THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 16 NUMBER 10
A DATA PUBLICATION
PRICE TWO SHILLINGS

May 1963

An EF183 Preselector

Also featured

4-Transistor Amplifier
●
Dual-Speed Teleprinter Governor
●
"Neogen" A.F./R.F. Signal Generator
●
R107 Receiver for Amateur Use
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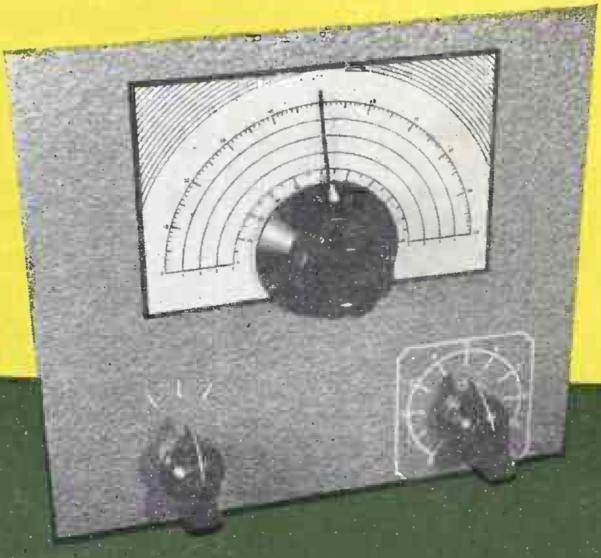

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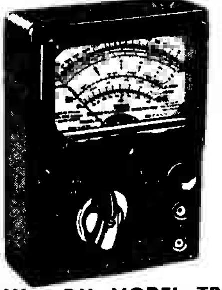

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As described in *"THE RADIO CONSTRUCTOR"*, August issue

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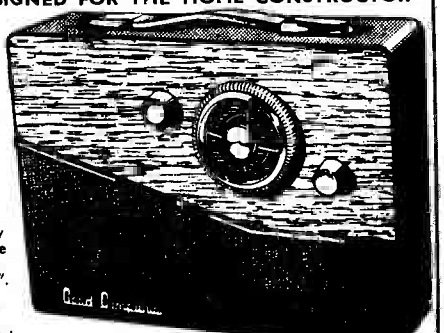

- ★ 750mW output.
- ★ 6 transistors and 1 diode.
- ★ Full Medium and Long Wave coverage.
- ★ Quality speaker.
- ★ Brilliantly styled 2-tone cabinet, size 11" x 8" x 3".
- ★ Very fine tuning with calibrated dial.

★ Latest printed circuit. ★ Internal high gain aerial with car aerial socket. Easy to follow construction data (available separately 3/6). All parts sold separately and full illustrated details will be sent on request. Total Cost **£9.19.6**

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

"Practical Wireless" 6 TRANSISTOR PERSONAL RECEIVER. 2 band, printed circuit, etc. Building cost **£7.19.6. "Pocket 4"** TRANSISTOR PERSONAL. Ideal for beginner. Building cost **42/6.**

All components sold separately, price lists for either of above, SAE.

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The SPRITE

A 6-TRANSISTOR SUPERHET MINIATURE PERSONAL POCKET RADIO

- ★ Fully tuneable over Long and Medium wavebands.
- ★ Uses single PP3 battery.
- ★ Ferrite Rod aerial.
- ★ High sensitivity circuit.
- ★ I.F. Frequency 470 kc/s.
- ★ Transistors used: 3 x Philco 2067's, 2 x Mullard OC81 M, OC81 DM and OA90 diode.
- ★ 3" speaker.
- ★ Printed circuit 2¼" x 2".
- ★ Slow Motion Drive.
- ★ In very attractive plastic case, size 4" x 2½" x ¾".

FOR YOUR CONVENIENCE and in order to ensure perfect results, **The Sprite** is supplied to you with R.F. and I.F. stages. Driver and Output stages, ready built with all components ready mounted on the printed circuit. In order to complete assembly you only have to fit the wave-change switch, tuning condenser and drive, volume control, earphone socket and aerial rod; the remaining components all having been prefitted at the factory for you. **The Sprite** is offered as above, pre-assembled, plus cabinet, speaker and all components for final construction at the inclusive price of **79/6** *Postage and Packing 3/6 extra*

Data and Instructions separately **2/6**. Refunded if parcel is purchased. Real calf leather case, wriststrap, personal earphone and case for earphone and battery **12/6** the lot extra. Make no mistake this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

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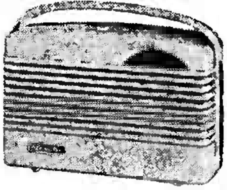
REALISTIC "7"

The finest receiver at present available for home construction. Fully tunable long and medium wavebands. Uses 7 Mullard Transistors: OC44, 2 OC45s, OC71, OC81D and 2 OC81s, plus Crystal Diode OA70.



£5.19.6

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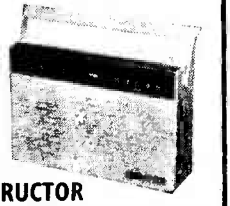
7 Transistor Superhet. 350 milliwatt output into 4" high flux speaker. All components mounted on a single printed circuit board, size 5½" x 5½", in one complete assembly. Plastic cabinet with carrying handle, size 7" x 10" x 3½", in choice of colours: red/grey, blue/grey, all grey. Easy to read dial. 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.

CAN BE BUILT FOR £5.19.6

PP9 Battery 3/9 extra. *P. & P. 4/6 extra.*

Data and instructions separately, 2/6, refunded if you purchase the parcel.

THE Corover "6"



as featured on page 603 of the March issue of

RADIO CONSTRUCTOR

A SUPERHET 6-TRANSISTOR PLUS TWO DIODE RECEIVER USING THE LATEST CIRCUITRY.

- ★ Three Mullard AF117 alloy diffused transistors are used with OA79 and OA91 diodes, followed by OC81D and two OC81s in push-pull. I.F. Frequency 470 kc/s.
- ★ Covers the full medium and long wavebands.
- ★ Sockets are provided for a personal earpiece or tape recorder, and car radio aerial. Large internal ferrite rod aerial gives high sensitivity. Operates from four 1.5 volt pen torch batteries.
- ★ All components mounted on a single printed circuit. Easy to build from simple stage-by-stage instructions.
- ★ Cabinet size 6½" x 4" x 1½". With carrying handle. All coils and if.s ready wound.

£5.7.6 P. & P. 4/– extra. Data and instructions separately 2/6. Refunded if you purchase the parcel.

All components available separately

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SCOOP!!

Brand new and unused—by famous British manufacturer. Fully guaranteed. Original list price £26.18.11.

A fully transistorised go-anywhere portable that automatically becomes a car radio simply by sliding into a metal car-tray.

★ Covers full medium and long wave band ★ All-transistorised superhet ★ Internal ferrite rod aerial ★ Press button wave change ★ All connections to car battery—booster speaker—car aerial automatically accomplished by sliding into metal car-tray.

Battery drain is exceptionally low—the life of the self-contained battery within the set is approx. 200 hours. Transistors used: 1 OC44, 2 OC45, 1 OC82d, 2 OC82 and diode. Compares with set costing at least double.

Contemporary finish in two-tone red and grey vyanide, washable material. Supplied complete with car extension loudspeaker, car-tray and full easy-to-follow fixing instructions.

Internal loudspeaker provides ample volume as a portable. Separate 8" x 5" speaker with 8" x 6" baffle, for car fixing.

Carrying handle folds away when not in use. The scale is illuminated when the set is operating in the car-tray.

Dimensions 9½" x 7½" x 3".

As a car radio this receiver operates only from a 12V electrical system, either positive or negative earth. As a portable it is powered by its own internal battery type PP9 or equivalent.

LASKY'S PRICE £10.19.6

complete with tray, all car fittings, 8" x 5" car speaker and baffle. **Carr. and Pack 7/6 extra.** PP9 Battery 3/9 extra, supplied with full fitting and installation instructions.

BETA TWO

A 2-Transistor plus 2 diode personal receiver for home construction. Uses printed circuit and ferrite rod aerial. Personal earphone gives clear reception for private listening. Tunes over full medium waveband. Size 5¾" x 3½" x 1½" overall. All components available separately.

Can be built for 21/-

Postage 2/6 extra

including personal earphone, cabinet, etc. Circuit diagram and step-by-step instructions 1/6. (Free with parcel.)

