

# THE Radio Constructor

RADIO  
TELEVISION  
AUDIO  
ELECTRONICS

VOLUME 18

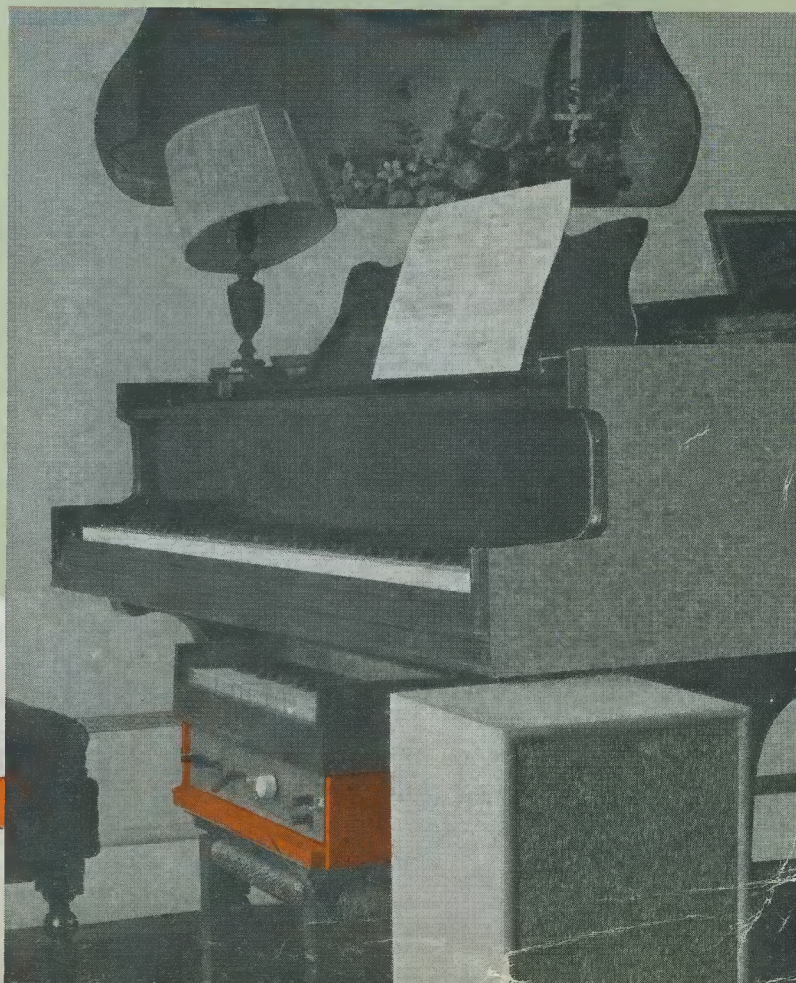
NUMBER 6

A DATA PUBLICATION

TWO SHILLINGS & THREEPENCE

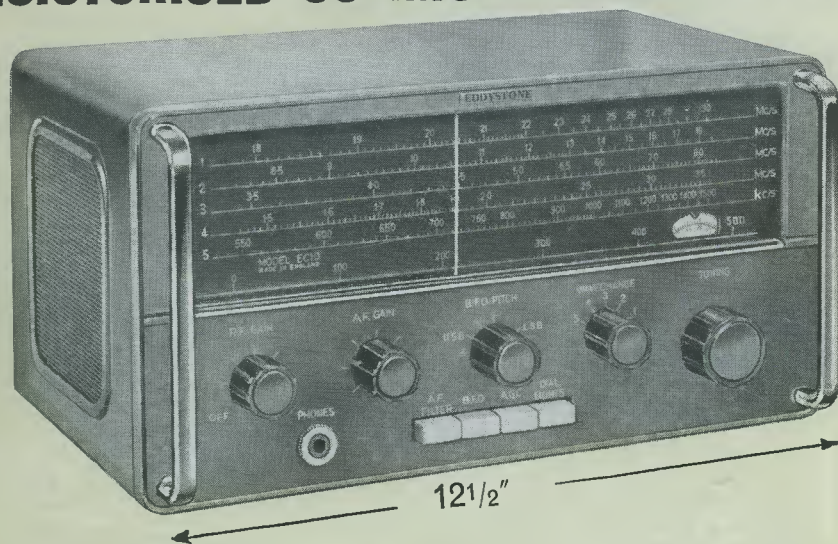
January 1965

**THE  
"TRANSIVOX"  
MONOPHONIC  
ORGAN**



- ★ Leakage/Insulation Tester
- ★ Crystal Tone Tx for Model Control
- ★ Variable Spooling for Collaro Deck

# THE **EDDYSTONE** MODEL "EC 10" TRANSISTORISED COMMUNICATIONS RECEIVER



**RUGGED, LIGHT AND COMPACT  
FOR PROFESSIONAL AND AMATEUR USE**

A most efficient transistorised receiver giving an excellent and consistent performance over the whole range from 550 kc/s to 30 Mc/s. Thirteen transistors and diodes, including stabilising Zener diode. Ample audio output to internal speaker, and panel jack also fitted for telephone headset. Precision slow-motion drive with 110 to 1 reduction ratio ensures delightfully easy tuning.

Self-contained battery unit holds long-life cells. Alternative aerial inputs for dipole, long wire and short wire aerials. Selective audio filter improves c.w. reception. Robust construction, modern styling, attractive two-tone grey finish. Dimensions are 12½ inches wide, 6¾ inches high, 8 inches deep. Weight with batteries 14 lb.

*List Price (in U.K.) £48. 0s. 0d.*

**STRATTON & CO. LTD. BIRMINGHAM · England**



# LASKY'S RADIO

## FOR THE FINEST RANGE OF TRANSISTOR RECEIVERS

We consider our construction parcels to be the finest value on the home constructor market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded, less postage.

### The SKYROVER Range



**GENERAL SPEC.**  
7 transistor-2 diode superhet portables, covering full Mod. plus 6 S.V. bands.

#### THE SKYROVER MK II

Now supplied with redesigned cabinet, edgewise controls, new colour tuning scale and cabinet in Sierra Tan. Controls: Waveband Selector, Volume Control with On/Off Switch, Tuning Control. In plastic cabinet, size 10" x 6 1/2" x 3 1/2", with metal trim and carrying handle.

Can now be built for **£8.19.6** H.P. Terms: 20/- deposit and 11 months at 16/6 P. & P. 5/- extra

#### THE SKYROVER DE LUXE

Tone Control circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11 1/2" x 6 1/2" x 3", covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for **£10.19.6** H.P. Terms: 25/- deposit and 11 months at 20/- P. & P. 5/- extra

All components available separately. Four U2 batteries 3/4 extra. Data for each receiver, 2/6 extra, refunded if you purchase the parcel.

**LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THESE WELL-KNOWN SETS.** A simple additional circuit provides coverage of the 100-1,950 metre band (including 1,500 metre Light Programme). This is in addition to all existing medium and short wavebands. All necessary components with construction data. This conversion is suitable for both models that have already been constructed. Only 10/- extra Post Free.

### SPEAKER BARGAINS

**12" FANE Type 122/17**  
Power handling 25 watts—15 ohms imp. Flux density 17,000 gauss. Special anisotropic magnet. Listed at £11.17.6. Limited stock. LASKY'S PRICE £5.19.6 P. & P. 5/-

**WHARFDALE WNA12, 12" 15Ω imp.** Flux density 14,000 oer/ds. Max. input 15 watts RMS, 30 watts peak. Frequency range 25-4,000 cps. Cone fitted with roll surround.

**WHARFDALE SUPER 5, 5" mid-range and high frequency speaker.** 15Ω imp. Frequency range 300-17,000 c.p.s. Aluminium voice coil. These two speakers provide an ideal matched pair for a full range hi-fi speaker system. Both brand new and individually boxed. LASKY'S PRICE £12.19.6 the pair. P. & P. 10/-

#### Sub-Miniature Transistorised Amps.

British made, these sub-min. transformerless amplifiers come to you fully built and ready for immediate use. Thousands of uses in all branches of electronics: sound and signal amplification—models—electro medico equipment—pre-amps—radio tuners—tape head amps., etc. All use NPN-PNP circuit powered by 9V battery.  
PC1, input 250mV, output 150mW at 40Ω, size 2" x 1" x 3/4". LASKY'S PRICE 29/6 P. & P. 1/-  
PC2, input 1mV, output 400mW at 15Ω, size 2" x 2 1/2" x 3/4". LASKY'S PRICE 37/6 P. & P. 1/-  
PC3, input 5mV, output 400mW at 15Ω, size 2 1/2" x 1 1/2" x 3/4". LASKY'S PRICE 37/6 P. & P. 1/-  
PC4, input 150mV, output 400mW at 15Ω, size 2 1/2" x 1 1/2" x 3/4". LASKY'S PRICE 37/6 P. & P. 1/-

### BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers 2- or 4-track models

**COLLARO STUDIO TAPE DECK.** Latest model 3 speed, 3 motors. Take 7" reels. Fitted with half-track heads. LASKY'S PRICE £10.10.0. New and Unused. P. & P. 7/6

**COLLARO STUDIO TAPE DECK.** As above but fitted with the latest quarter-track heads. LASKY'S PRICE £13.19.6 P. & P. 7/6

**MARTIN TAPE RECORDER AMPS.** Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3-ohm output, equalising, etc. For 200-250V a.c. mains. PRICES: 1-track Model £11.11.0. 1-track Model £12.12.0. P. & P. 2/6. Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9" x 5" speaker. Price complete with speaker £5.5.0. P. & P. 5/-

**HI-FI TAPE RECORDER HEADS**  
High Impedance Record Play. Low impedance erase. Upper or lower track.  
LASKY'S 29/6 Post free per pair. State track required.  
MARRIOTT "X" Type 1-track heads. Record/Play and Erase. LASKY'S PRICE 4 gns. pair 1-track heads Record/Play and Erase 59/6 pair

**TAPE DECK MOTORS**  
Motors for the Collaro Studio Deck—new and unused. 200-250V A.C. Take-up and rewind listed at £2.5s. each. LASKY'S PRICE 14/11 each. P. & P. 2/6. State motor required when ordering.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size: 4" dia., x 2" high. 1" x 1/4" spindle. LASKY'S PRICE 19/11. P. & P. 3/6.

**TAPE POSITION INDICATOR**  
Open type—as used by most makers. With re-set knob: 3 DIGIT 7/6; 4 DIGIT 10/6. P. & P. 9d. on each.

**INTERNATIONAL TAPE**  
Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

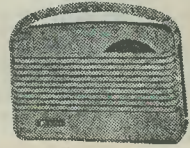
5in double play, 1,200ft. Mylar base ... 15/-  
5in long play, 900ft. Acetate base ... 10/-  
5in standard play, 600ft. PVC base ... 8/6  
5 1/2in long play, 1,200ft. Mylar base ... 15/-  
5 1/2in double play, 1,800ft. Mylar base ... 22/6  
5 1/2in long play, 1,200ft. Acetate base ... 12/6  
5 1/2in standard play, 850ft. PVC base ... 11/6  
7in standard play, 1,200ft. Mylar base ... 12/6  
7in long play, 1,800ft. Mylar base ... 19/6  
7in double play, 2,400ft. Mylar base ... 25/-  
7in long play, 1,800ft. Acetate base ... 15/-  
3in message tape, 150ft. ... 3/6  
3in message tape, 225ft. ... 4/11  
3in message tape, 300ft. ... 7/6  
3in triple play, 450ft. Mylar base ... 12/6  
4in triple play, 900ft. Mylar base ... 22/6  
5in triple play, 1,800ft. Mylar base ... 42/6  
5 1/2in triple play, 2,400ft. Mylar base ... 55/-  
7in triple play, 3,600ft. Mylar base ... 75/-  
P. & P. 1/- extra per reel; 4 reels and over Post Free.

**TRANSISTORS** New and Guaranteed  
GET.S1, GET.S5, GET.S6—2/6; 873A, 874P—3/6; OC.45, OC.71, OC.81D—4/6; OC.44, OC.70, OC.76, OC.81—5/6 (matched pair 10/6); AF.117, OC.75, OC.171, OC.200—6/6; OC.42, OC.43, OC.73, OC.82D—7/6; OC.671—9/6; OC.28, OC.201, OC.204—15/-; OC.205, OC.206—19/6; OC.28—24/6.

### REALISTIC SEVEN

★ 7-transistor Superhet. ★ 350 milliwatt output into 4" high flux speaker. ★ All components mounted on a single printed circuit

board, size 5 1/2" x 5 1/2" in one complete assembly. ★ Plastic cabinet with carrying handle, size 7" x 10" x 3 1/2", available in Blue/Grey. Full L. & M. coverage ★ Easy to read dial. ★ External socket for car aerial.



★ I.F. frequency 470 kc/s. ★ Ferrite rod internal aerial. Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly.

An Outstanding Receiver. LASKY'S PRICE for the complete parcel including Transistor, Cabinet, Speaker, etc., and Full Construction Data. Can be built for: **£5.19.6** P. and P. 4/6

PP9 Battery, 3/9. Data and instructions separately, 2/6. Refunded if you purchase the parcel. All parts sold separately.

### REALISTIC 'Seven' De Luxe

With the same specification as standard model—PLUS a superior wood cabinet in contemporary styling. ALSO a full vision circular dial

FOR ONLY **£1** EXTRA P. & P. as std. model

### SINCLAIR SUPER MINIATURES

**THE SINCLAIR SLIMLINE**  
The new 2-transistor pocket radio, size only 2 3/4" x 1 5/8" x 1 5/8". Micro alloy transistors and printed circuit. Easy to assemble. CAN BE BUILT FOR **49/6**

### THE SINCLAIR MICRO-6

Self-contained pocket radio. Size only 1 4/5" x 1 3/10" x 1/2"—truly amazing performance. Without doubt the most advanced transistor circuit ever offered to home constructors—yet may be built in an evening. Complete with earphone and detailed construction data. Mercury cell CAN BE BUILT FOR **59/6** 1/11 extra (2 required).

### THE SINCLAIR X10

10 watt power amplifier fitted with integrated pre-amp. Requires only 1mV for an output of 10 watts undistorted. Frequency response is flat, ±dB from 5 c/s to 10 kc/s. Size only 6" x 3" x 2", weight 5 oz., built on printed circuit. Operates from 12V d.c. at 75μA quiescent. Circuit uses 7 MATs and 4 r.f. power transistors. KIT PRICE **£5.19.6** READY **£6.19.6**

3 pots. 10r volume, bass & treble, 7/6 the 3 extra.

### TRANSISTERS BY BRUSH CRYSTAL CO.

TO-01B 465 kc/s ± 2 kc/s  
TO-01D 470 kc/s ± 2 kc/s  
TO-02B 465 kc/s ± 1 kc/s  
TO-02D 470 kc/s ± 1 kc/s  
TF-01B 465 kc/s ± 2 kc/s  
TF-01D 470 kc/s ± 2 kc/s

### PICK-UP CARTRIDGES

Crystal P.U. Cartridges complete with stylus—at lowest prices ever!  
NOMO C.T.1. ... 4/11  
Collaro Type C, stereo, 2 sapphires ... 15/-  
Collet S.C.T. Stereo Diamond LP Suppl. ... 17/6  
Sonotone 8T, stereo, 2 sapphires ... 19/11  
Sonotone 2TA, mono, 2 sapphires ... 15/-  
Postage 1/- each extra.

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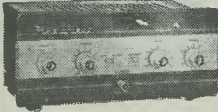
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(ELECTRONICS Fleet St. Ltd) FLEET 2833.  
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# HI-FI AMPLIFIERS RECORD PLAYERS RADIO TUNERS

S-33



AT-6



MA-12



S-99



**GOLDRING Lenco TRANSCRIPTION PLAYER. Model GL-58.** With G-60 pick-up arm and Ronette 105 cartridge. **£20.13** incl. P.T.

**GARRARD AUTO/RECORD PLAYER. Model AT-6.** With R 105 cartridge. **£13.12.1** Decca Deram pick-up **£14.6.1** incl. P.T.

**HI-FI MONO AMPLIFIER. Model MA-5.** A general purpose 5W Amplifier, with inputs for Gram., Radio. Presentation similar to S-33. Kit **£10.19.6** Assembled **£15.10.0**

**HI-FI MONO AMPLIFIER. Model MA-12.** 12W output, wide freq. range, low distortion. Kit **£11.18.0** Assembled **£15.18.0**

**R.P.M. INDICATOR (Electronic Rev. Counter).** A must for the motoring enthusiast. For 4 cylinders, pos. or neg. earth. 12V. Send for details. (Assembled only) **£8.10.9**

**HI-FI 6W STEREO AMPLIFIER. Model S-33.** 3 watts per channel 0.3% distortion at 2.5W/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram, Stereo or Monaural, ganged controls. Kit **£13.7.6** Assembled **£18.18.0**

**DE LUXE STEREO AMPLIFIER. Model S-33H.** De luxe version of the S-33 with two-tone grey perspex panel, and higher sensitivity necessary to accept the Decca Deram pick-up. Kit **£15.17.6** Assembled **£21.7.6**

**HI-FI STEREO AMPLIFIER. Model S-99.** 18W output. Ganged controls. Stereo/Mono gram., radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£27.19.6** Assembled **£37.19.6**

**POWER SUPPLY UNIT. Model MGP-1.** Input 100/120V, 200/250V. 40-60 c/s. Output 6.3V, 2.5A A.C. 200, 250, 270V, 120mA max. D.C. Kit **£5.2.6** Assembled **£6.12.6**

A wide range of American equipment available under direct mail order scheme. Full details and catalogue 1/- post paid.

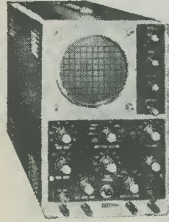
**Heathkit**  
DAYSTROM

## Make the most of the winter evenings...

### INSTRUMENTS

**T.V. ALIGNMENT GENERATOR. Model HFW-1.** Offers max performance at lowest cost. Covers 3.6 to 220 Mc/s fundamentals. Electronic sweep oscillators. Built in marker generators (5 Mc/s crystal)

Kit **£34.18.0**  
Assembled **£44.10.0**



IO-12U



S-3U

**DE LUXE LARGE-SCALE VALVE VOLT-METER. Model IM-13U.** Circuit and specification based on the well known model V-7A but with many worth-while refinements. 6" Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Kit **£18.18.0** Assembled **£26.18.0**

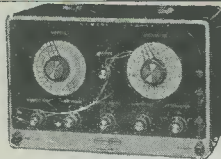
**AUDIO SIGNAL GENERATOR. Model AG-9U.** 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's. Kit **£22.10.0** Assembled **£30.10.0**

**VALVE VOLTMETER. Model V-7A.** 7 voltage ranges d.c. volts to 1,500. A.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1Ω to 1,000MΩ with internal battery. D.c. input impedance 11MΩ. dB measurement, has centre-zero scale. Complete with test prods, lead and standardising battery. Kit **£13.18.6** Assembled **£19.18.6**

**MULTIMETER. Model MM-1U.** Ranges 0-1.5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0.2Ω to 20MΩ. 4 1/2" 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

**R.F. SIGNAL GENERATOR. Model RF-1U.** Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100 mV output. Kit **£13.8.0** Assembled **£19.18.0**

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE. SEND FOR LISTS OF PRICES



HFW-1

**5" GENERAL-PURPOSE LABORATORY OSCILLOSCOPE. Model IO-12U.** This outstanding oscilloscope, with its professional specification and styling, fulfills most laboratory and service requirements. Vertical frequency response 3 c/s to over 4.5Mc/s, sensitivity 10mV r.m.s. per cm. at 1 kc/s. T/B covers 10 c/s-500 kc/s. Kit **£32.12.6** Assembled **£41.10.0**

**2 1/2" PORTABLE SERVICE 'SCOPE. Model OS-1.** This is a light, compact oscilloscope, ideal for servicing, etc. Dimensions 5" x 8" x 1 1/4" long. Wt. 10 1/2 lb. Fitted multi-metal CRT shield. Kit **£22.18.0** Assembled **£30.8.0**

**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. Kit **£12.18.0** Assembled **£18.10.0**



IM-13U

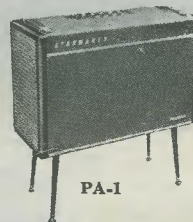


V-7A



RF-1U

### FOR THE MUSIC MAKER



PA-1

**PA AMPLIFIER PA-1.** The ideal compact unit for VOCALISTS, INSTRUMENTALISTS, RECORDS, with 50 Watt output, 2 Heavy Duty Speakers. Variable TREMOLO. Elegant modern cabinet. Kit **£54.15.0** Assembled **£74.0.0**

Legs optional extra 1/76 set of 4

**POWER AMPLIFIER MA-50** 50W output. Kit **£19.18.0** Assembled **£27.18.0**

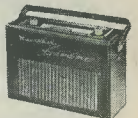
### ELECTRONIC ORGAN

(Transistorised). Ideal for Soloists, Home use, Groups. FULL 20 WATTS VOLUME. **£187.10.0** Matching bench **£14.10.0** extra.

### TRANSISTOR RADIOS

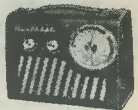
"OXFORD" LUXURY PORTABLE.

**Model UXR-2.** Specially designed for use as a domestic, car or personal portable receiver. Many features, including solid leather case. Kit **£14.18.0** incl. P.T.



UXR-2

**TRANSISTOR PORTABLE. Model UXR-1.** Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7" x 4" loudspeaker. Real hide case. Kit **£12.11.0** incl. P.T.



UXR-1

**JUNIOR EXPERIMENTAL WORKSHOP. Model EW-1.** More than a toy! Will make over 20 exciting electronic devices, incl: Radios, Burglar Alarms, etc. 72 page Manual. The ideal present! Kit **£7.13.6** incl. P.T.



UJR-1

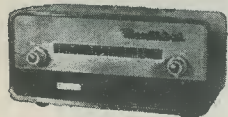
**JUNIOR TRANSISTOR RADIO. Model UJR-1.** Single transistor set. Excellent introduction to radio. Kit **£2.7.6** incl. P.T.

### Money-back Guarantee

Daystrom Limited unconditionally guarantees that each Heathkit product assembled in accordance with our easy-to-understand instruction manual must meet our published specifications for performance or the purchase price will be cheerfully refunded.



# TAPE AMPLIFIERS TAPE DECKS CONTROL UNITS



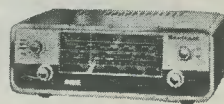
FM-4U



MAGNAVOX



TRUVOX



AM/FM

**HI-FI FM TUNER. Model FM-4U.** Also available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10.7 Mc/s, and amplifier unit, with power supply and valves (£13.3.0). Total Kit **£15.18.0**

**TAPE RECORDING/PLAYBACK AMPLIFIER.** Thermometer type recording indicators, press-button speed compensation and input selection. Mono Model TA-1M, Kit **£19.18.0** Assembled **£28.18.0**  
Stereo Model TA-1S, Kit **£25.10.0** Assembled **£35.18.0**

**MONO CONTROL UNIT. Model UMC-1.** Designed to work with the MA-12 or similar amplifier requiring 0.25V or less for full output. 5 inputs. Baxandall type controls. Kit **£8.12.6** Assembled **£13.12.6**

**STEREO CONTROL UNIT. Model USC-1.** Push-button selection, accurately matched ganged controls to  $\pm 1$ dB. Rumble and variable low-pass filters. Printed circuit boards. Kit **£19.10.0** Assembled **£26.10.0**

**MAGNAVOX "STUDIO" TAPE DECK.** The finest buy in its price range. Operating speeds: 1 $\frac{1}{2}$ ", 3 $\frac{1}{2}$ " and 7 $\frac{1}{2}$ " p.s. Two tracks, "wow" and "flutter" not greater than 0.15% at 7 $\frac{1}{2}$ " p.s. **£14.19.6**

**TRUVOX D93 TAPE DECKS.** High quality stereo/mono tape decks.

D93/2,  $\frac{1}{2}$  track, **£36.15.0** D93/4,  $\frac{1}{4}$  track, **£36.15.0**

**HI-FI AM/FM TUNER. Model AFM-1.** Available in two units which, for your convenience, are sold separately. Tuning head (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£21.16.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total Kit **£26.10.0**

## Enjoy yourself building a Heathkit model

### SPEAKER SYSTEMS

**COTSWOLD "MFS" SYSTEM.** Specially developed to give best possible results in small rooms. This minimum floor space model is based on standard Cotswold. Size: 36" high x 16 $\frac{1}{2}$ " wide x 14 $\frac{1}{2}$ " deep.

Kit **£23.4.0** Assembled **£30.15.0**



MFS



SSU-1

**THE "COTSWOLD".** This is an acoustically designed enclosure 26" x 23" x 15 $\frac{1}{2}$ " 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.

Kit **£23.4.0** Assembled **£30.15.0**

**HI-FI SPEAKER SYSTEM. Model SSU-1.** Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical or horizontal models with legs, Kit **£11.12.0**, without legs, Kit **£10.17.6** incl. P.T.



MALVERN

### HI-FI CABINETS

A wide range of equipment cabinets is available to meet the differing needs of enthusiasts. Designed for max. operating convenience or for where room space is an overriding consideration, this range includes kits, ready assembled cabinets or fully finished cabinets, and has at least one model to suit your requirements. Send for full details.

Prices from **£7.7.0** to **£37.16.0** incl. P.T.

### SEND FOR FREE BRITISH HEATHKIT CATALOGUE

American catalogue also available 1/- post paid

Deferred terms available in U.K. over **£10**.  
Extended terms over **£75**. Send for details.

**DAYSTROM LTD** DEPT. RC. 1 GLOUCESTER

### "AMATEUR" EQUIPMENT

**AMATEUR BANDS RECEIVER. Model RA-1.** To cover all the Amateur Bands from 160-10 metres. Many special features, including: half-lattice crystal filter; 8 valves; signal strength "S" meter; tuned R.F. Amp. stage.

Kit **£39.6.6** Assembled **£52.10.0**

**THE "MOHICAN" GENERAL COVERAGE RECEIVER. Model GC-1U.** With 4 piezo-electric transmitters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised general purpose receiver for Amateur and Short wave listeners. Printed circuits, telescopic aerials, tuning meter and large slide-rule dial.

Kit **£37.17.6** Assembled **£45.17.6**

**160-10M TRANSMITTER. Model DX-100U.** Careful design has achieved high performance and stability. Completely self-contained.

Kit **£79.10.0** Assembled **£104.15.0**



SB-10U

**COMMUNICATIONS TYPE RECEIVER. Model RG-1.** A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s-1.5 Mc/s and 1.7 Mc/s-32 Mc/s.

Kit **£39.16.0** Assembled **£53.0.0**

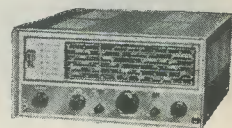
**SINGLE SIDEBAND ADAPTOR. Model SB-10U.** May be used with most A.M. transmitters. Less than 3W R.F. input power required for 10W output. Operation on 80, 40, 20, 15 and 10m bands on U.S.B., L.S.B. or D.S.B.

Kit **£39.5.0** Assembled **£54.18.0**

Many other British 'Amateur' models. Send for Catalogue.



RA-1



RG-1

### AMERICAN HEATHKIT "AMATEUR" EQUIPMENT

A wide range of American Amateur SSB equipment is now available in the U.K. Why not send for full details of range, for example:—

**80-10M RECEIVER. Model SB-300E.**

Of advanced design employing up-to-date construction techniques, its specification ensures unparalleled performance.

Kit **£133.14.0** (less speaker) + 15% import levy.



SB-300E

Without obligation please send me **FREE BRITISH HEATHKIT CATALOGUE**.....

(Tick here)

**FULL DETAILS OF MODEL(S)**.....  
(Please write in BLOCK CAPITALS)

NAME .....

ADDRESS .....

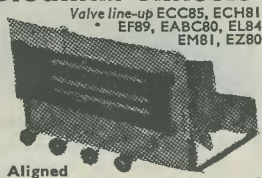
DEPT. RC.1



## 7 VALVE AM/FM RADIOGRAM CHASSIS

Three Waveband & Switched Gram positions. Med. 200-550m. Long 1,000-2,000m. VHF/FM 88-95 Mc/s. Phillips Continental Tuning insert with permeability tuning on FM & combined AM/FM IF transformers. 460 kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC & Neg. Feedback. 3 watt output. Sensitivity and reproduction of a very high standard. Chassis size 13 1/2" x 6 1/2". Height 7 1/2". Edge illuminated glass dial 1 1/2" x 3 1/4". Vert. pointer Horiz. station names. Gold on brown background. A.C. 200/250V operation. Magic-eye tuning. Circuit diag. now available.

Comp. with 4 knobs—walnut or ivory to choice. Indoor FM aerial 3/16 ex. 3/2 P.M. Speaker only required. Recommended Quality Speakers 10" Rola, 27/6. 13 1/2" x 8" E.M.I. Fidelity, 37/6. 12" R.A. with conc. Tweeter, 42/6. Carr. 2/6.



Valve line-up ECC85, ECH81 EF89, EABC80, EL84 EM81, EZ80  
Aligned and tested ready for use. **£13.10.0** Carr. & Ins. 7/6.

## ANOTHER TAPE RECORDER BARGAIN

Manufacturers' end of production Surplus Offer



A 24 gns. Tape Recorder offered at the bargain price of only 15 gns. plus 10/- carr. Supplied in 3 Units already wired and tested. A modern Circuit for quality recording from Mike Gram or Radio, using latest B.S.R. Twin Track Monardeck Type TD2. Valve line-up—EF86, ECL82, EM84, EZ80 and Silicon Diode. Send for detailed list—3d. stamp.

**Completed Kit** comprising items below  
**BARGAIN PRICE 15 Gns.** + 10/- Carr.

2-tone Cabinet and 8" x 5" Speaker. Size 14" x 10 1/2" x 7 1/2" ... £3 10 0 + 5/- Carr.  
Wired Amplifier complete with 4 Valves, front Panel, Knobs, etc. ... £5 15 0 + 3/6 Carr.  
B.S.R. Monardeck Type TD2 ... £7 7 0 + 4/6 Carr.  
Accessories: Mike, Tape, Empty Reel, screened Lead and Plugs, Instructions, etc. ... £1 0 0 + 2/- Carr.

Jack Plugs. Standard 2 1/2" Irganic Type, 2/6. Screened Ditto, 3/3. Miniature scr. 1 1/2", 2/3. Sub-min. 1/3. Jack Sockets. Open Irganic Ploughed Type, 3/6. Closed Ditto, 4/-.

Soldering Irons. Mains 200/220V or 230/250V. Solon 25 watt Inst., 22/6. Spare Elements, 4/6. Bits, 1/- 6d. each, 27/6 etc.

Alumin. Chassis. 18g. Plain Undrilled, folded 4 sides, 2 1/2" deep, 6" x 4", 4/6, 8" x 6", 5/9, 10" x 7", 6/9, 12" x 6", 7/6, 12" x 8", 8/- etc.

Alumin. Sheet. 18g. 6" x 6", 1/-, 6" x 9", 1/6, 6" x 12", 2/-, 12" x 12", 4/6 etc.

## RECORDING TAPE

Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT Brand new, boxed and fully guaranteed. Fitted with leader and stop folds.

| Standard | Double Play | Long Play |      |
|----------|-------------|-----------|------|
| 50'      | 13/-        | 1,200'    | 31/6 |
| 90'      | 18/-        | 1,800'    | 37/6 |
| 150'     | 21/-        | 2,400'    | 47/6 |
| 270'     | 28/6        | 1,800'    | 28/6 |

Post & Package per reel, 1/- plus 6d. each for additional reels.

| New Boxed | VALVES | Reduced Bargain Prices | Electrolytics All Types New Stock |
|-----------|--------|------------------------|-----------------------------------|
| IT4       | 3/6    | EF80 7/6               | 25/25V 1/9                        |
| IR5       | 6/-    | EF86 8/6               | 50/12V 1/9                        |
| IS5       | 6/-    | EL33 12/6              | 50/50V 2/-                        |
| 354       | 7/-    | EL34 12/6              | 100/25V 2/-                       |
| 3V4       | 7/-    | EL84 7/-               | 4/350V 2/3                        |
| ECC81     | 7/-    | EY51 9/-               | 100+300/275V 12/6                 |
| ECC82     | 7/-    | EY86 9/-               | 16+16/450V 5/6                    |
| ECC83     | 7/-    | EL83 8/-               | 32+32/450V 6/6                    |
| ECL80     | 9/-    | EZ80 7/-               | 2000+4000/6V 3/6                  |
| ECL82     | 10/-   | EZ81 7/-               | 1000/25V 3/9                      |
| ECL86     | 10/6   | GZ32 9/6               | Ersin Multicores 60/40, 4d.       |
|           |        | PCC84 8/-              | per yard. Cartons 2/6, etc.       |
|           |        | UL84 9/-               |                                   |

## DE LUXE R/PLAYER KIT

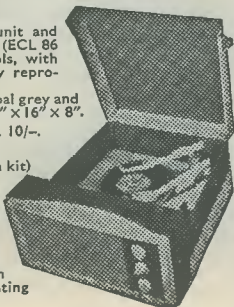
Incorporating 4 Speed Garrard Auto-Slim unit and Mullard latest 3 watt printed circuit amplifier (ECL 86 and EZ 80), volume, bass and treble controls, with 8" x 5" 10,000 line speaker. Superb quality reproduction.

Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief. Size: 17 1/2" x 16" x 8".  
**COMPLETE KIT £13.19.6** Carr. & ins. 10/-.

Illuminated Perspex escutcheon, 7/6 extra. Catalogue & construction details 2/6 (free with kit)

## STANDARD RECORD PLAYER KIT

Using BSR UA14 Unit, complete kit £11.10.0, carr. 7/6. Ready wired Amplifier, 7" x 4" quality Speaker and O/P trans. £3.19.6, carr. 2/6. BSR UA14 Unit, £6.10.0, carr. 5/-, Rexine covered cabinet in two-tone maroon and cream, size 15 1/2" x 14 1/2" x 8 1/2" with all accessories plus unc. record player mounting board 14" x 13", 59/6, carr. & ins. 5/-.



## 6 VALVE AM-FM TUNER UNIT

Med. and VHF 190m-550m, 86 Mc/s-103 Mc/s, 6 valves and metal rectifier. Self-contained power unit, A.C. 200/250V operation. Magic-eye indicator, 3 push-button controls, on/off, Med., VHF. Diodes and high output Sockets with gain control. Illuminated 2-colour perspex dial 1 1/2" x 4", chassis size 1 1/2" x 4" x 5 1/2". A recommended Fidelity Unit for use with Mullard "3-3" or "5-10" Amplifiers. Available only at present as built-up units, aligned and tested ready for use.  
**Bargain Price £12.10.0.** Carr. 5/-.  
We hope to produce this popular unit in kit form very shortly.

**Volume Controls**—5K-2 Meg-ohms, 3" Spindles Morganite Midget Type, 1 1/2" diam. Guar. 1 year, LOG or LIN ratios less Sw. 3/-. D.P. Sw. 4/6. Twin Stereo less Sw. 6/6. D.P. Sw. 9/6 (100 kc. to 2 Meg. only). + Meg. VOL Controls D.P. Sw. 1/2" flatted spindle. Famous Mfrs. 4 for 10/- post free.

**ENAMELLED COPPER WIRE**—1/16 edge, 14g-20g, 2/6; 22g-28g, 3/-; 36g-38g, 4/3; 39g-40g, 4/6, etc.

**TINNED COPPER WIRE**—14-22g. 2/6 ± lb.

**PVC CONNECTING WIRE**—10 colours (for chassis wiring, etc.)—Single or stranded conductor, per yd., 2d. Sleeving, 1mm, and 2mm., 2d. yd., etc.

## COAX 80 OHM CABLE

High grade low loss Cellular air spaced Polythene—1/4" diameter. Stranded cond. Famous mfrs. Now only 6d. per yard.

**Bargain Prices—Special lengths:**  
20 yds. 9/- P. & P. 1/6.  
40 yds. 17/6 P. & P. 2/-.  
60 yds. 25/- P. & P. 3/-.  
Coax Plugs 1/3 Sockets 1/- Couplers 1/3. Outlet Boxes 4/6.

**Condensers**—S/Mica all values 2pF to 1,000pF 6d. Ditto Ceramic 9d. each, .005, .01 and .1, etc., 1/-. Paper Tubular 450V .001 mfd to .01 mfd and 1/250V 9d. .02-1 mfd 1/-, .25 mfd 1/6, 5 mfd 1/9.

**Close Tol. S/Micas**—10% 5pF-5000pF 8d. 600-5,000pF 1/-. 1% 2pF-100pF 9d. 100pF-5000pF 11d. 575pF-5,000pF 1/6. Resistors—Full Range 10 ohms-10 megohms 20% ± and 1W 3d., ditto 1/2W 4d., 1/2W 5d. (Midget type modern rating) 1W 6d., 2W 9d. Hi-Stab 5% ±—1W 10 ohms 1 megohm 6d. Other values 9d. 1% ± 1W 1/6. W/W Resistors 25 ohms to 10K 5V 1/3, 10W 1/6, 15W 2/-.

