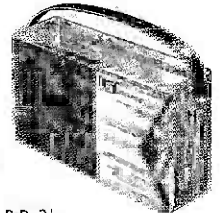
As featured in the May Edition of Radio Constructor. Just plugs into the aerial socket of your car radio. Crystal controlled—covers amateur and short wave broadcast bands from 5-16 Mc/s.

Total cost with sprayed cabinet, etc.  
 P.P. 2/-

Send 1/- stamp for full Booklet.  
 No modifications to car radio at all.

Medium  
 and  
 Long Wave  
 Radio

Size  
 $5\frac{1}{2} \times 3\frac{3}{8} \times 2$  in.



P.P. 2/-

Modified version of previously advertised "PW" Superhet. Now with new style Two Tone Cabinet. 1st grade components and transistors. Printed circuit.

**DETAILS ON REQUEST**

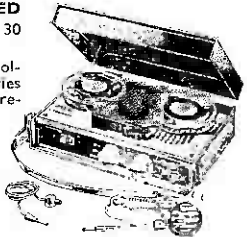
**BUILT AND TESTED**

Play/record up to 30 minutes.

Built-in speaker volume control batteries and play/record/rewind.

Quality reproduction.

Sturdy case  $6 \times 8\frac{1}{2} \times 2\frac{1}{2}$  in.



P.P. 3/-  
**FULLY GUARANTEED  
 NEW LOW PRICE**

Supplied complete with microphone, tape, batteries and personal phone.