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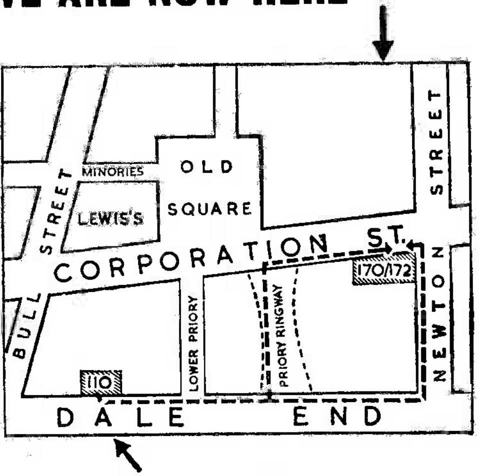
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SINGLE SIDEBAND ADAPTOR. Model SB-10U. May be used with most A.M. transmitters. Less than 3W R.F. input power required for 10W output. Operation on 80, 40, 20, 15 and 10m bands on U.S.B., L.S.B. or D.S.B. **£39.5.0**

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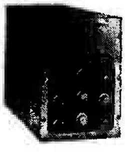
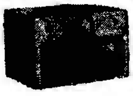
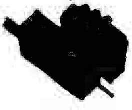
2½" SERVICE 'SCOPE. Model OS-1. Light, compact portable for service engineers. Dim. 5" x 8" x 14½" long. Wt. 10½lb. **£19.19.0**

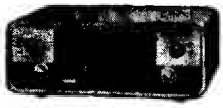

SB-10U


DX-40U


GD-1U


"GLOUCESTER"


GL-58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HI-FI AM/FM TUNER, Model AFM-1. Available in two units which, for your convenience, are sold separately. Tuning heart (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£20.13.0). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total **£25.6.6**

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GARRARD AUTO/RECORD PLAYER, Model AT-6. With Ronette 105 cartridge. **£13.12.1** With Decca Deram pick-up **£14.6.1**

Prices include free delivery in U.K.

☆ Construction is so simple from start to finish

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XIR-1U (remote)	**£4.7.6**
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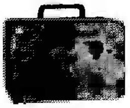
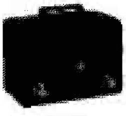
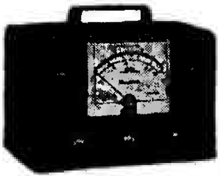
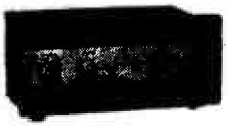
SUGDEN MOTOR UNIT "CONNOISSEUR CRAFTSMAN". Heavy duty motor operating at 33⅓ and 45 r.p.m. Very heavy 12" turntable. Virtually no rumble. **£16.6.6**

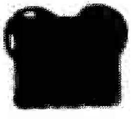

O-12U


S-3U


C-3U


AG-9U


S-33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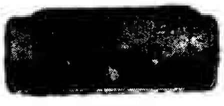
TA-1S

NEW 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. **£15.17.6**

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. Sensitivity 200mV. **£13.7.6**

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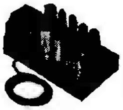
HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Presentation similar to S-33. **£10.19.6**

4 W-B TRANSISTOR PORTABLE RECEIVER. Model RSW-1. In a handsome leather case it has retractable whip aerial and socket for car radio use. Covers Med., Trawler and two S wave bands. **£19.17.6**

HI-FI SINGLE CHANNEL AMPLIFIER. Model MA-12. 12W output, wide freq. range, low distortion. **£11.9.6**

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. **£5.2.6**


MA-12

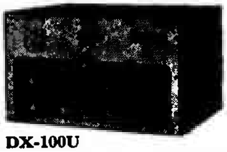

RSW-1

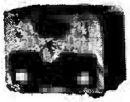
ANNOUNCING OUR NEW INTERNATIONAL MAIL ORDER SCHEME COVERING AMERICAN HEATHKIT RANGE OF 250 MODELS.

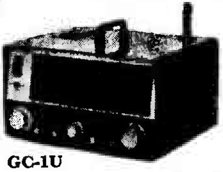
For direct delivery from U.S. Plant to your U.K. address. **Latest American Heathkit catalogue** *and full details of the scheme can be obtained from us at the nominal charge of 1/–, post paid.*

SEND FOR **FREE** ILLUSTRATED BRITISH CATALOGUE TO

You can build any of these Models


DX-100U


VF-1U


GC-1U

NEW MODEL! BASIC 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. Amplifier Stage. Full specification sheet available on request. **£39.6.6**

THE "MOHICAN" GENERAL COVERAGE RECEIVER. Model GC-1U. With 4 piezo-electric transfilters, 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 circuit boards, telescopic whip antenna, tuning meter and large slide-rule dial, 10 transistors. **£39.17.6**

AMATEUR TRANSMITTER. Model DX-100U. The world's most popular, compact and completely self-contained Amateur Transmitter. Covers all amateur bands: 160–10 m. 150W d.c. input. Careful design has achieved the stability and high performance for which the DX-100U is noted and no less than 35 disc ceramic capacitors reduce TVI to a minimum. **£74.19.0**

VARIABLE FREQUENCY OSCILLATOR. Model VF-1U. Calibrated, 160–10 m. Fundamentals on 160 and 40 m. Ideal for our DX-40U and similar transmitters. **£11.17.6**

Deferred terms available over £10


V-7A


MM-1U


RF-1U

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. **£13.18.6**

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. 4½" 50μA meter. **£12.10.0**

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£12.15.6**

AUDIO WATTMETER. Model AW-1U. Up to 25W continuous, 50W intermittent. **£15.15.0**

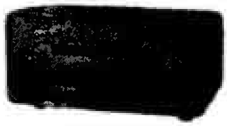
AUDIO VALVE MILLIVOLTMETER. Model AV-3U. 1mV–300V A.C. 10 c/s to 400 kc/s. **£14.17.6**

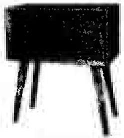
AUDIO SINE-SQUARE WAVE GENERATOR. Model AO-1U. Covers 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V, distortion less than 1%. **£13.15.0**

The instruction manual guides you step-by-step☆


USC-1


Truvox D83


FM TUNER


SSU-1

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 (£12.6.0). Total **£15.1.0**

TRUVOX D83 & D84 TAPE DECKS. High quality mono/stereo tape decks.
D83, 2 track, for highest fidelity. **£31.10.0**
D84 (identical presentation), 4-track. **£29.8.0**

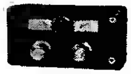
STEREO CONTROL UNIT. Model USC-1. Push-button selection, accurately matched ganged controls to ±1dB. Negative feedback, rumble and variable low-pass filters. Printed circuit boards. **£19.10.0**

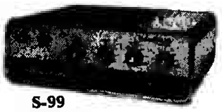
ELECTRICITY MAINS EXTENSION KIT. Model PUE-1. Completely safe, conforms fully to I.E.E. Regulations, ideal light and power source to out-buildings (or for soil heating). Complete with sockets, cables, switches, lampholder, junction box, etc. **£4.15.6**

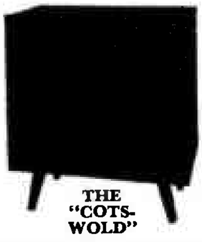
MAINS POWER SUPPLY—BATTERY ELIMINATOR KIT. Model UBE-1. Designed to supply 9V or 12V d.c. to transistor receivers. Many other uses. Sizes: 3$\frac{5}{16}$" x 2¼" x 1¼". **£2.17.6**

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. **£12.11.0**

TELEPHONE AMPLIFIER. Model TTA-1. Easy-to-assemble. Transistorised, enables hand-free conversation. Ivory toned cabinet. **£7.9.6**


UJR-1


S-99


THE "COTSWOLD"

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

CAPACITANCE METER. Model CM-1U. Direct-reading 4½" scale. Full-scale ranges 0–100μμF, 0–1,000μμF, 0–0.01μF and 0–0.1μF **£15.15.0**

HEATHKIT ELECTRONIC WORKSHOP. Model EW-1. This educational kit will teach and amuse your children. It can make 21 exciting experiments including transistor radios, burglar alarm, radio or TV silencer, intercom, etc. **£7.13.6**

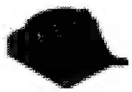
JUNIOR TRANSISTOR RADIO. Model UJR-1. Single transistor set. Excellent introduction to radio. An instructive present. **£2.7.6**

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

THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15½" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo.

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 16½" wide x 14½" deep. Either Model, **£23.4.0**


UXR-1


TTA-1

Assembled *models also available* — **prices** *on request.*

DAYSTROM LTD DEPT. RC5 GLOUCESTER

Without obligation please send me (Tick here)
FREE BRITISH HEATHKIT CATALOGUE .... ☐
FULL DETAILS OF MODEL(S) .... ☐
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COLLARO STUDIO TAPE RECORDER KIT

SPECIAL BARGAIN OFFER. Comp. Kit only **£25** *Carr.* 12/6

Famous mfr's. surplus offer—listed 42 gns. A quality Tape Recorder Kit based on Mullard's famous design—EF86, ECC83, EL84, EM81 and Rectifier. Specially designed Kit for Collaro latest Studio Deck, freq. response ±3dB, 60 c/s–10 kc/s. Amp. and Power Pack already wired, inter. unit wiring only required. Cabinet size: 18" x 16½" x 6" finished in contemp. 2-tone blue Rexine with gilt Speaker Escutcheon. Magic Eye indicator. Circuit and Tech. H/book. supplied free with kit. *Send 3d. stamp now for full details of today's outstanding Tape Recorder Bargain.*

TWELVE ONLY OF THESE COMPLETE KITS NOW LEFT £12.19.6 *P. & P.* 10/–

SPECIAL OFFER! Cabinet and cut-out mounting board and Collaro Studio Tape Deck. **£13.10.0**, carr. 10/–.