Pre-set TV Pots. W/W 25 ohms-50K 3/-. 50K-2Meg. (Carbon) 3/6. Speaker Fret—Expanded gilt anodised metal 1/2" x 1/2" diamond mesh, 4/6 sq. ft., multiples of 6" cut. Max. size, 4ft. x 3ft. 47/6. Carr. extra. Ditto, finer mesh, 4/6 sq. ft. Multiples 12" only, max size 3ft x 2ft. 27/6.

**Plus Carr**  
**TYGAN FRET** (contemp. pat.) 12" x 12" 1/8", 12" x 18" 3/4", 12" x 24" 4/-, 18" x 18" 4/6, etc.

**BONDACOUST Speaker Cabinet** Acoustic Wadding, superior grade, 1" thick, 12" wide, any length cut 1/6 per ft, 4/- per yd.

**KNOBBS**—Modern Continental types: Brown or Ivory with Gold Ring, 1" dia., 9d. each; 1 1/2" dia., Brown or Ivory with Gold Centre, 1" dia. each; 1 1/2" dia., 1/3 each. LARGE SELECTION AVAILABLE.

## TRANSISTOR COMPONENTS

Midget I.F.'s—465 kc/s 1 1/2" diam. 5/6 Osc. Coil—1 1/2" diam. M/W. 5/3 Osc. coil M. & L.W. 5/9 Midget Driver Trans. 3.5:1 6/9 Midget O/Put Push-pull 3 ohms 6/9

**Elect. Condensers**—Midget Type 15V 1mfd-50mfd, ea. 1/9. 100mfd, 2/- Ferrite Aerial—M. & L.W. with car aerial coupling coil, 9/3.

**Condensers**—150V. wkg. .01 mfd. to .04 mfd, 9d. .05 mfd., .1 mfd., 1/- .25 mfd., 1/3. .5 mfd., 1/6, etc.

**Tuning Condensers**. J.B. "00" 208+176pF, 8/6. Ditto with trimmers, 9/6. 365pF single, 7/6. Sub-min. 2" DILEMIN 100pF, 300pF, 500pF, 7/-.

**Midget Vol. Control** with edge control knob, 5KΩ with switch, 4/9, ditto less switch, 3/9.

**Speakers P.M.**—2" Plessey 75 ohms, 15/6. 2 1/2" Continental 8 ohms, 13/6. 7" x 4" Plessey 35 ohm, 23/6.

**Ear Plug Phones**—Min. Continental type, 3ft. lead, jack plug and socket. High Imp. 8/-, Low Imp., 7/6. High sensitivity M/coil 8-10 ohms, 12/6.

## JASON FM TUNER UNITS

Designer-approved kit of parts:  
FMT1, 5 gns. 4 valves, 20/-.  
FMT2, 7 gns. 5 valves, 35/-.  
JTV MERCURY 10 gns.  
3 valves, 22/6.  
JTV2 £13.19.6. 4 valves, 28/6.

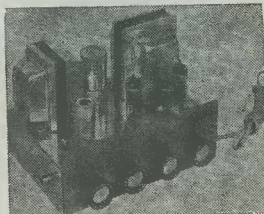
**NEW JASON FM HANDBOOK**, 2/6. 48 hr. Alignment Service 7/6. P. & P. 2/6.

## MULLARD "3-3" & "5-10" HI-FI AMPLIFIERS

### 3 OHM AND 15 OHM OUTPUT

"3-3" Amp. 3-valve, 3 watt, Hi-Fi quality at reasonable cost. Bass Boost and Treble controls, quality sectional output transformer, 40 ohms-25 kc/s ± 1dB, 100mV for 3W, less than 1% distortion. Bronze escutcheon panel.  
**Complete Kit only £6.19.6.** Carr. 5/-. Wired and tested 8 gns.

**MULLARD "5-10" AMPLIFIER**—5 valves 10W, 3 and 15 ohm output.  
**Complete Kit £7.19.6.** Carr. 3/6.



Mullard's famous circuit with heavy duty ultra-linear quality output trf. Basic amplifier kit price £9.19.6. Carr. 7/6. Ready built 11 1/2 gns.

### CONTROL PANEL KIT

Bass, Treble and Volume controls with 4-position selector switch for radio, tape and pick-up and 1 1/2" x 4" escutcheon panel.  
**Amplifier Kit and Control Panel Kit £11.19.6.** Ditto ready wired £14.19.6.

### 2-VALVE PRE-AMP. UNIT

Based on Mullard's famous 2 valve (2 x EF86) circuit with full equalisation with volume, bass, treble, and 5-position selector switch. Size 9" x 6" x 2 1/2".  
**Complete Kit £5.19.6.** Carr. 3/6.

Send for detailed bargain lists, 3d. stamp. We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans., etc. Enquiries invited for Specials, Prototypes for small production runs. Quotations by return.

## RADIO COMPONENT SPECIALISTS

70 Brigstock Road, Thornton Heath, Surrey THO 2188. Hours: 9 am-6m., 1 p.m. Wed. Terms C.W.O. or C.O.D. Post and Packing up to 1 lb. 9d., 1 lb. 1/3, 3 lb. 2/3, 5 lb. 2/9, 8 lb. 3/6.



Est. 1946



# Pioneers in build it yourself tuners and test equipment

## Jason KITS

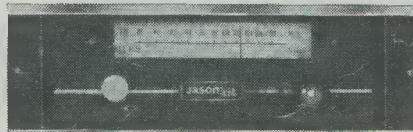
Jason were first to produce a stable switched f.m. tuner for reception of BBC transmissions and an outstanding success has been achieved with the introduction of simple-to-operate switched tuners to receive both f.m. and TV sound transmissions. Jason tuners and test equipment offer a wide choice of models designed to meet present-day requirements and are a delight to build.

### OTHER JASON KITS

|                                          |          |
|------------------------------------------|----------|
| FMT1 F.M. Tuner, less valves             | £5.19.0  |
| MERCURY 11 Switched Tuner, less valves   | £9.15.4  |
| ARGUS Transistor M.W. Tuner, complete    | £7.10.0  |
| OG10 Oscilloscope, less c.r.t.           | £18.10.0 |
| W11 Wobbulator, complete                 | £14.19.0 |
| EM10 Valve Voltmeter, complete           | £23      |
| SB26 Tape Deck (built only) ½-track mono | 31 gns.  |
| 4-track stereo                           | 39 gns.  |

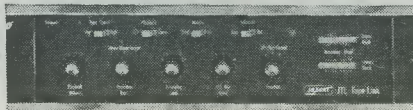


**JTV2 SWITCHED TUNER** for the reception of all BBC f.m. transmissions and BBC-I and ITV television sound channels at the turn of a switch. Foster-Seeley discriminator. Built-in power supply.  
Sensitivity 10 $\mu$ V for 40dB quieting. Audio output 0.4V approx. All components, including turret and coil plate but less four valves—£14.0.4.



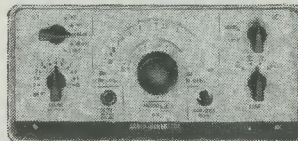
**FMT2 FM TUNER** covering 88-108 Mc/s. Built-in power supply sensitivity better than 100 $\mu$ V for 40dB quieting. All components, less four valves, £9.9.0, less power supply components, £7.15.0.

**FMT3 TUNER** similar appearance to above, but for fringe area reception. All components, less valves, £10.9.0, less power supply components, £8.15.0.



**JTL TAPE PREAMPLIFIER** designed to suit any tape deck or head. Will simultaneously record and play back stereo or mono using two or four-track heads.

Especially recommended for use with the Lorlin SB26 tape deck. (Send for details.) All components including valves, £22.1.0. Ready built and tested £30.9.0.



**AG10 AUDIO GENERATOR.** Excellent stability with constant output over entire range. Tunes from 10 c/s to 100 kc/s in four switched ranges. Square wave or sine wave outputs. Square wave rise time less than 2 $\mu$ sec. at all frequencies. Minimum calibrated output 100mV. Self-powered. All components, including valves, £15.19.0.

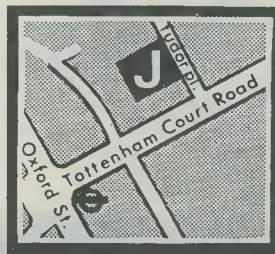
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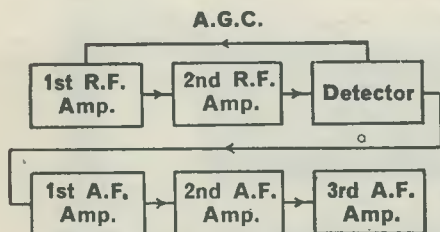
## ① MICRO-6 SIX-STAGE POCKET RECEIVER

*The smallest set in the world!  
Easily built in an evening!*

THE 100% BRITISH DESIGNED SINCLAIR MICRO-6 continues unchallenged as the most remarkable receiver of its kind ever made available to the public anywhere in the world. It has special 6-stage circuitry and is, at the same time, the smallest set on earth. Everything except the lightweight earpiece is contained in the smart, minute white, gold and black case which is appreciably smaller than a matchbox, as the illustration shows. With vernier-type tuning control, bandspread over the higher frequency end of the medium waveband and powerful A.G.C. to ensure fade-free reception of the most distant stations, the Micro-6 provides remarkable standards of performance. Quality of reproduction is outstandingly good, and again and again the set is reported to give excellent results where other sets cannot be used at all. Order yours now and you will at once see why the Micro-6 cannot be too highly recommended, both as an intriguing design to build, and a most practical radio to use.



- SIZE 1 4/5" x 1 3/10" x 1/2"
- WEIGHS UNDER 1 OZ
- BAND SPREAD TUNING FOR EASY RECEPTION FROM LUXEMBOURG
- VERNIER-TYPE TUNING OVER MEDIUM WAVE BAND
- CHOICE OF MANY STATIONS
- BATTERIES AND FERRITE ROD AERIAL CONTAINED IN CASE



### SIX-STAGE POWER AND SELECTIVITY

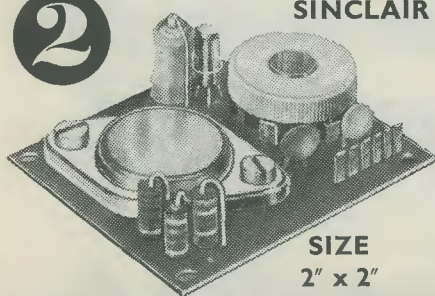
The Micro-6 uses only three Micro-Alloy Transistors in a unique and very efficient circuit as follows: Two stages of R.F. amplification are followed by an efficient double-diode detector which drives a high-gain 3-stage A.F. amplifier. Powerful A.G.C. applied to the first R.F. stage ensures fade-free reception from the most distant stations tuned in. Everything including ferrite-rod aerial and batteries is contained within the elegant tiny case.

Building is simple. All parts including lightweight earpiece, case and dial, and 8-page instructions manual come to

# 59'6

Sinclair "Transista" well-styled, strong black nylon wrist strap 7/6  
Mallory Mercury Cell Type ZM312 (2 required) each 1/11  
Pack of 6 10/6

## ②



SIZE  
2" x 2"

SINCLAIR

## TR750 POWER AMPLIFIER

Designed specially for use with the Micro-6

THE TR750 enables the Sinclair Micro-6 Receiver to be used as a powerful car, domestic or portable loud-speaker set. A connecting plug is provided for this. The TR750 also has many other applications such as a record reproducer, intercom or baby alarm. An output of 750 milliwatts for feeding into a standard 25-30Ω loudspeaker requires only a 10mV input into 2kΩ. Frequency response 30-20,000 c/s ±1dB. Power required—9 to 12 volts.

All parts with instructions come to

# 39/6

Ready built and tested with instructions

# 45/-

# sinclair

## SINCLAIR RADIONICS LTD

COMBERTON, CAMBRIDGE Telephone: COMBERTON 682



# SINCLAIR

## ③ SINCLAIR X-10

INTEGRATED 10-WATT  
HI-FI AMPLIFIER  
AND PRE-AMP  
WITH P.W.M.



The  
only design  
of its kind in  
the world

Cost of all parts  
together with In-  
struction Manual

£5.19.6

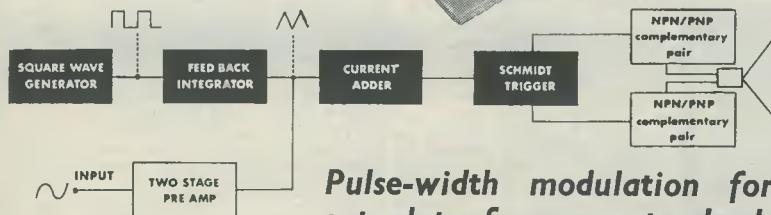
Ready built and  
tested together  
with Instruction  
Manual

£6.19.6

Mains power supply  
unit (A.C.  
200-240 volt) to  
drive one or two  
X-10 amps.

£2.14.0

THE GREATEST ADVANCE  
IN AMPLIFIER DESIGN  
IN YEARS



*Pulse-width modulation for  
superb performance standards*

The principle of P.W.M., used in this remarkable amplifier which is complete with its own pre-amp stage and unique output stage, is briefly as follows: A square wave of constant voltage amplitude and with a frequency well above the highest audio-frequency to be reproduced, is applied to the terminals of the load. As the load has a high impedance at this frequency, negligible current flows through the voice coil of the speaker.

When an input signal is applied, the mark-space ratio changes with the result that there

is a net current flowing through the voice coil which deflects the cone. When the input signal is at any frequency up to 20 kc/s the net current is an exact replica of the input signal and is independent of the transfer characteristics of the output transistors, making the distortion figures incredibly low. The output transistors act as switches and so dissipate negligible power. This enables us to use 5 Mc/s transistors for this with great savings in space, current consumption and costs. No heat sink is required.

- ★ 11 Transistors and no heat sink
- ★ Unique output stage
- ★ Add your own choice of tone control circuit
- ★ Input sensitivity 1mV into 1kΩ
- ★ Can be used with all types of inputs including low-output pick-ups and microphones
- ★ Total harmonic distortion < 0.1%
- ★ Output power up to 10 watts
- ★ Frequency response 5-20,000 c/s ±0.5dB
- ★ Speaker impedance 15Ω
- ★ Damping factor—greater than 100
- ★ Supply voltage 12 volts from batteries or mains supply unit
- ★ Size 6" x 3"

### SINCLAIR X-10 MANUAL

Explains how the amplifier functions and how you can add the correct tone and volume control system to suit your precise requirements. A variety of systems is shown, none of which will add more than a few shillings to the original cost of your Sinclair X-10, be it for MONO or STEREO. Available separately. Price 1/-.

TO SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE. Comberton 682

Please send items detailed below

£ s d

NAME

ADDRESS

TOTAL £

For which I enclose cash/cheque/money order

RC1-65

**sinclair**

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Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries, please. Personal shoppers welcomed at any of the branches below. Open all day Saturday.

**BRADFORD** 54 Morley Street, Nr. Alhambra Theatre (Half-day Wednesday)

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**BIRMINGHAM** 30/31 Gt. Western Arcade, opp. Snow Hill Station (No half-day)

**DERBY** 26 Osmaston Rd., The Spot (Half-day Wednesday)

**DARLINGTON** 13 Post House Wynd (Half-day Wednesday)

**EDINBURGH** 133 Leith Street (Half-day Wed.)

**GLASGOW** 326 Argyle Street (Half-day Tuesday)

**HULL** 51 Savile Street (Half-day Thursday)

**LEICESTER** 32 High Street (Half-day Thursday)

**LEEDS** 5-7 County (Mecca) Arcade (No half-day closing)

**LIVERPOOL** 73 Dale Street (No half-day closing)

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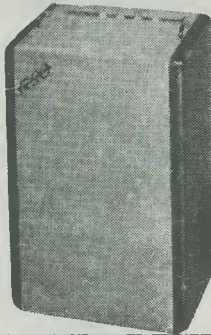
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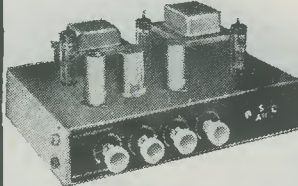
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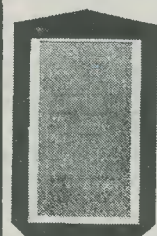
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as featured on page 699 in the May issue

COIL TURRET CT.7/B

This turret is the basic portion of the CT.7. It comprises cadmium plated steel frame (5 1/4" deep x 4 1/4" high x 3 1/2" wide), silver plated contacts, polystyrene insulation and rotary turret movement, incorporating Aerial, Mixer and Oscillator Coils for the three bands 1.5-4 Mc/s, 4-12 Mc/s and 10-30 Mc/s. Price 75/-

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"BASIC SUPERHET FOR BEGINNERS"

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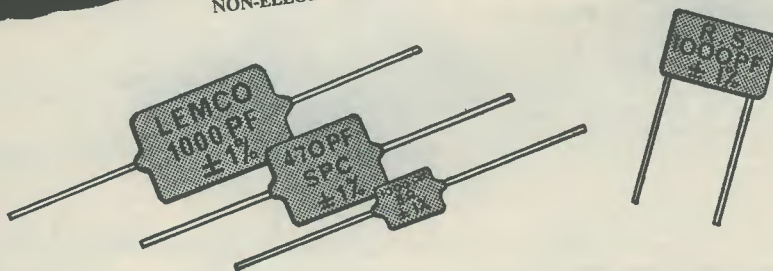
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# THE Radio Constructor

Incorporating THE RADIO AMATEUR



## JANUARY 1965

Vol. 18, No. 6  
Published Monthly  
(1st of month)

*Editorial and  
Advertising Offices*  
57 MAIDA VALE LONDON W9

*Telephone*  
CUNningham 6141

*Telegrams*  
Databux, London

First Published  
1947

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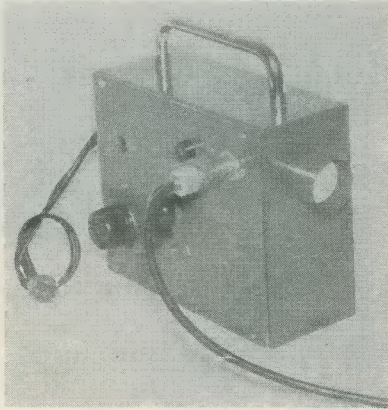
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Annual Subscription 33s. (U.S.A. and Canada \$5) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

Published in Great Britain by the Proprietors and Publishers Data Publications Ltd. 57 Maida Vale London W9  
Printed by A. Quick & Co. (Printers) Ltd. Oxford Road Clacton-on-Sea England

# The "Mint with the Hole" Transmitter Monitor

By F. C. JUDD, A. Inst. E., G2BCX



**D**URING THE COURSE OF RECENT DEVELOPMENT work on transistor transmitters, the need arose for a rather specialised c.r.t. monitor. This had to display the amplitude of the r.f. carrier at the aerial terminal, the waveform of the r.f. carrier, and modulation amplitude. The usual trapezoidal display produced by feeding the r.f. and audio signals to X and Y plates was found to be unsuitable.

The "Mint with the Hole" monitor, so called because of the display form, provided the answer.

This is simple to build and could in fact be quite portable if operated from a 6 volt dry battery. The original, shown in the photograph, was arranged to operate from a 12 volt supply provided by a car battery.

## Circular Display

The basic principle of the device, the circuit of which is shown in Fig. 1, is to display the waveform of one cycle of the carrier as a complete circle. The diameter of the circle represents amplitude

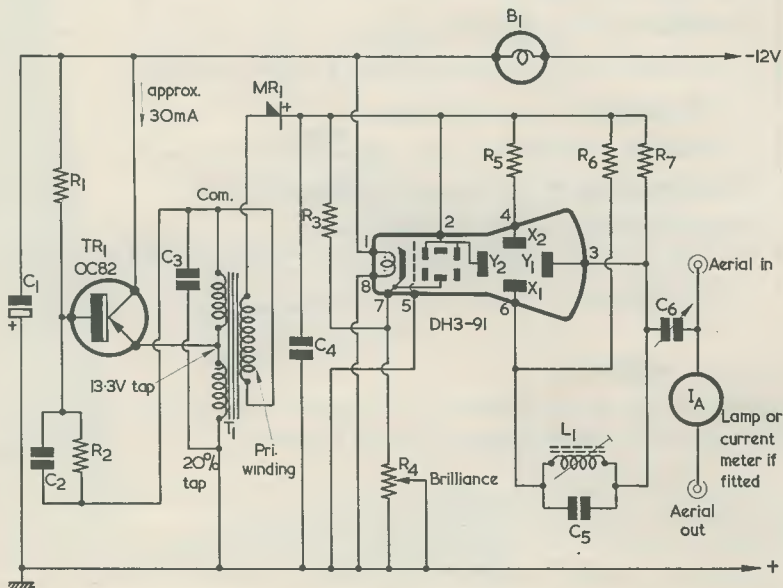


Fig. 1. The circuit of the transmitter monitor



and can be set to any predetermined level. The circle will not appear as a circle if the r.f. waveform is distorted in any way.

To obtain the circle is quite simple, and requires only a coil and capacitor tuned to the frequency of operation and connected between the X and Y plates of a small cathode ray tube. Since the r.f. voltage will be in opposite phase at each end of the coil a circle composed of two half cycles will be displayed.\*

Under modulation the circle will expand outwards and the area of the carrier being modulated will appear shaded. When modulation is 100% a bright green dot will just start to appear at the centre. Fig. 2 shows the result of modulation between at 0, 50 and 100%, as well as overmodulation.

\* To obtain a circular display under normal conditions, it is necessary to have 90° phase difference between the signals applied to the X and Y plates. In this respect the author states: "The voltage at each end of the tuned circuit is in complete phase opposition, i.e. when the voltage at one end is going positive the voltage at the other is going negative. If the two voltages are applied to the X and Y plates respectively, the resultant display would be a straight line. However, when the tuning of the circuit is adjusted, phase shift through 360° can occur. At 90° the resultant display is a circle."—EDITOR.

### Components List

#### Resistors

(All fixed values  $\frac{1}{4}$  watt 10%)

- R<sub>1</sub> 27k $\Omega$
- R<sub>2</sub> 10k $\Omega$
- R<sub>3</sub> 3M $\Omega$
- R<sub>4</sub> 500k $\Omega$  potentiometer, linear track
- R<sub>5,6,7</sub> 470k $\Omega$

#### Capacitors

- C<sub>1</sub> 100 $\mu$ F electrolytic, 12V wkg.
- C<sub>2,3</sub> 0.01 $\mu$ F paper
- C<sub>4</sub> 0.1 $\mu$ F paper, 500V wkg.
- C<sub>5</sub> 200pF silver-mica
- C<sub>6</sub> 50pF variable

#### Inductors

- T<sub>1</sub> Radiospares c.r.t. heater transformer (see text)
- L<sub>1</sub> Denco "Maxi-Q" Range 3 Blue coil (coupling winding not used)

#### Cathode Ray Tube

1in oscilloscope tube type DH3-91 (Mullard)

#### Transistor

TR<sub>1</sub> OC82

#### Rectifier

MR<sub>1</sub> 500V silicon rectifier

#### Bulb

B<sub>1</sub> 6.3V 0.5A, or equivalent resistor (see text)

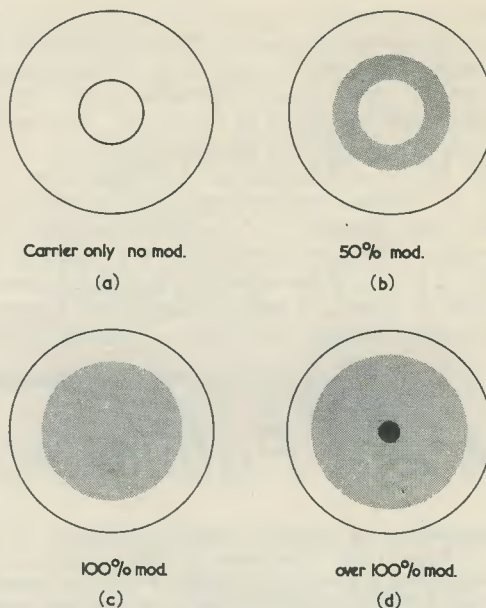


Fig. 2. Cathode ray tube displays for various degrees of modulation

A ringing oscillator, incorporating an OC82 transistor, provides approximately 500 volts h.t. for the tube.

The original circuit was designed for the 160 metre band and employed a Denco Range 3 coil with the grid winding shunted by a 200pF mica capacitor. The coil can be tuned over the whole band by means of the dust iron slug. This is quite easily controlled by fitting a small knob or disc on the protruding end of the threaded brass end that moves the iron core. The coil is, of course, mounted on the front panel.

#### Components

Any 1in or 1½in c.r.t. could be used, but in the model shown in the photograph a Mullard type DH3-91 1in tube was employed. This has fixed

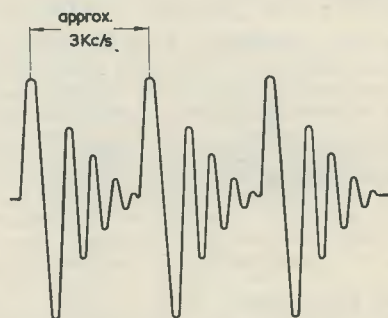


Fig. 3. The waveform on the secondary of T<sub>1</sub>, the ringing oscillator transformer

focus which simplifies things a little and necessitates only a control for brilliance. The ringing oscillator h.t. supply can be devised from a Radiospares 13 volt TV c.r.t. mains transformer with a 20% tap connected as shown in the circuit. The waveform produced by this is shown in Fig. 3.

The heater requirement of the DH3-91 is 6.3 volts at 550mA. In the prototype, the 12 volt supply was dropped to a suitable potential by inserting a 6.3 volt 0.5 amp bulb, B<sub>1</sub>, in series, as shown in Fig. 1. Alternatively, a dropping resistor of suitable value and wattage could be employed in place of the bulb. The bulb (or resistor) is not

required with a 6 volt supply.

The circuit shown is exactly that being used by the writer, but it could be modified in various ways to suit individual requirements. The size of the carrier circle is set by means of the small variable capacitor, C<sub>6</sub>, which also isolates the tube h.t. and deflection plates from the aerial terminals.

In use, tune the transmitter up and adjust the tuning coil slug until the circle appears. Set the diameter as required. Modulation at 100% will expand the circle to about twice the diameter and shade the area within as shown in Fig. 2 (c).

## Recent Publications . . .

**EXPERIMENTAL RADIO ENGINEERING.** By E. T. A. Rapson, M.Sc.(Eng.), A.C.G.I., D.I.C., M.I.E.E., M.Brit.I.R.E. 214 pages, 5½ x 8½in. Published by Sir Isaac Pitman & Sons, Ltd. Price 14s.

This is the fifth edition of a book which first appeared in 1940, and a new chapter on transistors has been added. The book describes a large number of experiments suitable for a three or four year course in radio engineering at a technical college. Experiments are presented in the following form: Purpose, Procedure, Results, and Conclusions. The text is very well illustrated with clear diagrams. The presentation does not confine the book's usefulness to the student, since it also provides the engineer with a ready-made approach to many measurement problems. The 104 experiments include such wide-ranging subjects as finding the dynamic impedance of a tuned circuit, measuring the output impedance of a cathode follower, determining the frequency response of a loudspeaker, and finding the reverberation characteristics of a room.

**FUN WITH TRANSISTORS.** By Gilbert Davey, edited by Jack Cox. 64 pages, 7½ x 10in. Published by Edmund Ward (Publishers) Ltd. Price 12s. 6d.

This book has been written for the boy reader (Jack Cox is the Editor of *Boy's Own Paper*) and so no pretence is made at any technical depth. The style of writing is direct and down to earth. "These small two-transistor earphone sets are very effective. I took one on holiday to North Wales in 1963 and Radio Luxembourg came in regularly at fine volume. I expect the signals bounced down from the Heaviside layer conveniently at that point!" The book describes the construction of several simple amplifier and receiver circuits, and there are some further notes on other aspects of transistors, including their use in commercially made receivers. Your reviewer was chagrined to find that *The Radio Constructor* was not in the list of periodicals at the end of the book whereas *Popular Wireless*, which ceased publication around 1938, was!

**DIRECT CURRENT AND MAGNETISM.** Edited by Edgar J. Black. 119 pages, 5¼ x 8½in. Published in Philips Paperback series. Distributors (outside Benelux countries) Iliffe Books, Ltd. Price 10s. 6d.

This book, printed in the Netherlands, offers a very simple introduction to direct current and magnetism. It is strictly for the beginner and takes electricity through Ohm's Law to the influence of temperature on resistance; resistors up to potentiometers and series and parallel connection; batteries and accumulators through types, construction and maintenance to different methods of connection; magnetism up to the relay and the electric bell; and meters up to the universal voltage and current meter.

Further titles in the Philips Paperback series, and all having the same format and distributors, are:

**ALTERNATING CURRENT AND ACOUSTICS.** Edited by Edgar J. Black. 116 pages. Price 10s. 6d.

This deals at elementary level with alternating current, inductance, capacitance and acoustics. The latter section, which occupies only 19 pages, briefly discusses sound waves; carbon, dynamic, capacitor and crystal microphones; the moving-coil loudspeaker; and the magnetic earphone.

**AERIALS.** By D. J. W. Sjobbema. 110 pages. Price 10s. 6d.

This book, which deals in particular with TV and f.m. receiving aerials, goes very much more deeply into its subject than do the two preceding publications, and it contains a wealth of useful practical and theoretical information. As well as dipole aerials and arrays, the author covers the V-reflector and the helical aerial, giving sufficient formulae in all cases to enable aerials to be constructed. Also described are attenuators and distribution networks. *Aerials* is comprehensive, concise and full of information.

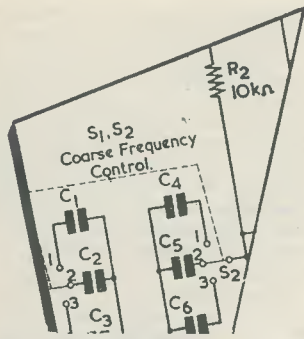
**THE TAPE RECORDER.** By C. G. Nijssen. 142 pages. Price 13s. 6d.

*The Tape Recorder* is aimed at the general enthusiast, and takes technicalities up to simple block diagram level. It offers a great deal of sensible practical advice, together with a description of fault location. There is much useful information on sound effects and studio techniques.



# Low cost

# LEAKAGE and INSULATION TESTER



**SUGGESTED  
CIRCUIT No. 170**



ALTHOUGH THIS SERIES OF articles is mainly intended to present unusual circuits or unusual applications for familiar components, the writer finds that there is a surprisingly high demand from readers for circuits of very simple and inexpensive test equipment. Two previous articles have been included in the series to meet this requirement, these being a "Pocket 'Valve Voltmeter'" in the February 1963 issue and a "Spares-Box' Voltage Measuring Instrument" in the December 1963 issue. The first device employed a DM70 tuning indicator as a voltage indicator having a very high input impedance, whilst the second used a potentiometer calibrated in terms of voltage and coupled to a neon bulb. The potentiometer was adjusted until the neon became illuminated, whereupon the voltage applied across the potentiometer track could be read from its scale. Despite their considerable simplicity, both these circuits were commented on favourably in subsequent correspondence.

In consequence the writer discusses, this month, another simple testing device, this being a neon leakage and insulation checker.

Neon lamps have been used by amateurs for leakage and insulation tests for many years now, but the present circuit employs a somewhat unorthodox method of supply which is not normally encountered. The components required are inexpensive

and few in number and many may already be available in the spares-box.

### Operation

The basic circuit for testing insulation and leakage with the aid of a neon lamp is shown in Fig. 1. In this diagram, the d.c. supply potential and the series resistor have values such that the neon lights in normal fashion when the test leads are short-circuited.

When the test leads are open-circuit, the neon will not, of course, be illuminated. If, however, a very high resistance is connected across the test terminals and is then reduced in value, a point will be reached at which the neon will commence to glow. The glow will be at reduced brilliance and may be confined to part of the electrode structure only. By choice of a suitable neon bulb it is readily possible to obtain a glow of this nature when resistances of the order of tens of megohms are presented to the test terminals. The circuit may therefore be employed as a sensitive and inexpensive insulation tester, a very rough idea of the resistance existing between the test points being given by the brilliance and position of the glow discharge in the neon. If there is no illumination when the test leads are applied to a component, the insulation between them is of a high level since too great a resistance is present to cause a glow in the neon.

By G. A. FRENCH

If the test leads are applied to a capacitor of sufficient value the neon will strike momentarily as the initial charging current flows through it, after which it will extinguish. If the capacitor has a very high leakage resistance it will retain its charge for a long period, with the result that the potential across the neon does not rise sufficiently high to enable it to strike again, and it remains extinguished. A capacitor with a lower leakage resistance will discharge more rapidly after the initial charging pulse, whereupon the potential across the neon rises after a period and causes it to strike once more. This process repeats continually whilst the capacitor is connected. A capacitor with a lower leakage resistance again will cause the neon to remain continually illuminated at a brilliance level corresponding to

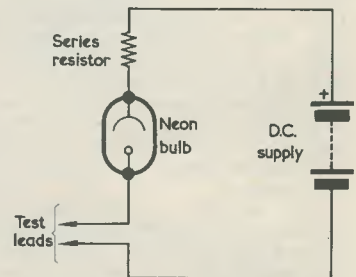


Fig. 1. The basic neon insulation tester

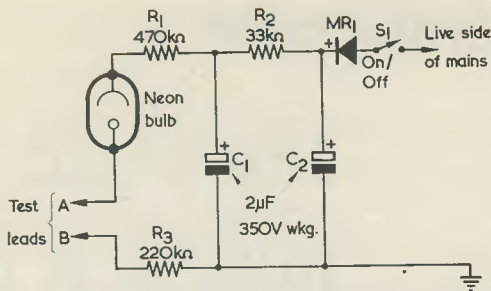


Fig. 2. A circuit which enables the tester to be powered from the mains supply. The components are discussed in the text

the leakage resistance in the capacitor. In this instance the discharge current through the leakage resistance is too high to enable the capacitor to retain a charge. If the capacitor is short-circuited the neon will glow at full brilliance and, if the capacitor is open-circuit it will not flash at all.

Thus, a "good" capacitor will cause a single flash in the neon. A capacitor with significant leakage will cause the neon to flash repeatedly at a regular rate dependent upon the leakage resistance (and the capacitance) of the capacitor. Lower leakage resistance will cause continual illumination, whilst an open-circuit capacitor results in no initial flash.

It should be noted that the initial flash is only given by capacitors above a certain value which depends upon the type of neon employed. The charging current in capacitors of lower values will not be sufficient to cause the flash. Leakiness in such capacitors will still, nevertheless, be indicated, if this is below the insulation level which can be detected by the neon.

### The Present Circuit

The only requirements for a neon insulation and leakage tester are, therefore, a d.c. supply, a series resistor and the neon lamp itself. However, the d.c. supply needs to be of the order of 200 to 350 volts and the provision of such a voltage argues the construction of a mains power unit with a double-wound mains transformer to provide isolation. Such a power pack is unjustifiably expensive for use with a device as simple as a neon tester.

This month's circuit, which is shown in Fig. 2, employs a mains-derived power supply which does not incorporate a mains transformer. Nevertheless, it still offers a d.c. voltage which is equivalent, from the point of view of isolation,

to that appearing on the h.t. positive rail of valve equipment whose chassis is connected to earth. A single connection is made to the live side of the mains, this being applied, via switch  $S_1$  and rectifier  $MR_1$ , to reservoir capacitor  $C_2$ . The negative plate of  $C_2$  is connected, not to the neutral side of the mains, but to earth. A rectified voltage, corresponding in value to the alternating voltage between the live side of the mains and earth, then appears across  $C_2$ . As may be seen, the d.c. voltage on the positive plate of  $C_2$  is similar to the h.t. positive voltage in equipment having an earthed chassis.

The voltage across  $C_2$  is passed, via the smoothing circuit,  $R_2$ ,  $C_1$ , to the series resistor  $R_1$  and the neon. The other terminal of the neon connects to test lead A. Another series resistor,  $R_3$ , appears between the negative rail and test lead B. The reason for the inclusion of  $R_3$  is discussed later. The combination of neon bulb,  $R_1$  and  $R_3$  functions in the same manner as did the neon bulb and series resistor of Fig. 1. Components and capacitors can then be tested for insulation and leakage by applying the test leads and observing the neon.