New Boxed VALVES All Guaranteed

1T4	6/–	ECC83	8/–	PCC84	9/6
1R5	7/6	ECL82	10/6	PCF80	9/6
1S5	7/6	ECL80	10/6	PCL83	12/6
3S4	7/6	EF80	8/–	PCL84	12/6
3V4	7/6	EF86	12/6	PL81	12/6
DAF96	9/–	EL84	8/6	PL82	9/6
DF96	9/–	EY51	9/6	PL83	10/6
DK96	9/–	EY86	10/–	PY32	12/6
DL96	9/–	EZ81	7/6	PY81	9/6
ECC81	8/–	GZ32	12/6	PY82	7/6
ECC82	8/–	EM84	9/6	U25	12/6

Electrolytics All Types New Stk.

TUBULAR		CAN TYPES	
25/25V	1/9	8+8/450V	4/6
50/12V	1/9	16+16/450V	5/6
50/50V	2/–	32+32/275V	4/6
100/25V	2/–	50+50/350V	6/6
8/450V	2/3	60+250/275V	12/6
4/350V	2/3	100+300/275V	12/6
16+16/450V	5/6	2000+4000/6V	3/6
32+32/450V	6/6		
1000/25V	3/9		

Ersin Multicore Solder 60/40 3d. per yard. ¼lb. 2/6, etc.

RECORDING TAPE—*REDUCED BARGAIN PRICES*

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 foils.

	Standard	Long Play	Double Play
5"	600ft, 13/–	900ft, 17/6	1,200ft, 31/6
5¾"	900ft, 16/–	1,200ft, 19/6	1,800ft, 37/6
7"	1,200ft, 21/–	1,800ft, 28/6	2,400ft, 47/6

Post and Packing, per reel, 1/–, plus 6d. each for additional reels.

SPECIAL OFFER—3" mfrs. surplus tape, Std. 150 ft. 3/9, L.P. 225 ft. 4/9. D.P. 300 ft. 6/6. P. &. P per reel 6d. Plastic Tape Reels 3" 1/3, 5" 2/–, 5¾" 2/–, 7" 2/3. Plastic Spool Containers 5" 1/6, 5¾" 2/–, 7" 2/3

Jack Plugs. Standard 2½" Igranic Type, 2/6. Screened Ditto, 3/3. Miniature 1½", 2/3. Screened Ditto, 2/6.

Jack Sockets. Open Igranic Moulded Type, 3/3. Closed Ditto, 3/9. Miniature Closed Type, 1/9. Sub-min (deaf aid) ditto, 1/3.

Phono Plugs 1/–. Phono Sockets (open), 1/–. Ditto Closed, 1/6. Twin Phono Sockets (open), 1/6.

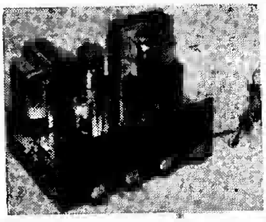
Soldering Irons. Mains 200/220V or 230/250V. Solon 25 watt Inst., 22/6. Spare Elements, 4/6. Bits, 1/– 65 watt, 27/6 etc.

Alumin. Chassis. 18g. Plain Undrilled, folded 4 sides, 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.

MULLARD "3—3" HI-FI AMPLIFIER

3 VALVES 3 WATT



3 ohm and 15 ohm Output

A really first-class Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit. Valve line-up: EF86, EL84, EZ81. Extra H.T. and L.T. available for Tuner Unit addition. This is the ideal companion Amplifier for FM tuner units.

TECHNICAL SPECIFICATION—Freq. Response: ± 1dB. 10 kc/s. Max. Bass Boost 14dB at 80 c/s sensitivity: 100MV for 3W output. Output Power (at 400 c/s); 3W at 1% total harmonic distortion. Hum and Noise Level: At least 70dB below 3W.

COMPLETE KIT (incl. valves, all components, wiring diagram and special quality sectional Output Trans.) **ONLY £6.19.6** carr. 4/6.

Complete wired and tested, **8 gns.** Wired power O/P socket and additional smoothing for Tuner Unit, **10/6** extra.

Bronze Escutcheon Panel, Printed Vol., Treble, Bass, On-Off, supplied with each Kit.

Recommended Speakers—R. & A. 12" with tweeter **52/6**, WBHF10–12 **£4.10.0**, Goodmans Axiette **£5.5.0**, Axiom 10 **£6.5.0.**

Volume Controls—5K–2 Megohms, 3" Spindles Morganite Midget Type. 1⅛" diam. Guar. 1 year. LOG or LIN ratios less Sw. 3/–. DP. Sw. 4/6. Twin Stereo less Sw. 6/6. D.P. Sw. 8/–.

COAX 80 OHM CABLE

High grade low loss Cellular air spaced Polythene—¼" 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/–. Sockets 1/–. Couplers 1/3. Outlet Boxes 4/6.

Close Tol. S/Micas—10% 5pF–500pF **8d.** 600–5,000pF 1/–. 1% 2pF–100pF **9d.** 100pF–500pF **11d.** 575pF–5,000pF **1/6.** **Resistors—Full Range** 10 ohms–10 megohms 20% ¼ and ½W **3d.**, ¾W **5d.** (Midget type modern rating) 1W **6d**, 2W **9d.** **Hi-Stab** 10% ¼W **5d.**, ½W **7d.** 5% ¼W **9d.**, 1% ½W **1/6.** **W/W Resistors** 25 ohms to 10K 5W **1/3**, 10W **1/6**, 15W **2/–**. **Pre-set T/V Pots. W/W** 25 ohms.–50 K **3/–**. 50 K–2 Meg. (Carbon) 3/–.

JASON FM TUNER UNITS

Designer-approved kits of parts:
FMT1, 5 gns. 4 valves, **20/–.**
FMT2, £7. 5 valves, **37/6.**
JTV MERCURY 10 gns.
JTV2 £13.19.6. 4 valves, **32/6.**
NEW JASON FM HANDBOOK, 2/6. 48 hr. Alignment Service **7/6.** P. & P. 2/6.

Speakers P.M.—3 ohms 2½" E.M.I. **17/6.** Goodmans 3½" **18/6.** 5" Rola **17/6.** 6" Elac **18/6.** 7" x 4" Goodmans **18/6.** 8" Rola **20/–.** 10" R. x A. **25/–.** 9" x 6" Goodmans **25/–.** E.M.I. Tweeter **29/6.**

Speaker Fret—Expanded bronze anodised metal ¼" x ¼" diamond mesh, **4/6** sq. ft., multiples of 6" cut. Max. width 4 ft.

TYGAN FRET (contemp. pat.) 12" x 12" **2/–**, 12" x 18" **3/–**, 12" x 24" **4/–**, 18" x 18" **4/6**

BARGAINS 4-SPEED PLAYER UNITS

Single Players	carr. 3/6
Garrard SRB10	£5.5.0
B.S.R. Latest Model TU12	72/6
E.M.I. Junior "985"	67/6
Auto-Changers	carr. 5/–
Garrard AT6 Mono	9 gns.
Garrard "Auto-Slim"	£6.15.0
Collaro C60	£6.19.6
B.S.R. (UA14)	£6.10.0

ENAMELLED COPPER WIRE—¼lb reels, 14g-20g, **2/6**; 22g-28g, **3/–**; 30g-40g, **3/9.** Other gauges quoted for.

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

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s 7/16" diam.	5/6
Osc. Coil—7/16" diam. M/W.	5/3
Osc. coil M. & L.W.	5/9
Midget Driver Trans. 3.5:1	6/9
Ditto O/Put Push-pull 3 ohms	6/9

Elect. Condensers—Midget Type 12V 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. ¾" 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.** 2½" 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.**

TRANSISTOR BARGAINS

Brand New—BVA 1st Grade

OC44	8/6	OC70	5/6
OC45	8/–	OC71	6/–
OC81	7/6	GEX34	2/9
2/OC81	15/6	OA70	2/9
GET114	6/6	OA81	2/9
OC72	7/6		

SPECIAL OFFER

OC44 2/OC45	21/6	OC81D 2/OC81	19/6

TRIMMERS, Ceramic (Compression Type)—30pF, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, **1/9.**

PHILIPS, Bee Hive Type (conc. air spaced)—2-8pF, **1/–**; 3-30pF, **1/–.**

KNOBS—Modern Continental types: Brown or Ivory with Gold Ring, 1" dia., **9d.** each; 1⅜", **1/–** each; Brown or Ivory with Gold Centre, 1" dia., **10d.** each; 1⅜", **1/3** each. LARGE SELECTION AVAILABLE.

METAL RECTIFIERS, STC Types—RM1, **4/9**; RM2, **5/6**; RM3, **7/6**; RM4, **16/–**; RM5, **21/–**; RM4B, **17/6.**

RECORD PLAYER CABINETS

Contemporary style, rexine covered cabinet in mottled red and white polka dot. Size 18½" x 13½" x ht. 8¼", fitted with all accessories including baffle board and anodised metal fret. Space available for all modern amplifiers and auto-changers, etc. Uncut record player mounting board 14" x 13" supplied.

Cabinet Price £3.3.0 Carr. and Ins. 5/–

2-VALVE 2 WATT AMPLIFIER

Twin stage ECL82 with vol. and neg. feedback tone control. A.C. 200/250V with knobs, etc., ready wired to fit above cabinet. **£2.17.6.** P. & P. 1/6. 6" Speaker and trans. **22/–**. P.P. 2/–

COMPLETE R/PLAYER KIT. As ill. inc. BSR UA14 Unit Reduced Price £12.10.0. Carr. 7/6.

Ditto **RECORD PLAYER KIT with BSR UA20 Unit. New Reduced Price £11.19.6.** Carr. 7/6.

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. Quotation by return

TRS
Est. 1946

RADIO COMPONENT SPECIALISTS

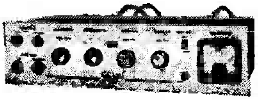
70 Brigstock Rd., Thornton Heath, Surrey
THO 2188 *Hours; 9 a.m., —6 p.m., 1 p.m. Wed. Terms C.W.O. or C.O.D. Post and Packing up to ¼ lb 9d., 1 lb.,* 1/3 3 lb., 2/3 5 lb., 2/9 8 lb. 3/6

Stern's

SPECIALISTS IN SOUND EQUIPMENT FOR OVER 25 YEARS

TAPE RECORDING EQUIPMENT

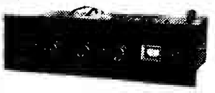
STEREO TAPE PRE-AMPLIFIER



Model STP-1. For use with current TRUVOX, BRENELL or COLLARO " STUDIO" ½ and ¼ track Stereo Decks. Incorporates Ferroxcube Oscillator, 4-speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.

KIT OF PARTS **£22.0.0** ASSEMBLED AND TESTED **£28.0.0**

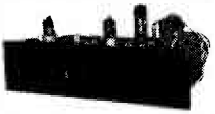
MULLARD'S TYPE "C" TAPE PRE-AMPLIFIER



Suitable for most ½-track Mono Tape Decks. Incorporates Ferroxcube Push Pull Oscillator and 3-Speed Treble Inductor. Includes separate Power Unit.

KIT OF PARTS **£14.0.0** ASSEMBLED AND TESTED **£19.10.0**

MULLARD'S TAPE AMPLIFIER (Model HF/TR3)



Based on Mullard's Type " A " design and suitable for most ½ track Mono Tape Decks. Incorporates Ferroxcube 3-speed Treble Inductor and Gilsen Output Transformer. Includes separate Power Unit.

KIT OF PARTS .... **£13.13.0** ASSEMBLED AND TESTED **£19.0.0**

STERN'S "ADD-A-DECK"

A self-contained Unit consisting of Garrard Deck and matched Pre-amplifier on one chassis. Provides full tape recording facilities and replays through Pick-up Sockets of standard Radio receiver or Amplifier.

PRICE: Includes Complete Tape Magazine **£18.18.0**

TAPE DECKS AND COMPLETE RECORDERS

By Collaro, Brenell, Truvox, Wearite, Grundig, Ferrograph, Philips and others . . . Descriptive leaflets readily available.

Mk. II "Fidelity" FM TUNING UNIT

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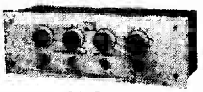

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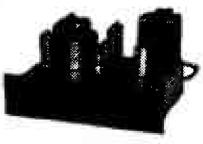

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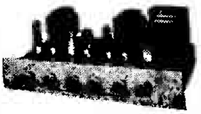

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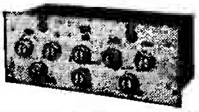

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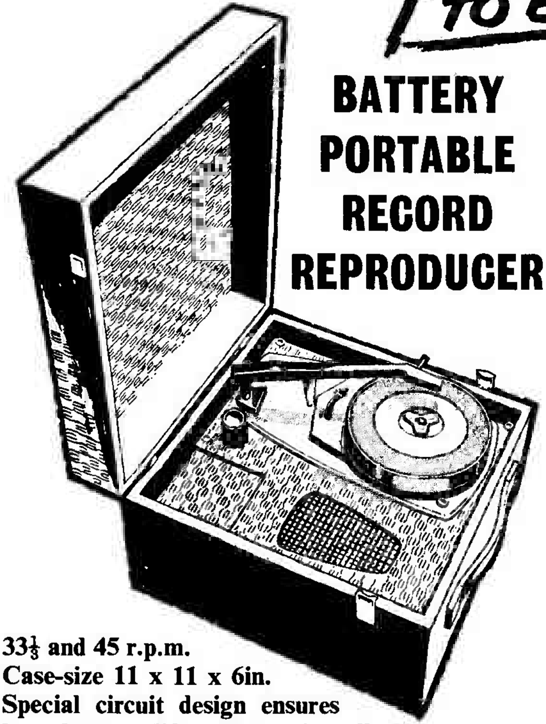

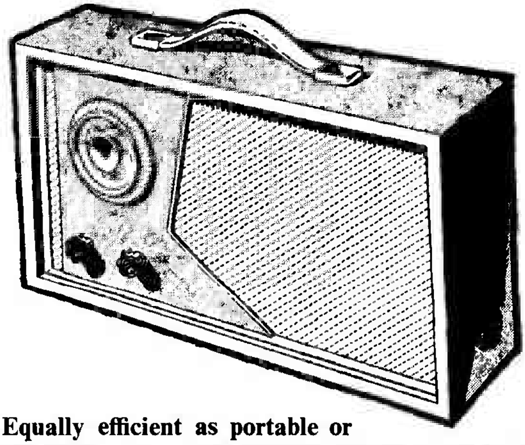

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We would like to thank all those constructors who have written us such pleasant letters and to apologise for slight delays in delivery which have occurred owing to the overwhelming demand. However we have now increased our staff to cope with this and can give a very prompt service.

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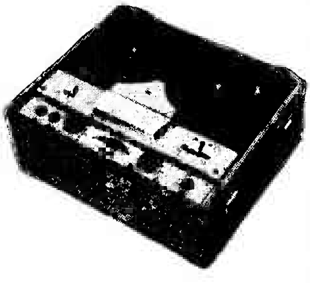

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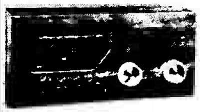

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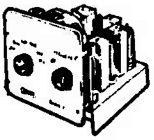

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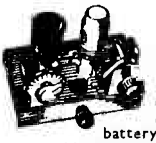

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TECHNICAL QUERIES must be submitted in writing. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

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

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"TRANSISTOR QUARTET"

By A. S. Carpenter

ALTHOUGH THIS PHYSICALLY SMALL AND SELF-contained transistor amplifier was constructed for use with a gramophone crystal pick-up it could also be employed as a receiver "back end", various "front ends" of the t.r.f. or superhet variety being separately constructed and subsequently connected for comparison purposes or to form a complete receiver.

Whilst a t.r.f. type tuner might need the full amplifier in order to provide adequate audio output, a superhet version would usually be sufficiently sensitive to make the first stage unnecessary, in which case the arrangement could be reduced to a 3-transistor configuration. The amplifier input circuit would also need to be modified slightly to accommodate a tuner, especially if the full amplifier circuitry was used. The 3-transistor arrangement can also be driven by a crystal pick-up or tuner if desired although full output might not result.

Various 45 r.p.m. battery powered gram units are available for use with the amplifier, and all components specified are easily obtainable. The driver and output transistors should if possible be purchased as a set, and the output transistors must be a matched pair. No claims to "hi-fi" are made but the quality obtained is considered adequate for the uses envisaged. The quiescent current drain is approximately 7 to 9mA rising to some 25 to 30mA with average music, and the output is conservatively rated at 450mW when fed from a crystal pick-up delivering 0.5V at 1,000 c/s. If a pick-up of lower sensitivity is used the value of R$_1$ may be reduced slightly to, say, 680kΩ. With higher inputs a peak output power of 1 watt is feasible.

The Circuit

The circuit is shown in Fig. 1, where four transistors are employed fairly conventionally in grounded emitter mode. TR$_1$ functions as a pre-amplifier stage feeding the driver TR$_2$ which, in turn, operates the pair of OC81 output transistors working together in push-pull.

Under static conditions TR$_1$ operates with an emitter current of 0.5mA and, due to the high impedance input, the feed capacitor C$_2$ can be kept to a reasonably low value, e.g. 0.01μF.

The emitter current of the driver transistor, TR$_2$, is 1.5mA and the base feed potentiometer, together with the supply circuit around TR$_1$, is decoupled by means of C$_3$, R$_8$. A potential of −7V appears on the negative plate of C$_3$.