### Circuit Details

*Before proceeding further it must be emphasised that the process of obtaining a rectified voltage from the live side of the mains and earth should only be carried out if the current drawn is very small. In this instance, the currents involved are of the order of a milliamp or less. The scheme should not be used for powering receivers and the like, as the current drawn will be too great and there is a risk of shock if the earth connection is broken. Obviously, a reliable earth connection must be employed.*

In the present instance, and bearing in mind the fact that no isolating transformer is employed,

it was felt that it would be of interest to examine the question of shock from the test leads in the light of the recommendations in British Standard 415.<sup>1</sup> This states that the leakage current which may flow to earth from the whole group of terminals in a piece of reproducing equipment to which modulating apparatus is applied (e.g. the terminals by means of which a microphone is connected to an a.f. amplifier) should not exceed 2mA. In many commercially produced radiograms and record players having a.c./d.c. chassis, this requirement is met by completely insulating the pick-up connections and by connecting the gram deck to the chassis via a  $0.02\mu\text{F}$  capacitor. The reactance of this capacitor ( $159\Omega$  at 50 c/s) ensures that the leakage current to earth from any exposed metalwork of the gram deck cannot exceed about 1.5mA.

In the circuit of Fig. 2, the leakage current flowing to earth from test lead A cannot exceed some 0.65mA. If, due to mischance, the supply connection to earth is broken, the current flowing from test lead B is limited, mainly because of the presence of  $R_3$ , to less than 1mA. If it is felt that the connection to earth is completely reliable,  $R_3$  may be omitted and test lead B connected direct to the negative line.

It is desirable to keep connections to mains isolating components spaced apart by greater than 0.5in.<sup>2</sup> In consequence it would be preferable to employ resistors in the  $R_1$  and  $R_3$  positions whose lead-out wires are greater than 0.5in apart and to ensure that they do not connect to tags or other anchor points having spacing less than 0.5in. Suitable resistors here would, for instance, be the 1 watt Erie type 8, which has a body length of 0.71in.

### Components And Construction

Apart from the points just made with respect to  $R_1$  and  $R_3$ , the components are not in any way critical.

The rectifier  $MR_1$  may be any "metal" or contact-cooled rectifier rated at 250 volts. Since the current drain is very small, an inexpensive 30mA component will be more than adequate. Capacitors  $C_1$  and  $C_2$  are shown as  $2\mu\text{F}$ , although any

<sup>1</sup> B.S.415. Safety Requirements for Radio and other Electronic Apparatus.

<sup>2</sup> This is according to BS415 and is recommended unless some means of preventing accidental "bridging" (say by stray pieces of wire) is provided.



value between 1 and  $8\mu\text{F}$  would be quite satisfactory in practice.

It may be thought that the provision of the smoothing components  $R_2$  and  $C_1$  is over-generous, and that the neon circuit could obtain its supply directly from  $C_2$ . Tests with a prototype showed, however, that the small ripple across  $C_2$  gave slightly misleading results when checking some capacitors, and so  $R_2$  and  $C_1$  were added.

The neon bulb used in the prototype was a Hivac type 16L, obtainable from Henry's Radio Ltd. A Hivac type 34L would also be suitable. These neons are very sensitive and that employed with the prototype gave a glow with test resistances in excess of  $20\text{M}\Omega$ . It also provided an initial charging flash with test capacitors as low in value as  $300\text{pF}$ .

A suitable method of construction

for the unit would consist of mounting all the components in an insulated case, the test leads, mains lead and earth lead passing out through suitable grommets. A small aperture will be needed for the neon lamp, which could be mounted below the surface of the front panel. It will then be shadowed from room lighting and other sources of illumination, and its glow will be more readily observed.



## Transistor Economiser

A. J. Ley

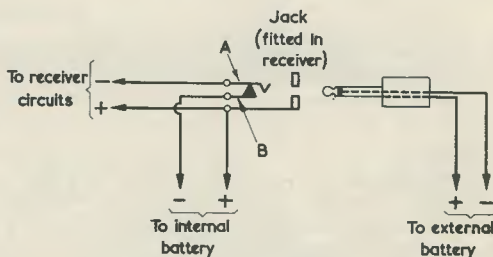
THE WRITER RECENTLY CONSTRUCTED A 6-TRANSISTOR superhet of small dimensions. This worked very well and proved ideal for portable use but, because of the small size of the internal battery, prolonged use was expensive. The simple device shown in the diagram was employed to enable a PP9, or a similar large battery, to be employed. As can be seen, the internal battery is disconnected by the insertion of a miniature jack plug, the larger external battery then powering the receiver.

In the writer's instance, the most convenient method of obtaining a jack socket for the external supply consisted of sacrificing the personal earphone facility. The internal wiring to the personal earphone socket was disconnected and the supply wiring shown in the diagram substituted. Since the socket had a contact which broke when the plug was inserted, the internal battery was automatically disconnected when an external supply was applied. The two original earphone socket wires which connected to the breaking contacts (A and B in the diagram) were joined together to enable the receiver to provide normal reproduction over its loudspeaker.

Alternatively, the power supply socket may be an additional item, it being mounted at a convenient point on the case of the receiver. Any earphone wiring which may be in existence need not then be disturbed. Arrangements should be made, in this case, to ensure that the battery plug is not fitted to the existing earphone socket, and vice versa.

As with all transistor work, correct polarity of the supply must be observed. This necessitates ensuring correct polarity of the connections to the jack plug. It is possible for the tip and sleeve of the jack plug to short-circuit momentarily via the bush of the socket when the plug is inserted and removed. Because of this, it might be preferable to connect the external battery to the jack plug leads after the plug has been inserted and to disconnect it before the plug is removed.

This simple alternative supply system turns a miniature transistor receiver from a fascinating toy, which is liable to pack up on one just when needed, to a receiver which may be powered from a battery for a long time, and which reverts to full portability by merely removing a jack plug.



A simple modification which enables a small transistor receiver to operate from an external battery. The jack is a miniature type and, together with the associated wiring, is fitted in the receiver. When the jack plug is inserted, the internal battery is disconnected and the external battery applied

# Variable L. F. Sine Wave Generator

By I. M. Rees

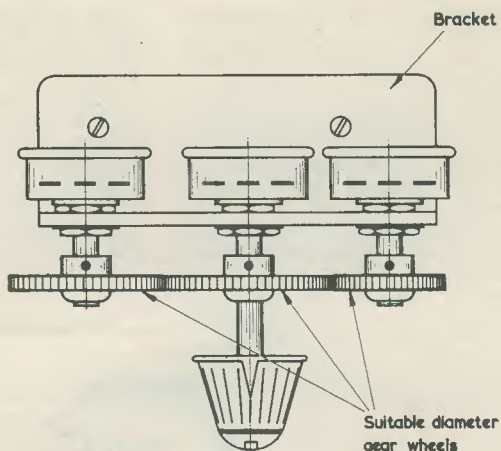


Fig. 2. A suggested method of ganging the three potentiometers

## An Inexpensive Low-Cost Unit

THIS SIMPLE LITTLE UNIT WAS originally designed to investigate resonances and rattles in speakers and cabinets at the lower audio frequencies. Since being built, however, other uses have been found, these including the provision of a.f. for bridge energisation, morse code practice, signal tracing and distortion checks in audio amplifier circuits.

## Circuit

Fig. 1 shows the oscillator which, as can be seen, is a straightforward phase shift circuit. This gives an average of 3.25 volts peak-to-peak sinusoidal output which is continuously variable between 20 and 1,000 c/s in two overlapping ranges (Range 1 from 20 to 150 c/s, Range 2 from 150 to 1,000 c/s) switched by  $S_1$ , which also serves as the on/off control.

Oscillation in this type of circuit is obtained by feeding a proportion

of the amplified signal at the collector back via the CR ladder network to the base. Oscillation occurs at the frequency which corresponds to 180° phase shift between collector and base. The frequency of oscillation is governed by the time constant of the CR network.

The time constant of the ladder network is changed by selecting different values of C, as is done for the range switching, and of R, by employing three potentiometers for fine frequency control. In practice, if oscillation is to be maintained the three potentiometers should not be adjusted too far out of step. Fig. 2 shows a method by which means they may be ganged together. If this system is used it should be noted that the direction of rotation of the wipers of the outer potentiometers will be reversed in relation to that of the centre one. This point will have to be remembered at the time of assembly and wiring. The prototype

employed three separate potentiometers which were kept approximately in step so as to maintain oscillation at the required frequency.

Stabilisation of the base bias of TR<sub>1</sub> has been omitted mainly for economy, but it may be included if so desired.

## General

The construction is by no means critical and any suitable layout may be employed.

Other transistors than that specified can be used, with slight variations of R<sub>7</sub> and R<sub>8</sub> for optimum performance. Types OC71, OC72,

## Components List

### Resistors

- R<sub>1</sub> } 10kΩ potentiometer (preferably wirewound)
- R<sub>2</sub> }
- R<sub>3</sub> }
- R<sub>4</sub> }
- R<sub>5</sub> } 1kΩ ½W, 20% carbon
- R<sub>6</sub> }
- R<sub>7</sub> } 470kΩ ½W, 20% carbon
- R<sub>8</sub> } 3.9kΩ ½W, 20% carbon

### Capacitors

- C<sub>1</sub> } 0.5μF 150V wkg.
- C<sub>2</sub> }
- C<sub>3</sub> }
- C<sub>4</sub> }
- C<sub>5</sub> } 0.1μF 150V wkg.
- C<sub>6</sub> }
- C<sub>7</sub> }
- C<sub>8</sub> }
- C<sub>9</sub> } 0.01μF 500V wkg.

### Miscellaneous

- TR<sub>1</sub> Mullard OC84 (or see text)
- S<sub>1</sub> 3-pole 3-way switch
- 9 volt battery and connections
- Coaxial plug and socket

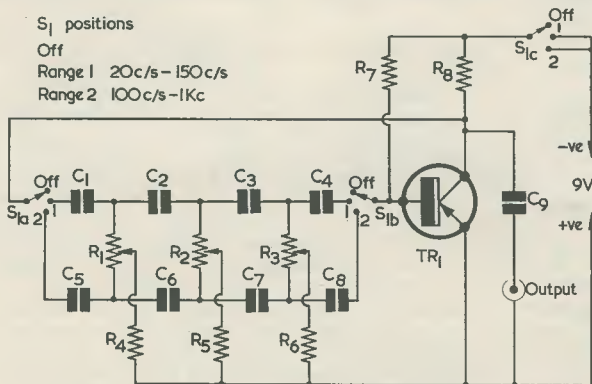


Fig. 1. The circuit of the sine wave generator



OC76, and OC201 have all been tried successfully, the only qualification being that they must have a current gain of greater than 56.

The output is terminated in a coaxial socket and the output lead should be screened if it is to be connected to the high impedance input of an amplifier.

It should be noted that the output

of the unit varies in amplitude according to frequency, and therefore should be monitored if response curves are to be measured. For example, at 20 c/s the prototype gave 2.74 volts and at 1 kc/s it gave 3.8 volts peak-to-peak.

The current drawn by the unit is in the order of a few milliamps and

this should enable the battery to have a long life.

If other ranges than the ones embodied in this circuit are required the easiest way of obtaining them is by altering the capacitors of the ladder network. Increasing their value decreases the oscillator frequency. Decreasing their value has the opposite effect.

# Experimental Metal Locator

By G. Morgan

*A simple experimental device for the reader who*

*is interested in unusual circuits and applications*

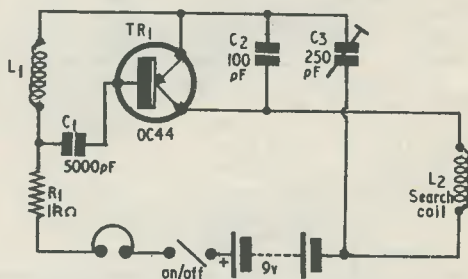
THE RE-ROUTING OF AN ELECTRICAL SUPPLY system in a very old house gave cause for considerable thought when it came to tracing the conduit piping, which had been "built in" in the walls. After several initial experiments it was felt that a metal sensing device was required and, with this in mind, the circuit described here was devised.

## Search Oscillator

The circuit eventually employed is shown in the diagram, and it may be seen that this includes an oscillator (OC44) in combination with the search coil  $L_2$ . The circuit can be set up such that either a whistle or a clicking noise may be heard in the headphones, the frequency of either varying as the search coil approaches a metal object.

The search coil consists of 46 turns of 30 s.w.g. enamelled copper wire random-wound on a wooden former having a diameter of 5in. A suitable method of construction consists of cutting out three discs of  $\frac{1}{4}$ in plywood, two having a diameter of 6in and one having a diameter of 5in. The 5in disc may then be concentrically "sandwiched" between the other two, thereby providing a former of 5in diameter, with  $\frac{1}{2}$ in cheeks given by the two outside pieces of plywood.

The oscillator components may be fitted to a tagboard which is then mounted, in a suitable housing, on the search coil assembly. A simple wooden handle then completes the assembly.



The circuit of the experimental metal locator.  $L_1$  is a 30mH r.f. choke (Bulgin type SW144). The headphones are high impedance, having a total d.c. resistance of 4,000 $\Omega$ .

## Setting Up

After completion, the unit may be set up and checked out. By adjusting the 250pF trimmer,  $C_3$ , it should be possible to obtain either a whistle or a continual clicking in the headphones, the frequency of which should then alter as the search coil approaches a metal object. It may also be necessary to adjust the value of  $C_1$  to obtain the requisite response. With the prototype, it was found possible to locate large metal objects, such as tin cans, at a depth of about 12in. Coins, such as pennies and shillings, were detectable at about 3in.

## EDITOR'S NOTE

We present this circuit purely as an experimental project which has been found empirically to work. It will be noted that there is no bias on the base of the transistor, and it may be found that improved results will be given if a relatively high-value resistor is added between the base and the negative terminal of the battery.

# NEWS

# AND

# COMMENT

## Science Fact

Scientists meeting at a symposium held in connection with the 126th meeting of the Electro Chemical Society in Washington recently outlined a wide range of uses and potential uses for the electron microprobe—an instrument which not only sees objects not normally visible to the naked eye but also determines their chemical make-up.

The microprobe can shoot a beam of electrons at a target as small as 1,000 million millionths of a gram and scientists can determine its make-up by the X-ray it gives off.

The first working model was built in France in 1950 but in its present form it incorporates the technical features of the scanning electron microscope invented in Germany, the X-ray spectroscope developed in France and Sweden, and radiation detectors developed in America.

Dr. Theodore Hall of the Cavendish Laboratory, Cambridge, speaking at the symposium, said that British scientists use the probe to identify weak spots in exotic space-age metals and that biologists hope to adapt it to determine the difference between normal and cancerous cells.

## Our Contributors on TV

Within the last few weeks, two of our authors have appeared on television.

In the B.B.C.2 programme "Horizon", on 15th November, four amateur scientists were the central figures, one of them was Frank W. Hyde, who readers will remember wrote the popular series of articles in this magazine on "Radio Astronomy".

The other contributor, who has written for us from time to time, was Clive Sinclair, now managing director of Sinclair Radionics of Cambridge. He also appeared in a B.B.C. programme where he described the success of his firm in the field of miniaturisation. It was most heartening to hear of a British firm which has, in some cases, outshone the Japanese in this branch of electronics, where they are so often assumed to be the leaders.

## A Real Constructor?

Under the above heading in our October issue, we referred to the use of a lathe purely to make tools for use on the lathe. A doctor, resident in Kuala Lumpur, has written to say that a couple of years ago—"I might have thought that the comment was directed straight at ME!"

We quote further from the letter: "A chap who uses his lathe for making tools to be used on the lathe, does so because he either LIKES making things better than locomotives or stationary steam engines; or, because he feels that one day he may suddenly find a use for the gadget".

"Let's face it; the fellow that makes a beautiful little stationary steam engine must know that, once made, the wretched little thing can only do one thing; and is never going to be of any use. I do not wish to denigrate the model engineer one whit; . . ."

"One day those attachments are suddenly needed . . . and usually in a hurry".

"I built myself a high fidelity superhet tuner . . . winding my own i.f.'s . . . on the lathe!"

The point at which builders or assemblers of radio apparatus become, or cease to be, true radio constructors is one that will never be resolved, presumably it is rather like the proverbial chicken and the egg.

## Balloon v. Anemometer

Having described in our August issue the construction of a transistor operated Anemometer for the measurement of wind forces at 10 metres above ground level, we can now give some general information on the manner in which High Altitude winds are measured.

New radar equipment which will enable the Meteorological Office to obtain more accurate information about high altitude winds—an important factor in the production of weather forecasts for aviation and the public—has recently completed a three-month trial at the Radio Sonde Station, Crawley, Sussex.

The Meteorological Service has long appreciated the necessity to

know the strength and direction of the wind at altitudes up to 100,000 feet. In many parts of the world wind strengths of 120 knots (132 m.p.h.) are not uncommon. To the Royal Air Force accurate knowledge of the upper winds has become increasingly important with the introduction of high-flying planes. It will be equally important for operating supersonic civil aircraft.

Wind finding is performed by a small balloon carrying a radar target or reflector. As the balloon ascends it is blown horizontally by the wind and the mean wind from one height to the next can thus be measured by the horizontal distance the balloon moves in a given period of time. A very accurate and sensitive radar is required to measure this movement at a distance of 100 miles, when the total movement might only be a mile a minute.

Since the war, a modified anti-aircraft radar (the GL/3) has been in use. With a limited range of a little over 50 miles, and manual tracking, many balloons were lost before they reached the desired height. The new wind-finding equipment (made by Cossors) with its narrow beam, automatic tracking and accuracy, will be a valuable addition to meteorological equipment.

## Reith Lectures 1964

Electronics enthusiasts may very well have been more interested than usual in the Reith Lectures for 1964, just concluded, because they were on the subject of automation.

The lecturer, Sir Leon Bagrit, believes that the second half of this century will be known as the Automation Age. One tends to think that automation will be opposed to cultural interests but, in fact, automation should result in giving everyone the opportunity and the means to lead a full life.

Sir Leon certainly pursues a cultural life despite his responsibilities in the field of automation—he is probably the only industrialist to have played the violin in a famous symphony orchestra, The London Philharmonic.



# Electronic Locks and Anti-Thief Devices

## Part 2

by R. M. Marston

Protect Your Home By Electronics

### Plug And Socket Locks

A RATHER DIFFERENT APPROACH TO THE SUBJECT of electronic locks is given by the plug and socket lock. The basic principle here is quite simple. If, say, a 12 way plug is used, and it is necessary to get a particular two of its pins in series to complete a circuit and operate a relay, then the chances against finding those two pins by systematic trial and error methods are 132 (12 x 11) to 1. If three pins are required, the odds are 12 x 11 x 10, or 1,320 to 1, and so on. If all twelve pins are required then the odds become some hundred millions to one against. The circuit would be completed by connecting a suitably wired plug to a correspondingly wired socket. This, then, is the principle.

The practice, unfortunately, is not quite so simple. With reference to Fig. 8, which might at first sight correspond to the above requirements, it will be seen that the relay can be made to operate by simply connecting pin 1 to pin 12 of the socket. It is essential in the basic design of this type of lock, therefore, that no pin or pins can be effectively by-passed.

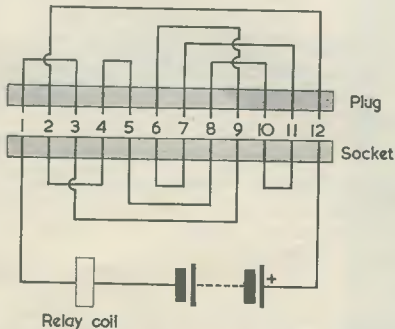


Fig. 8. A possible method of using a 12-way plug as a "key". This circuit is of no great value in practice, however, as the relay may be operated by simply short-circuiting pins 1 and 12

This can be accomplished in a number of ways, and it can also be arranged that the "key", which would be the plug, modifies in a particular way the signal or voltage to a particular set of pins, which must be able to decode the signal or voltage and so further increase the odds.

The following are a few suggestions along these lines. Many other ideas will, no doubt, occur to the reader.

It can be arranged that six pairs of pins are used, each pair of pins being connected to a separate battery and relay as shown in Fig. 9. The supply to the latch operating relay is interrupted by a contact from each relay, so that all six relays

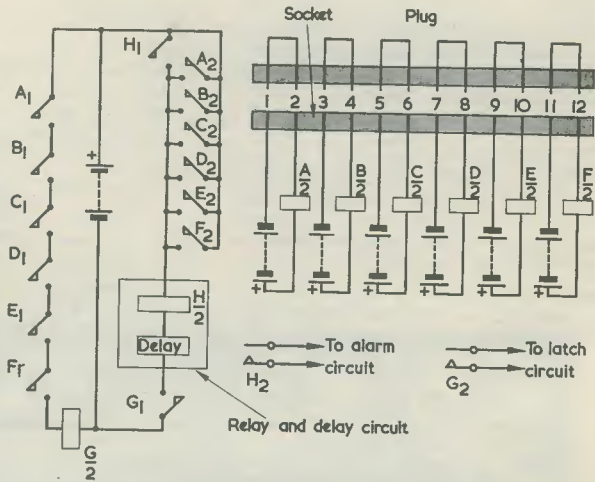


Fig. 9. An alternative arrangement which overcomes the disadvantages of Fig. 8. Also incorporates is an alarm circuit. The short-circuited pairs of pins in the plug need not, of course, be in simple numerical order illustrated here. The circuit will still offer a considerable obstacle to any would-be thief if fewer than six plug-operated relays are used

must be energised before the latch relay can operate. It is essential that separate batteries be used for each relay. If desired, only four out of the available six pairs of pins need be used, with a resulting saving in components and cost. This is at the expense of a reduction in the "odds", although these will still be at about one million to one, which should be sufficient to deter any would-be thief. It is a matter of individual choice whether delay circuits are fitted, although it would appear to be an unnecessary expense. An alarm circuit is also shown in Fig. 9. This is recommended, but not essential.

The operation of the alarm circuit is as follows. A contact set from each of the six socket relays is wired in parallel with the other five, and the whole parallel assembly connected in series with the alarm relay H/2 and its delay circuit, together with contact G1. If any one or more of the socket

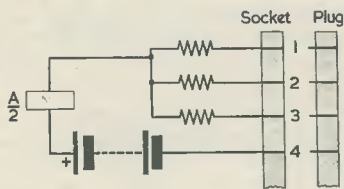


Fig. 10. A further safeguard which may be added to the plug and socket system of Fig. 9. Relay A/2 will only energise if all four pins in the plug are connected together

relays are made, one of the contacts (A2, B2, C2, D2, E2 or F2) will switch over and connect the supply to relay H/2 and its delay circuit. After a short delay the alarm will then sound. Also, contact H1 will switch over and latch relay H/2 on, so that the alarm will continue to ring even if the plug is removed.

If, on inserting the plug, all socket relays are energised, the latch relay G/2 will also energise and its contact G1 will break the supply line to H/2 and prevent the alarm from operating. The delay in the alarm circuit need only have a duration of about one second, and can be simply provided by a large capacitor in parallel with the relay coil and a resistor in series. It is fitted purely as a precaution against triggering the alarm if the "key" is fitted unevenly or in a fumbling fashion.

Another simple but effective method, which can result in a saving in cost, is shown in Fig. 10. Here, 4 pins of the 12 way plug are shown. The battery and relay A/2 are connected in series to a group of three resistors, R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub>. The resistors are of fairly high value. For example, if A/2 is of the 500Ω, 6 volt working type, a battery rated at 12 volts could be used and the resistors would be 1,500Ω each. The relay coil and resistors act as a voltage divider. If, say, pins 1 and 4 are connected together, only 3 volts will appear across A/2 and it will not operate. It is only when all four pins are connected together and the three resistors are all in parallel that sufficient voltage will appear across A/2 to cause it to operate. It is not practical to parallel more than three resistors in a circuit of this type.

#### Further Possibilities

The ideas described in this article represent just a few of the many configurations that may be used.

The variety of electronic locks that can be built seems to be almost endless. Types that are activated by high frequency coded signals, or by the radioactive properties of the key; or by the light refractive properties and weight, or even just the resistive characteristics of the key, represent but a few.

(Conclusion)

## 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.

**R107 Receiver.**—C. Angell, School House, The College, Malvern, Worcs., is in urgent need of the handbook.

\* \* \*

**Hallicrafters S22R Receiver.**—P. Warner, 1 Delamere Street, Chesham, Bury, Lancs, wishes to purchase the handbook.

\* \* \*

**Canadian Mk. II, No. 19 Set.**—P. Richards, 38 Castle Row, Canterbury, Kent, requires handbook, also details of pin connections for power supply unit.

**RME69 Receiver.**—T. Oman, 140 Anns Hill Road, Gosport, Hants, wishes to obtain the manual and details of any conversions to this (1937) receiver.

\* \* \*

**TV Alignment/Pattern Generator.**—J. K. Owen, 11 Clyde Road, Redland, Bristol 6, would like to obtain the instruction manual or circuit of the Cossor Model 1320.

**R220 Receiver.**—D. Bowers, 95 Grenfell Avenue, Saltash, Cornwall, would like to hear from any reader who has modified this receiver for 70 and 144 Mc/s operation.



# The "TRACOS" Signal Tracer and Oscillator

Sockram Akkal

*Our contributor, who hails from Dutch Guiana and is currently resident in Hyderabad, India, describes an inexpensive servicing instrument which has many unusual and outstanding features*

THIS ARTICLE DESCRIBES THE CONSTRUCTION of a test instrument for broadcast sound receivers and a.f. amplifiers which combines considerable versatility with low cost and ease of construction. The name "Tracos" stands for "tracer-oscillator", but the tracer section offers quite a bit more than the usual instrument of this type. The oscillator section provides a sine wave output at 1,000 c/s for injection into the stages of an a.f. amplifier. The detected signal from the local radio station is also available for this purpose. This station may also be heard through the internal speaker of the instrument, if desired, thereby providing entertainment during working hours in the workshop or laboratory.

## Components List (Fig. 1)

### Resistors

- R<sub>1</sub> 56kΩ 20% ¼ watt
- R<sub>2</sub> 270kΩ 20% ¼ watt
- R<sub>3</sub> 270kΩ 20% ¼ watt

### Capacitors

- C<sub>1</sub> 500pF variable (see text)
- C<sub>2</sub> 50pF silver-mica or ceramic
- C<sub>3</sub> 0.02μF paper
- C<sub>4</sub> 50pF silver-mica or ceramic
- C<sub>5,6</sub> 100pF silver-mica or ceramic
- C<sub>7</sub> 50pF silver-mica or ceramic
- C<sub>8</sub> 100pF variable (see text).
- C<sub>9</sub> 0.01μF paper
- C<sub>10</sub> 0.05μF paper, 600V wkg.

### Inductors

- L<sub>1,2</sub> Medium or long wave aerial coil (see text)
- L<sub>3</sub> I.F. coil (see text)

### Valves

- V<sub>1(a)</sub> ½6B8. (Pentode section in Fig. 3)
- V<sub>2</sub> 6H6

### Switches

- S<sub>1(a)-(d)</sub> 4-pole 7-way Yaxley (see text)

During signal tracing, indications can be given in 3 ways: these being *aural*, by the instrument's speaker; *visual*, by an optional output meter; and *visual*, by a tuning indicator.

The selector switch offers 7 functions as follows:

1. Local radio,
2. A.F. tracing,
3. R.F. tracing,
4. I.F. tracing,
5. Local oscillator checking,
6. A.G.C. Checking,
7. 1,000 c/s sine wave output.

The writer has no doubt that this instrument will be a welcome addition to any experimenter's, service engineer's or constructor's test bench.

## Circuit Description

The input switching section of the instrument is shown in Fig. 1. The switch used here is a 4-pole 7-position type.<sup>1</sup> Pole 1 (S<sub>1(a)</sub>) switches the connections to the probe. Pole 2 (S<sub>1(b)</sub>) switches the input of the a.f. amplifier incorporated in the instrument. Pole 3 (S<sub>1(c)</sub>) switches in coil L<sub>3</sub> on position 4, this being the "i.f. tracing" position. Pole 4 (S<sub>1(d)</sub>) switches the grid of the tuning indicator to various sections of the circuit to monitor signal or a.g.c. level.

In position 1 of the switch (local radio) the wiper of S<sub>1(b)</sub> connects to the two diodes of V<sub>1(a)</sub> (½6B8). These are coupled via C<sub>2</sub> to the tuned secondary of the coil L<sub>1</sub>, L<sub>2</sub>, this secondary being tuned to the local radio station.<sup>2</sup> The local

<sup>1</sup> 7-way switches are not "standard" components and it may be necessary to use a 4-pole 12-way switch with 5 positions blank.—EDITOR.

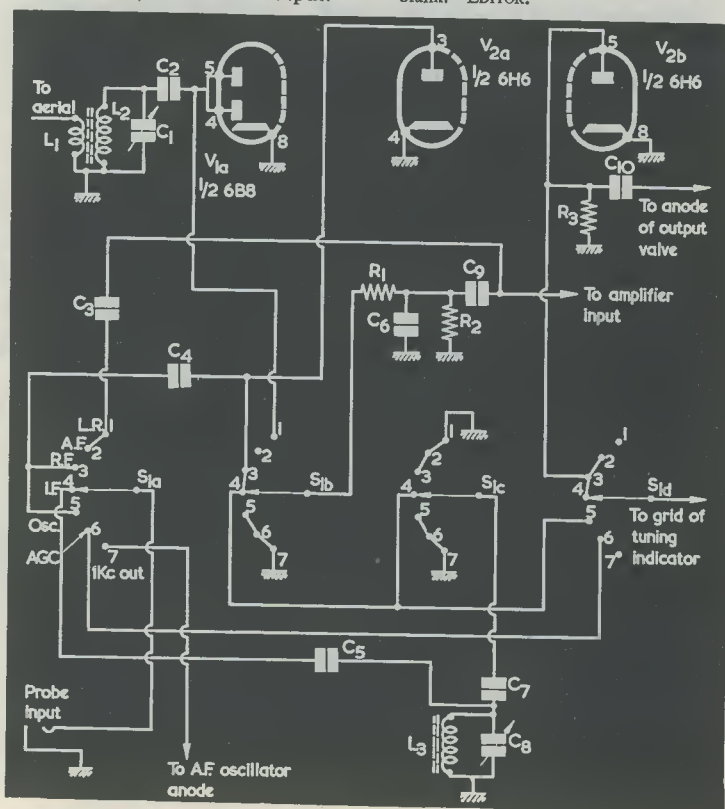


Fig. 1. The input switching circuits of the "Tracos" signal tracer-oscillator

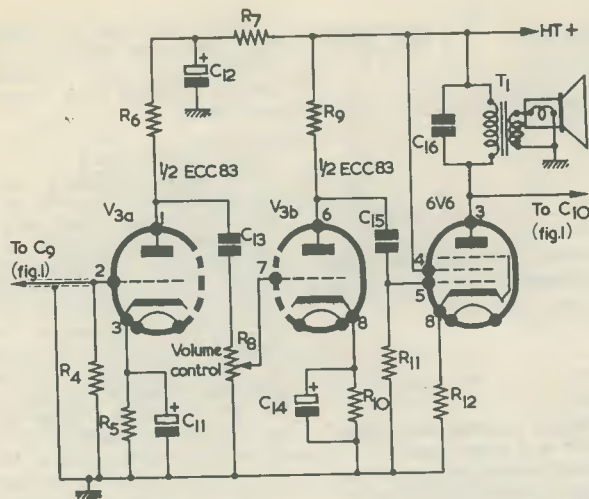


Fig. 2. The circuit of the a.f. amplifier incorporated in the instrument

station signal is fed, via S<sub>1</sub>(b), to the diode load and filter given by R<sub>1</sub>, R<sub>2</sub> and C<sub>6</sub>, whereupon the detected a.f. appears across R<sub>2</sub>. The detected a.f. is then passed, via C<sub>9</sub>, to the input of the instrument's amplifier. It is also applied, via C<sub>3</sub>, to the input of the probe so that it may be injected into audio equipment for testing purposes. According to individual requirements, C<sub>1</sub> may be either preset or a panel-mounted variable component.

In position 2 (a.f. tracing) the probe couples, via S<sub>1</sub>(a) and isolating capacitor C<sub>3</sub>, to the input of the

instrument's amplifier. At the same time, the wiper of S<sub>1</sub>(b) couples the grid of the tuning indicator to the shunt diode rectifier given by V<sub>2</sub>(b) (½6H6). This couples, via C<sub>10</sub>, to the anode of the output valve in the instrument's amplifier. Thus, a rectified negative voltage, proportional to a.f. amplitude at the output anode, is fed to the tuning indicator. The tuning indicator gives a comparative indication of the gain provided by each stage of the amplifier under test. If, for instance, the deflection given when the probe is applied to the anode of an a.f. amplifying valve is less than that its grid, then the valve stage is obviously faulty. The gain control of the instrument a.f. amplifier should, of course, remain in the same position for both tests.

<sup>2</sup> L<sub>1</sub>, L<sub>2</sub> may be a standard medium or long wave aerial coil according to the wavelength of the desired local station. In parts of the country where the simple tuned circuit shown in Fig. 1 would not be able to resolve the local station clear of interference, a more comprehensive tuning circuit (say, a band-pass pair) may be needed.—EDITOR

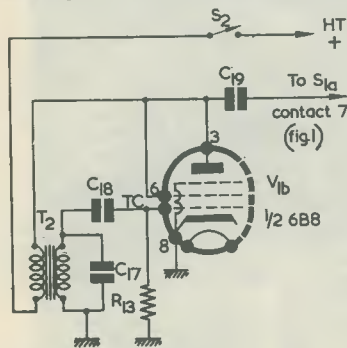


Fig. 3. The a.f. oscillator. This employs the pentode section of the 6B8, the diode section of this valve appearing in Fig. 1

### Components List (Fig. 2)

**Resistors**  
(All fixed resistors ¼ watt 20% unless otherwise specified)

- R<sub>4</sub> 1MΩ
- R<sub>5</sub> 4.7kΩ
- R<sub>6</sub> 220kΩ
- R<sub>7</sub> 100kΩ
- R<sub>8</sub> 1MΩ potentiometer, log track
- R<sub>9</sub> 220kΩ
- R<sub>10</sub> 4.7kΩ
- R<sub>11</sub> 470kΩ
- R<sub>12</sub> 330Ω

### Capacitors

- C<sub>11</sub> 100μF electrolytic, 6V wkg.
- C<sub>12</sub> 16μF electrolytic, 350V wkg.
- C<sub>13</sub> 0.01μF paper
- C<sub>14</sub> 12μF electrolytic, 6V wkg.
- C<sub>15</sub> 0.01μF paper
- C<sub>16</sub> 0.005μF paper

### Valves

- V<sub>3</sub> ECC83
- V<sub>4</sub> 6V6

### Transformer

- T<sub>1</sub> 45:1 speaker transformer

### Loudspeaker

- 3Ω impedance

In position 3 (r.f. tracing) the probe connects, via S<sub>1</sub>(a) and capacitor C<sub>4</sub>, to contact 3 of S<sub>1</sub>(b) and the anode of V<sub>2</sub>(a) (½6H6). S<sub>1</sub>(b) then applies the probe input to the filter R<sub>1</sub>, R<sub>2</sub> and C<sub>6</sub>. Diode V<sub>2</sub>(a) rectifies, and the detected signal across R<sub>2</sub> is fed to the instrument's amplifier. In this position of the switch, the tuning indicator grid is still coupled, via S<sub>1</sub>(a), to the rectifier circuit connected to the output anode of the instrument's amplifier, and it provides indications of signal strength in the same manner as occurred on position 2.

Position 4 allows for i.f. tracing. In this position the probe is coupled, via S<sub>1</sub>(a) and capacitor C<sub>5</sub>, to the tuned circuit L<sub>3</sub>, C<sub>8</sub>. This tuned circuit can be adjusted to the intermediate frequency of the receiver under test by C<sub>8</sub>. L<sub>3</sub> is the secondary of a discarded 465 kc/s i.f. transformer with the trimmer removed. The signal across L<sub>3</sub>C<sub>8</sub> is fed, via C<sub>7</sub> and S<sub>1</sub>(c), to contact 4 of S<sub>1</sub>(b), where it couples to the diode detector V<sub>2</sub>(a) and the filter R<sub>1</sub>, R<sub>2</sub> and C<sub>6</sub>. Thus the i.f. signal on the probe is detected and passed to the instrument's amplifier in the same manner as was given in position 3. Similarly, the tuning indicator couples, via S<sub>1</sub>(a), to the rectifier circuit around V<sub>2</sub>(b). It is possible to fit C<sub>8</sub> with a scale calibrated in terms of frequency,

### Components List (Fig. 3)

#### Resistor

- R<sub>13</sub> 150kΩ 20% ¼ watt

#### Capacitors

- C<sub>17</sub> 0.1μF paper
- C<sub>18</sub> 0.005μF paper
- C<sub>19</sub> 0.001μF paper

(Note: the values of C<sub>17</sub> and C<sub>18</sub> may need adjustment to produce the desired tone).

#### Transformer

- T<sub>2</sub> Tone transformer (see text)

#### Valve

- V<sub>1</sub>(b) ½6B8 (Diode section in Fig. 1)

#### Switch

- S<sub>2</sub> s.p.s.t. toggle or rotary



and this may then be employed as an aid in i.f. alignment and test.

In position 5 (local oscillator checking) the probe couples, via  $S_{1(a)}$ , to  $C_4$  and the diode  $V_{2(a)}$ . The probe is applied to the local oscillator of the receiver under test and, since this has no a.f. modulation, the detected signal from  $V_{2(a)}$  is not fed to the instrument's amplifier. Instead, it connects to the grid of the tuning indicator which, in the presence of oscillation, gives a deflection. (The diode load resistor for this particular combination does not appear in Fig. 1, and it consists, as shown in Fig. 4, of a  $3M\Omega$  resistor between the grid of the tuning indicator and chassis). This test is very useful as it can eliminate a lot of trouble-shooting in the case of a defective local oscillator.<sup>3</sup>

The wiring to contact 5 of  $S_{1(d)}$  should be kept well clear of that to contacts 2, 3 and 4 to prevent the risk of feedback from the amplifier output to its input when the instrument is switched to positions 3 or 4.

In position 6, (a.g.c. checking) the probe connects, via  $S_{1(a)}$  and  $S_{1(d)}$ , directly to the grid of the tuning indicator. The latter then functions in the same manner as the tuning indicator of a valve radio and shows whether the a.g.c. circuit is operative. The probe may be applied at any point along the a.g.c. line to ensure that all stages in the receiver under test are being effectively controlled.<sup>4</sup>

Position 7 (1,000 c/s sine wave output) causes the probe to connect, via  $S_{1(a)}$ , to the anode of an a.f. oscillator (not shown in Fig. 1). This oscillator consists of the pentode section of the 6B8, the diodes of which appear as  $V_{1(a)}$  in Fig. 1. Thus, a 1,000 c/s signal is available on the probe for testing a.f. amplifiers.

#### The Instrument Amplifier

The instrument amplifier, shown in Fig. 2, is based on a design published in the "Suggested Circuit" series.<sup>5</sup> This employs the two triodes of

#### Components List (Fig. 4)

##### Resistors

$R_{14}$   $3M\Omega$  20%  $\frac{1}{4}$  watt  
 $R_{15}$   $560k\Omega$  20%  $\frac{1}{4}$  watt

##### Valve

$V_5$  EM84

an ECC83 in cascade, the volume control being fitted between them. As there is adequate gain without it, a cathode bias bypass capacitor is not employed for the output stage. Any alternative valve offering approximately the same output may be employed instead of the 6V6 specified. Alternative valves may, however, require altered cathode bias resistor values or output transformer ratios. The speaker employed should be at least a 4in model in order that it may comfortably handle the signals passed to it.

The input of the amplifier is connected, via screened cable, to capacitor  $C_9$  of Fig. 1.<sup>6</sup> The anode of the output valve couples to  $C_{10}$  of Fig. 1.

#### The Oscillator

The circuit of the 1,000 c/s oscillator is given in Fig. 3. This employs the pentode section of the 6B8, the diodes of which provided  $V_{1(a)}$  in Fig. 1. The pentode section is triode-connected.

As will be noted, the oscillator circuit is perfectly straightforward. The prototype employed a tone oscillator transformer taken from a surplus ALS230 transmitter, but such a component may not be generally available. Almost any intervalve transformer could be employed in the circuit, but it may be necessary to change the values of  $C_{17}$  and/or  $C_{18}$  to obtain a good tone at the desired frequency.

Switch  $S_2$  was found to be necessary as the oscillator frequency tended to break through on switch

<sup>5</sup> G. A. French, "Suggested Circuit No. 136. A High Gain R.F.-A.F. Signal Tracer", *The Radio Constructor*, March 1962.

<sup>6</sup> It is possible for hum to be picked up by any wiring connecting directly, or via the switches, to  $R_{14}$  or  $C_9$  in Fig. 1. Leads carrying a.c. should be kept well clear of this wiring.—EDITOR.

<sup>3</sup> This will be more true of valve oscillators, which give a high r.f. voltage amplitude and will cause a considerable change in tuning indicator deflection. Transistor oscillators normally offer a low r.f. voltage amplitude, and tuning indicator deflection will be very much smaller.—EDITOR.

<sup>4</sup> This test applies, again, to valve receivers. Conventional transistor receivers have a positive-going a.g.c. line and exhibit only small positive excursions. It is, nevertheless, feasible that changes in a.g.c. voltage in a transistor radio could give readable indications if the probe earthing clip (see Fig. 5) were connected to the a.g.c. line and the tip to chassis.—EDITOR.

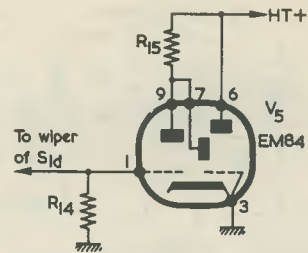


Fig. 4. The tuning indicator section

positions 1 to 4. The oscillator is, then, only switched on when it is actually needed.

#### Tuning Indicator

The tuning indicator circuit is given in Fig. 4. This is quite conventional and requires no further explanation here.

The  $3M\Omega$  grid leak,  $R_{14}$ , provides a grid-cathode circuit when  $S_{1(d)}$  of Fig. 1 is set to positions 1 and 7. As was explained earlier, it also functions as a diode load for  $V_{2(a)}$  when the selector switch is on position 5.

#### The Probe

Details of the probe employed by the writer are shown in Fig. 5. Part A consists of a length of threaded studding taken from a mains dropping resistor, one end being filed down to a point. It is secured to part B, a fibre disc, by a nut on either side of the disc. The studding is covered with sleeving over nearly all its length, the tip being left uncovered. The body of the probe, part C, consisted of a cylindrical screening can taken from an i.f. transformer, but any similar metal item of the requisite size and shape could be used instead. This part of the probe should be completely covered with an insulating material to reduce the risk of accidental shock whilst working with mains-driven equipment. Alternatively, a handle made of insulating material could be used. A fly-lead terminated in a crocodile clip enables connection to be made to the chassis of the equipment under test.

The probe is coupled to the main

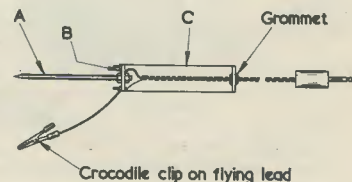


Fig. 5. Details of the probe employed with the prototype. The parts designated A, B and C are discussed in the text

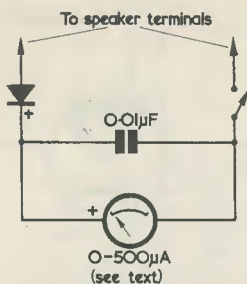


Fig. 6. An optional meter circuit for monitoring the a.f. output from the amplifier in the instrument. The crystal diode may be an OA70 or equivalent

**Components List (Fig. 7)**

**Resistor**

R<sub>16</sub> 1kΩ 5 watts

**Capacitors**

C<sub>20,21</sub> 16µF electrolytic 350V wkg.

**Transformer**

T<sub>3</sub> Mains transformer. Secondaries: 250-0-250V at 60mA; 6.3V at 2A; 5V at 2A.

**Valve**

V<sub>6</sub> 5Y3

**Switch**

S<sub>3</sub> s.p.s.t. toggle

unit by insulated screened wire terminated in a jack plug.

**Additional Meter**

If desired, an additional meter may be fitted to monitor the a.f. output level from the instrument's amplifier. This is not essential, but it enables alterations in a.f. output to be judged more accurately than is possible with the tuning indicator of Fig. 4.

The circuit employed is illustrated

in Fig. 6, and it consists, quite simply, of a meter and a series crystal diode. The circuit connects to the speech coil terminals of the instrument's loudspeaker. The prototype employed a 0-500µA meter, which happened to be to hand, but a 0-1mA meter could be used in its place. A switch, S<sub>3</sub>, is incorporated to enable the meter to be switched out of circuit when not required. The crystal diode may be an OA70, or equivalent.

**Power Supply**

The power supply circuit appears in Fig. 7. This is quite conventional and employs standard components. A double-wound mains transformer is used, this being essential for an instrument of this nature in order

tuning the i.f. coil. On the left hand side is a variable inductor and dial, which, if removed, leave a round hole of 3½ in. diameter for a loud-speaker aperture. New holes are required for other panel-mounting components, and it is necessary to provide a new chassis.

**Operation**

The operation of the "Tracos" follows standard practice.

When tracing a.f. circuits, a suitable audio signal is applied to the equipment under test, and the probe, with the instrument switched to position 2, is then applied to each stage in the amplifier in the normal manner. The output amplitude of the "Tracos" amplifier is indicated by the tuning indicator

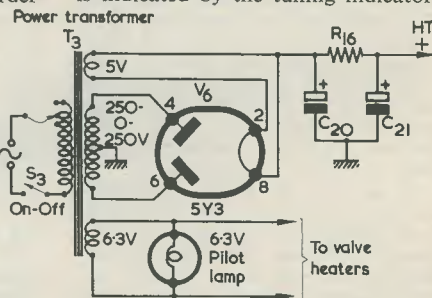


Fig. 7. The power supply circuit

to provide isolation from the mains supply.

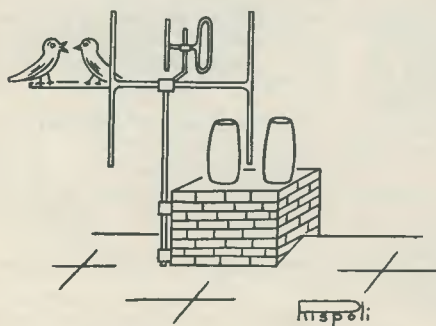
**Construction**

The construction of the "Tracos" presents no problems, as long as the usual precautions of screening the input circuits are observed. The constructor may design his own layout. In the writer's case, the cabinet and front panel of an ex-W.D. wavemeter type W1117 were used. Apart from any other factors, the W1117 has a 7-position switch which is excellent for S<sub>1</sub>. The tuning capacitor on the right of the W1117 panel was used for

or by the optional meter of Fig. 6, if fitted.

R.F. tests are made on position 3. An aerial signal should be applied to the receiver under test, whereupon this may be traced through the r.f. and frequency-changer circuits with the probe.

For i.f. testing, S<sub>1</sub> is set to position 4, and a station tuned in on the receiver under test. The signal leaving the frequency-changer anode may be peaked by C<sub>8</sub> of Fig. 1. Further tracing through the i.f. stages can then be carried out.



"I wonder which channel we're on?"

**NEW MULLARD TRANSISTORS**

Latest addition to the Mullard ACY20 range of p-n-p alloy junction transistors is the ACY39. The new transistor can operate at collector/base potentials of up to 110V and is intended for use in a wide range of industrial switching circuits, pulse circuits, amplifiers and oscillators.

Other new additions to this range are the ACY40 and ACY41. The ACY40 is intended for use where a low or medium current gain is required, whilst the ACY41 is for use in circuits where a high current gain is essential.

Three other new general purpose transistors are the GET896, GET897 and GET898. They are particularly suitable for low-cost industrial applications in which slightly lower current gains than those provided by the Mullard GET880 series are acceptable. These new devices are p-n-p germanium alloy junction types with a comprehensive range of medium frequency industrial applications.



# understanding radio

By W. G. MORLEY

Our "Understanding Radio" feature starts, this month, with the process of gettering in high-vacuum valves, after which it carries on to the use of diode rectifiers in receiver power supply circuits

IN LAST MONTH'S ISSUE WE INTRODUCED THE valve in its simplest form—the diode. We showed that emission of electrons from the heated cathode forms a space charge around it, and that a flow of electrons (and, hence, an electric current) could be set up by introducing an anode into the evacuated valve envelope and giving this a positive potential with respect to cathode. We saw, also, that no current flowed through the diode if the anode was negative with respect to cathode. We then turned to more general aspects of the valve, including in particular the terms employed to define its component parts. We shall now consider a few more general points relating to the high vacuum valve, after which we shall turn to the use of the diode as a rectifier in radio power supply circuits.

## The Getter

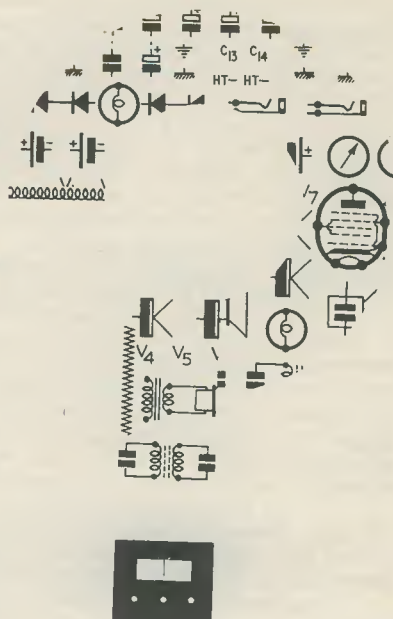
In a valve of the type we are considering here (i.e. one whose electrodes are mounted in an evacuated glass envelope) it is essential that the vacuum be maintained at a very high level indeed. Electrons travelling from the cathode to the anode are liable to strike any gas atoms which may be present and, by upsetting the balance of electrons around the proton in such atoms, may cause these to acquire either a positive or a negative charge (according to whether electrons are lost or gained). These atoms thus become *ions* and, being charged particles, become attracted to the electrodes of the valve having opposite polarity. Their presence may, in consequence, upset the functioning of the valve.

If, however, the number of gas atoms is very small (so small that an electron would have to travel many times the distance between cathode and anode before it encountered one) their presence can be tolerated, and they do not have any serious effect on the operation of the valve.

Although valve envelopes are evacuated during manufacture by highly efficient pumps, these pumps cannot provide complete evacuation and small amounts of gas are still left after the pumping operation. There is the further difficulty that traces of gas remain occluded (i.e. absorbed) in the internal component parts of the valve during pumping, and that these may be gradually released when the valve is in service. To augment the pumping operation and to maintain gas traces at a minimum during service, a gas-absorbent material known as a *getter* is introduced into the envelope.

A number of getter materials are employed, common examples being barium or magnesium. Normally, the getter material, in inert form, is applied to a cup or disc welded to the electrode assembly and, because of its high avidity for gas atoms, is not rendered active until the envelope has been evacuated. The activation is brought about by "flashing", or raising the temperature of the material. This "flashing" may, typically, cause the breakdown of an inert compound into the active getter.

A conventional manufacturing process consists of pumping the gas out of the glass envelope of the valve, heat being applied to the electrodes to cause as much as possible of the occluded gases to be released during this process. Such heating may be given by passing the envelope through a



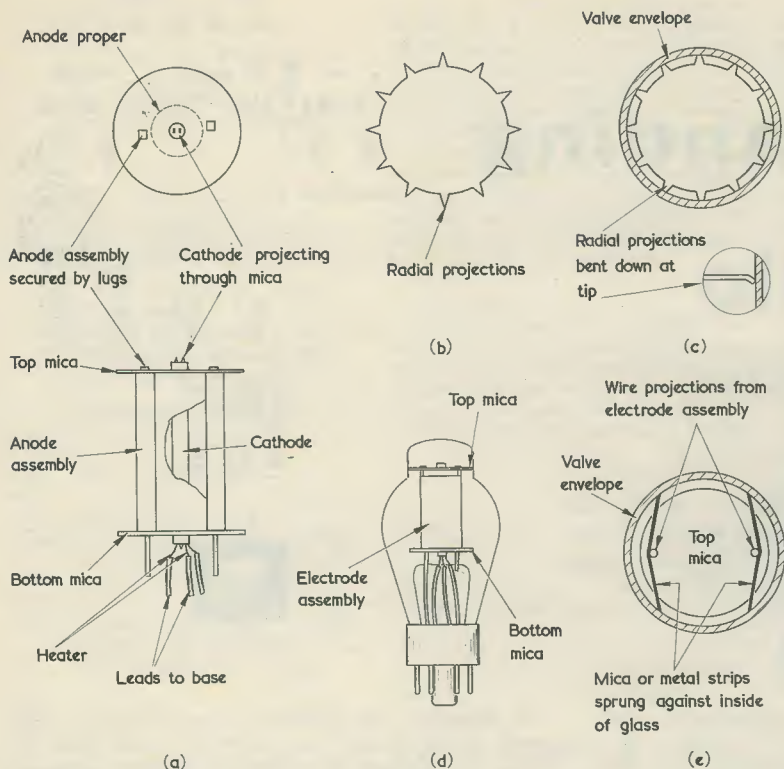


Fig. 251 (a). The electrode structure of a typical indirectly-heated diode. The electrodes are mounted between two mica plates, being held in position by projections passing through holes in the latter. The anode is secured at the upper end by lugs passing through slots in the mica

(b). In valves of the B7G and B9A class, the mica plates usually have pointed radial projections, as shown here

(c). Cross-sectional view from above showing that, when the electrode assembly is inserted into the valve envelope the tips of the mica projections are bent downwards. This causes both mica plates to be held securely with respect to the glass

(d). With valves of the octal class, only the upper mica plate may be secured against the glass envelope

(e). Cross-sectional view from the top showing an alternative method of securing the upper mica in valves such as that of (d)

strong radio frequency field, the eddy currents induced in the electrodes causing these to rise in temperature. Either just before, or after, sealing-off the valve envelope, a specially directed r.f. field raises the temperature of the getter support and the getter material. The latter then "flashes" and results in the active getter being deposited, by evaporation and condensation, on the inside of the glass envelope. This getter then remains active during the life of the valve, absorbing any gas atom which impinges on it.

It is important that the getter material is not deposited upon any insulating electrode supports as it could cause the insulation to be impaired. For this reason the holder for the getter material is mounted in such a position that the deposit, after "flashing", appears on the inside of the envelope well away from the electrode structure.

It is readily possible to see the getter in most glass valves, this appearing as a dark area of irregular outline on the inside of the glass. It is sometimes possible, also, to see the metal getter-holder, but it is usually necessary to break the envelope open to examine this in detail.

### Electrode Structure

A brief description of electrode mounting is desirable at this point, since it will enable further points concerning the valve to be introduced later.

The type of construction almost invariably employed for small radio receiving valves uses

two mica insulating plates, one being above the electrode assembly and the other below. An indirectly-heated version of the diode we have considered up to now could, for instance, have its electrodes mounted between the two mica plates shown in Fig. 251 (a).

If the valve envelope has the cylindrical shape offered typically by the "all-glass" construction with the B7G or B9A base, both mica<sup>1</sup> plates are securely maintained in position against the inside surface of the envelope. The mica plates are usually manufactured with a number of pointed radial projections, as in Fig. 251 (b), the overall diameter of the plate being slightly greater than the internal diameter of the envelope into which it will be inserted. The result is that the outside ends of the mica projections are then bent downwards as in Fig. 251 (c), and both mica plates are positioned rigidly with respect to the glass envelope.

"All-glass" valves appeared in quantity production shortly after the war, the previous types having a glass envelope mounted on a phenolic base in which the pins were mounted. A typical example is given by the range of octal glass valves.<sup>2</sup> The

<sup>1</sup> In these valves the pins project directly from the glass at the base. A B7G valve has seven pins, and a B9A valve has nine pins.

<sup>2</sup> The octal, or "International Octal" valve has eight pins. There were a large number of valve pin layouts in use before the war, these all employing the phenolic (Bakelite is a phenolic) bases but having different numbers of pins and different pin positioning. So far as radio receiving valves are concerned, the octal pin layout is the only one of this type in general use today.



envelopes of such valves usually have the bulbous shape illustrated in Fig. 251 (d), and only the top mica plate is held against the inside surface of the glass. Rigidity is imparted to the bottom of the assembly by using stout wire supports (which may also provide connections) at the lower ends of the electrodes. Some octal valves have envelopes with a cylindrical shape but even these may have only the top mica plate positioned rigidly inside the glass.

An alternative method of holding the top mica plate in position for valves of this nature is shown in Fig. 251 (e).

It should be mentioned, before concluding on this subject, that the octal valve is still frequently employed in modern radio receiving circuits. It is normally encountered in valves having a large electrode structure which cannot be accommodated in the smaller envelopes of the "all-glass" valve. Valve electrode structures which dissipate a high level of heat may also be fitted into the octal construction.

### The Diode As Rectifier

We saw, last month, that current only flows through the diode when its anode is positive of its cathode. If the anode is negative of the cathode no current flows. This attribute can be used in radio equipment employing valves to obtain a direct voltage from the a.c. supply mains, the direct voltage offering a high tension supply for the other valves in the equipment.<sup>3</sup>

Let us connect up the circuit illustrated in Fig. 252 (a), where a source of alternating voltage is applied to a diode in series with a resistive load, and examine the voltages which appear with respect to the lower end of the load. As is to be expected, the alternating voltage at the anode of the diode has the familiar sine wave appearance, and this is shown in Fig. 252 (b).

Immediately after point A in Fig. 252 (b) the anode of the diode is commencing to go positive with respect to the lower end of the load resistor. It is also, therefore, commencing to go positive of the cathode. In consequence, a current flows and the upper end of the resistor goes positive as well. If we assume that no voltage is dropped across the diode the potential at the top end of the resistive load is the same as that produced by the source of alternating voltage.

Looking at the process from the point of view of electron flow, we may say that there is an electron flow from the lower terminal of the source of alternating voltage (which, immediately after instant A, is negative), through the load resistor, through the diode (from the cathode to the anode), and back into the upper terminal of the source of alternating voltage.

As the half-cycle following point A proceeds, current still continues to flow, and the voltage at

the upper end of the resistive load is the same as that offered by the source of alternating voltage. This continues until we reach point B of the waveform, where the voltage from the source of alternating voltage is zero. So, also, is the voltage across the load resistor.

After point B we go into the next half-cycle. But this causes the upper terminal of the source of alternating voltage to go negative with respect to the lower end of the load resistor. In consequence, the anode of the diode is negative with respect to cathode and no current flows. During the whole of the second half-cycle, the voltage across the resistive load is zero.

If we prefer to look at the circuit in terms of electron flow we can see that, for current to flow during this second half-cycle, electrons would need to pass from the anode of the diode to its cathode. However, the diode is a one-way device and a flow of electrons in this direction cannot occur. The result is that no voltage appears across the resistive load.

The next half-cycle starts at point C, and the upper terminal of the source of alternating voltage starts to go positive again. Once more the diode conducts, and so another cycle commences.

The waveform at the upper end of the load resistor is shown in Fig. 252 (c) and it consists of half-cycles of voltage spaced at intervals of a half-cycle. The important point about this voltage is that its polarity does not alter and that it is the same in this respect as a direct voltage, even though its waveform

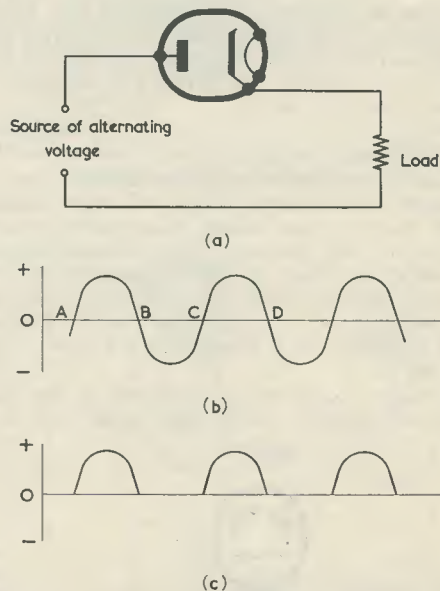
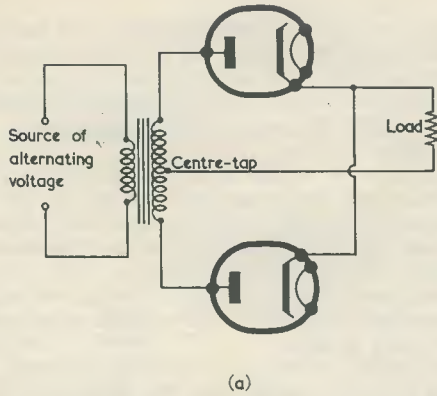
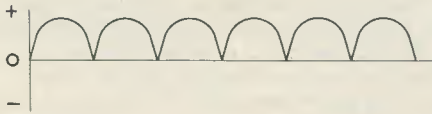


Fig. 252 (a). A half-wave rectifier circuit.  
 (b). The voltage applied to the diode anode relative to the lower end of the load  
 (c). The rectified voltage appearing at the upper end of the load

<sup>3</sup> As we shall see later, valves having more complex electrode structures than the diode require a source of high tension voltage to enable them to carry out their functions. Current is drawn by these valves from the source of high tension voltage.



(a)



(b)

Fig. 253 (a). A full-wave rectifier circuit  
(b). The voltage appearing at the upper end of the load

does not look at all like the steady direct voltage we would obtain from, say, a battery. As we shall see later, it is quite an easy matter to "smooth out" the irregularities so that it *does* resemble the voltage from a battery.

Any device which passes electric current in one direction only is known as a *rectifier*, and this name can be applied to our diode of Fig. 252 (a). In the instance shown in Fig. 252 (a), the diode passes current during alternate half-cycles only, and for this reason the process is described as *half-wave rectification*.

### The Full-Wave Rectifier

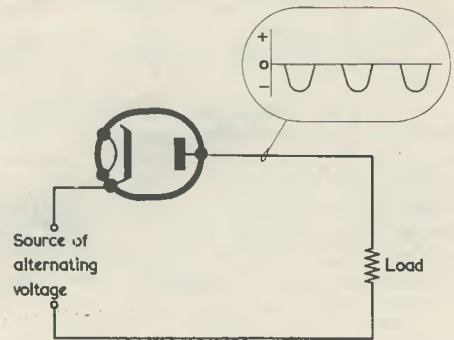
Fig. 253 (a) illustrates a development from the half-wave rectification circuit of Fig. 252 (a). In this diagram, the source of alternating voltage connects to the primary of a transformer, the secondary of which is centre-tapped. We now have two diodes, with the anodes connected to opposite ends of the secondary and the cathodes joined together and connected to the upper end of the load.

Let us commence our examination of this circuit at the half-cycle in which the upper end of the

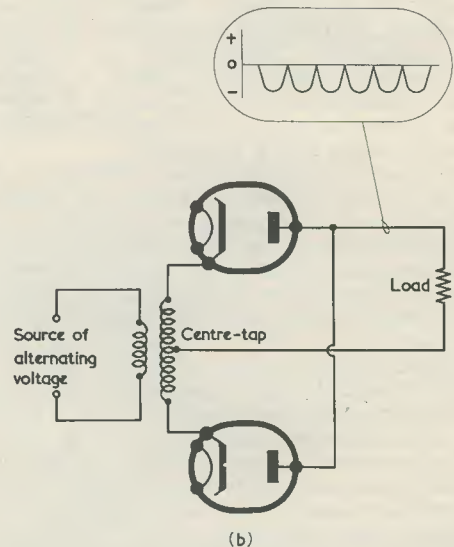


Fig. 254. The two diodes of Fig. 253 (a) may be combined in one envelope with a single cathode

transformer secondary is positive of the centre-tap. Since this causes the anode of the upper diode to be positive, the upper diode passes current, and we get the same half-cycle of voltage appearing across the load that we had in Fig. 252 (c). Whilst the upper diode is conducting, the anode of the lower diode, which is connected to the other end of the secondary, is negative with respect to the centre-tap and so it does not conduct.



(a)



(b)

Fig. 255. In Figs. 252 (a) and 253 (a) the rectified voltage is taken from the cathodes of the diodes. The diodes will similarly function as rectifiers if they are reversed, but in this case the voltage at the upper end of the load is negative with respect to the lower end. A half-wave rectifier is shown in (a) and a full-wave rectifier in (b)

During the next half-cycle it is the anode of the lower diode which becomes positive, whilst the anode of the upper diode goes negative. Thus the lower diode allows a further half-cycle of voltage to appear across the load resistor, whilst the upper diode does not conduct at all.



During the next half-cycle the upper diode conducts once more, and so the process goes on.

The waveform appearing across the load is shown in Fig. 253 (b) and it will be seen that this consists of a series of half-cycles, and that there is no half-cycle spacing as occurred with the half-wave rectifier of Fig. 252. Instead, as soon as one half-cycle of voltage (given by one diode) ceases, the next half-cycle (given by the other diode) commences.

Once again, we have a rectified voltage whose polarity does not alter and, once again, this waveform does not resemble the steady voltage we would obtain from a battery. Nevertheless, the voltage is still capable of being "smoothed" until it does resemble that given by a battery.

It should be noted that, whereas the half-cycles of Fig. 252 (c) have the same amplitude as the half-cycles provided by the source of alternating voltage, the half-cycles of Fig. 253 (b) have the same amplitude as the voltage appearing across half the transformer secondary. This is because the alternating voltage applied to each diode in Fig. 253 (a) is that appearing between the corresponding end of the secondary and the centre-tap.

Since both half-cycles of the applied alternating voltage are rectified in the circuit of Fig. 253 (a), the process is described as *full-wave rectification*. It will be noted that the cathodes of both diodes connect to the same point, and it becomes very convenient to combine the two valves into one envelope having a single cathode and two anodes, as shown in Fig. 254. Such a valve, when it is intended for full-wave rectification in the manner we have just noted, is then described as a *full-wave rectifier*. The single diode of Fig. 252 (a), when it is intended for rectification as shown in that diagram, is similarly referred to as a *half-wave rectifier*.

In practice, the two rectifier circuits we have just discussed are normally employed to provide a high tension voltage for other valves in the

associated equipment. The alternating potentials will be obtained from the domestic a.c. supply mains.

### Reversing The Diode

In the diode rectifier circuits we have seen up to now, the diode anodes are connected to the source of alternating voltage. The result is that the rectified half-cycles (at the cathode end of the load) have a positive polarity.

The diode may also be connected the other way round, as shown in Figs. 255 (a) and (b). In these two circuits it is the cathodes, and not the anodes, that are connected to the source of alternating voltage. These diodes rectify in the same manner as before, but in this case the rectified half cycles (now at the anode end of the load) are negative in polarity relative to the lower end of the load. This is to be expected since the diodes will only conduct, this time, when a negative half-cycle is applied to the cathode, allowing an electron current to flow from cathode to anode and then through the load.

In practical radio equipment employing valves it is almost always necessary to have a positive high tension voltage and it is most convenient to obtain this from circuits of the type shown in Figs. 252 (a) and 253 (a). The circuits in Figs. 255 (a) and (b), where the diodes offer a negative rectified voltage, are rarely encountered in the high tension circuits of valve equipment. Nevertheless, Figs. 255 (a) and (b) emphasise the fact that the alternating voltage to be rectified may be applied just as readily to the cathode of a diode as to the anode, but that the rectified output is then reversed in polarity.

### Next Month

In next month's issue we shall continue to discuss rectifiers, and will introduce the circuits which are employed to "smooth" the rectified voltages.

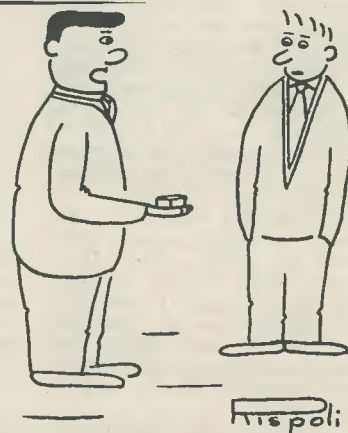
## NEW OSCILLOSCOPE TUBE

Mullard announce a further addition to their range of oscilloscope cathode-ray tubes which should be of particular interest to designers of small general purpose oscilloscopes and the "built-in" type of monitor.

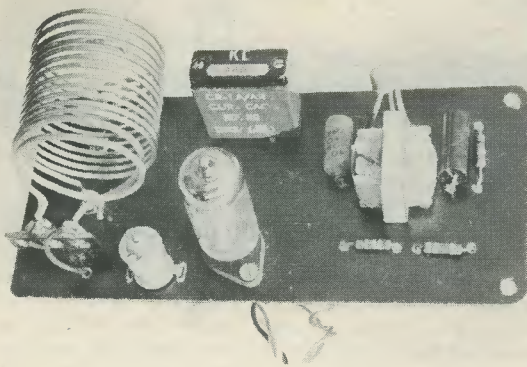
The new D13-27GH is an inexpensive 5in (13cm) tube with an overall length under 14in (350cm). This compactness enables it to be substituted with advantage for the small screen types frequently used in monitor applications.

This tube has a flat faced, medium persistence green phosphor screen with a helical post-deflection accelerator. In common with other recently introduced Mullard types, a separate electrode arrangement permits direct beam blanking to be accomplished—a great advantage in circuit design. The deflection blanking voltage required to blank the tube is 60V maximum under 3kV operating conditions.

The deflection sensitivity, also under 3kV operating conditions, is better than 27 V/cm for the X direction and 13 V/cm for the Y direction; the minimum picture size is 10 x 8cm.



"Personally I think Receiving Licences should be based upon the size of the set!"



# Crystal Tone Transmitter

## for Model Control

F. G. Rayer Assoc. Brit. I.R.E., G30GR

**T**HE TRANSMITTER DESCRIBED HERE is suitable for use with single channel tone receivers. It is crystal controlled, and thus has a frequency stability which is good enough for use with any transistor or valve receiver, including superhets. The crystal control also avoids illegal out-of-band operation. Power may be drawn from batteries, a mains unit, or a rotary converter.

### Transmitter Circuit

Fig. 1 shows the circuit of the transmitter, the 6C4 requiring 6.3 volts at 0.15 amps for its heater. This is within the capacity of dry cells of reasonable size, and the same 6 volt battery also powers the transistor modulator. When operating within the vicinity of a house with a mains supply available, the 6C4 heater can be supplied from a 6.3 volt heater transformer, with a separate small dry battery for the transistor stage. H.T. can be 90 to 250 volts, a series resistor being necessary with the higher voltages, as described later.

The crystal is a 9,065 kc/s unit, providing an output on its third overtone of 27.195 Mc/s. It is important to use a crystal intended for this type of circuit. If necessary, the transmitter can be used for c.w. control by omitting all the modulator components, and including the control switch or key in the h.t. circuit.

$L_1$  is tuned by the 30pF pre-set capacitor  $C_2$ , and  $L_2$  provides aerial coupling. The audio tone

generated by the transistor oscillator is applied to the 6C4 control grid through the r.f. choke, and little audio power is required here for adequate modulation of the 6C4.

### Transmitter Panel

The transmitter panel comprises a sheet of thin Paxolin, measuring 6 x 3 x  $\frac{1}{8}$  in. Fig. 2 shows the positions of components above the panel.  $T_1$ , and the resistors and capacitors, are mounted by passing their leads through small holes. The crystal holder and valveholder are secured with short 6BA bolts. The 30pF trimmer has its tags passed through holes as shown.

Three 6BA tags are bolted, as indicated, to support the coil  $L_1$ .  $L_2$  will be soldered to tags on a two-way tagstrip. This strip can be pivoted to adjust the coupling between  $L_1$  and  $L_2$ .

A yellow/green spot transistor was used, and the transistor leads are shown in Fig. 2. There is greater spacing between base and collector wires than between base and emitter wires. About 1in of 1mm sleeving is placed on each transistor lead before threading through the appropriate hole in the Paxolin panel.

Wiring and components under the panel are shown in Fig. 3. All connections in the r.f. section should be short and direct, and sleeving is placed on all leads. The self-supporting coil is not fitted until assembly is otherwise complete.

### Modulator Stage

The audio oscillator or modulator stage can be tested first, and before

completing the r.f. section. The crystal, valve, coil, and r.f. choke are not required at this stage. Components are checked against Fig. 2, and wiring should agree with Fig. 3.

Phones may be wired temporarily from the free end of the 0.05 $\mu$ F capacitor  $C_3$  to battery negative. The leads to the key should be twisted together, and a 6 volt dry battery connected, taking care to ensure correct polarity, as shown.

A strong audio tone should be heard. If a meter is inserted in one battery lead, this should show approximately 2mA. If a transformer other than that listed has been fitted and no oscillation is obtained, leads from one of the windings should be reversed.

Cheap surplus transistors vary somewhat, and if oscillation is very weak and the transistor current very small, the value of  $R_2$  may be reduced. Alternatively,  $R_3$  may be increased to 10k $\Omega$  or even 12k $\Omega$ . The component values, transformer, and transistor type specified should, however, prove suitable at once. Other audio or output transistors, if already to hand, can be tried. Should a different transistor or transformer result in a very high pitched note, this can be lowered by wiring a capacitor across one winding of the transformer. Values from some 0.01 $\mu$ F to 0.05 $\mu$ F may be tried.

A spring loaded push switch or other device, such as a semi-automatic sequence switch, will generally be used for keying. When the equipment is finished, the key leads are taken to this switch.