In the output stage that bugbear of q.p.p. stages—cross-over distortion—is reduced by applying the

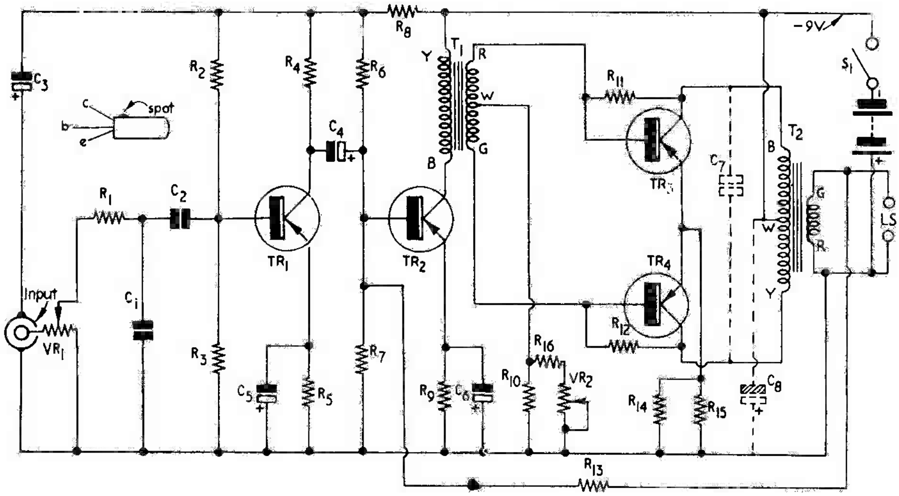
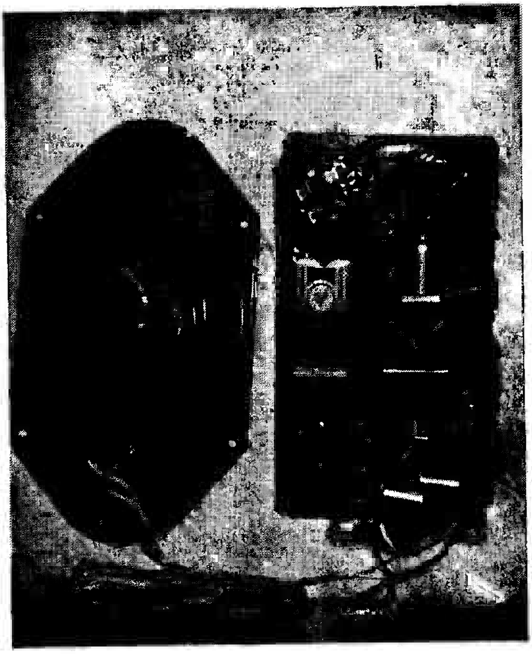


Fig. 1. The circuit of the amplifier

usual small forward bias, and here the circuit is varied somewhat in the interests of quality. Two possible methods of supplying the required potential are illustrated in Fig. 2, method (*a*) being frequently used since it is easy to fit and consists of two resistors, R_1 R_2, arranged as a potentiometer across the supply and having a resistance ratio of approximately 50:1. The base of each transistor receives its potential via the driver transformer centre-tap. In method (*b*) a rearrangement enables the d.c. resistance of the halves of the secondary winding of T to be used and R_1 and R_2 then have a resistance ratio of 1:1. In Fig. 2 (*a*) R_1 may be made variable to permit the quiescent current to be set to a suitable level, and in Fig. 2 (*b*) a similar effect may be achieved by making both R_1 and R_2 variable. Choice of method depends largely upon the type of driver transformer used.

Referring back to Fig. 1 it will be seen that a part of both methods just described has been used, because an external variable resistance is introduced at the driver transformer secondary centre tap and consists of R_{10}, R_{16} and VR_2. The method of base resistor connection is similar to that depicted in Fig. 2 (*b*) except that the upper ends of the resistors are now connected to the output transistor collectors instead of to the negative rail. This introduces some a.c. feedback and improves stability. Although this circuit is likely to compensate automatically for slight matching inaccuracies



A general view of the prototype before heat sinks were fitted

Components List

Resistors–¼ watt, 10%

R_1	1.5MΩ
R_2	68kΩ
R_3	22kΩ
R_4	4.7kΩ
R_5	2.2kΩ
R_6	33kΩ
R_7	10kΩ
R_8	2.2kΩ
R_9	820Ω
R_{10}	100Ω
R_{11}	6.8kΩ, 5%
R_{12}	6.8kΩ 5%
R_{13}	56kΩ
R_{14}	20Ω
R_{15}	10Ω
R_{16}	100Ω
VR_1	1MΩ log. miniature potentiometer with d.p. switch
VR_2	150Ω miniature preset potentiometer

Battery

9V–PP3 or similar

Tagboard

Miniature 18-way, 4½ x 1½in Radiospares

Capacitors

C_1	330pF ceramic or mica
C_2	0.01μF ceramic or paper
C_3	100μF electrolytic, 15 w.v.
C_4	10μF ,, ,,
C_5	100μF ,, ,,
C_6	100μF ,, ,,
C_7	0.25μF (see text)
C_8	100μF electrolytic, 15 w.v. (see text)

Transistors

TR_1	OC45 Mullard	
TR_2	OC81D Mullard	
TR_3	OC81 ,,	Matched pair or part of a set
TR_4	OC81 ,,	

Input socket with plug

Belling-Lee flush mounting (Type L734/P and L734/S)

Miscellaneous

Panel material size 6 x 3½in. Heat sinks, speaker, etc.

T_1 Push/pull Driver transformer—Ardente type D.3053

T_2 Push/pull Output transformer—Ardente type D.30273—3Ω L.S.

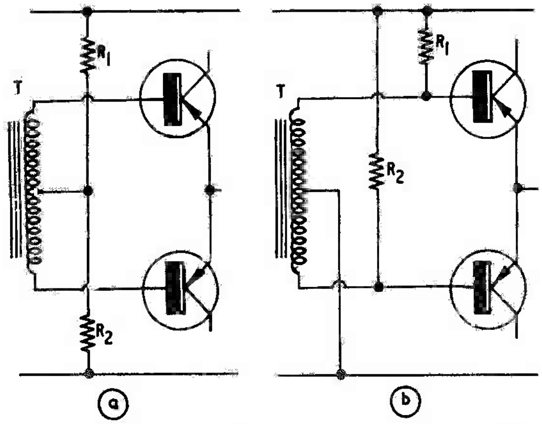


Fig. 2 (a), (b). Some bias arrangements for Class B push/pull output transistors

in the output transistors it is not adequate in itself; in consequence, matched output transistors are required and R_{11} and R_{12} should be selected from 5% stock. Final setting of the quiescent current in the output pair is accomplished by means of VR_2, which is a pre-set component.

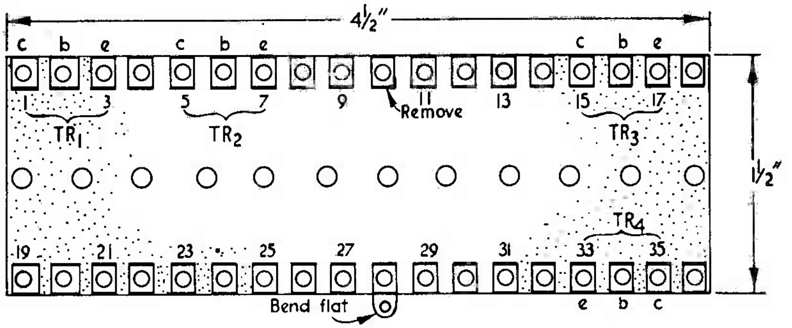


Fig. 3. Tagboard dimensions, showing tag numbering

Although it might be possible to dispense with R_{10} and R_{16} in certain cases, their inclusion is desirable to prevent the centre tap of T_1 from becoming accidentally disconnected from the positive supply rail should VR_2 prove faulty.

The common emitter resistor, R_{14}, R_{15}, is made up here of two components in parallel. A single resistor may be used if a suitable value is to hand.

A transformerless output circuit was originally envisaged but the idea, although attractive in some respects, was discarded mainly on the grounds that the cost of the high impedance speaker required would far exceed that of the output transformer it would displace. Also, it was considered that many readers would already have suitable 3Ω speakers in their possession. Transistors are usually associated with sub-miniature apparatus, but using the amplifier with a large speaker causes a greater air disturbance than that obtained from say a 2½in cone, so that the output is apparently increased and furthermore a better quality results. The inclusion of the output transformer means also that more than one loudspeaker of 3Ω impedance can be connected if desired. Heat sinks are not shown in the photographs of the prototype, but are essential for high output working. Details of suitable heat sinks are given later.

As in valved amplifiers feedback may be taken from the output transformer secondary, and here it is applied to the base of TR_2 via R_{13}. Benefit sometimes results from connecting a small value capacitor across the feedback resistor and this may be tried. A fixed capacitor of value approximately 0.25μF may also be tried across the primary winding of T_2, and this item is shown in dotted lines in Fig. 1 as C_7. Another capacitor similarly shown as C_8 might also prove beneficial in certain cases, especially when the battery voltage falls low and thereby introduces unwanted internal resistance.