### The Coil And Choke

The coil is wound with 16 s.w.g.



### Components List

#### Resistors

- R<sub>1</sub> 3.9kΩ ½ watt
- R<sub>2</sub> 27kΩ ½ watt
- R<sub>3</sub> 6.8kΩ ½ watt
- R<sub>4</sub> 1kΩ ½ watt

#### Capacitors

- C<sub>1</sub> 1,000pF ceramic
- C<sub>2</sub> 30pF concentric trimmer
- C<sub>3</sub> 0.05μF paper 250V wkg.
- C<sub>4</sub> 0.1μF paper 150V wkg.

#### Inductors

- L<sub>1,2</sub> See text
- R.F. Choke See text
- T<sub>1</sub> Transistor driver transformer type PW/DT. (Osmor)

#### Valve

- V<sub>1</sub> 6C4

#### Transistor

- TR<sub>1</sub> Yellow-green spot

#### Crystal

- Radio-control crystal, 9,065 kc/s, valve circuit third overtone. (Henry's Radio)

#### Sockets

- 1 B7G valveholder
- 1 Socket for crystal. (Henry's Radio)

#### Miscellaneous

- Paxolin panel, 6 x 3 x 1/8 in.
- 2-way insulated tagstrip
- 6BA bolts, nuts, tags
- Sleeving, coloured flex, wire, etc.

tinned copper wire, using a temporary former of about 1 1/4 in diameter (such as a spare U2 cell). The wire is straightened, and one end anchored or gripped in a vice. About 14 turns are then wound on the temporary former, as tightly as possible and side by side. This can be done by rotating the former and walking slowly forward as necessary.

When the coil is removed, it will be about 1 1/2 in outside diameter. Turns are separated by running a pencil or similar small-diameter object round and round between the turns, as this gives more regular spacing than stretching. Excess wire is removed, and the ends are bent so that the finished coil has 12 turns, and is about 1 1/2 in long. See Fig. 4 (a). A short piece of 20 s.w.g. wire is soldered on at the third turn. The solder must not short-circuit to adjoining turns, and this tapping may have to be moved, as described later.

The projecting ends of the coil are about 1/2 in long, and these and

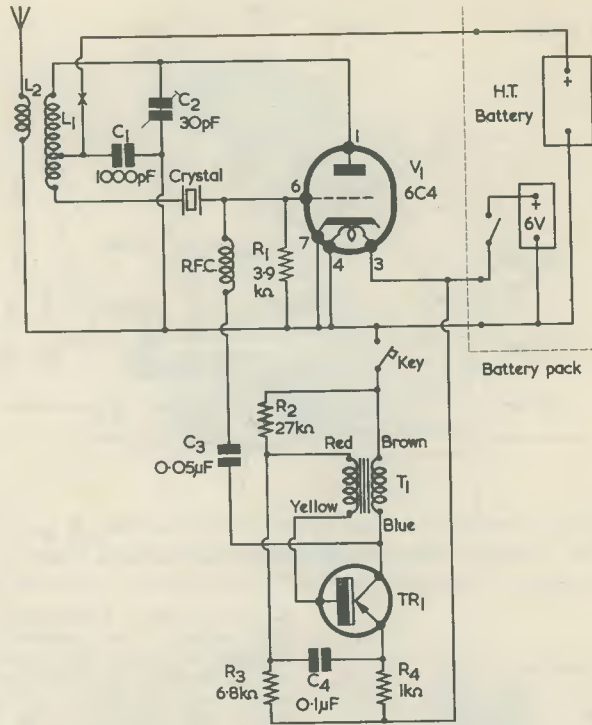


Fig. 1. The circuit of the crystal controlled transmitter

the tapping are soldered to the tags indicated in Fig. 2. The aerial loop is 2 turns of the same wire and with the same diameter as L<sub>1</sub>. The wire for L<sub>2</sub> must be provided with sleeving to avoid contact between h.t. positive and h.t. negative circuits.

The coupling coil is mounted as in Fig. 4 (b). The small tagstrip

shown is fixed with a single bolt, and can be pivoted to adjust coupling to suit the aerial.

The r.f. choke is wound with 32 s.w.g. enamelled wire. A piece of ebonite or other insulated rod or tube, about 1 1/2 in long and 1/8 in diameter, is required, and two stout wire leads are threaded through small holes, as in Fig. 4 (c). The

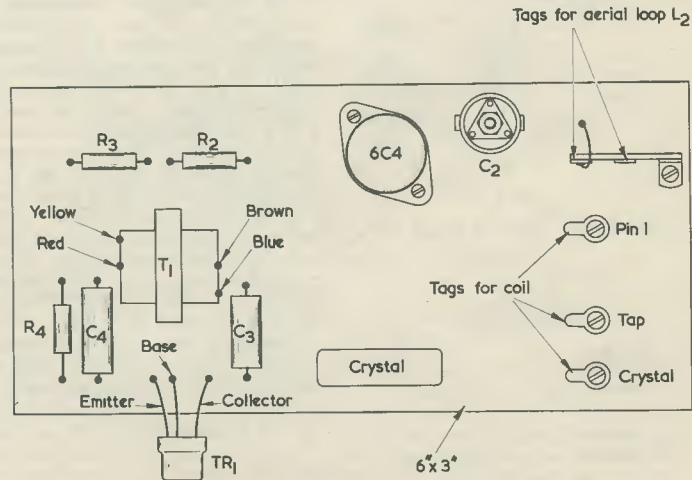


Fig. 2. Layout above the Paxolin panel

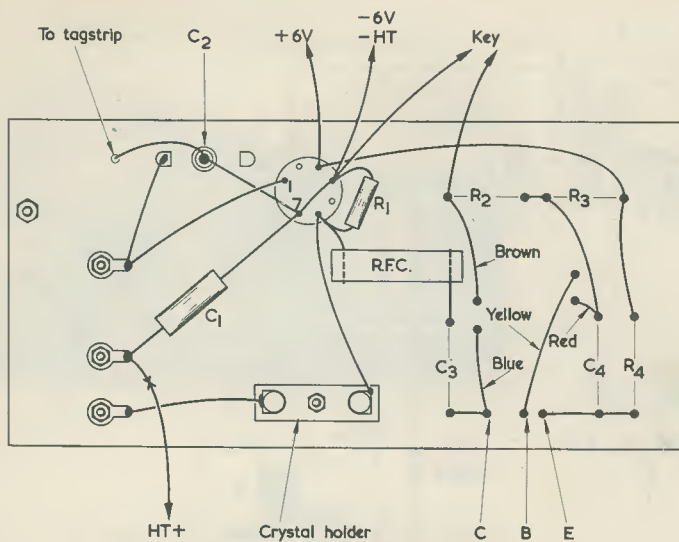


Fig. 3. Wiring and components below the panel

12 turns  $1\frac{1}{2}$ " dia x  $1\frac{1}{2}$ " long

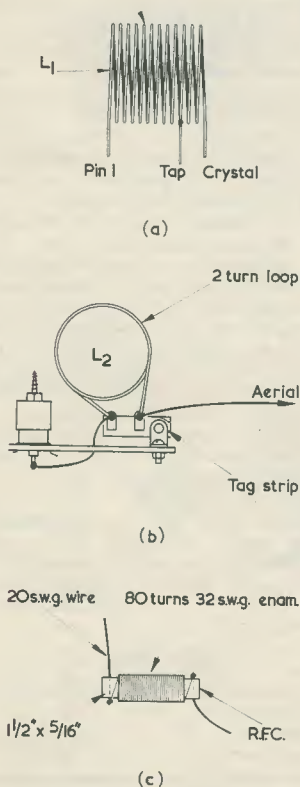


Fig. 4 (a). Details of coil  $L_1$   
(b). How the aerial coupling coil is mounted  
(c). Winding the r.f. choke

32 s.w.g. wire is soldered to these stout leads. The actual choke winding is about 80 turns, and will be satisfactory if the turns are wound side by side for a total of about 1in. The r.f.c. is wired into circuit as in Fig. 3.

#### Oscillator Adjustments

When suitable adjustments have been made the circuit will only oscillate at the correct crystal controlled frequency. Initial tests are made without an aerial, and a meter should be included in one h.t. lead. A lamp loop, consisting of 2 turns soldered to a 6 volt 0.06 amp. bulb, is also useful for testing for r.f. Alternatively, a 27 Mc/s tuned wavemeter or bulb-meter can be used instead, and this will confirm that operation is on the correct crystal harmonic.

For a 90 volt h.t. supply no series dropping resistor is needed. For a 120 volt or 150 volt battery supply, a  $1k\Omega$  resistor is wired in the h.t. positive line, at the point marked with a cross in Figs. 1 and 3. As the transmitter can readily be powered from a mains unit, for use indoors or in the garden, more voltage may be available. If the unit delivers 250 volts h.t., the resistor must be  $10k\Omega$ .

The 30pF trimmer is fully opened initially. An insulated rod or tube is filed to engage with the trimmer nut, or a strip of Paxolin is filed to make a spanner to rotate the trimmer. The transistor stage may be left off (key disconnected).

The 6C4 should reach working temperature in 20 to 30 seconds,

and the h.t. circuit meter will probably show a current of some 10 to 15mA or so. The trimmer is then slowly screwed down, and a dip in h.t. current should show that oscillation has commenced. This can be confirmed with the lamp loop or wavemeter.

If oscillation is not obtained at any setting of the trimmer, the tap should be moved one turn towards the "pin 1" end of the coil, and adjustments repeated.

Should oscillation be found at almost any setting of the 30pF trimmer, the tapping is too near the "pin 1" end of  $L_1$ , and must be moved a turn or so towards the "crystal" end. Generally, the tapping should be suitable at the third or fourth turn, but this depends on the h.t. voltage and crystal activity. The tapping is correct when the circuit oscillates well only when the trimmer is tuned to the harmonic wanted. In these circumstances, the transmitter frequency is controlled by the crystal.

Tests with the lamp loop will show that the r.f. generated increases sharply as the trimmer is set to its optimum position. It is usually necessary to de-tune the trimmer *very slightly* from this position, to assure that the oscillator always starts readily.

When the aerial has been connected, slight readjustment may be necessary for best r.f. output. This, and the coupling between  $L_1$  and  $L_2$ , can best be checked by setting up a field strength meter a few yards away from the transmitter. Alternatively, results will generally be good if  $L_2$  is some  $\frac{1}{8}$ in to  $\frac{1}{4}$ in from  $L_1$ , tuning being adjusted for nearly minimum h.t. current or maximum brilliance of the lamp loop.

If  $L_1$  has its turns rather close together or the trimmer is screwed very far down, in some circumstances 18 Mc/s may be tuned, and oscillation may be obtained at this frequency. This can be avoided by beginning with the trimmer fully open, as mentioned, and by stretching  $L_1$  slightly, if necessary. Any receiver or wavemeter will readily show the frequency to be wrong if this occurs at 18.13 Mc/s.

A pick-up loop consisting of a few turns of insulated wire, and connected to phones with a crystal diode in one lead, can be used to check the presence of the modulated r.f. signal. If this loop is near the transmitter, the audio tone should be heard when the keying circuit is closed.



# IN YOUR WORKSHOP



The immediate future looks very promising if, on New Year's Day, the only repair job in sight is a simple two-valve record player. So should it have been with Smithy and his assistant Dick, had it not been for their too-ready acceptance of New Year customs!

"AND A HAPPY NEW YEAR TO you, too!"

"Blimey," said Dick, impressed with Smithy's entry into the Workshop, "you sound cheerful. Most times when you come in on New Year's Day you look as though you've compressed the Thousand and One Nights into one!"

"Things," pronounced Smithy, "are going to be different this year. Come to that, how is it that you've got into the Workshop before me? I don't usually see you on New Year's Day till it's time to go home."

"I just thought," said Dick artlessly, "that I'd start the New Year right by getting to work nice and early."

Smithy eyed his assistant suspiciously.

"I don't like the sound of that," he said distrustfully. "You're up to something."

"No, I'm not," protested Dick. "It's just that I've made a New Year's resolution, that's all. From now on I'm going to be as helpful, polite and obliging as I possibly can be."

"Well, that's a pleasant surprise," exclaimed Smithy. "Funnily enough, I've decided to do exactly the same thing myself. I've made a resolution to go through the New Year as a paragon of courteous affability and even temperament."

"Fancy that," commented Dick, "both of us having the same New Year's Resolution!"

"You know what they say about great minds, don't you?"

"Of course I do," replied Dick. "They always think alike!"

## A Simple Record Player

The pair sat down and beamed at each other.

"I must say," commented Smithy happily, "that this is a very pleasant atmosphere."

"Isn't it?"

"It seems a pity," continued Smithy, "to even think about bringing up the subject of work."

"Not at all," replied Dick help-

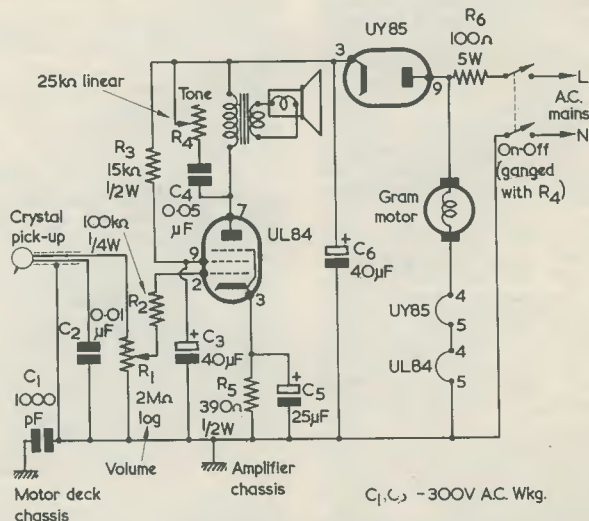


Fig. 1. The basic circuit employed in record players using the UL84 and UY85 combination. Component values are representative of commercial practice, and small variations may be encountered in the heater supply circuit. The screening on the lead to the pick-up, and the pick-up connections themselves, are insulated. In some instances, the upper terminal of the gram motor may connect to the supply side of the limiter resistor  $R_6$ .

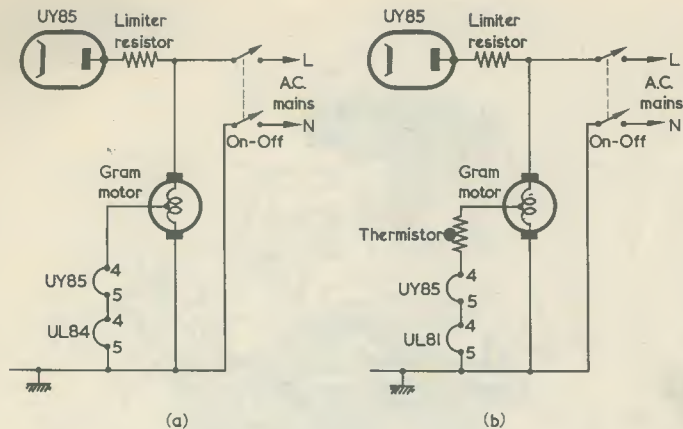


Fig. 2 (a). A common practice consists of supplying the heaters from an '80 volt tap' in the motor windings  
 (b). Occasionally a thermistor is connected in series with the heaters to limit initial current when switching on

fully, as he rose from his stool. "Pray, let me examine the racks." Even the newly-resolute Smithy blanched at this manifestation of Dick's changed temperament, and he watched, fascinated, as his assistant walked over to the "For Repair" racks. Now that the Christmas rush was over, these seemed to be almost completely empty.

"What a pity," called out Dick. "There's only one job in for repair!" He returned to his bench carrying a record player in a brightly coloured case.

"Still," he continued, "I can do this one myself. You can take it easy today, Smithy."

"We'll both do it," replied Smithy promptly. "By dint of mutual aid we shall both then obtain the maximum amount of pleasure from the job."

"What an excellent idea!" commented Dick. "I am glad I went in for this New Year resolution jazz."

Whilst he spoke, Smithy had started thumbing his way through the service manual files. The Serviceman soon found the sheet he wanted. He placed it on the bench with the circuit upwards. (Fig. 1).

"It's hardly worth getting the manual out," commented Dick. "This record player is only one of those two-valve efforts."

"Still, we've got all day to do it in," replied Smithy, "so we might as well commence in the approved fashion. Plug it into the mains and see what happens."

Dutifully, Dick inserted the record player plug into the appropriate

socket in the assortment mounted at the back of his bench. He picked up the Workshop collection of test records and placed a battered 45 r.p.m. disc on the changer. After ensuring that the correct speed and stylus were selected, he switched on. He operated the record changer control, but this gave no sign of life. There was, further, no sound from the speaker, even after a more than adequate wait for the valves to achieve working temperature.

"Dead as a door-nail," announced Dick. "Let's have a shufti inside the case."

"That's not the most obvious place," said Smithy. "You want to check the connections at the plug first."

"Oh yes, of course," said Dick. "I keep forgetting how many times a piece of equipment is described as being duffy when its only fault is a broken lead or a loose connection at the plug."

Dick quickly removed the mains plug cover and checked the connections and the mains flex at the anchorage point.

"All O.K. here," he pronounced.

He picked up a screwdriver and cheerfully proceeded to attack the screws securing the inspection cover of the record player.

"I should check the valves for heater continuity," suggested Smithy, "they're in series with the motor windings."

"Righty-ho," said Dick, "anything to oblige! Incidentally, isn't it rather a queer business putting the heaters in series with the motor?"

"Not at all," replied Smithy.

"It's an idea which saves a dropper resistor and prevents the dissipation of unnecessary heat inside the cabinet. With the changers you have in these record players the motor is running all the time, and so it might as well carry out the secondary function of dropping the heater volts as well as rotating the turntable and operating the changer mechanism."

"I seem to remember," remarked Dick, "that some of these players have the heaters run from a tap in the motor windings."

"That's right," confirmed Smithy. "In fact, the tapped winding idea is rather more common than the series circuit we have here. Inexpensive record players of this type all employ a UL84 output pentode, which has a heater rated at 45 volts and 100mA, together with a UY85 rectifier having a heater rated at 38 volts and 100mA. So, when the heaters are in series, they require a supply of 83 volts at 100mA. This is given either by putting the motor in series, as we've got here, or by tapping into its windings. In the latter case, the heaters connect across the tapped section directly (Fig. 2 (a)) or via a thermistor (Fig. 2 (b)). The tap in the windings is usually described as an '80 volt tap' for obvious reasons."

#### New Rectifier

By now Dick had removed one of the valves and was checking its heater for continuity.

"You were quite right," he announced triumphantly, "the rectifier heater has gone open-circuit."

"Good show," said Smithy, walking towards the valve cupboard. "Incidentally, I think you'd better measure the total heater voltage after you've put the new UY85 in."

"But that," protested Dick, "will mean getting the amplifier chassis out to reach the connections."

"Perhaps so," said Smithy. "But you should remember that the heaters of these mains valves are pretty robust, and that they don't burn out all that readily. It might be that a fault in the motor is causing too much heater current to flow."

Dick opened his mouth to voice further objections, then suddenly remembered his New Year's resolution.

"I fully understand the situation, Smithy," he remarked sweetly, "and I'm only too happy to do as you ask."

Smithy's hand, reaching for the replacement rectifier, faltered momentarily. This new, honeyed relationship in the Workshop was going



to be difficult to get used to. He summoned up his own determination to see the New Year through as an exponent of mutual help and genteel courtesy.

"That's very good of you," he said, returning to the bench. "Perhaps I can be of some assistance in getting the chassis out."

"Thank you," replied Dick politely, as he groped in the recesses of the cabinet, "but it's really a one-man job, and I've already removed the screws which hold the chassis to the case. Drat it, the darned thing's stuck!"

"I'll raise the motor board," offered Smithy. "If this is tilted back a little you should be able to ease the chassis out a bit more."

"You'll need to be quick, then," said Dick. "I've only just got a hold on the chassis."

Whilst Dick, with an expression of stern resolution, clutched the little amplifier chassis inside the cabinet, Smithy took off the test record, removed the wood screws which secured the motor board and quickly raised it. There was a sharp cry of anguish.

"I hate to be difficult," remarked Dick through clenched teeth, "but at this moment you are neatly crushing my right wrist between the end of the motor board and the inside edge of the cabinet!"

"Oh dear," said Smithy apologetically. "Can you get your hand out of the way?"

"If I do," replied Dick, "I'll drop the chassis. It's in a very awkward position."

"I'll drop the motor board down a little," volunteered Smithy, "perhaps you can jiggle the chassis round a bit further then."

"That's a good idea," commented Dick. "Incidentally, please don't think I'm ungrateful for your help even if it has resulted in my wrist being squashed flat!"

"I'm very sorry about that," said Smithy contritely, "it was most remiss of me."

"Accidents," replied Dick forgivingly, as he manipulated the chassis now that Smithy had dropped the motor board a little, "can happen in the best-regulated circles. I think I'm getting a bit more of the works out."

An output transformer and electrolytic capacitor had now appeared. Frowning heavily, Dick attempted to edge the remainder of the chassis over the level of the motor board held by Smithy.

"Blow it," he grunted. "It's the volume control spindle that's got caught now!"

"Shall I raise the motor board again?"

"No thanks," said Dick quickly. "I've got my other wrist in the way now. Try dropping it a bit more. Gently, now!"

Carefully, Smithy lowered the motor board, to be rewarded by a tormented shriek from his assistant. He quickly raised it again, only to hear an agonised yell of even greater intensity.

"What are you trying to do?" remarked Dick bitterly. "Make me walking wounded, or something?"

"You said lower it."

"I know I did," replied Dick irritably, "but not so's you'd bend my little finger right off. After which you had to go and raise the blistering thing up again and catch my left wrist as well. I'm only managing to hold the chassis by my finger tips as it is, and how I can do that with two broken wrists passes my comprehension!"

"We seem," remarked Smithy mildly, "to have reached an impossible situation. I can't raise the motor board because I catch your wrist, and I can't lower it because I catch your finger. At the same time, you can't let go of the chassis. Do you know, Dick, this requires quite a bit of thinking out!"

Smithy fell into a contemplative silence. Dick watched him with increasing resentment.

"Are we going," he queried indignantly, "to spend all of 1965 standing here with our four hands thrust into this electronic man-trap?"

"Of course we're not," said Smithy soothingly. "And in any case it's suddenly occurred to me that we set about removing this chassis the wrong way in the first place."

"What should we have done then?" asked Dick sarcastically. "Blasted it out with dynamite?"

Smithy looked pained.

"Now, don't be like that," he said mildly. "What we *should* have done was to raise the motor board out of the way completely before we even attempted to shift the chassis."

"Right," said Dick promptly. "In that case the chassis is going back to its original position, if I have to strain every muscle in my body to do it!"

Forcefully, Dick thrust the chassis down below the level of the motor board, whereupon a loud bang suddenly resounded from the inside of the cabinet. Startled, Dick jumped back, pressing against the Serviceman and extricating his hands just one split instant before the stumbling Serviceman pulled the

motor board edge clear above the top level of the cabinet.

"Blimey," said Dick, "that was a close thing!"

As he mopped his brow preparatory to inspecting himself for damage, Smithy peered down into the cabinet at the irregularly-shaped little amplifier chassis which had caused all the trouble.

#### Voltage Tests

"You have," remarked Smithy accusingly, "broken the UL84."

"Good!" said Dick vindictively.

With the motor board raised Smithy picked up the chassis and, without the slightest difficulty whatsoever, took it out and placed it on the front top of the cabinet. There was more than sufficient lead length to enable him to return the motor board to its original position.

"There you are," he said triumphantly. "It's a piece of cake if you lift the motor board right out first of all."

"That information," snorted Dick, "is a fat lot of use now."

"There doesn't," continued Smithy, "appear to be any damage to the chassis other than the broken valve."

"I am," said Dick sarcastically, "delighted to hear it."

Smithy turned round and gazed at his assistant.

"I must say," he said reprovingly, "that you don't seem to have the right idea at all at the moment. I thought we were going to start the New Year with an attitude of mutual help and assistance."

"If what has just happened," replied Dick hotly, "is the result of mutual help and assistance, the sooner we get back to the bad old days the happier I'll be!"

Smithy made his second trip of the morning to the valve cupboard.

"I shan't argue," he remarked mildly. "I'll get another UL84 and check the total heater voltage myself."

With which words the Serviceman selected a replacement valve, carried it back to the bench and plugged it, in company with the new UY85 he had previously taken from the cupboard, into the chassis. Interested despite himself, Dick tore his attention away from his injuries and watched the Serviceman as he applied his test clips to the chassis.

Smithy re-fitted the knobs to the chassis and switched on. A busy whirring from the changer indicated that the motor was now running.

"There we are," said Smithy, watching the needle of the testmeter. "The heaters are cold at the instant of switching on, so that the total

voltage across them starts at around 50 to 60. After which, it very quickly rises to a nice steady figure slightly in excess of 80 volts."

Smithy placed the test record back on the changer and started its mechanism. The pick-up rose from its rest and the record clattered on to the turntable. The pick-up then moved sideways and descended at exactly the correct point near the edge of the record.

"The record changer seems to be working O.K. too," continued Smithy, "and I didn't notice any significant variation in heater voltage whilst the changer mechanism was operating."

"Did you expect any?"

"I thought the point was worth checking," said Smithy.

The pair listened to the tinny sound of music from the pick-up stylus.

"There's nothing," Dick pointed out, "coming out of the speaker."

"Neither is there," agreed Smithy. "Let's turn the volume up a bit."

Smithy adjusted the volume control knob. The recording became audible but at much reduced volume. "We have," pronounced Smithy, "another snag."

"Good show," said Dick. "Shall I have a go at it?"

"That's very kind of you," replied Smithy, surprised. "But I thought you'd just retired from the combat with multiple injuries plus a serious attack of the needle!"

"Oh, that," said Dick carelessly. "It takes more than a little accident like that to make me drop a New Year resolution. I'm fully back on the old politeness stakes now!"

"Good show," said Smithy, standing up and surrendering the bench stool to Dick. "I should start off with voltage measurements first."

"Couldn't the snag be a duffy pick-up or something like that?"

"Doubtful," commented Smithy. "Usually the pick-up either works or it doesn't. Voltage checks are the best to start with."

"How about an open-circuit cathode bypass electrolytic? That would cause low volume due to cathode degeneration."

"The loss in volume," said Smithy shortly, "wouldn't be as high as we've got here. Try the voltage checks."

"Shorted turns in the speaker transformer primary?"

"Why," asked Smithy, with a visible effort at self-control, "do you keep chuntering on about all these remote possibilities when the obvious and easiest thing to do is to take some voltage tests?"

"You would prefer," queried Dick

pleasantly, "that I start off with voltage tests, then?"

"Yes," replied Smithy in a strangled voice. "I would."

"Just as you like," commented Dick agreeably, "anything to oblige."

At this moment the test record reached the end of its track. The pick-up raised itself from the disc and returned to its rest.

"I see," said Dick chattily, "that the changer mechanism is O.K. at the end of the record as well as at the beginning. So there's no trouble there."

"Will you," rumbled Smithy, "start these voltage tests?"

"Yes, of course," said Dick. "Let's get nice and comfy!"

Watched by the fuming Serviceman, he settled himself down on his stool, moved his testmeter to a convenient position and carefully tightened its terminals. He next clipped the negative lead to the amplifier chassis and held the positive prod poised in the air.

"Now where," he remarked musingly, "shall I start?"

"Where shall you start?" exploded Smithy. "My life, you've got just one pentode and just one rectifier and you say where shall you start? There's only four places you *can* get voltage readings from, and those are the pentode anode, screen and cathode, and the rectifier cathode!"

"What about the rectifier anode?" suggested Dick, with an air of sweet reasonableness. "There *could* be low a.c. volts on the anode, you know."

Smithy held up his hands, then let them fall helplessly to his sides again.

"We have already," he said brokenly, "spent half the morning establishing that the heaters are getting the right voltage and that the motor is running O.K. Since the motor gets its supply after the limiter resistor, and at the same point as does the rectifier anode, could we not safely assume that the rectifier anode is getting its proper whack of alternating voltage?"

"Do you know," said Dick, in the patronising tone of one who believes in giving credit where credit is due, "I think you've got rather a good point there, Smithy."

#### Low Screen-Grid Potential

If Perseus had been accompanied by Smithy in his travels, the latter would have been of inestimable assistance over the Medusa affair. The look which Smithy turned on Dick at that moment would have overcome the most virulently calcifying stare that the good lady of the strange hair-do could produce, and

would have sent her snakes screaming towards their associates ensconced with her Gorgon sisters. Fortunately for himself, however, Dick chose that exact moment to turn his attention to the chassis. At last his test prod descended.

"Here we are," he announced brightly. "We've got about 250 volts on the rectifier cathode. That seems reasonable enough to me."

Disregarding the silence which greeted this remark, Dick once more applied the test prod. There was a crackle from the loudspeaker.

"The anode voltage," sang out Dick, "is only a little bit lower, at 245 volts."

"Humph," grunted Smithy, a flicker of interest showing through his wrath. "That seems a bit high."

"How's that?"

"Well," said Smithy, "the UL84 takes a pretty fat anode current of about 60mA at the h.t. voltage you've got there, and you should normally drop at least 10 volts across the transformer primary. Try the volts on the screen-grid."

"No sooner said," replied Dick affably, "than done! Blimey, what's this?"

"Have you found something?" "I have, indeed," said Dick. "The screen's running at around 20 volts only." (Fig. 3 (a).)

"Good show," commented Smithy, his irascible mood evaporating now that the cause of the fault had been located. "You've got two major probabilities open to you now. Either the screen-grid feed resistor's gone high or the bypass electrolytic's leaky."

But Dick had already switched off the chassis and started taking ohmmeter readings.

"The electrolytic," he announced, "is O.K. But the screen feed resistor isn't. It should be 15kΩ but it's reading well over 200kΩ."

"Fair enough," said Smithy. "I'll get you a new one right away."

Smithy wandered over to the spares cupboard and returned with a new resistor. He watched his assistant remove the faulty component and solder in the replacement.

"You know," remarked Dick, as he briskly rattled his soldering iron about the chassis, "it *is* pleasant working away in harmony as we are doing this morning. I must confess, though, that I got a little niggly a few moments ago over the business of getting this chassis out. Still, the feeling's eased off now."

"Same here," admitted Smithy. "I felt somewhat irritated myself just now, but I'm not going to let that spoil my New Year's resolution."



"There's nothing," continued Dick, "like being in concord. I bet there aren't many service workshops where they get on as well with each other as you and I do here!"

"That's quite a thought," said Smithy, impressed by his assistant's observation. "It may well be that we could set an example in industrial relations!"

### Stylus Trouble

By now, Dick had soldered in the new resistor. He switched the amplifier on again and rechecked the voltages on the UL84.

"That's better," he announced. "We've got 205 volts on the screen-grid. Also, the voltage on the rectifier cathode has dropped down a little, to around 245 volts."

"That's because the UL84 is drawing more current."

"The anode voltage," continued Dick, "is around 230, and the cathode is reading about 18 volts." (Fig. 3 (b).)

"Much more like it," said Smithy approvingly. "Try the record again."

Once more Dick operated the changer. This time there was ample volume from the loudspeaker. Experimentally, Dick adjusted the volume and tone controls and found that these functioned adequately.

"It doesn't sound too bad," he announced after some moments. "It's certainly *loud* enough, even if the quality isn't all that hot."

"These aren't meant to be hi-fi jobs," Smithy pointed out. "The idea is to screw as much gain out of the single pentode amplifier as you can get."

"Why," asked Dick, "do you have such a high value resistor in series with the screen-grid? In conventional amplifiers you usually return the screen-grid to the h.t. positive line."

"True enough," agreed Smithy. "The reason is mainly due to the operating conditions for the UL84 when it's working at h.t. potentials above 200 volts or so. You'll find in practical radios and record players that, under these conditions, the UL84 nearly always has a lower voltage applied to its screen-grid than to the top end of the output transformer primary. As I mentioned just now the valve draws a pretty heavy anode current, which means that you can get quite a high voltage drop in the primary of the output transformer if this is of the small type you encounter in inexpensive record players and mains radios. It isn't always a desirable thing to have the screen-grid voltage of an output pentode significantly higher than the anode voltage; but

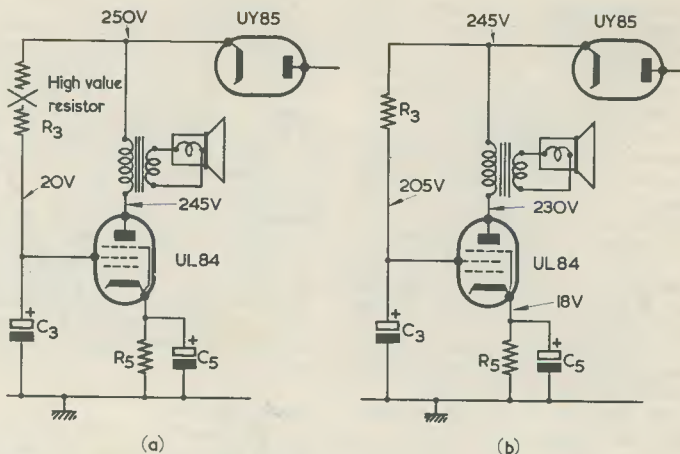


Fig. 3 (a). A fault in  $R_3$  caused the screen-grid of the UL84 in the record player serviced by Dick and Smithy to have an excessively low potential (b). Fitting a new screen-grid feed resistor restored the pentode to correct operation, with the representative electrode potentials illustrated here. All voltages in this diagram and in (a) are with respect to chassis

I don't want to be dogmatic on that point because much depends on circuit conditions and the type of valve employed. In the present case, the most important reasons for having the rather high screen-grid series resistor are the limiting voltages which apply to the UL84. This valve packs a great deal of power in a small envelope, and the maximum limiting anode voltage is 250, whilst the maximum limiting screen-grid voltage is only 200."

"We are," Dick reminded him, "getting 205 volts on the screen-grid here."

"Ah, yes," said Smithy, "but the 200 volt figure is relative to cathode, whereas the 205 volt reading you've got on that amplifier is relative to chassis. Subtract the 18 volts which is dropped across the cathode bias resistor, and you'll find that the screen-grid voltage is comfortably below the 200 volt limiting figure. Anyway, that's quite enough about the UL84. I think the next thing we'd better do is to check this record player with a 78 record."

Dick groaned.

"Don't say," he complained, "that we're going to have 'Selections from *The Student Prince*' all over again."

"Of course we are," said Smithy, resolutely extracting a dusty 12 inch 78 r.p.m. disc from the pile of test records. "This is one of the best records which was ever made."

"But it's prehistoric," protested Dick. "It isn't even an electrical recording, it's an acoustic one!"

"All the better," pronounced

Smithy. "They *had* to be singers in those days. I can just imagine them all straining their guts out whilst they yelled down the tin horn at the recording studio!"

"The last time we had a record player in for repair," grumbled Dick, with a shudder at the memory, "you played both sides of that record about four times each. I can remember it yet."

"Nonsense," said Smithy, an anticipatory gleam in his eye. "Now, put it on so that we can have a spot of *real* music!"

With an air of extreme reluctance, Dick placed the record on the changer.

"Treat it carefully now," said Smithy peremptorily. "Records like that are irreplaceable these days."

"Dash it all," said Dick testily. "What d'you think I'm going to do? Bash a new hole in it for the spindle to go through?"

Peevishly, he started the changer. The record fell with a ponderous crash on to the turntable, causing the deck to jitter violently on its springs. The vibrations had hardly ceased when the pick-up descended. Smithy and Dick listened as the surface noise gave way to the first few bars of music.

"You great oaf," snarled Smithy, "you've forgotten to change the speed!"

Dick moved his hand hastily towards the speed control.

"Don't change it whilst it's playing," snorted Smithy. "Stop it and start all over again."

Bad-temperedly, Dick stopped the changer, set it up again at the correct speed and re-started it. Once more the record fell clangorously on to the turntable, and once more the pick-up travelled over to it.

"Ah," said Smithy, with obvious pleasure as the offerings of the long-forgotten orchestra became audible over the loudspeaker, "now that's more like it!"

"I thought it sounded better at 45 r.p.m.," commented Dick dispassionately, "apart from the fact that it would have lasted nearly twice as long."

"Don't be silly, boy," said Smithy, his equanimity fully restored by the soothing strains of the music.

The Serviceman glanced towards the record player and stiffened.

"You *still*," he complained, "haven't got it right."

"What's wrong now?"

"You haven't turned the cartridge over," replied Smithy accusingly. "You're playing that record with the l.p. stylus. Do you know, you might even spoil the grooves doing that."

"You must be joking," said Dick incredulously. "When that record was made the grooves were put in with a hammer and chisel!"

"There's only one way," pronounced Smithy flatly, "of doing a job properly and that's to do it the right way. So let's get that record started off in the correct manner."

Rebelliously, Dick stopped the changer once more. He rotated the cartridge to select the 78 stylus and, for the third time, started the mechanism. Again the record crashed heavily on to the turntable and again the pick-up travelled over and descended on to its surface.

But this time, instead of following its steady spiral inwards, the pick-up swept swiftly and erratically back and forth across the surface of the record. There was an ominous scratching noise.

"Stop it!" yelled Smithy. "That record's getting ruined."

Concertedly, both Smithy and Dick rushed to raise the pick-up. So great was their haste, however, that they bumped into each other and, falling forwards, pressed their fingers against the outermost edge of the 12 inch disc on its 10 inch turntable. Even a record of as many winters as this had seen could not stand the sudden strain, and it cracked neatly across the middle. Bemusedly, Dick and Smithy watched the pick-up jump into the air. At this instant the changer mechanism took over and the pick-up moved sedately across the turntable to descend, undamaged, upon its rest.

#### Resolutions Over

"Do you know what you are?" fumed Smithy, waving his half of "Selections from *The Student Prince*", "You're a steaming, addle-pated git!"

"Was it my fault," yelled Dick furiously, the remainder of the record clenched in his fist, "that that blistering pick-up didn't work? It was *you* who said change the cartridge over."

Smithy opened his mouth to speak, then suddenly stopped. Sitting down, he commenced to chuckle.

"You're perfectly right, too," he laughed. "It's quite true that you weren't to know that the pick-up was faulty."

"Of course I'm right," said Dick indignantly. "So what's the big joke?"

"What I'm laughing at," said Smithy, "is the fact that all the capers we've got up to this morning are the direct result of those New Year resolutions of ours."

"Hey?"

"That's right!" grinned Smithy. "We're being so blooming polite and helpful to each other that all the normal little niggles and annoyances which take place are piling up inside of us. The result is, that when they *do* come out, they're about ten

times as violent."

"Do you mean," queried Dick, "that we're more liable to have bust-ups if we're polite to each other than if we continually insult each other in the normal way?"

"I'm convinced of it. Just look at what's happened this morning."

An expression of intense relief spread over Dick's face.

"Well, I'm certainly glad about that," he exclaimed. "I was getting fed up to the teeth with this polite-ness racket. It just seemed to be too good to be true! There's still one thing that's puzzling me, though."

"What's that?"

"Why *did* the pick-up skate around all over the record when I selected the 78 stylus?"

"Oh *that*?" exclaimed Smithy. "You'll probably find that there isn't a stylus fitted on the 78 side of the cartridge at all. What sometimes happens is that the owners of record players don't bother to get a new stylus when the l.p. one wears out. They simply whip the one off the 78 side and fit that in its place!"

"But that's all wrong, isn't it?"

"Of course it is," replied Smithy. "But we can now put it right by fitting a new l.p. stylus and, preferably, a new 78 one as well. After which, we'll give the record player a final check-out and call it a day."

"Fine," said Dick enthusiastically. "Now we've got over this resolution business, it looks as though the New Year isn't going to be so bad after all. Do you know what I think, Smithy?"

"What do you think?"

"I think you're a pompous old goat!"

"That's nothing to my opinion of you," replied Smithy. "I consider you to be an incompetent young ninny!"

Dick heaved a sigh of immense satisfaction.

"Thank goodness," he pronounced contentedly. "We're back to normal!"

## Computer's Capacity Doubled

A further stage in the development of the EMIac II analogue computer doubles the capacity of each module.

A dual chopper stabilised d.c. amplifier enables the computing capacity of the standard module to be increased from 18 to 36 computing units. This dual unit has two separate chopper stabilised amplifiers each having a larger gain than the standard single amplifier. The gain of the main amplifier section has been maintained at 10<sup>4</sup> to 1k.

In addition, a quarter squares multiplier C box employing 12 break points and having a nominal 0.1% accuracy has been introduced.

These units are completely interchangeable with the standard range of EMIac II units and may be used side by side with them to suit the problem in hand. By this means, existing customers may enlarge their computing capacity without the necessity of purchasing a new module.

Since the inception of these new units the overall price of a 36 amplifier installation has been considerably reduced.



# Cathode Ray Tube Power Supply Unit

By H. N. RUTT

**M**OST OF THE MORE USUAL CIRCUITS FOR CATHODE ray tubes in oscilloscopes require two power supplies—one at high voltage and low current, and negative with respect to chassis; and the other at normal h.t. voltage and current, positive with respect to chassis and capable of supplying the timebase and the Y amplifier, etc. The unit described here meets both these requirements, and is suitable for running most small oscilloscope tubes.

The unit is built around an ordinary 350-0-350 volt transformer, of the type readily available from advertisers in this magazine. The silicon rectifiers (most types having a high enough peak inverse voltage rating are suitable, e.g. 2 x BY100) are also easily obtainable. The e.h.t. rectifier, type 36EHT45 is not often seen in advertisements, but is also easily obtainable.\*

## The Circuit

The circuit, shown in Fig. 1, is simple and requires little explanation. One end of the 350-0-350 volt secondary winding is earthed (preferably the end of the winding nearer the core) and the 350 volts developed at the centre-tap is half-wave rectified to provide the positive h.t. supply. 700 volts is developed across the entire winding, and this is half-wave rectified to supply the negative e.h.t. If the oscilloscope circuit requires positive e.h.t., the connections to the 36EHT45 must be reversed. The transformer should be, preferably, a sound new component, and not a salvaged or surplus type.

The e.h.t. developed is about -800 volts (depending on the load) with a maximum current rating of 2mA. The h.t. is slightly in excess of +350 volts, the current rating depending on the transformer and choke, since the silicon rectifiers will stand a very high forward current. The surge limiter, R<sub>1</sub>, should not be omitted from the circuit, or the rectifiers or reservoir capacitor may be damaged by the charging current surge when the unit is switched on.

\* The 36EHT45 is available from Home Radio (Mitcham) Ltd. —EDITOR.

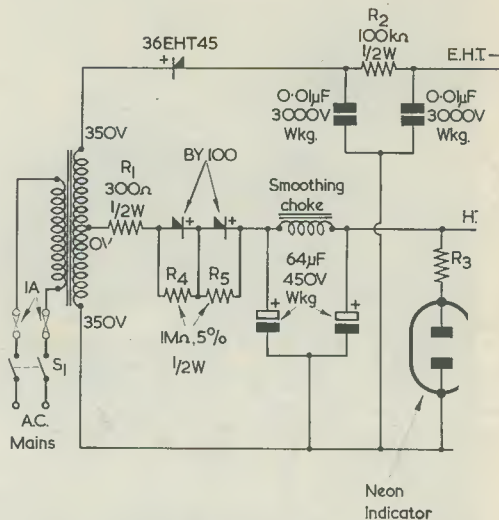


Fig. 1. The cathode ray tube power pack. Rectifiers suitable for the h.t. system are 2 x BY100, 3 x 15103, or 3 x XU604. A 1MΩ 5% resistor must be connected across each of the h.t. rectifiers to ensure even distribution of the inverse voltage. The value of R<sub>3</sub> is chosen to suit the neon indicator

## Bleeder Chain

A suitable bleeder chain for such tubes as the ACR13, VCR97, VCR138 and VCR138A is suggested in Fig. 2. The values are not critical, and

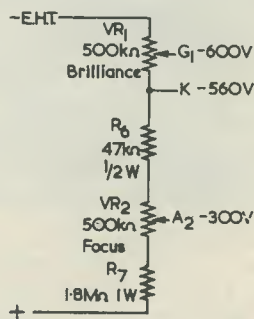


Fig. 2. A suggested bleeder chain. A<sub>1</sub>, A<sub>3</sub> and the internal conductive coating may be strapped and held at +190 volts

various values of resistance for R<sub>6</sub> and R<sub>7</sub> may be tried to give the best results for the particular tube used. All the tubes mentioned have a 4 volt 1 amp heater, and this should be supplied from a separate heater transformer because, in most circuits using these tubes, the heater is strapped to the cathode and so is at a high potential. Using a 4 volt winding on the transformer supplying the e.h.t. might well cause the insulation to break down, as voltages in excess of 1,500 could easily appear between the e.h.t. winding and the heater winding.

Cover Feature

# The "Transivox"

## Monophonic Organ

By A. T. HAWKINS

*An ingeniously designed monophonic electric organ which ranges over the two octaves above Middle C. Despite its simplicity, the design features several output tones, a frequency-varying tremulant with controllable speed, and an electronic delayed attack circuit for avoiding key clicks. The keyboard can be extended below Middle C, if this is desired, and additional percussive and gong effects may be readily incorporated*



ALTHOUGH MANY PEOPLE HAVE AN AMBITION TO build a full-scale polyphonic type of electronic organ, perhaps on the same lines as the one described in *The Radio Constructor* some time ago,<sup>1</sup> a deterrent would be the thought of having to provide the large number of components required, not to mention the great deal of precious leisure time that would be consumed before such a project can be completed. However, as a compromise, a simple monophonic (single-note) instrument is relatively easy to build and is certainly less costly. Nevertheless, it is capable of giving a great deal of pleasure and entertainment, especially when used with a piano or organ accompaniment, and even an inexperienced player can soon learn to play it to advantage! The organ to be described can always be extended further down the scale going as far as two or three octaves below middle C, either during construction or at a later date. If desired, percussive and gong effects can be obtained by an additional switching circuit.

### Circuit Description

In looking at the circuit shown in Fig. 1, it will be seen that, when a key is depressed, a bias voltage is fed to the base of one of a pair of transistors,

TR<sub>3</sub>, connected as a multivibrator, whereupon it is caused to oscillate as a square wave generator. The signal is then passed to the base of the "buffer" or gating transistor, TR<sub>5</sub>. But this buffer stage is inoperative until it receives a voltage supply from the key contacts, after which it amplifies and passes the signal via a coupling capacitor (C<sub>8</sub>) to the load given by potentiometer RV<sub>1</sub>. The signal is then fed to the main amplifier before driving a loudspeaker.

The reason for this buffer stage is to minimise the effect of "contact-click", a great disadvantage in home-built organs; the click being caused by the sudden stopping and starting transients whenever switching is employed. As it is very important to understand the system by which the buffer stage works, it will be discussed in greater detail.

Every key has a small piece of beryllium-copper or phosphor-bronze strip affixed to it and is so arranged that at the first quarter of the travel of the key, when being depressed, two of the three contact wires, (a) and (b), are shorted together. The result is that a note is generated, together with the "contact-click", by the multivibrator section. Further depression of the key to about three-quarters of its travel causes the shorting-strip to make contact with the third wire, (c), thus bringing the buffer transistor into action by completing its supply circuit. There is therefore a mechanical

<sup>1</sup>S. Astley, "A Transistorised Electronic Organ", *The Radio Constructor*, August, September, October, November, 1962. Also, "Further Notes", February 1963.



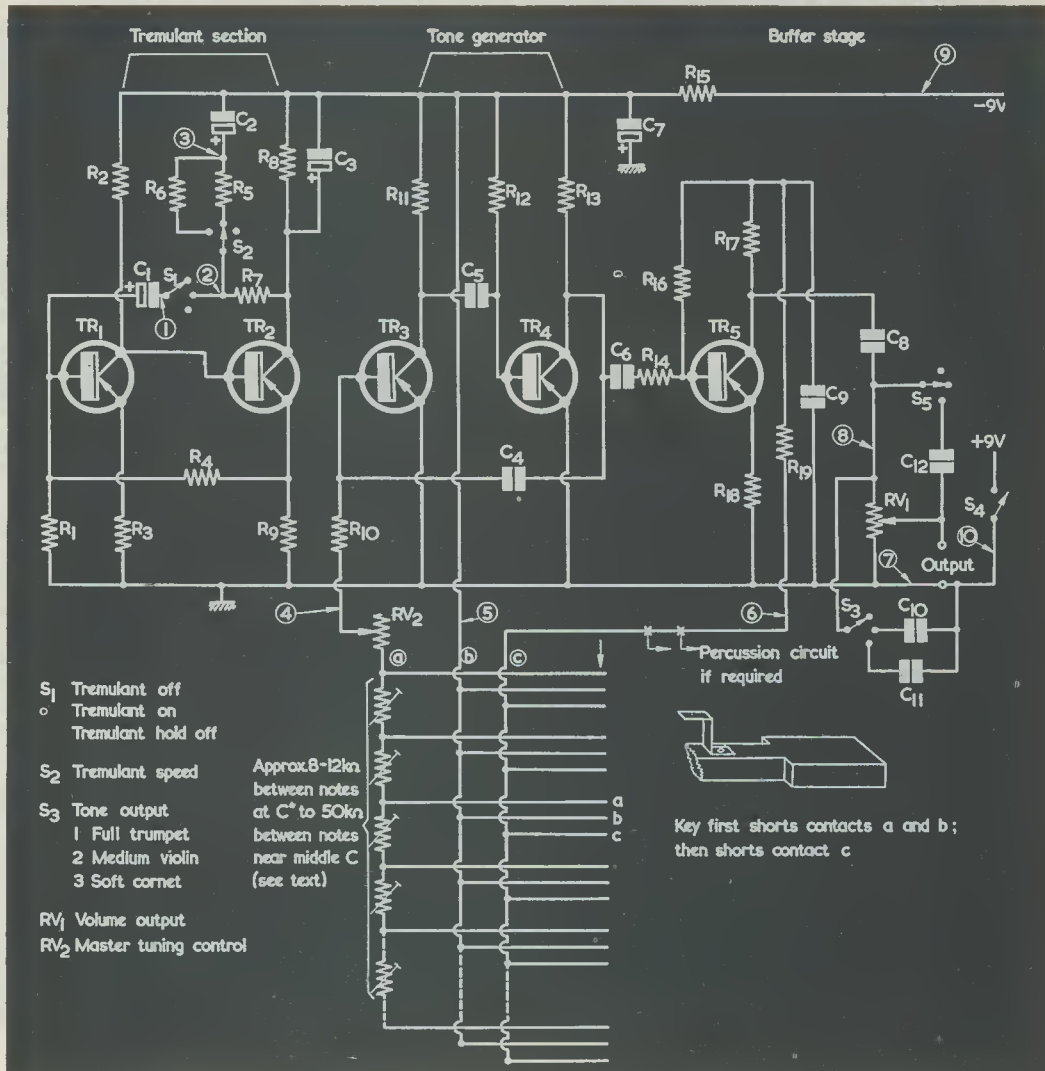


Fig. 1. The circuit of the "Transivox" Monophonic Organ. There are 25 keys, ranging from Middle C to the C two octaves above. The functions of the tremulant speed control are indicated in Fig. 2

delay, together with a small electrical delay introduced by R<sub>19</sub> and the reservoir capacitor C<sub>9</sub>. These reduce the "contact-click" to negligible proportions.

The object of C<sub>9</sub> is to "round off" the stopping and starting, i.e. attack and decay, of the generated note by taking a time (in milli-seconds) to charge up and discharge through the buffer transistor. Increasing the value of the capacitor would of course slow down the "attack" of the note, but the decay time would take longer also and, as the key travels quickly back to rest when released, the "counter-click" would be audible before the note has had time to die away.

A compromise has to be made so that the attack is not so fast as to give a "morse-key" effect, whilst the decay is still quick enough for the click to be

inaudible when the key travels from full depression with all three contact wires shorted to the point of a quarter depression where only two wires are in contact. The value of capacitance found to be satisfactory with the prototype keyboard was 0.5μF. However, some keyboards may have faster or slower acting keys, and a modification of the value for C<sub>9</sub> may be needed for best results. It must be pointed out that as transistors are three-point resistive devices and have a slight leakage, the buffer stage transistor will pass a very small signal with no supply voltage across it, so that an "echo" is heard if the key is not fully depressed. This "echo" effect has been reduced by choosing a large value of resistance for R<sub>16</sub> and by inserting the series resistor R<sub>14</sub>, and under normal playing it is difficult to detect.

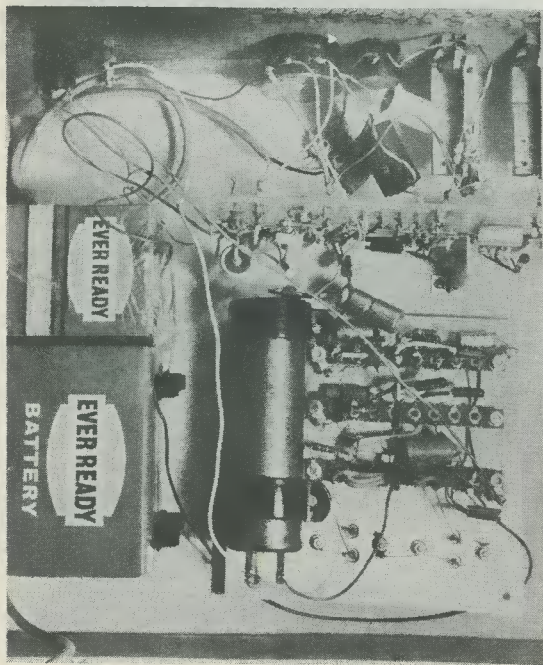
### Tremulant Section

The tremulant section has two transistors (TR<sub>1</sub> and TR<sub>2</sub>) connected in a modified form of Wien bridge circuit, producing a sinusoidal waveform of low frequency. The low frequency generated causes a varying current drain from the battery supply which, in turn, produces a voltage drop across the dropper resistor R<sub>15</sub>. This low frequency voltage fluctuation causes the pitch to alter in sympathy, giving a true tremulant which is very pleasing to the ear. (In a guitar tremulant amplifier only the volume is made to fluctuate, and this kind of sound is immediately recognised and is no doubt familiar to most readers).

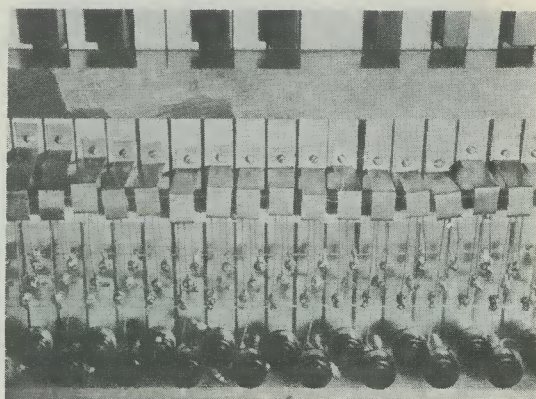
The circuit is so arranged that the current drain from the battery (under 2mA) is constant whether the tremulant is on or off, or is fast or slow, so that as far as possible a constant voltage is maintained under running conditions.

It should be mentioned that this instrument will produce only one note at a time. If several keys are depressed together, only the highest note will sound.

The pitch of the note selected by each key depends on the resistance inserted between the base of TR<sub>3</sub> and the negative supply line. This resistance



A view underneath the keyboard. The components at the top, from left to right, are the main switch, the output sockets, RV<sub>1</sub>, RV<sub>2</sub> and two of the P.O. switches. The upper 9 volt battery supplies the organ circuits whilst the lower battery (two 4.5 volt units in series) supplies a power amplifier, the components for which are mounted on the flat square sheet with the large electrolytic capacitor. On the upright Perspex board above the amplifier are the organ circuit components, TR<sub>5</sub> being at the left



The key switching components. This photograph shows some of the shorting strips, together with the sets of contact wires. The preset variable resistors appear at the bottom

increases for each key in descending order of pitch. For a 2-octave keyboard (Middle C to the C two octaves above) 24 resistors are needed between the keys, in addition to the resistance inserted by R<sub>10</sub> and the master tuning control, RV<sub>2</sub>. In practice, each of the inter-key resistors is made up of a fixed resistor in series with a miniature preset potentiometer, the value of the fixed resistor being such as to allow the preset potentiometer to offer the correct pitch at about the centre of its track. In the prototype, 8 preset resistors having a value of 10k $\Omega$  were employed at the upper end of the keyboard, 8 preset resistors with a value of 22k $\Omega$  at the middle of the keyboard, and 8 preset resistors with values ranging from 47k $\Omega$  to 100k $\Omega$  at the lower end of the keyboard.<sup>2</sup> Fig. 6 shows the approximate resistance needed between keys in the prototype.

The keyboard may be extended below Middle C by continuing the key switching and inserting further series resistance between each key.

The prototype employs OC44's for TR<sub>1</sub> and TR<sub>2</sub>, OC71's for TR<sub>3</sub> and TR<sub>4</sub>, and an OC76 for TR<sub>5</sub>. However, the experimental work was carried out with "red-spot" types, and it is possible that such transistors could be successfully employed in the completed organ, if desired. Also, OC71's could be used, and there appears to be plenty of latitude. A low-leakage OC202 was tried in the TR<sub>5</sub> position in an attempt at alleviating the "echo" effect, but as this gave no advantage it was not considered worthwhile incorporating this transistor instead of a less costly type.

### The Main Amplifier

The main amplifier need not be fully discussed

<sup>2</sup> The preset variable resistors employed by the author between the keys were miniature Plessey types. Miniature preset carbon potentiometers are available from many component suppliers at low cost, this being especially true when manufacturers' surplus lines are offered. The preset variable resistors need not have exactly the same values as those used in the prototype, provided the final resistance value between keys may be obtained with sufficiently fine adjustment. —EDITOR.



as it will depend on individual choice and requirements as to output power. The output of the organ on its own is sufficient to drive a pair of headphones—one can practice in complete privacy if desired! A useful way of making the instrument completely independent of mains power supply is to incorporate a transistor main amplifier. A suitable amplifier is the 10 watt 24 volt transistorised power amplifier obtainable as a kit or ready-built from Henry's Radio, Ltd. The writer has found that an amplifier of this type gives adequate power for a small hall if driven by 9 volts only. Two 4.5 volt bell batteries in series will suffice here.

### Construction

The construction of the "Transivox" may begin by building the "heart" of the instrument—that is, the combined tone generator, tremulant and buffer stage—on a single piece of Perspex or other suitable material. The layout and outside dimensions are shown in Fig. 2. A number of 8BA clearance holes are drilled, and by mounting 8BA double-ended solder tags with short 8BA screws and nuts, the components can be soldered into position on the prepared board. Note that the tag numbers in Fig. 2 correspond with those shown in Fig. 1.

The board can then be checked for working by connecting tags 7 and 8 to a pair of headphones

or an external amplifier, and by shortening tags 4, 5 and 6 together. A tone should be heard when a 9 volt battery is connected across tags 9 and 10, after making sure that the wiring is of course correct, and that the battery is right way round!

Shorting tags 1 and 2 will cause the tremulant to operate, and it will function at its slowest frequency. It will be speeded up at a later stage by the addition of a resistor across tags 2 and 3, and this is done by the control panel components.

### The Keyboard

Having checked that the generator board is satisfactory, the next major item is the keyboard itself. Either a practice board with keys covering two octaves could be pressed into service if one can be acquired from a second-hand music dealer, or a keyboard will have to be constructed out of piano keys and a cabinet made to accommodate them. Some piano keys may have the pivoting in the middle of their length, whilst others may have the pivoting at the extreme end. Whichever system is used, Fig. 3 shows how the short-circuiting strip is mounted.

One very important item of advice is concerned with the contacts and tuning variable resistors. Arrange these so that they are readily accessible when the organ is complete, in order that tuning

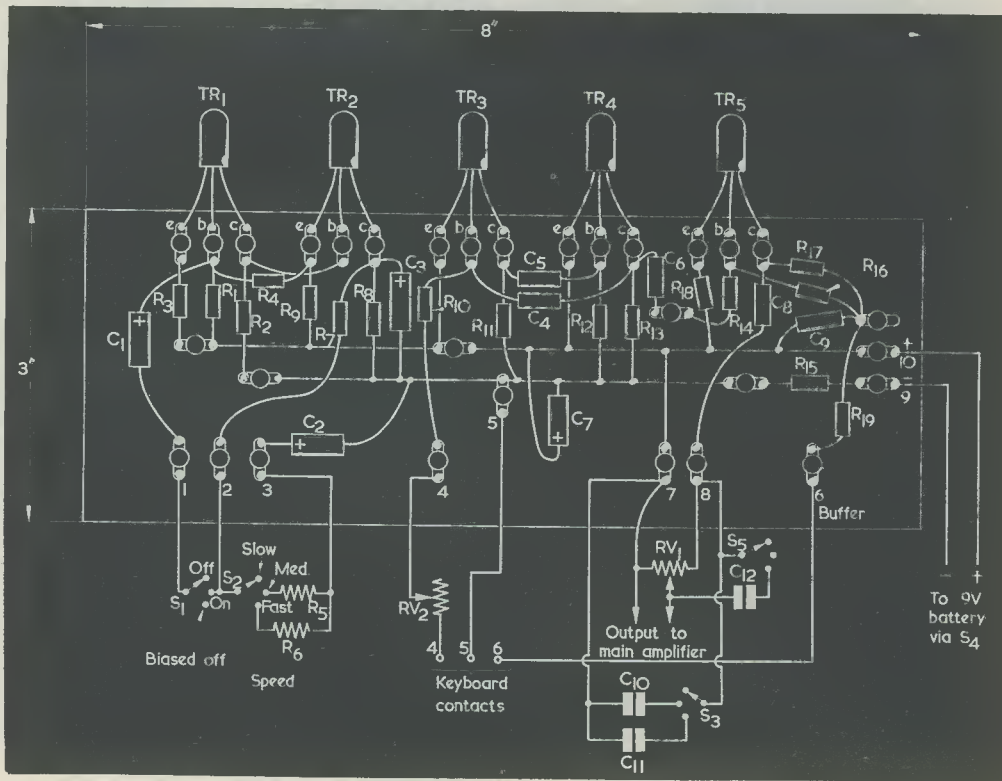


Fig. 2. Layout and outside dimensions of the Perspex board on which are mounted the tremulant section, tone generator and buffer stage components. The board thickness should be at least  $\frac{1}{8}$  in. The tag numbers correspond to those shown in Fig. 1. Components shown below the board are mounted on the control panel

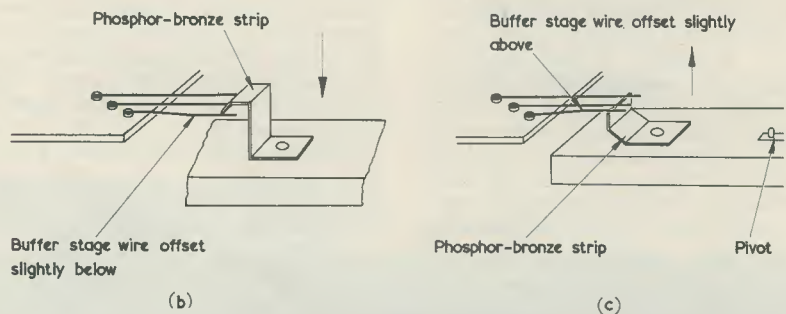
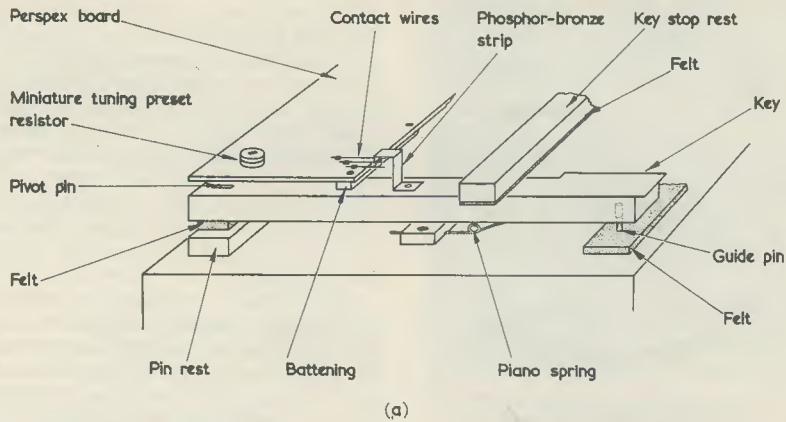


Fig. 3 (a). End view of the keyboard, showing the contacts and variable series resistor for the end key. These are mounted on a Perspex board  
 (b). Detail of contact arrangements when the shorting strip travels downwards. The wire for the buffer stage is contacted after the other two wires, as explained in the text  
 (c). An alternative arrangement, for use when the shorting strip travels upwards

and adjustments can easily be made. It may appear rather expensive to provide a variable resistor for every note, but the reader may rest assured that this is a very worthwhile expenditure, since tuning will take only a matter of minutes at any time that it is required. During extremes of tem-

peratures, some slight retuning may have to be carried out, although the master tuning control on the front panel (RV<sub>2</sub>) will take care of most cases of slight shift of pitch.

The control panel accommodates four Post Office type key-switches, which are ideal for the job: two for tremulant control, one for tone, and one which modifies the output "colouring". This last switch (S<sub>5</sub>) was originally incorporated as a

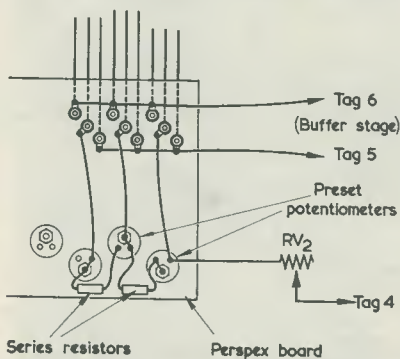


Fig. 4. Underside view of the Perspex panel of Fig. 3 (a) showing the layout of the contact wire tags, series resistors and preset potentiometers. The dimensions of the Perspex panel depend on the size of the keyboard employed

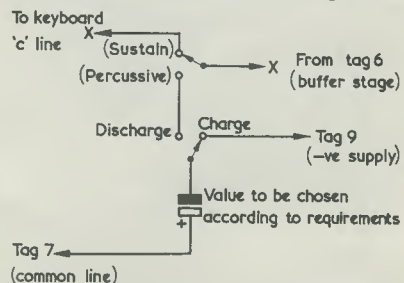


Fig. 5. An additional circuit which allows percussive and gong effects to be given. When the upper switch is set to "Sustain" the organ functions normally. When set to "Percussive" the additional capacitor circuit is brought into operation

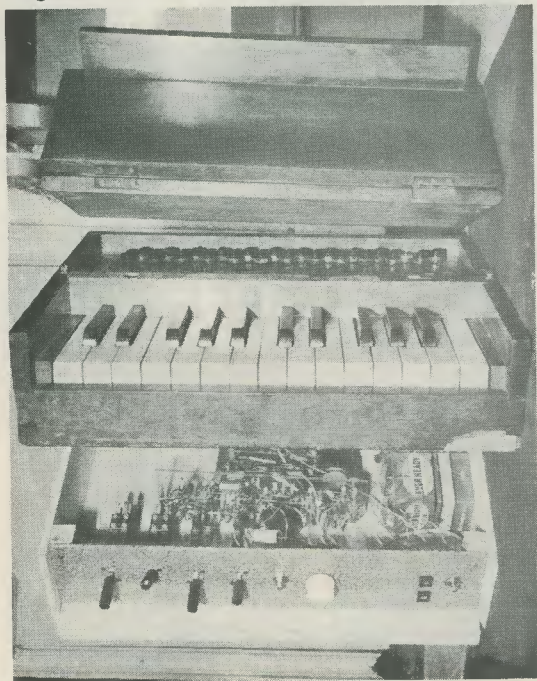


spare, but it is now used to bring  $C_{12}$  into circuit as shown in Fig. 1. When the output control is about half-way advanced,  $S_5$  mellows the effect given by  $S_3$ . Also mounted on the panel are two variable resistors each of  $25k\Omega$ , one being the master tuning and the other the volume control; two output sockets, one supplying an output to a loudspeaker if a power amplifier is incorporated in the organ whilst the other carries the output from the buffer stage, and a main battery switch.

The key-switch employed in the  $S_1$  position turns on the tremulant section in its central position. It is mechanically biased, however, so that the key can spring back from the downward to the central position when released, this facility enabling the tremulant to be momentarily stopped at will during playing. There is no mechanical bias on the other key-switches.

A Perspex sheet, strengthened if necessary by thin wooden battening, is employed for the series resistors and the key contact wires. This is drilled with the holes for the 8BA cheese-head screws and nuts, these being so arranged that, when the contact wires are soldered into position, they will be directly over each key. See Figs. 3 and 4. Before mounting the screws, it would be best to clean and tin each cheese-head surface, as this will considerably ease the job of soldering the contact wires.

The contact wires are cut from a reel of 20 s.w.g. tinned copper wire, making certain that it



The general construction of the author's prototype. The lid is hinged at the centre to enable the keyboard to be neatly covered when the instrument is not in use

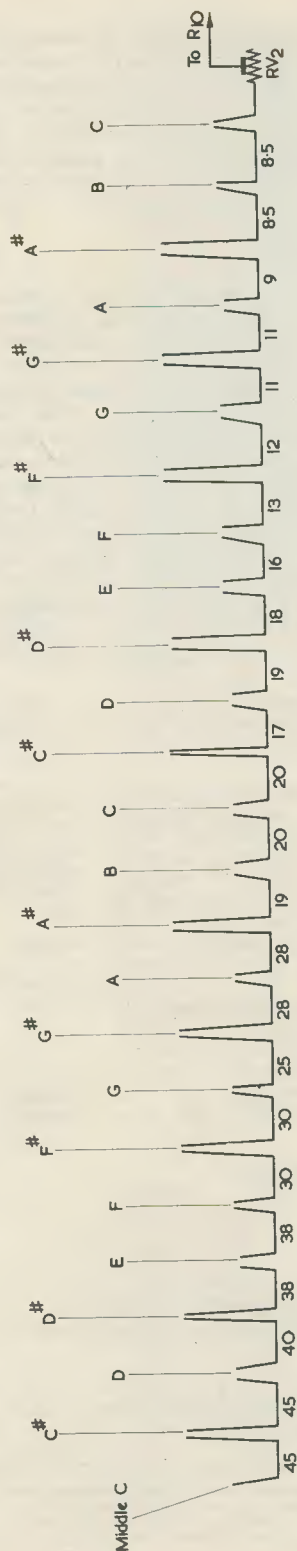


Fig. 6. As a guide to the resistance required between keys, this diagram illustrates the approximate resistances (as measured by an ohmmeter) which appear in the author's prototype. Each value is in  $k\Omega$  and is given by the fixed resistor in series with the preset resistor after adjustment

is bright and clean. A more professional job could be made with gold-plated wires if this material is to hand, but the tinned copper is quite satisfactory for normal purposes as the mechanism has a wiping action and is hence self-cleaning. Should any trouble be experienced due to slight oxidizing, a small drop of "Electrolube" will cure this and one treatment will last for many months.<sup>3</sup>

### Tuning The Organ

With the organ connected up, the resistor  $R_{10}$  may have to be selected so that the top note of C (two octaves above middle C) will agree with that of a piano when  $RV_2$  is set to about mid-position. The rest of the keys are tuned by descending down the scale one note at a time and by inserting fixed resistors in series with the adjustable resistors set at mid-point and soldering into position. The tuning need not be exact at this stage as the variable resistors will be finally adjusted after the contact wires have been set up. These are carefully arranged so that the first quarter of key travel will start the note (which can be heard as a faint "echo" with the volume turned right up), and the full note (mind your ears!) when the key has reached three-quarter travel. Bending the contact wires carefully

with a pair of tweezers will be the best way of adjusting the organ.

The speed of the tremulant can be altered by choosing alternative values for  $R_5$  and  $R_6$ , and also by changing the value of the capacitors  $C_1$  and  $C_3$ , these being a pair having equal values. Reducing the value of capacitance will raise the speed of the tremulant and increasing the value will have the opposite effect.

If percussive effects are desired, they can be achieved by inserting the circuit shown in Fig. 5 in the lead from tag 6. The capacitor in Fig. 5 is charged by connecting it across the battery supply and is then discharged to tag 6 whilst a key is held down. Gong-like effects will be heard, the length of duration depending on the value of the capacitor. Capacitances from, say,  $0.1\mu\text{F}$  to  $100\mu\text{F}$  will give results ranging from a short "bong" to a very sustained and slowly dying-away tone lasting for half a minute or so, therefore the tone is very wide indeed!

<sup>3</sup> Gold-clad wire (0.016in diameter) and phosphor-bronze strip ( $\frac{7}{16}$ in x 22 s.w.g.) for the shorting strips are available from Stern-Clyne Ltd., 3-4 Eden Grove, Holloway, London, N.7. It may be difficult to obtain beryllium-copper strip through the usual retail channels, but the phosphor-bronze offers a suitable alternative. Phosphor-bronze strip is also available from H. Rollet & Co., Ltd., 6 Chesham Place, London, S.W.1.—EDITOR.