Constructional Notes

The amplifier is built on a miniature 18-way tagboard affixed to a simple baseboard measuring

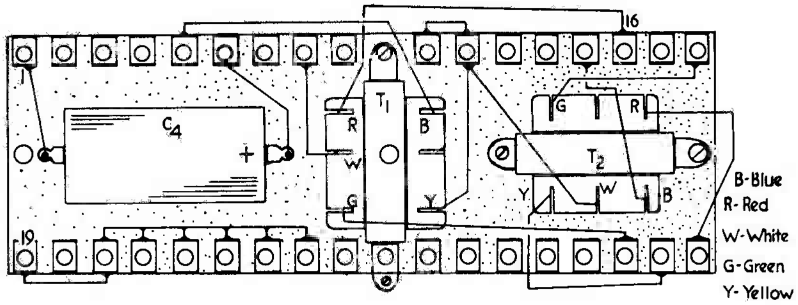


Fig. 4. How the transformers are mounted and connected

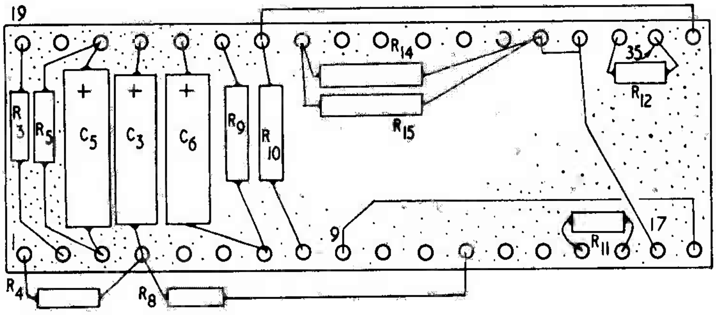


Fig. 5. The wiring below the tagboard

6 x 3½in only. The loudspeaker is considered an external unit.

Initial work is carried out on the tagboard. To simplify point-to-point wiring the tags are given numbers as depicted in Fig. 3, there being a total of 36 tags in all. These may be made identifiable if desired by appropriately affixing gummed paper and inking the figures on to it. Usually, however, it will be considered sufficient to locate tags 1 and 19 and check from there as construction proceeds.

Referring to Fig. 3 it will be observed that tags 1 to 3, 5 to 7, 15 to 17 and 33 to 35 are marked "c, d, e, TR_1," etc. At this stage these markings should be ignored. It is first necessary to remove tag 10 carefully, and to press tag 28 out flat as shown. The two transformers are next mounted as depicted in Fig. 4, the fixing clamps being positioned over the laminations so as to permit the five lead-out wires on each to protrude at the top as illustrated. The fixing lug of T_1 will project at one side as shown, and it becomes located over the opened-out tag 28, to which it should be bolted. The outside fixing bolt for T_2 is only fitted temporarily at this stage.

The rather springy lead-out wires will immediately prove troublesome, and so the next step is to connect them as shown in Fig. 4. Also fitted is C_4 which will remain, as will all other capacitors, quite firm without the aid of clips provided the leads are kept short. When the other minor wiring associated with Fig. 4 is complete the assembly should be turned over and the tag positions re-located as illustrated in the underside view of Fig. 5. The thirteen components shown here should now be connected, sleeving being fitted over all resistor and capacitor lead-out wires. When this wiring is completed the strip may be placed temporarily to one side and a baseboard of hardboard, Paxolin, etc., prepared to agree with Fig. 6. VR_1 and the input socket can be bolted in position, with VR_2 secured base down as illustrated by any convenient means.

Two 1¼in 4BA bolts are passed through the outermost fixing holes of the tagboard one of these replacing the temporary bolt securing T_2. Spacers 1in long are next slid over the bolts which are then passed through the holes already drilled in the base panel to receive them. Nuts are fitted and tightened, care being taken to ensure that no component mounted below the tagboard is fouled or squeezed, and that the tagboard is not distorted in any way. The assembly should now be completely rigid and should be as shown in Fig. 7.

The battery can now be clamped or otherwise fixed, and the wiring shown in Fig. 7 completed, taking care to see that S_1 is in the "Off" position. *The lead marked "X" should be left unconnected at this stage.*

The next step is to connect the transistors after each has had its lead-out wires fitted with suitable sleeving. Referring back to Fig. 3 the correct tags can be located and careful connections made using a heat shunt. The individual transistor leads may then be curved gently to bring the units into a convenient position as shown in the photograph.

Heat Sinks

One form of heat sink is depicted in Fig. 8, the sink proper consisting of 16 s.w.g. aluminium of "L" section mounted vertically, to which a clip made of slightly thinner metal is firmly bolted and which holds the transistor. Other methods are possible and even the clip alone is better than nothing at all. One thing is really important and that is to see that the clip fits snugly around the transistor so that it excludes all air yet does not exert excessive pressure.*

The type of sink shown in Fig. 8 can easily be fitted to this amplifier by mounting one on either side of the base panel.

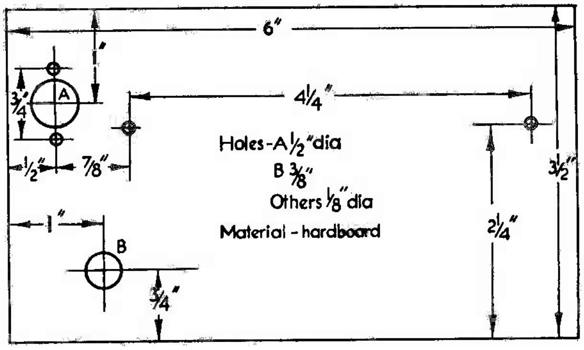


Fig. 6. Dimensions of the base mounting panel

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* The clip material specified by Mullard is 0.5 mm copper strip commercial half-hard to BS899.—EDITOR.

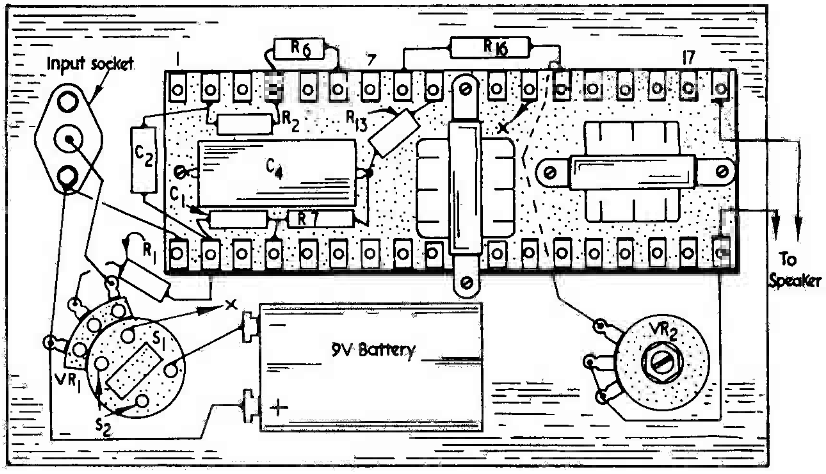


Fig. 7. Final stages of the wiring

After fitting the heat sinks, the wiring should be thoroughly checked and not until the constructor is completely satisfied should the connection marked "X" in Fig. 7 be made. It should be noted that C_7 and C_8 are not shown in the layout diagrams. These components may be fitted, if desired, after setting up.

Setting up

To set up, a meter adjusted to read 0–10mA should be connected in series with the white lead of T_2, and an external speaker connected to the amplifier. S_1 may be turned to "On" whereupon a reading of some 3 to 7mA should be obtained. This is the quiescent current of the output stage and VR_2 may be adjusted to bring the meter reading as low as is possible. With the meter still connected, but now switched to read 0–50mA, the output from a crystal pick-up may be connected via screened cable to the input, whereupon the appropriate recording should be heard as VR_1 is advanced. The action of the output stage will then be more fully appreciated for, on *fortissimo* passages, the meter pointer will swing upwards to indicate some 20 to 30mA or more, depending upon the setting of VR_1.

Unfortunately, over-economy due to too low a quiescent current can give rise to crossover distortion. If excessive distortion occurs, readjust VR_2 slightly to give a reading of say 5 to 6mA quiescent current and try again until best results are obtained in conjunction with the smallest practical quiescent current. Finally, the amplifier may be switched off and the meter removed.

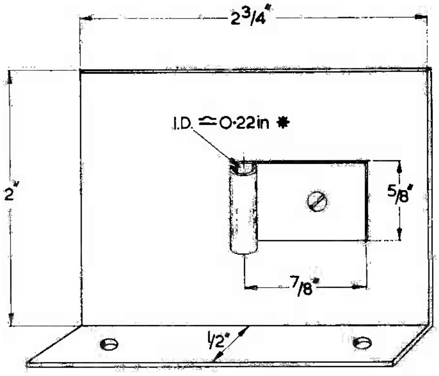


Fig. 8. Dimensions of suitable heat sinks for the output transistors. 16 s.w.g. aluminium should be used for the actual sinks and thinner metal for the clips. See text.

In conclusion, it will have been noted that one section (S_2) of the d.p. switch associated with VR_1 is shown unconnected in Fig. 7. This has been done deliberately so that the switch may be used to control ancillary apparatus such as a gram. motor.

B.B.C. TV and VHF Sound Transmitting Station at Forfar, Scotland

The B.B.C. has placed a contract with J. L. Eve Construction Co. Ltd. for the supply and erection of a 500-ft mast to carry the aerials of the new television and VHF sound station which is to be built at Harecairn near Forfar, Angus.