## Components List

### Resistors

(All fixed resistors  $\frac{1}{4}$  watt 10%)

|            |                                                  |
|------------|--------------------------------------------------|
| $R_1$      | 2.2k $\Omega$                                    |
| $R_2$      | 22k $\Omega$                                     |
| $R_3$      | 470 $\Omega$                                     |
| $R_4$      | 3.3k $\Omega$                                    |
| * $R_5$    | 10k $\Omega$                                     |
| * $R_6$    | 4.7k $\Omega$                                    |
| $R_7$      | 1k $\Omega$                                      |
| $R_8$      | 4.7k $\Omega$                                    |
| $R_9$      | 1.2k $\Omega$                                    |
| † $R_{10}$ | 56k $\Omega$                                     |
| $R_{11}$   | 4.7k $\Omega$                                    |
| $R_{12}$   | 68k $\Omega$                                     |
| $R_{13}$   | 4.7k $\Omega$                                    |
| $R_{14}$   | 22k $\Omega$                                     |
| $R_{15}$   | 2.7k $\Omega$                                    |
| $R_{16}$   | 470k $\Omega$                                    |
| $R_{17}$   | 10k $\Omega$                                     |
| $R_{18}$   | 3.3k $\Omega$                                    |
| $R_{19}$   | 18k $\Omega$                                     |
| $RV_1$     | 25k $\Omega$ potentiometer, log track            |
| $RV_2$     | 25k $\Omega$ potentiometer, preset, linear track |

### Tuning Resistors (see text)

- 24 miniature carbon potentiometers
- 24 fixed resistors  $\frac{1}{4}$  watt

### Capacitors

|             |                                        |
|-------------|----------------------------------------|
| $C_1$       | 8 $\mu\text{F}$ electrolytic 12V wkg.  |
| $C_2$       | 25 $\mu\text{F}$ electrolytic 12V wkg. |
| $C_3$       | 8 $\mu\text{F}$ electrolytic 12V wkg.  |
| $C_{4,5,6}$ | 0.01 $\mu\text{F}$                     |
| $C_7$       | 10 $\mu\text{F}$ electrolytic 12V wkg. |
| $C_8$       | 0.02 $\mu\text{F}$                     |
| ‡ $C_9$     | 0.5 $\mu\text{F}$                      |
| $C_{10}$    | 0.1 $\mu\text{F}$                      |
| § $C_{11}$  | 1 $\mu\text{F}$                        |
| $C_{12}$    | 0.1 $\mu\text{F}$                      |

### Transistors

See text for suitable types

### Switches

|           |                                       |
|-----------|---------------------------------------|
| $S_1$     | P.O. key-switch 3-position (see text) |
| $S_{2,3}$ | P.O. key-switch 3-position            |
| $S_4$     | s.p.s.t. on-off switch                |
| $S_5$     | P.O. key-switch 3-position            |

### Miscellaneous

- Keyboard
- Perspex sheets
- Phosphor-bronze material for shorting strips (see text)
- Double-ended and single-ended 8BA solder tags
- Short 8BA cheese-head screws
- 8BA nuts
- 9-volt battery
- 20 s.w.g. tinned copper wire (or gold-plated—see text)

\* Value may need adjustment for required tremulant speed.

† Value may need adjustment for tuning top note.

‡ Value may require adjustment with some keyboards.

§ If electrolytic type is used, connect positive terminal to  $S_3$ .



# A "Flashing Man"

By M. FARNSWORTH

The body of this all-electronic "flashing man" is made up from the components which cause him to operate

TO AMUSE THE CHILDREN THE "Flashing Man" described here was made up from components found mainly in the oddments box. It is so constructed that, when raised, the eyes flash alternately. What will be more appreciated by the engineer is the fact that all components used in the circuit go to make up the man.

## Circuit

As will be readily seen from the circuit in Fig. 1, a symmetrical multivibrator is used. For those not familiar with the circuit this operates in the following manner. Assume transistor  $TR_1$  is conducting and, hence, lamp  $B_1$  is lit. Transistor  $TR_2$  will be cut off with a positive bias on its base, which will leak away via  $R_1$  and  $R_2$ . When the base of  $TR_2$  starts to go negative,  $TR_2$  will switch on and lamp  $B_2$  will light. The collector of  $TR_2$  will go positive and this change will be communicated to  $TR_1$  base via  $C_2$ , cutting off  $TR_1$  and extinguishing  $B_1$ . The positive bias on the base of  $TR_1$  will leak away via  $R_3$  and  $R_4$  and, when it goes negative,  $TR_1$  will

switch on, re-lighting lamp  $B_1$ . The positive change on  $TR_1$  collector is passed via  $C_1$  to cut off  $TR_2$  and extinguish  $B_2$ . The cycle then repeats.

The time that  $TR_2$  is off is given approximately by:  $t = 0.7 C_1 (R_1 + R_2)$ .

With the values as shown,  

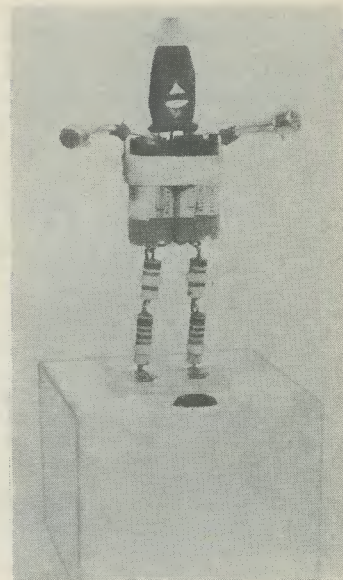
$$t = \frac{0.7 \times 200 \times 2020}{10^6} = 0.28 \text{ sec.}$$

The lamps flash alternately and each will stay on, therefore, for approximately a quarter of a second.

When  $TR_2$  is on, the current out of the base must be sufficient to allow, by transistor action, at least 150mA in the collector. With the sum of resistance in  $R_1$  and  $R_2$  being 2,020 $\Omega$ , the base current will be approximately  $\frac{6V}{2020} = 3\text{mA}$ . Assuming a gain of 50 for the ACY18, the collector will then pass  $50 \times 3 = 150\text{mA}$ .

## Assembly

When assembling, the negative ends of the capacitors are soldered



The completed all-electronic "flashing man". The head is made from a crocodile clip rubber cover surmounted by a plastic grommet. A microswitch is fitted in the base, and switches the circuit on when this is lifted

to the lamp tips, and the lamp bodies strapped together. The 1.8k $\Omega$  and 220 $\Omega$  resistors are soldered to the lower ends of the capacitors to form the legs. See Fig. 2. Before wiring in the transistors, extend the base and emitter leads and insulate all wires with sleeving. Connect up as shown in Fig. 2. Attach a wire to the junction of the emitters and another to the junction of the lamps. These two wires are then run down the back of the "man" between the capacitors, after which they separate, one wire going down the back of each leg. Small rubber bands

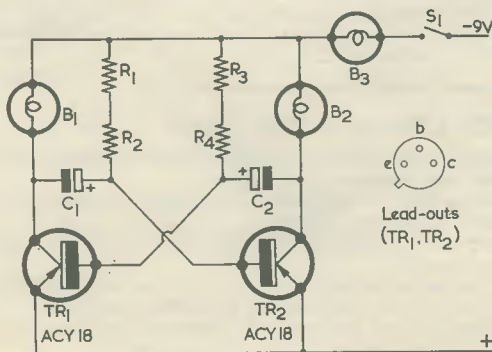


Fig. 1. The circuit of the "flashing man"

## Components List

### Resistors

(Employ resistors which offer best presentation)

$R_{1,3}$  220 $\Omega$

$R_{2,4}$  1.8k $\Omega$

### Capacitors

$C_{1,2}$  200 $\mu\text{F}$  electrolytic 12V wkg.

### Transistors

$TR_{1,2}$  ACY18

### Lamps

$B_{1,2}$  6.5V, 150mA, m.e.s.

$B_3$  2.5V (see text)

### Switch

$S_1$  s.p.s.t. microswitch (see text)

### Battery

9 volt battery type PP9 (Ever Ready)

secure the wires to the legs. Solder tags or bent wires are then soldered to the lower ends of  $R_1$  and  $R_3$  to act as feet, and these help to stabilise the "man" when the lead-out wires of  $R_1$  and  $R_3$  are passed through into the box. The latter houses a PP9 9-volt battery. The wire from the emitter junction is passed through into the box and connected to the positive terminal of the battery. The ends of  $R_1$  and  $R_3$ , and the common wire from the lamps, are all soldered together and taken to the negative terminal of the battery via a 2.5 volt bulb and a switch. A 2.5 volt bulb was included to drop the 9 volts to a reasonable voltage to feed the multivibrator lamps.\* The author used a micro-switch in the base of the box such that the eyes flashed when the "man" was lifted up.

To make the head, the bulbs were covered with a rubber crocodile clip insulator having holes cut in appropriate positions for the eyes, the

\* A normal 2.5 volt flash-lamp bulb will drop slightly less voltage than is required to keep  $B_1$  and  $B_2$  at correct operating voltage, although little difficulty should result in practice from slight over-running of these lamps. If desired, the circuit could be started initially with a 3.5 volt lamp in the  $B_3$  position, reverting to a 2.5 volt lamp if greater brightness in  $B_1$  and  $B_2$  is required.  
—EDITOR.

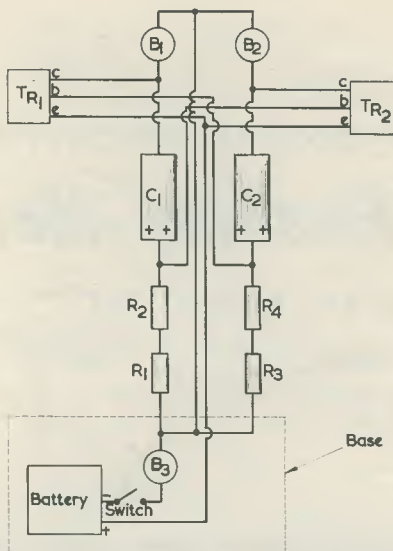


Fig. 2. How the body of the "man" is assembled. Check all connections against the circuit of Fig. 1 before applying the battery

insulator being capped with a plastic grommet. A strip of insulation tape was put around the upper part of the body to hold the wires from the transistors securely. After a trial, some red Cellophane was placed between the bulbs and insulator, and

this gave the eyes a much fiercer appearance.

The author has described the model as it was made, but no doubt the constructor will be able to improve on it, and adopt the circuit for other uses.

## INTERNATIONAL CONFERENCE ON THE MICROWAVE BEHAVIOUR OF FERRIMAGNETICS AND PLASMAS

A five-day international conference on the microwave behaviour of ferrimagnetics and plasmas will be held at the I.E.E., London, from 13th to 17th September, 1965.

The meeting will cover:

Electromagnetic wave propagation in ferrimagnetics and plasmas and in structures containing these media. Microwave devices employing ferrimagnetics and plasmas. Measurement of ferrimagnetic and plasma properties. Nonlinear phenomena in ferrimagnetics and plasmas. Antiferrimagnetic phenomena and applications. Behaviour of thin ferrimagnetic films. Electron-beam interactions with ferrimagnetics and plasmas. Microwave studies of solid-state plasmas. Electro-magnetic-acoustic phenomena in ferrimagnetics and plasmas.

The Organising Committee invite the submission of contributions of not more than 2,000 words for inclusion in the programme. Prospective authors are asked to notify their intention to offer contributions to the Secretary of the I.E.E. as soon as possible; synopses of not more than 500 words should be submitted by 1st March, 1965, and full texts by 1st June, 1965.

The conference is jointly sponsored by the I.E.E. Electronics Division, the Institute of Physics and the Physical Society, the Institute of Electrical and Electronics Engineers, and the Institution of Electronic and Radio Engineers.

Registration forms will be available about six weeks before the conference. Applications should be made to the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

## BRENELL ENGINEERING CO. LTD. IN A NEW HOME

Brenell have now completed their move to a new factory and offices at 231-235 Liverpool Road, N.1, with very little interruption in the production of their famous quality tape recorders and decks.

The new factory has a floor area of 15,000 sq. ft. on three floors and includes a very well equipped demonstration room on the first floor to which tape recording enthusiasts are cordially invited.

The machine and press shop, the stores, the wiring shop and the test and inspection departments are on the ground floor with a very useful loading bay at the rear and off the road.

On the second floor is the assembly shop where mechanical assembly is carried out under ideal conditions; these two floors are interconnected by an automatic goods lift. Completed mechanical assemblies and wired chassis come together on the ground floor, are put into cabinets and then go into the test and inspection departments for a very thorough check on electrical and mechanical performance.

It is hoped that this move will enable Brenell to meet the ever increasing demands for their machines whilst maintaining their reputation for first-class performance and reliability.



# Variable Spooling *for the* Collaro Tape Deck

By J. HOWELL



An ingenious method of obtaining variable spooling on the "Studio" tape deck. The basic idea may be applicable, also, to other decks employing three motors

## Introductory Note

This article describes a simple means of achieving variable spooling with the popular Collaro "Studio" tape deck. It should be pointed out that the particular modification described by the author applies to earlier production units (up to mid-1963) of this deck. The changes needed for later production are covered in the Editor's Note following the article. The modifications described should only be attempted by the more experienced constructor who fully understands the principles involved.—EDITOR.

**A**N INTERESTING AND USEFUL MODIFICATION TO A tape recorder is the provision of continuously variable fast wind in either direction using only one control knob. Many professional and semi-professional tape decks are fitted with this facility, and it greatly assists in place finding and editing, especially when the programme on the tape can be monitored whilst spooling. Although this article is primarily intended for users of the Collaro "Studio" tape deck, there is no reason why the idea

could not be applied to any machine using three motors (capstan and two spool motors), provided that the switch contacts are available as described later.

## Spooling Control

The spooling control is provided by a potentiometer which should, preferably, be mounted on the deck itself in the vacant left-hand position. Alternatively, it may be mounted anywhere in the tape recorder where there is room and where extra heat will not affect the rest of the components.

The original deck wiring diagram is shown in Fig. 1. When the "Start" key is depressed, current is supplied to the capstan motor and to the two series connected spool motors. A resistor of some 2.5k $\Omega$  is connected across the windings of the left-hand spool motor to reduce the back tension on the tape. When either of the "Fast Wind" buttons is pressed, full mains voltage is applied to the appropriate spool unit. It will be noted that when fast winding to the right, the capstan motor is allowed to run; this merely simplifies the switching arrangements.

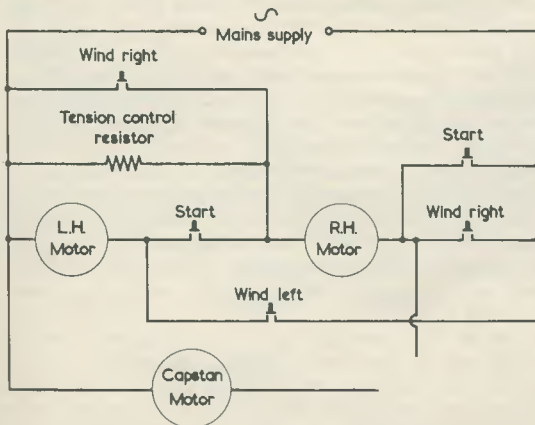


Fig. 1. The original circuit of the tape deck modified by the author. Switch contacts are closed to provide the function indicated

## The Modified Circuit

There are two possible methods of wiring the variable spooling control. The first and most obvious is that shown in Fig. 2 (a). In this diagram, the position of the slider on the potentiometer governs which of the two motors receives the greater voltage from the mains. It can be seen from Fig. 2 (b) that when one motor is running on full power, the other still has a voltage on it due to the series resistance, R. As a result there will be a reduction of the available winding speed, because the deck motors are not intended to work against each other.

Fig. 3 shows the circuit finally selected. The ends of the potentiometer are connected to the supply and the slider is taken to the junction between the two motors, which are connected in series. Thus as the contact is rotated, one motor receives more and more power while the other is progressively short-circuited.

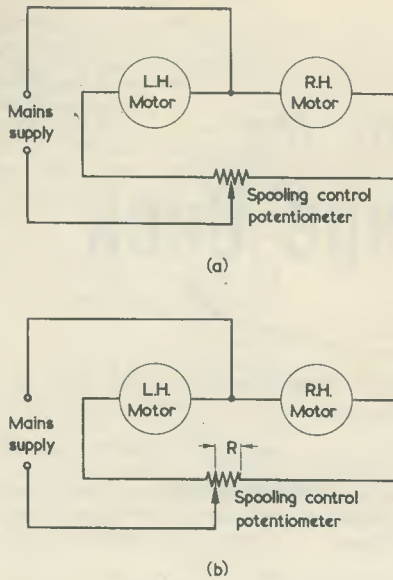


Fig. 2. Details of a possible method for obtaining variable spooling speeds

If the potentiometer used has a low resistance, it draws a high standing current from the mains, but provides a good even control of spooling speed. If a higher value is used, the standing current is low, but all the effective speed variation is compressed at the extreme ends of the track. Having taken into account these two effects, a component was chosen having a value of  $3.5k\Omega$ , and a current rating of  $0.088A$ , which means that its dissipation has a maximum of about 27 watts. The mounting is by a standard  $\frac{3}{8}$ in bush through which the spindle passes and, as the diameter of the body is  $1\frac{1}{2}$ in, the potentiometer fits neatly into the vacant deck position. At the time of writing a small stock of these potentiometers is available from a component supplier.\* These are supplied with a round  $1\frac{1}{8}$ in knob. The spindle length is correct ( $\frac{1}{16}$ in) when the plastic cover is refitted to the Studio deck, and there is a projection which will engage with the vertical

\* The potentiometers are manufactured by Berco as type T25, and are available from G. W. Smith & Co. (Radio) Ltd., 3 and 34 Lisle Street, London, W.C.2.

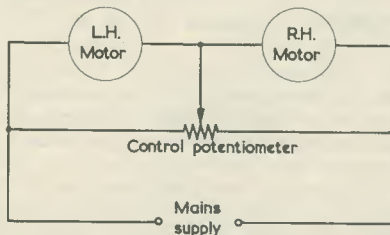


Fig. 3. A better way of obtaining variable spooling. This is the basic method employed for the modifications described in the text

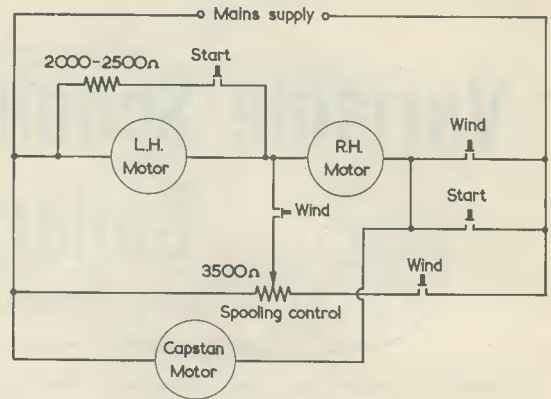


Fig. 4. The circuit of Fig. 1 after modification

slot in the deck plate to prevent the control from shifting. It is fortunate that, with these potentiometers, the mounting bush is insulated from the slider, and this point must be borne in mind if the constructor uses a component of a different design. If there is a direct connection between the slider and the mounting bush or bracket, high quality Paxolin or Bakelite insulating washers *must* be used, as the deck plate is usually earthed and the slider is at mains potential.

#### Altering the Deck Wiring

The complete deck circuit after modification is shown in Fig. 4.

When the "Start" button is pressed the motors all function as in the original circuit. When the "Wind" buttons are pressed the spooling potentiometer is brought into circuit and controls the speed and direction of the winding. It will be seen from the original circuit in Fig. 1 that, when "Wind Right" is selected, two contacts are made while only one is made when "Wind Left" is depressed. As the final circuit requires three make switches, both "Wind" keys must be pressed at the same time. In the prototype, the felt washer between the two "Wind" keys was removed and they were glued together with polystyrene cement. No modification to the mechanics of the deck is necessary as these two keys are not interlocked.

The usual precautions must be observed when rewiring with respect to adequate insulation for wires carrying mains voltages, and their careful positioning away from hot valves and moving parts on the deck. When complete, the circuit must be

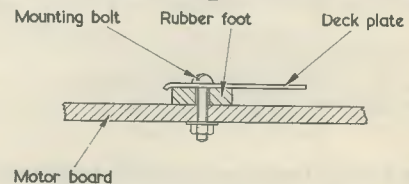


Fig. 5. How to increase ventilation



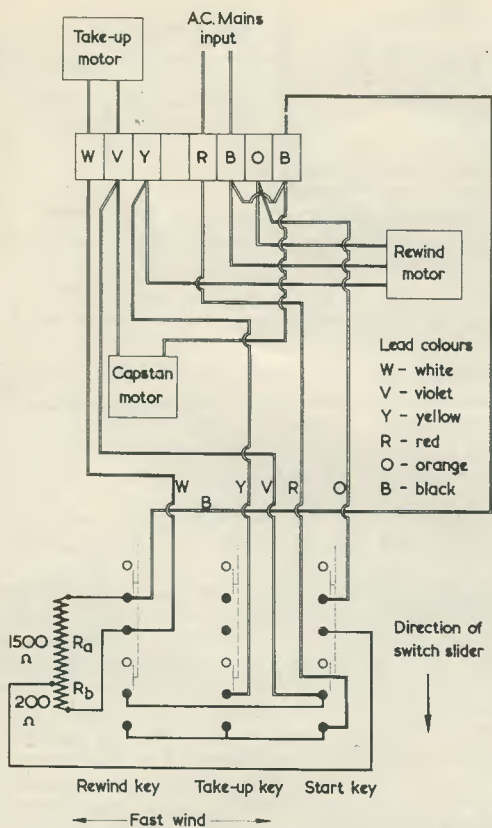


Fig. 6. Wiring diagram for current production of "Studio" decks. (Courtesy The Magnavox Electronics Company Ltd.)

checked, as a mistake may mean a blown fuse or a damaged switch wafer or potentiometer. If it is not clear which contacts make or break on the deck switch, an ohmmeter (or even a torch bulb and battery) can be useful for continuity checks.

### Results

When the deck has been rewired and checked, the mains can be applied and the spooling control tried out. If it is found that a clockwise movement of the knob promotes spooling to the left, the outer connections of the potentiometer simply need reversing to correct the situation. It will be found that the potentiometer will get fairly hot whilst spooling. If the deck is bolted directly to the motor board it would, in consequence, be advisable to raise it a little, using rubber feet under the four mounting bolts as in Fig. 5, to provide a measure of extra ventilation. The machine will probably run cooler in the "Play" condition if the above alteration is carried out. After spooling for half an hour on a modified machine, the potentiometer was no warmer than the envelope of the output valve in the recording amplifier (EL84), even though a "hot" smell could be detected. No damage from the heat

should occur with a potentiometer of the type used by the author as the resistive element is wound on a porcelain or similar material, and the wiper is made of carbon.

### Operation and Editing

The spooling action is very useful for editing and place finding on a tape and a little practice will reveal the technique necessary to overcome the occasional loop formed when the direction is quickly reversed. This is due to the different inertias of full and empty tape spools.

If the signal on the tape can be monitored while spooling, tape editing enthusiasts will find the variable control a great asset. The potentiometer can be set to its central position and the spools rocked or spun to locate the best place to cut the tape. This will not damage the motors as they are only receiving half voltage (120V) each. The writer's modified deck has been functioning satisfactorily for a long time now, and there seems to be no wear on the potentiometer or adverse effects to the deck or motors.

### Editor's Note

We have checked the above with The Magnavox

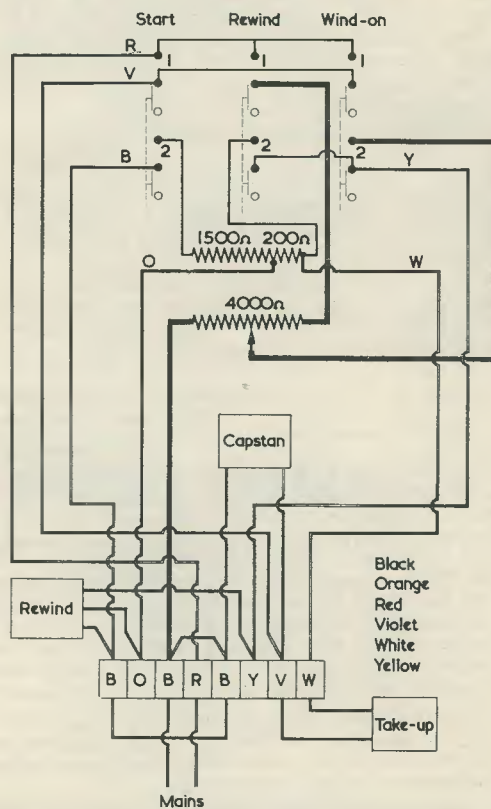
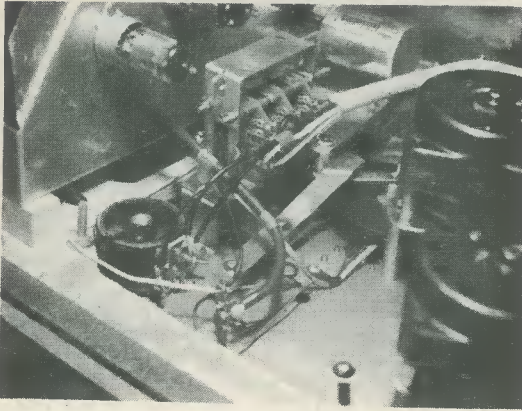


Fig. 7. Modified wiring diagram incorporating a variable spooling control. (Courtesy The Magnavox Electronics Company Ltd.)



The manner in which the author mounted the additional variable spooling control to his own unit

Electronics Company Ltd., who commend the modification but point out that it applies to older production units made before the middle of 1963 and does not apply to units manufactured after that date. Nevertheless, the modification may be made to these more up-to-date units, and Magnavox Electronics Company Ltd. have suggested details of the manner in which it may be carried out.

Fig. 6 illustrates the current wiring diagram for the tape deck, this incorporating a "tapped rewind and resistor" modification. Fig. 7 shows how the wiring diagram may be modified to incorporate variable spooling, whilst Fig. 8 gives the appropriate circuit diagram.

It should be emphasised that Figs. 6, 7 and 8 are intended only to show how variable spooling may be incorporated on the later "Studio" tape decks. The manufacturer's modifications from the Fig. 1

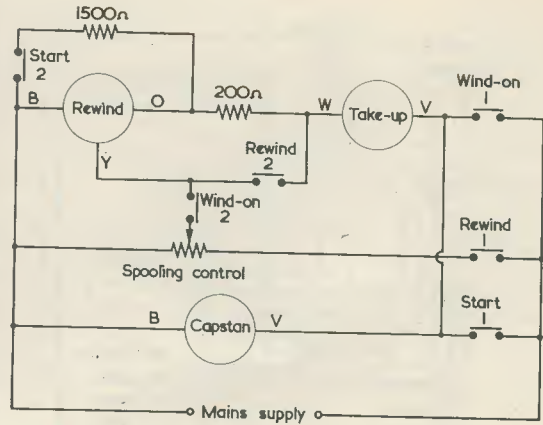


Fig. 8. The circuit diagram corresponding to Fig. 7. (Courtesy The Magnavox Electronics Company Ltd.)

circuit to that illustrated in Fig. 6 involve changes in motor windings. If owners of the older "Studio" decks try to carry out such modifications it is possible that values on current production units might not line up with suitable resistors on their decks, and damage may result to the motors. To reiterate: current production units may be modified to variable spooling by changing Fig. 6 to Fig. 7 and Fig. 8; but no attempt should be made to modify older production units to the current circuit of Fig. 6.

Grateful acknowledgements are due to The Magnavox Electronics Company Ltd., and to Mr. D. G. Cufflin, their Chief Engineer, for checking the modification described in this article and for suggesting the further modification to current production units.

## FARADAY LECTURE 1965 — COLOUR TV

This year's Faraday Lecture, the 36th in the series arranged by the Institution of Electrical Engineers, is being given by Mr. F. C. McLean, C.B.E., B.Sc., M.I.E.E., Director of Engineering of the British Broadcasting Corporation. His subject is "Colour Television". Mr. McLean is delivering the lecture throughout Britain over the next few months.

In the lecture Mr. McLean explains the basic principles of colorimetry—the science of colour and colour measurement—and, with the aid of a number of demonstrations, shows how these principles are applied to colour television systems. From this he goes on to explain and demonstrate how a scene viewed by a colour television camera is analysed into its three primary colour components and converted by the colour camera into equivalent electrical signals, which are transmitted and finally appear again at the receiver as a colour reproduction of the original scene.

To illustrate how a colour receiver works, a large model of a shadow-mask tube is used. This demonstrates optically the manner in which the electrical signals are converted into the colour picture appearing on the face of the tube. The demonstrations also include colour television pictures obtained from "live" cameras in a studio and from films and slides, which are projected on to a large screen.

The Faraday Lecture series is intended to spotlight various aspects of modern electrical engineering in straightforward language for the general public, and special performances for students are being arranged in many of the towns on the tour. Members of the public are admitted, by ticket, free of charge to these lectures. See page 425 for further details.



## BRIDGE BUILDING

by Craig Mackay

*This is the first of a series of four articles which cover, from a strictly practical viewpoint, the principles of simple bridge networks. The articles, which conclude with a description of a comprehensive home-built bridge, are written especially for the beginner and for those constructors who tend to eschew test equipment projects. This month's contribution discusses basic principles and introduces practical techniques.*

**M**OST MULTIMETERS WHICH ARE SOLD NOWADAYS include facilities for the measurement of resistance and continuity. These meters generally have a circuit of the type shown in Fig. 1, and they work by measuring the current flowing through X, the unknown resistor. The maximum current possible is set by means of R to correspond to full-scale deflection on the meter, and resistance can then be directly read from a suitably calibrated scale on the meter. This method of measuring resistance is adequate for approximate results, but the accuracy with which X can be measured is not very great since calibrations are affected by variations in the cell voltage. Even the best multimeters do not claim to give the resistance of X any closer than about 5% on either side. This figure is not, however, of very much use where any serious experimental work is to be done, and a tolerance of  $\pm 1\%$  or  $\pm 0.5\%$  would be much more realistic.

The same is true when it is capacitance which is required to be measured. A few of the more expensive multimeters have facilities for measuring capacitance, this being generally carried out by means of a circuit embodying the principles shown in Fig. 2. The circuit is powered by the a.c. mains supply, the voltage of which is suitably stepped down by means of a transformer. The calibration here is affected not only by changes in the voltage, but also by changes in the frequency of the a.c. mains. The accuracy suffers accordingly, and an error of  $\pm 6\%$  is quite common.

We require, therefore, some method of measuring resistance and capacitance which is much more accurate.

### The Wheatstone Bridge

The basic Wheatstone bridge circuit is shown in Fig. 3. The principle is very simple: G is a centre-

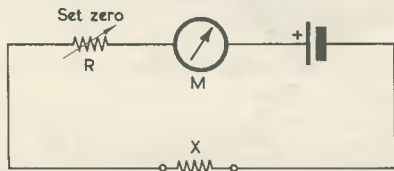


Fig. 1. A basic ohmmeter circuit, as employed in many multimeters

zero galvanometer, X is the unknown resistor, and R is varied until G indicates zero current. As no current is flowing through G we can then say that no potential difference exists between points L and M and that the potential dividers formed by firstly, B and R, and secondly, A and X, are set at the same ratio. Therefore,  $\frac{B}{R} = \frac{A}{X}$  and  $X = \frac{AR}{B}$ . A and B are usually standard components and if the variable resistor R is calibrated, X may be found.

This approach has several major advantages over the method used in Fig. 1:

(a) Any variation in the voltage of the cell has no effect whatever on the value found for X. The only limitation to be imposed upon V is that it must be large enough to give a sharp, clearly defined zero-current setting of R (usually called the null-point setting).

(b) The galvanometer need not be calibrated, as it is only the zero deflection point which has to be found. Even if this point is not marked, a spring loaded switch could be included in series with G, the open position giving the zero-current reading in G.

(c) The range of values of X which can be measured accurately without getting too near to the limit of R depends on the ratio of A to B. Therefore, by switching in different ratio values, it is possible to measure an extremely wide range of values of X, all with high accuracy.

(d) The bridge may be simply modified to allow measurement of capacitance and inductance.

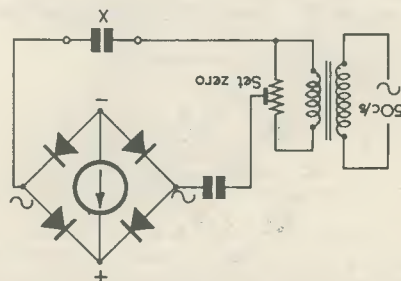


Fig. 2. A capacitance measuring circuit which operates in a similar manner to that of Fig. 1

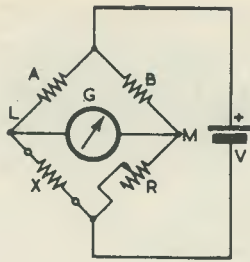


Fig. 3. The Wheatstone bridge

### The Capacitance Bridge

In the same way as for the Wheatstone bridge, it is possible to compare, and hence measure, the value of an unknown capacitor by means of the bridge circuit shown in Fig. 4. The direct voltage source has been replaced by an alternating voltage, the null detector has been changed to a pair of headphones, and A is now a standard capacitor. It can be shown that the value of the unknown capacitor X is given

$$\text{by } X = \frac{AB}{R}.$$

It should be noted that it is possible to use an a.c. source and headphones for the measurement of resistance also, employing the circuit of Fig. 3.

By replacing A in Fig. 4 by a standard inductor, it is possible to measure inductance directly, the unknown inductor then being given by  $X = \frac{AR}{B}$ .

However, as it is not very often required to measure inductance, attention will be concentrated in these articles upon resistance/capacitance bridges.

### The Ratio Arms

The variable resistor R is usually calibrated in such a way that the value of X can be directly read off the scale when the null point has been found. When using the circuit of Fig. 3 the calibration scale is of the type shown in Fig. 5. This scale is not very satisfactory as readings at the low end of the scale tend to be too cramped. In order to expand the small end of the scale, it is usual to slightly modify the circuit of Fig. 3 to that shown in Fig. 6. Here, the variable resistor forms two of the ratio arms, and the resulting scale is more satisfactory. This arrangement also has the advantage that only

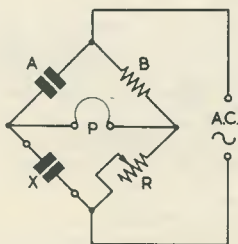


Fig. 4. A capacitance bridge

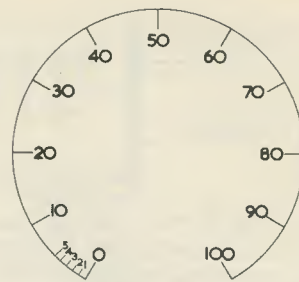


Fig. 5. The type required for R of Fig. 3

one standard component, A, is required for each range. By careful choice of standard components it is possible to make do with only one scale for resistance and one for capacitance. The capacitance scale can be directly deduced from the resistance scale as it is merely a function of the reciprocal of the resistance scale determined by the standard components. These scales are shown in Fig. 7 and they apply to a linear variable potentiometer.<sup>1</sup>

### Components

The whole reason for using a bridge circuit is to provide a highly accurate method of measuring resistance and capacitance. Accordingly, the components used should be of the best quality only. To attempt to economise at this stage is, indeed, folly.

The variable resistor should be a good quality wirewound type and should have as large a diameter as possible. This allows greater setting accuracy, greater stability and, usually, greater maximum permissible power dissipation. The last allows a higher source voltage to be used, and hence results in a considerable improvement in the sharpness of the null point. It should also have a nice smooth movement.

The fixed standards should be precision high stability components, with a tolerance of  $\pm 0.5\%$  or

<sup>1</sup> The scale shown in Fig. 7 applies to a balance potentiometer having an accurately linear track (which is, of course, required for this application) and a similar range of angular rotation. After completing the construction of a bridge, the balance control may be calibrated against another of known accuracy, against a close tolerance resistance box, or against several standard components, interpolating from Fig. 7. The last procedure will be the easiest for most home-constructors, although its accuracy may be lower than with the other two procedures.—EDITOR.

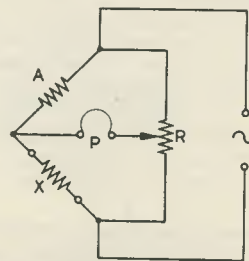


Fig 6 A modified version of Fig. 3





Fig. 7. The scale required for R in Fig. 6

$\pm 1\%$ , and should always be mounted well away from all sources of heat.<sup>2</sup> The circuit diagram of the bridge section of an instrument which will be fully described later is shown in Fig. 8, together with component values.

In Fig. 8  $R_4$  allows a rough estimation of the power factor of capacitors in the highest capacitance range to be made. The six ranges of this bridge circuit are:

|               |                 |
|---------------|-----------------|
| 10pF          | - 1,000pF       |
| 0.001 $\mu$ F | - 0.1 $\mu$ F   |
| 0.1 $\mu$ F   | - 10 $\mu$ F    |
| 10 $\Omega$   | - 1k $\Omega$   |
| 1k $\Omega$   | - 100k $\Omega$ |
| 100k $\Omega$ | - 10M $\Omega$  |

The circuit also allows any component to be compared with an external standard connected across terminals A.

Other ranges can be provided, as required, by adding different values in the standard arm. The value of the unknown is found by multiplying the value of the standard component by the null setting on a scale of the type shown in Fig. 7.

#### Notes

It is generally best to have one of the X terminals earthed as it is then possible to measure components

<sup>2</sup> Close tolerance resistors and capacitors up to and including 0.01 $\mu$ F may be obtained from some component suppliers, including Home Radio (Mitcham) Ltd. Capacitors are normally silvered mica types. 1 $\mu$ F capacitors (as employed in the circuit of Fig. 8) may be selected from paper capacitors. Alternatively, a capacitor on the low side of 1 $\mu$ F may be selected and padded up to that value by means of silvered mica capacitors in parallel.

without disconnecting the earthed end, which could be awkward in certain pieces of apparatus.

Notice that if, say, the source is an oscillator and the null detector is an amplifier, then one of these, usually the source, must not have either side earthed. For this reason, the source is usually coupled to the

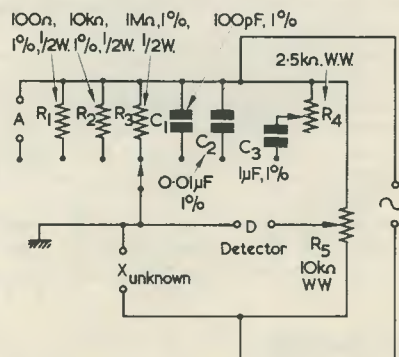


Fig. 8. A multirange bridge circuit

bridge circuit by means of a transformer.

In next month's issue the question of a.c. sources for driving these bridges will be examined, and the various problems which are encountered will be examined in detail.

(To be continued)

# THE NEW DUAL-STANDARD TV SETS

By Gordon J. King, Assoc. Brit. I.R.E., M.T.S., M.I.P.R.E.

PART 9

*This article, the ninth in our series on 405-625 line receivers, deals with the more unusual f.m. discriminator circuits, after which it carries on to introduce the subject of dual-standard timebases*

THE LOCKED OSCILLATOR F.M. DETECTOR USING the heptode valve, as described last month, is a development of earlier f.m. detectors employing a similar principle. These include the nonode detector, the gated-beam discriminator, using the 6BN6 gated-beam valve and the Bradley f.m. detector.

## Nonode F.M. Detector

Although the nonode valve is no longer manufactured, it is of academic interest to see briefly how it works. The valve has seven grids, and to the third and fifth of these are applied signals at i.f. which differ in phase by  $90^\circ$ . This phase displacement is accomplished by the conventional tuned transformer artifice, and the  $90^\circ$  value exists only when the frequency of the input signal equals that of the tuned transformer.

When the signal is frequency modulated, the phase varies about the  $90^\circ$  value according to whether the frequency rises above or falls below the tuned frequency of the transformer. The amount of anode current depends upon the relative phase swings at the two grids, and is thus related to the modulation of the i.f. carrier. An ordinary resistive load is included in the anode circuit, so that the changing current produces a changing voltage across the load. As the voltage changes in sympathy with the modulation, an audio signal is developed across the load, and this is fed to the audio stages through a coupling capacitor in the ordinary way.

One disadvantage of the nonode detector is that a relatively large input signal is needed for the circuit to provide a useful degree of amplitude limiting.

## Separate Channels

It has often been asked why intercarrier sound is employed on the 625 line system instead of the usual technique of using separate sound and vision channels, as in the 405 line system. Separate sound and vision i.f. channels on 625 lines are perfectly possible, of course, but since the sound on the 625 line system is f.m. and the vision a.m., a composite i.f. channel tends to simplify matters.

Another point is that, with separate channels and due to the use of f.m. sound, hum modulation

of the local oscillator, microphony or, indeed, any disturbance to the oscillator signal, produces unwanted frequency modulation of the sound i.f. signal. After detection, such modulation resolves as an interfering audio signal. This trouble is avoided by the use of the intercarrier technique, since the intercarrier frequency remains constant regardless of any f.m. present on the local oscillator signal. Moreover, any drift in frequency of the local oscillator signal does not change the intercarrier frequency, because the latter is locked to the frequency difference between the sound and vision carriers as sent out by the transmitter.

It will be understood, of course, that local oscillator drift will have the normal effect on the vision signal in the i.f. channel. Moreover, it will also tend to put the ratio of the levels of the sound and vision carriers in the composite i.f. channel out of balance, and excessive drift would thus result in sound distortion due to the production of harmonic frequencies. This effect is sometimes noticed when the fine tuner is put out of adjustment on the 625 line standard. On Bands IV and V the same effect occurs when the u.h.f. tuner is tuned slightly off channel.

A two-stage intercarrier sound amplifier, using the new PCF200 triode-pentode valve, will now be described. The PCF200 is a combined triode-pentode with completely independent and mutually screened electrode systems. The pentode section features a frame grid assembly similar to that of the EF184, but of smaller geometrical proportions. The gm is in the order of 14mA/V, which is just slightly below that of the EF184. However, the figure of merit ( $gm/C_{in}$ ) is better than the EF184. The triode has a high- $\mu$  value and is suitable for various applications. (There is also a PCF201 featuring a remote cut-off video pentode and a general purpose low- $\mu$  triode section).

## Decal Base

Another distinctive feature of the PCF200 (as with other valves in this series—such as the PCF201, triode-pentode; the PFL200, double-pentode; and the PCH200, triode-heptode) is that it is provided with an entirely new base having ten pins. This is called the decal base. The envelope and the pitch circle of the base are the same as with the noval



type valves; that is, with the same envelope and nine pins. The tenth pin on the decal base is accommodated by bringing the pins slightly closer together. This still retains the large gap between the two outside pins (pins 1 and 10 on the decal base), so that location of the valve in its holder is virtually unaffected.

The tenth pin was needed so that two pentodes with completely independent electrode systems could be housed in the same envelope and on a common base without resorting to the use of a top cap, a practice which is not compatible with printed circuit techniques. The pin connections are also arranged with inter-circuit shielding in mind, and extra-special attention is given to the internal screening between the two sections.

When the PCF200 is arranged as an intercarrier amplifier, its triode and pentode sections operate as amplifiers in cascade. Even in this very stringent application the internal cross-coupling capacitances are still sufficiently low to avoid insurmountable instability troubles. It is clear, then, that the valve working in less exacting applications will also perform adequately and independently over its two sections.

The circuit of the two-stage amplifier is shown in Fig. 28. The pentode section of the valve receives the intercarrier signal from the detector, this being tuned by  $L_1$ ,  $C_1$ .  $T_1$  in the anode circuit forms a bandpass coupling, and passes the signal to the grid of the triode section via a centre tap on the secondary winding. From the anode of the triode, the signal is applied to the f.m. detector. The circuit of the detector is also shown, since it differs a little from conventional versions and has, in addition, a bearing on the triode neutralising.

The triode is biased automatically by grid current, via the short time-constant RC filter comprising  $R_1$ ,  $R_2$ ,  $C_2$  and  $C_3$ . This means that any amplitude

modulation on the signal undergoes leaky-grid detection. The detected signal is developed across  $R_1$ ,  $R_2$ , and the proportion appearing at the junction of these resistors is fed back to the control grid of the pentode via  $R_3$ . The bias appearing at this junction due to the leaky-grid action is also applied to the pentode control grid. In this way envelope feedback and an a.g.c. effect is obtained.

### Triode Limiting

The leaky-grid effect provides the limiting action at the triode, of course, and in this circuit limiting occurs when the signal at the control grid of the pentode exceeds about 10mV.

Owing to the relatively high feedback factor due to the anode-to-grid capacitance of the triode, this valve must be neutralised. This is accomplished by feeding back to the triode grid an antiphase signal extracted from the bottom end of  $L_2$  (i.e., the signal developed across  $C_4$ ).

The feedback signal is taken via  $R_3$ , with  $C_5$  acting as a phase-correcting capacitor. The neutralising circuit is, in fact, formed by a capacitive bridge arrangement and is rendered non-critical by the low impedance loading of the triode grid and anode circuits, this being brought about by the tap on  $T_1$  secondary and the capacitive tap across  $L_2$  in the anode circuit.

It is of interest to note that the anode-to-grid capacitance of the pentode section is partially neutralised by the use of a common capacitor  $C_6$  for decoupling the anode and screen grid circuits.

The demodulator is of the ratio detector type, and the slightly modified design has the advantage of permitting the use of relatively inexpensive untapped coils in the  $L_2$  and  $L_3$  positions. The diodes are  $D_1$  and  $D_2$ , while  $R_4$  provides a balancing adjustment which offers optimum rejection of amplitude modulation such as intercarrier buzz.

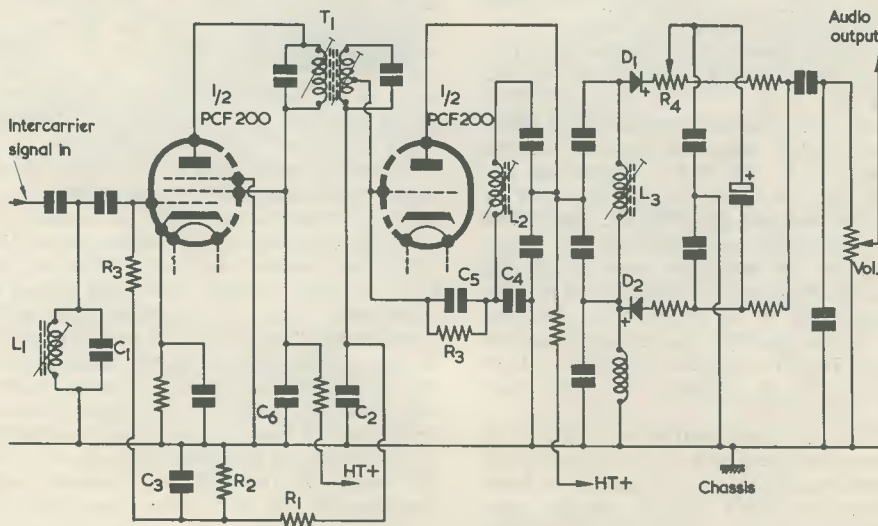


Fig. 28. An intercarrier sound amplifier and limiter using the new decal triode-pentode valve type PCF200

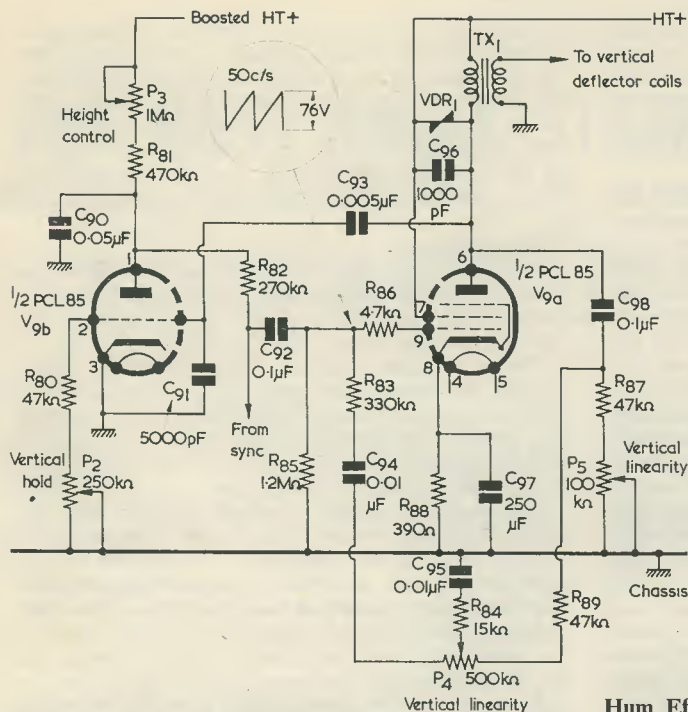


Fig. 29. The vertical timebase of a dual-standard receiver, as described in the text

So much, then, for the sound sections of the new 625 line and dual-standard receivers.

### Vertical Timebases

We now come to the timebases, and in general these do not differ greatly from the accepted design for 405-line-only models. The vertical timebase, in fact, undergoes no alteration at all over the two standards. For the sake of completeness, the vertical timebase of a G.E.C. dual-standard set is shown in Fig. 29.

The valve is a triode-pentode arranged in a form of multivibrator circuit, with the pentode section acting as the amplifier. As is now becoming accepted practice, the anode of the triode valve is energised from the boosted h.t. line, via the height control. This technique provides a more linear sawtooth output (see the waveform inset in Fig. 29) since the charging capacitor can be worked on the first, more linear, part of its exponential charging characteristic. It also endows the vertical timebase with a degree of overall compensation for voltage variations and so on, as reflected from the line timebase.

The boost voltage is, of course, a function of line timebase operation, and as it is now conventional practice to compensate this section against voltage and load changes the boost voltage remains substantially constant. This constancy of voltage is thus present on the vertical timebase as well.

The pentode derives its h.t. voltage from the ordinary h.t. line, as the voltage requirements here are less critical. The voltage-dependent resistor,  $VDR_1$ , across the primary of the vertical output transformer serves to damp the pulses which tend to develop across this inductive circuit during the retrace. It damps these pulses without disturbing the normal scanning operation of the timebase due to the fact that the resistance of the  $VDR_1$  decreases with increase of voltage across it. The retrace pulses are, of course, a number of times greater in magnitude than the scanning voltage across the circuit.

Two negative feedback vertical linearity controls are provided, as is now common practice.

The sync pulses applied to the vertical timebase have virtually identical characteristics on both standards, so switching here is not necessary. In Fig. 29 the sync pulses are applied to the junction of  $R_{82}$  and  $C_{92}$ .

### Hum Effects

There is one rather important factor which must be considered here, however, while it is accepted practice to lock the vertical sync pulses at the transmitter to the 50 c/s mains grid system on 405 lines, this is not always the case with the 625 line standard. Indeed, the vertical sync pulse repetition frequency may differ from the power frequency by a small amount on some transmissions. This is called "asynchronous working" and it can result in a beat effect on the picture at a frequency equal to the difference between the power frequency and the vertical sync pulse repetition frequency. The beat arises from residual mains hum in the vision and timebase circuits and, in sets where the h.t. smoothing is not fully up to standard, compression and expansion waves move slowly up or down the picture.

When the sync pulses are locked to the mains, slight residual picture hum is barely noticeable since it remains stationary as a slight horizontal shading, compression or expansion of the picture.

It is well known that hum in the vertical circuits can affect the vertical lock, and this is of greater significance on an asynchronous transmission. Thus, it has been observed on some dual standard models that, due to slight deterioration in the h.t. smoothing electrolytic capacitors, the vertical lock falls below the 405 line level of stability when receiving 625 lines. In an extreme case investigated by the author, virtually no lock was present on 625 lines, yet the lock was normal on 405 lines. Replacement of the main smoothing electrolytic capacitors effected a cure.

*To be continued.*



**T**RANSISTORS HAVE BEEN GRADUALLY TAKING over from valves in almost all applications, but where a very high input resistance is required the electrometer valve still reigns supreme. Transistorised digital voltmeters, for example, often employ a valve in the first stage of the input amplifier so that the highest possible input impedance can be obtained. The recent development of a new transistor by Mullard Ltd., with an input resistance of about one million megohms offers the possibility of using transistors instead of valves even in very high impedance circuits.

This new type of semiconductor device is a Metal Oxide Silicon Transistor (M.O.S.T.). The present development type is coded 95BFY. The device differs considerably from the normal transistor in its methods of operation and a different nomenclature for the electrodes is employed.

The 95BFY is a four terminal planar device with the structure shown in Fig. 1. It comprises two closely spaced n+ regions, known as the source and the drain, on a p-type silicon substrate. (An n+ material contains a large number of n-type impurity or "donor" atoms.) A thin oxide layer is grown on the substrate between the source and the drain; this layer acts as a dielectric between the substrate and an evaporated aluminium electrode known as the gate.

### Operation

When a positive potential is applied to the gate electrode, a negative charge is induced at the substrate surface causing an n-type channel to form. The latter provides a conducting path between the source and the drain. If a potential is applied between the source and the drain, a current flows, the magnitude of this current being controlled by the potential applied to the gate.

The symbol for this metal oxide transistor is shown in Fig. 2. This symbol emphasises that the gate is separate from the remainder of the device. The outer envelope is connected to the substrate electrode, a TO-5 construction being used.\* The maximum voltage rating is 35 volts and the maximum current 30mA. The leakage current is typically  $0.5\mu\text{A}$ . The input capacitance is about 4pF.

It should be emphasised that the new transistor is a majority carrier device; that is, the charges which flow to carry the current are electrons in n-type material. This is a property which the new device has in common with the tunnel diode. Ordinary transistors are minority carrier devices. Majority carriers devices are very much more resistant to the effects of nuclear radiation than minority carrier devices. It therefore seems likely that the new device will find a wide application in space research, since very high levels of radiation can occur in the van Allen belts and elsewhere as a result of solar activity.

\* The TO-5 construction employs a metal case having outside dimensions of 8.9mm diameter and 6.35mm height. It is used, for instance, with transistors type ACY17 to ACY21.—EDITOR.

# New Semiconductor Device with a Million Megohm Input Impedance

By J. B. DANCE, M.Sc.

Considerable interest has been aroused by the recent announcement by Mullard Ltd., of a metal oxide silicon transistor having an input resistance of  $10^{12}$  ohms. Large-scale production of this device is planned by Mullard and, when produced in quantity, it should be many times cheaper than any device of similar performance now available in Britain. The basic functioning of the device is described in this article

### Uses

The preliminary experiments performed by the manufacturers indicate that the new device will find application in oscillators at frequencies of up to 150 Mc/s, as "anode" modulated output stages at frequencies of up to 100 Mc/s and as mixers with 20dB conversion gains (the substrate being used as a second input terminal like the third grid of a multi-electrode valve). The device also shows great promise in "chopper" circuits for chopping frequencies of up to 1 Mc.

At the present time the new device is referred to as a transistor by the manufacturers. The method of operation differs so much from the conventional transistor, however, that it seems very desirable to the writer that a suitable specific name should

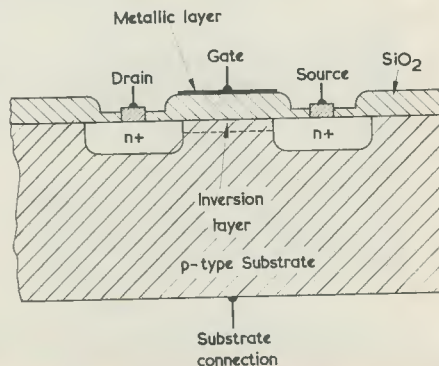


Fig. 1. The basic construction of the new semiconductor device. This is applicable to the development type 95BFY

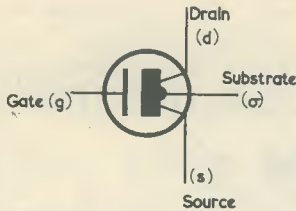


Fig. 2. The circuit symbol. This emphasises the fact that the gate is separated from the remainder of the device

be found for the new device to avoid confusion. One normally thinks of a transistor as a current operated device (i.e. output current is linearly related to the input current). The new device seems much more like a valve in its action, since the output current is linearly related to the potential of the gate electrode.

# RADIO TOPICS . . .

## by Recorder

Q. What is the difference between a serviceable solder joint and a reject solder joint?

A. It all depends on the inspector.

The above is not intended to be one of those inconsequential riddles of the "how high is a mouse?" variety. It represents, instead, one of the problems which frequently beset the manufacturer of electronic equipment; and it applies also to the home-constructor and the service engineer.

### An Extreme Example

It might be of interest to start off with an extreme example of "it all depends on the inspector". Some years ago, and shortly before the advent of printed circuits in mass-produced domestic equipment, an acquaintance of mine who had a small factory endeavoured to obtain a chassis wiring contract from a well-known manufacturer of high fidelity amplifiers. The idea was that the hi-fi manufacturer would supply chassis and components, and my friend would then assemble and wire them up.

But the job fell through. As my friend remarked bitterly afterwards: "All the component wires on the samples we submitted were wrapped several times around the tags, and they were all beautifully soldered. But the Chief Inspector picked up a pair of taper-nosed pliers and was able to untwist some of the wires off the tags even though the electrical connections were perfect. He did not consider the solder joints good enough and so we lost the contract."

With whom do we sympathise here? The Chief Inspector was

obviously a craftsman of the old school and he was responsible for the quality of a relatively expensive unit which had to look good technically as well as sound good. Yet most of us know that, unless the joint is completely covered in solder, it is quite possible to peel tinned copper wire away from an electrically perfect joint merely by twisting it round with taper-nosed pliers. (Presumably what happens is that a layer of the wire's tin coating is left with the solder). Common-sense tells us that my acquaintance's solder joints would only have been unsatisfactory in households where people devoted their spare time to untwisting wires with taper-nosed pliers.

This story, although quite true, represents an extreme case, and is not quite so applicable to present-day domestic equipment manufacture. Currently, we have printed circuit assemblies where it is quite impossible to have lead-out wires twisted round a tag. Instead, all the joints on the board are of the "laid-on" variety, being carried out automatically by such processes as passing the board over a "wave" of molten solder. It is still possible for one or two electrically poor joints to emerge from the system, and reliably identifying these by visual examination can be quite a difficult job.

How many of us, when confronted with an intermittent fault on a printed circuit receiver, have not hopefully picked up the soldering iron and fruitlessly touched up one or two joints merely because they look a little uncertain? Therein lies one answer, at any rate, to the question I started off with. One

way of ensuring that a solder joint is satisfactory is to make it yourself! There is, then, that little moment of truth when the two parts of the joint reach the liquid temperature of the solder and the latter flows beautifully over and into the work. It is when the solder flows smoothly over the surfaces of both parts, and away from the point of application of the iron, that we know we have made a good joint.

### Cored Solder

Soldering represents a minor hurdle to all beginners in radio and electronics, but it is a hurdle which can be very easily overcome with the exercise of a little patience and application. The newcomer to soldering would be well-advised to practice on odd tags and components before he starts soldering joints in actual working equipment.

It is also necessary to understand what occurs during the process of making a soldered wiring joint, such as is given by soldering a tinned copper wire to a solder tag. The latter will, almost always, be tinned as well, and this is to our advantage because tin is a metal which "takes" solder very readily. An essential requirement is a flux, and in the bad old days before resin-cored solder we would have smeared a little of this in the form of paste on to the wire and the tag before applying molten solder, wiping off the excess when the joint was completed. Flux is a chemical, or combination of chemicals, which when heated breaks down the oxides that appear on the surface of the parts being joined, and thereby enables the pure metal to be presented to the solder.

So far as radio wiring is concerned, the situation is nowadays completely different, this being due to the introduction of resin-cored solder in which the resin provides the flux. An important complementary point is that soldered connections on modern radio equipment are usually much closer together than occurred in the old



days, with the result that it becomes definitely *unwise* to use paste flux for present-day wiring. It is frequently impossible to completely clean away excess paste flux after wiring joints have been made, with the result that leakage paths may appear between soldered connections, and the assembled equipment may either not work correctly on switching on or may become unreliable at a later stage. For soldered connections in present-day radio equipment a good resin-cored solder is essential. To emphasise this point, some suppliers of radio kits append agonised advice to their assembly instructions telling would-be constructors of kits to use nothing *whatsoever* other than resin-cored solder for the solder joints.

The newcomer to soldering should, therefore, do his practice with resin-cored solder, as this is the type of solder which he will use in wiring up working assemblies.

#### Soldering Process

The events which take place when making joints with resin-cored solder are of interest, as quite a few processes are involved. When soldering such a joint, the resin-cored solder should *not* be melted on to the soldering iron bit and then carried over to the work. This is because the resin flux will lose much of its efficiency before it reaches the joint, since it will be wasting its activity in preventing the formation of oxides on the molten solder on the bit. The resin-cored solder should either be applied to the work at the same time as the iron or shortly afterwards. The oxide-reducing properties of the flux are then devoted entirely to breaking down oxides on the surfaces of the work and the solder making the joint. When the solder flows, the flux forms a protective film above it, keeping out the air and thereby further assisting in preventing oxidation. After the soldering iron is removed the solder on the joint solidifies. So also, with resin-cored solder, does any excess flux which may be left, this setting hard around the solder. In this instance there is no necessity to wipe away the excess flux, and it can cause no harm.

A serviceable joint will not, of course, be made unless *both* members of the joint are raised to soldering temperature. Heat is transferred from the soldering iron bit by conduction, and any film of oxide provides surprisingly effective insulation. For this reason the

soldering iron bit should always be well tinned so that heat can be transferred via molten solder to the work. The flux in resin-cored solder then breaks down the surface oxides on the parts being joined, thereby enabling an intimate heat-conducting path to be set up via the molten solder.

The complete heat-conducting path really commences at the heating element inside the soldering iron, whereupon the copper bit also plays its part in conducting heat to the work. Whilst the members of the joint receive heat from the soldering iron, they also lose heat by conduction, radiation and convection. So, if you have a very large solder tag and a soldering iron with a small heating element and a narrow diameter bit, the iron may not be able to provide sufficient heat quickly enough. It is possible, indeed, for the system to stabilise at a temperature below the melting point of solder!

Typical examples of a reliable solder for radio work are 60/40 Ersin "Multicore" or Ersin "Savbit". These solders carry the resin flux in a number of cores throughout their length, with the result that only a narrow wall of solder has to be melted by the iron before the flux becomes available. The term

"60/40" applies to an alloy of 60% by weight of tin to 40% of lead, and this is the most convenient for general radio work. The 60/40 alloy changes from the solid state to a "pasty" state at 183° C, then from this "pasty" state to the fully liquid state at 188° C. Other tin-lead alloys having more than 15% tin, such as the fairly commonly encountered 40/60 alloy (40% of tin and 60% of lead) similarly go from the solid to the "pasty" state at 183° C. However, as the percentage of lead increases, the temperature at which the transition from "pasty" to liquid takes place becomes higher. With 40/60 alloy, it is 234° C. There is one alloy, 63/37, which has no "pasty" stage at all, the alloy changing directly from the solid to the liquid state at 183° C. This represents rather too much of a good thing, however, because joints made with the alloy become too sensitive to vibration at the instant of setting. It is better to have a small "pasty" range, and best results are given by 60/40.<sup>1</sup> "Savbit" solder is very nearly the same as 60/40 solder except that a small proportion of copper is included in the alloy. This tends to prevent migration of copper from the soldering iron bit, and causes bit life to be extended.



One of the two brick corner enclosures built into a new bungalow (see "High Fidelity Built In"). This incorporates a Wharfedale W15 bass unit, a Super 3 and Super 8 being fitted in the cabinet on top



The solders just mentioned are manufactured, incidentally, by Multi-core Solders Ltd., and are readily available in small packs through retailers.

The flux in resin-cored solder is normally active enough to break down the oxides on capacitor or resistor lead-outs even when these have become badly oxidised and dirty due to long periods of storage. When in doubt it is usually desirable to tin the lead-out before fitting it to the tag or terminal point to which it is to be soldered. A particularly useful gadget for cleaning dirty lead-out wires was described in "In Your Workshop" in the July 1960 issue, and consists of two flat carborundum contact files measuring approximately  $4\frac{1}{2}$  in long by  $\frac{1}{2}$  in wide and tied together

<sup>1</sup> For the record it should be noted that if the percentage of tin is increased above that in the 63/37 alloy a "pasty" stage is re-introduced, and that the temperature at which the "pasty" state changes to the liquid state rises as the percentage of tin in the alloy is increased. (The change from solid to "pasty" remains unaltered, at 183° C). In terms of temperature a 68/32 alloy has approximately the same performance as 60/40; however, tin is more expensive than lead and it is cheaper to make the 60/40 alloy.

at their centres with a  $\frac{1}{4}$  in flat spacer between them. The two ends are pressed together like a pair of tweezers over the wire to be cleaned, which is then drawn through them.<sup>2</sup> The carborundum contact files may be obtained from most car and cycle accessory stores for a shilling or two. I've used one of these gadgets ever since the idea appeared, and it has proved to be a most useful and convenient little tool.

As a final point it is interesting to note that certain types of component lead-out which were perfectly satisfactory when soldered by manual methods in the days before printed circuits, obstinately refused to become even tinned when fitted to printed boards and passed through automatic soldering processes.

The reason? When soldering irons were applied manually to the lead-outs the operator unconsciously rubbed the bit against the wire, thus automatically breaking through the oxide surface. Once the heat of the iron was transferred to the lead-out by this direct contact

<sup>2</sup> This wire cleaner was a "reader's hint" submitted by L. H. Brown.

the flux in the resin-cored solder was able to do its work of clearing away the oxides and enabling a satisfactory solder joint to be made. Such mechanical abrasive action did not occur with the automatic soldering processes, and the lead-out wires remained securely unsoldered in their protective sheaths of oxide.

### High Fidelity Built In

If you are moving into a new house you are in an excellent position to incorporate a really good high fidelity installation. This is what Mr. J. Holding, the energetic Managing Director of the retail firm of Holdings of Blackburn, Ltd. (39-41 Mincing Lane, Blackburn), has done and, as is shown by the accompanying photographs, the results are quite impressive.

Whilst the building of his new bungalow was in progress Mr. Holding approached the builder, who was most co-operative in meeting his requirements. Submitting the Wharfedale Cabinet Construction Sheet, Mr. Holding had two brick corner enclosures incorporated into the lounge. These were plastered, papered and decorated under the strict supervision of Mrs. Holding, and toned in perfectly with the rest of the furniture and fittings. A Wharfedale W15 bass speaker was housed in each enclosure, whilst the Wharfedale Twin Treble Cabinet in walnut, containing the Super 8 and Super 3, fitted neatly on top.

The amplifier and radio units had to provide as high a quality as was possible from tape, disc and radio without being fantastically expensive. Quad equipment was the choice here, with two power amplifiers, a control unit and separate f.m. and a.m. tuners. The tape recorder, without compromise of quality, had to be small enough to fit into the "Queen Anne" cabinet selected for housing the equipment, and a Tandberg Series 6 was fitted. Also incorporated was a Thorens TD124 turntable, together with an Ortofon cartridge and arm tracking at 2.5 grams.

Before the floorboards were put down by the builders, wiring was installed to provide stereo in the lounge, kitchen and principal bedroom.

Mr. Holding states that the results have been more than satisfying, and that the sound of a pipe organ is almost breath-taking. Incidentally, if any reader wishes to hear the installation (Sundays excepted), he can do so by appointment with Holdings of Blackburn, Ltd.



Installing high fidelity equipment without upsetting the harmony with other furniture. This "Queen Anne" cabinet houses two Quad power amplifiers as well as a Quad control unit and a.m. and f.m. tuners. Also visible are a Thorens TD124 turntable and a Tandberg Series 6 tape recorder



### 1965 Ahead!

Here we are once more, throwing away the old calendars and starting yet another year; and if anybody

mentions cold turkey to me again I shall merely give a wan dyspeptic smile.

We now enter 1965, and I do

hope that it will be truly prosperous for all of you.

Happy New Year!

## FARADAY LECTURE 1965

"Colour Television" by F. C. McLean, C.B.E., B.Sc., M.I.E.E.

### SCHEDULE OF TOUR

| Date              | Place                                 | Time                                                       | Tickets from                                                                                                                               |
|-------------------|---------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 19 January, 1965  | BIRMINGHAM<br>(City Hall)             | 7 p.m. (Students' Lectures)<br>10.30 a.m. and 2.30 p.m.)   | Mr. J. Terry, T.D., M.I.E.E., 43 Somerville Road, Sutton Coldfield, Warwicks.                                                              |
| 21 January, 1965  | LEICESTER<br>(De Montfort Hall)       | 7.15 p.m. (Students' Lecture<br>2.30 p.m.)                 | Mr. G. M. Bayley, B.Sc.(Eng.), A.M.I.E.E., c/o Brush Electrical Engineering Co. Ltd., Rotating Machines Design Dept., Loughborough, Leics. |
| 26 January, 1965  | MANCHESTER<br>(Free Trade Hall)       | Evening (Students' Lecture<br>afternoon)                   | Mr. F. R. Perry, M.Sc.Tech., M.I.E.E., c/o Miss Lucas, Engineering Management, A.E.I. (Manchester) Ltd., Trafford Park, Manchester 17      |
| 28 January, 1965  | STOKE-ON-TRENT<br>(Victoria Hall)     | 7.30 p.m.                                                  | Mr. G. W. Pate, B.Sc., A.M.I.E.E., c/o The English Electric Co. Ltd., Stafford                                                             |
| 9 February, 1965  | PORTSMOUTH<br>(Guildhall)             | 6.30 p.m. (Students' Lecture<br>2.30 p.m.)                 | Mr. H. V. Harley, B.Sc., A.M.I.E.E., 72 Maylands Road, Bedhampton, Hants.                                                                  |
| 17 February, 1965 | LONDON (Central<br>Hall, Westminster) | 6 p.m. (Students' Lecture<br>18 February, 6 p.m.)          | Mr. L. H. Cullingford, The I.E.E., Savoy Place, London, W.C.2                                                                              |
| 24 February 1965  | BRADFORD<br>(St. George's Hall)       | 7.30 p.m. (Students' Lecture<br>2.30 p.m.)                 | Mr. G. Sheppard, A.M.I.E.E., C.E.G.B., St. Mary's Road, Leeds 7                                                                            |
| 2 March, 1965     | SHEFFIELD<br>(City Hall)              | 7.30 p.m. (Students' Lectures<br>10.30 a.m. and 2.30 p.m.) | Mr. J. R. Barratt, B.Sc., A.M.I.E.E., 6 Burnstones Close, Sheffield 10                                                                     |
| 16 March, 1965    | DUBLIN<br>(Mansion House)             | Evening                                                    | Mr. M. J. Forde, B.E., A.M.I.E.E., 27 Lower Fitzwilliam Street, Dublin 2                                                                   |
| 18 March, 1965    | BELFAST<br>(Ulster Hall)              | Evening                                                    | Mr. R. L. Marrs, A.M.I.E.E., Gallaher Ltd., Virginia House, York Street, Belfast 15                                                        |
| 1 April, 1965     | EDINBURGH<br>(Usher Hall)             | Evening (Students' Lecture<br>afternoon)                   | Mr. J. A. Stewart, A.M.I.E.E., 11 Dryburgh Gardens, Glasgow, N.W.                                                                          |
| 6 April, 1965     | NEWCASTLE<br>(City Hall)              | 7.15 p.m. (Students' Lecture<br>2.30 p.m.)                 | Mr. T. H. Charlton, A.M.I.E.E., 21 Dorset Avenue, South Shields, Co. Durham                                                                |

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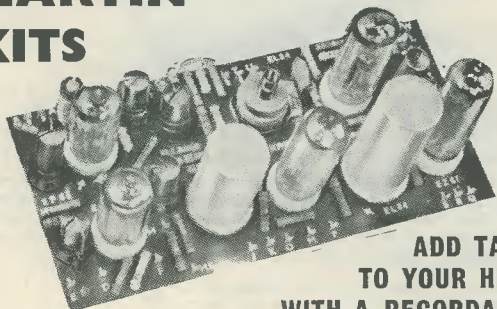
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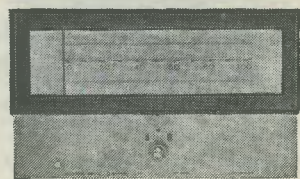
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*continued from page 429*

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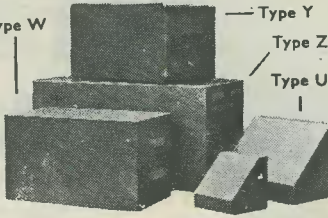
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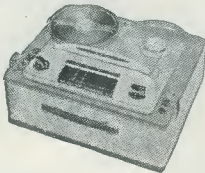
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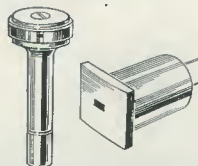
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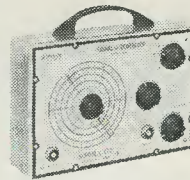


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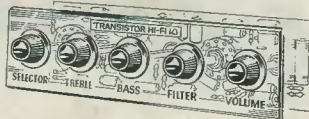
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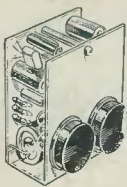
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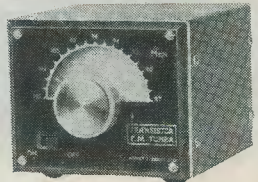
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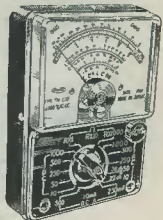


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