This is one of several stations which the B.B.C. is building to extend and improve the coverage of its television and VHF sound services in Scotland. It will serve the southern half of the county of Angus and parts of the adjoining counties of Kincardine, Perth and Fife. A separate television relay station is to be built to service the city of Dundee. It is expected that the Forfar station will be completed early in 1964.

Semiconductor Coding

By J. B. DANCE, M.Sc.

A NUMBER OF SYSTEMS HAVE BEEN USED FOR coding semiconductors, but many of these contain little or no information about the particular component to which they refer. For example, the American system merely carries the information as to whether the component is a diode or a transistor. In this system diodes are designated by 1N followed by a serial number, whilst transistors are designated by 2N followed by a serial number.

Many types of semiconductor are coded under the "Old European Code" which is really an adaptation of the Mullard system for coding valves (see "Valve Codes: What Do They Mean?", *The Radio Constructor*, August 1961). In this system the first letter is always an O which signifies that no heater supply is required. The second letter is an A if the component is a diode (e.g. OA81) or a C if the component is a transistor (e.g. OC71). The number which follows the letters is merely a serial number. A third letter is placed after the first two letters if the device is photosensitive or if it is a zener diode. For example, the OCP71 is a phototransistor, the P indicating that the device is photosensitive. The third letter in the case of a zener diode is a Z, for example OAZ200. In the old European coding all silicon semiconductor devices have a serial number between 200 and 300, except

The New European Semiconductor Code

FIRST LETTER	SECOND LETTER	SERIAL NUMBER	
		Non-Industrial Semiconductors	Industrial Semiconductors
A — Germanium device	A — Diode	The serial number is between 100 and 999	The serial number consists of a letter and two figures, for example Y11 or Z15
B — Silicon device	C — Audio transistor		
	D — Power transistor		
	E — Tunnel diode		
	F — R.F. transistor		
	L — R.F. Power transistor		
	P — Photosensitive device		
	S — Switching transistor		
	T — Thyristor, Shockley diode, or controlled rectifier		
	U — Power switching transistor		
	Y — Power diode		
	Z — Zener diode		

for the case of silicon rectifier stacks which are designated OSH or OSK followed by a serial number.

Many semiconductors which have recently been introduced are coded under the "New European Code", details of which are shown in the table. For example, the AAY11 is a germanium point contact diode whilst the BYZ12 is a silicon power diode rectifier. The AFZ11 is a germanium v.h.f. transistor, the AC107 is a low noise audio frequency germanium transistor and the ADZ12 is a germanium low frequency power transistor. The BTY27 is a silicon controlled rectifier. This code will probably be extended as new types of semiconductor device and new semiconductor materials become available.

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.

Pencil Soldering Iron.—R. Burns, The Hall, Cononley, Keighley, Yorks, has obtained this iron (Prov. Pat. 32532/47) which uses 6–12V from battery or transformer. The iron head ends with two carbon rods. Information required is the manufacturer's name, address, and/or instructions for use.

* * *

"The Radio Constructor" Indexes.—A. J. Smith, 37 Orchard Rise East, Sidcup, Kent, wishes to borrow or purchase the indexes for volumes 4, 5, 6, 7, 8, 9, 10, 11 and 15. All expenses met.

* * *

Hudson Radiogram.—H. Dunn, 23 Olinthus Avenue, Wednesfield, Staffs, would like to obtain the circuit diagram for this receiver. Existing valve line-up (mixer/oscillator is missing) is—6BA6 i.f., 6AT6 detector, 5Y3GT rectifier. Output valve is present but type number indecipherable.

* * *

Receiver Type 114.—J. Loosemore, 25 Lower Avenue, Heavitree, Exeter, Devon, requires information on this receiver and the associated i.f. chassis from the 1985 VHF Tx/Rx.

* * *

Canadian 52 Set and Radiovision Commander.—S. Smith, 19 Hyde Road, Kenilworth, Warks, requires to borrow or purchase the circuits or handbooks.

PCR3 Communication Receiver.—A. G. Elvy, 4 Fairway, Clifton, York, wants to purchase or obtain on loan the manual or circuit diagram for this receiver. Also would like to obtain details of any modifications including the addition of a b.f.o. stage.

* * *

Hallicrafters U.H.F. Receiver.—J. C. Knight, The Corner House, Manor Road, Tongham, Surrey, would be very grateful for the circuit of this receiver.

* * *

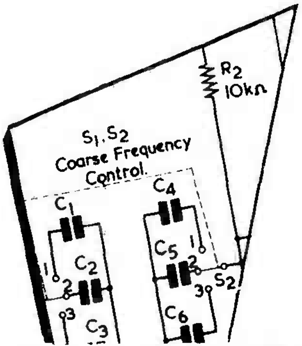
Bush Band III Converter Type 184.—A. B. Sammons, 141 Stroud Road, Shirley, Solihull, Warks, has the circuit and coil details of this unit but requires information on conversion to Band II including coil rewinding data.

* * *

Verdik S1 Hi-Fi Tape Deck.—W. C. Wallace, 20 Ridge Grove, Thatch Leach Lane, Whitefield, Manchester, requires to borrow or purchase the service sheet or obtain any information about this unit.

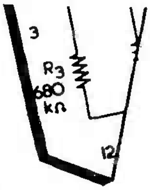
* * *

G.E.C. Miniscope, SW464 and R1392D Receivers.—A. C. Lewis, 41 West Street, Ryde, Isle of Wight, wishes to borrow or purchase the manuals or circuit diagrams of these units.



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

suggested circuits



No. 150 Two-Transistor Relaxation Oscillator

Audio oscillators are always useful in service and experimental work, wherein they can be employed for signal tracing, the energising of bridges, and for other functions. Frequently, all that is desired in this respect is a device which produces an a.f. tone at high amplitude. If such a device may be constructed in a small space with just a few inexpensive and non-critical components it becomes proportionately more attractive.

This month's article discusses a circuit which is capable of meeting these requirements. Two transistors are employed in a simple relaxation oscillator circuit whose frequency may be varied by a single potentiometer. Component values are not critical, and most a.f. transistors should give adequate results. The power supply can be provided by a 3 volt battery or by a single 1.5 volt cell as desired, current consumption averaging at 80μA for the 3 volt supply and at 45μA for the 1.5 volt supply. As may be noted, current requirements are extremely low, and the use of a very small battery or cell represents a sound economic choice.

The Circuit

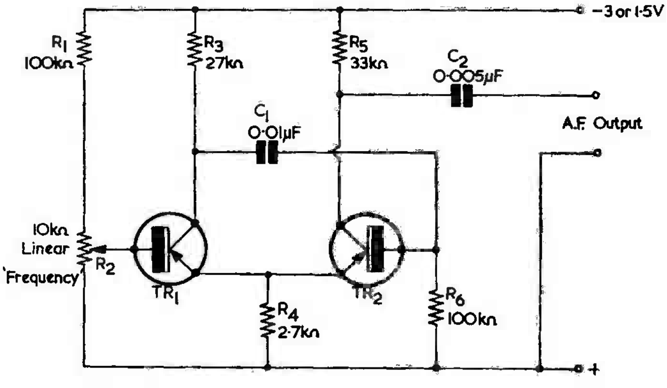
The circuit of the relaxation oscillator accompanies this article, and it will be recognised as consisting, basically, of an emitter-coupled multivibrator.

The functioning of an emitter-coupled multivibrator is roughly analogous to that of a cathode-coupled multivibrator employing triodes, and it is helpful to remember the operation of the valve circuit whilst considering the transistor equivalent.

At an instant during the cycle, transistor TR$_1$ (in the diagram) is off and TR$_2$ is on, with the result that C$_1$ charges. The charging circuit, from the negative supply line, is given by R$_3$, C$_1$, the conducting base-emitter junction of TR$_2$ and R$_4$. The potential dropped across R$_4$ is sufficiently high to maintain TR$_1$ in the off condition.

After a period, the increasing charge in C$_1$ allows the emitter of TR$_2$ (and, hence, the emitter of TR$_1$) to go sufficiently positive for TR$_1$ to conduct. TR$_1$ at once draws current through R$_3$, whereupon its collector goes positive. This positive excursion is passed, via C$_1$, to the base of TR$_2$, which passes less current and thereby further reduces the potential dropped across R$_4$. The cumulative mutual amplifying effect in a multivibrator takes over, and it results in TR$_1$ becoming conductive and drawing a high level of current through R$_3$. TR$_1$ collector is now at its most positive potential during the cycle, as also, due to the presence of the charged capacitor C$_1$, is the base of TR$_2$. TR$_2$ is, in consequence, cut off.

C$_1$ now commences to discharge, its left hand plate being coupled to the relatively constant potential existing at the junction of R$_3$ and the collector of the conducting transistor TR$_1$, and its right hand plate connecting to the positive supply line via R$_6$ and leakage resistance in TR$_2$. After a period of discharge in C$_1$, the base of TR$_2$ goes sufficiently negative for this transistor to pass



TR$_{1,2}$ -see text

current, whereupon its emitter, and that of TR$_1$, commences to go negative also. Current in TR$_1$ reduces as a result, whereupon its collector goes negative. This negative excursion is passed to the base of TR$_2$ by C$_1$, whereupon TR$_2$ passes an increased current and causes the emitter of TR$_1$ to go further negative. Again, the mutual amplification effect of the multivibrator takes over, and it ends with TR$_1$ being cut off and TR$_2$ fully on. Capacitor C$_1$ commences to charge again, and another cycle commences.

Whilst, with the cathode-coupled multivibrator, the triode corresponding to TR$_1$ could have its grid at chassis potential, it is essential for TR$_1$ to have its base returned to a point which is negative of the positive supply line. Without such a negative base potential, TR$_1$ could not pass current during that part of the cycle when it is required to be conductive. In the circuit under discussion here, TR$_1$ is brought on to its correct operating point by means of the potentiometer R$_2$, and the circuit oscillates when the voltage on TR$_1$ base lies between the approximate limits of 0.02 to 0.08 of the full supply potential.

R$_2$ can, however, perform the secondary function of controlling frequency, because it varies the collector current of TR$_1$ during the time when this transistor is conductive and, hence, the voltage on the left hand plate of C$_1$ during the discharge period of the cycle. If R$_2$ is set to apply an increased negative voltage to the base of TR$_1$, the collector undergoes an increased positive excursion at the instant of changeover, as also does the base of TR$_2$. In consequence, a longer period must elapse before C$_1$ becomes sufficiently discharged to make TR$_1$ non-conductive again. This effect is enhanced by the fact that, for an increased negative voltage on TR$_1$ base, the emitter of TR$_2$ must be raised to a higher negative potential by the discharging capacitor before TR$_1$ starts to reduce current. With the prototype it was found that R$_2$ gave a very wide control, this ranging from some 5 kc/s to 100 c/s. Below about 100 c/s the tone took the form of a series of discrete pulses, similar to motor-boating.

Adjustments in R$_2$ should not materially change the period of the cycle during which C$_1$ charges. This period is relatively quick, and the apparent audio frequency of the tone is governed entirely by R$_2$, the highest negative voltage on its slider corresponding to lowest frequency.

An output is obtained from the collector of TR$_2$ by way of the isolating capacitor C$_2$. The collector of TR$_2$ does not appear in the multivibrator circuit, and differing external loads do not, therefore, affect the operation of the oscillator. With the 3 volt supply, the output voltage given by the prototype was in excess of 1 volt peak-to-peak, this being approximately halved when a 1.5 volt supply was used.

Components

As was mentioned earlier, the components required for the oscillator are not critical in value. For instance, all the resistors employed could have a tolerance of ±20% without seriously affecting the operation of the circuit. Indeed, R$_4$, R$_5$ and R$_6$ could probably be replaced by components lying within ±40% of the values specified in the diagram.

Capacitor C$_2$ is merely an a.f. coupling capacitor, and alternative values between 0.001 and 0.02μF would be equally suitable. C$_1$ is rather more critical, and the capacitance specified for this component (0.01μF) was found empirically to be that most suitable. It could conceivably be necessary to slightly increase or decrease the value of C$_1$ to obtain the desired range of frequencies in other units employing the circuit, but this did not appear to be borne out by experience with the prototype. To save space, both C$_1$ and C$_2$ could be high-K ceramic capacitors, although, so far as C$_1$ is concerned, it must be remembered that such capacitors tend to have very wide tolerances on their nominal values.

The potentiometer R$_2$ should have a linear track, and it will be found that oscillation occurs over the centre three-quarters of its track only. This was not considered to be a disadvantage since the component can readily be calibrated accordingly.

In the prototype, transistors type OC72 were initially employed in the TR$_1$ and TR$_2$ positions. Other transistors, including an unbranded "a.f. transistor" were then checked in their place, with no noticeable change in performance. From this, it would seem safe to assume that most small transistors intended for a.f. operation should cope satisfactorily in the circuit.

Turning to more technical points, it will be noted that the value chosen for R$_6$ is rather high when considered from the point of view of frequency stability. To a certain extent this is true, as was made evident from the fact that, with the prototype, oscillator frequency increased perceptibly if TR$_2$ was warmed by holding it between finger and thumb.* In this case, obviously, the effect of increased leakage current was not being swamped by the resistance of R$_6$. On the other hand, the use of a high value resistor in the R$_6$ position enabled a high output to be given, and it was felt that this more than counterweighed the small frequency change given by variations in the temperature of TR$_2$.

Another factor is that it might appear advantageous to bypass the base of TR$_1$ to the positive supply line via a large value capacitor. This was tried with the prototype, but caused no noticeable change or improvement in performance.

Construction

Few problems should occur so far as construction is concerned, since layout is relatively unimportant. The low power consumption allows a very small battery or cell to be employed with the result that an extremely compact instrument of the "pocket" class may be built.

Whilst checking operation, the a.f. output terminals may be connected to a pair of high resistance phones or to the input of an a.f. amplifier. As has been mentioned, it may be necessary to adjust the value of C$_1$, although there was no evidence of this with the prototype. Probably the only other source of trouble would be the use of a transistor having excessive leakage current in the TR$_2$ position.

Power Consumption

With the prototype it was found that the current consumption varied between 60 and 100μA (according to frequency) when a 3 volt supply was employed. With a single 1.5 volt cell the current consumption dropped to 30 to 60μA.

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* It should be added that this was during the recent very cold weather when the ambient temperature in the author's workroom was by no means as high as it could have been!

NEXT MONTH . . .

An Introduction to Colour TV—Part I

Dual-Speed Teleprinter Governor

By D. F. Wadsworth

Radio teleprinter enthusiasts are often troubled by the need to change the speed of their printers from the European speed corresponding to 50 Bauds to the American speed of 45.45 Bauds, and vice-versa. The only quick way of doing this is to have two machines, one set to each speed, or to build a modified governor. The writer chose the latter method!

The circuit to be described was evolved for a Creed type 7B machine with a 180–250 volt d.c. motor, but with a suitable choice of diode it should work with any machine having a d.c. motor. The circuit involves no modifications to the printer wiring other than to the governor, and no extra slip rings or brushes are needed. The materials required are two normal governors, a diode, and a 2-pole changeover switch. The speed change is controlled by the switch, and takes place in about a second. The overall length of the governor, after modification, was sufficiently small to allow a standard Dust and Silence cover to be used with the author's type 7B.

A description is also given of the motor power supply which is employed with this governor. Thanks to the use of a silicon diode bridge and the absence of smoothing chokes, the whole power supply is contained, together with the speed change switch, in a box measuring 5 x 5 x 8in. It may be suggested that the mains transformer is redundant and that the d.c. supply could be obtained by direct rectification of the mains supply. This was considered undesirable on two counts: firstly, it was thought dangerous to have the power supply components and parts of the printer operating at mains voltage and, secondly, it was found that the use of a transformer with an earthed electrostatic screen between primary and secondary cut down the interference generated by the printer to a considerable extent.

Circuit Description

The circuit of the power supply is shown in Fig. 1. Two components are redundant in this circuit if an auto-stop device is not in use. These are N_1, which gives an indication that power is still on when the motor has stopped, and R_2, which serves to reduce the off-load volts across C_1 as well as acting as a bleeder to discharge C_1 when the supply and motor are both switched off. It will be seen that the speed change switch connected in the output merely reverses the polarity of the d.c. supply fed to the printer.

Referring now to Fig. 2 it may be seen, from what has just been stated, that current is fed to the governor through the slip-rings in one of two directions according to which speed is desired.

(*a*) *Slow Speed Operation.* In this case the current is fed in such a direction that diode D_5 is non-conducting. Upon switching on, the slow contact is closed and, hence, the motor speeds up rapidly until it reaches the slow speed. The slow governor then opens and regulates in the normal manner, no path existing through the reverse-biased D_5 and the fast governor contact. The printer then runs at the slow speed.

(*b*) *Fast Speed Operation.* In this case the current is applied in the direction which causes D_5 to

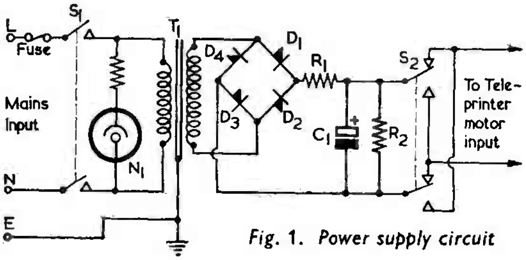

Fig. 1. Power supply circuit

Components List

Resistors
R_1 27Ω
R_2 22kΩ 4.5 watts, wirewound
Transformer
T_1 Primary: To suit mains input voltage. Secondary: 180V a.c. at 1A
Capacitors
C_1 200μF, 275V wkg
*C_2 5,000pF ceramic
Diodes
$D_{1, 2, 3, 4}$ OA210
*D_5 OA210 (see text)
Speed Switch
2-pole changeover, 250V a.c. wkg
Mains Switch
2-pole, 250V a.c. wkg
Neon
N_1 250V
Fuse
2A

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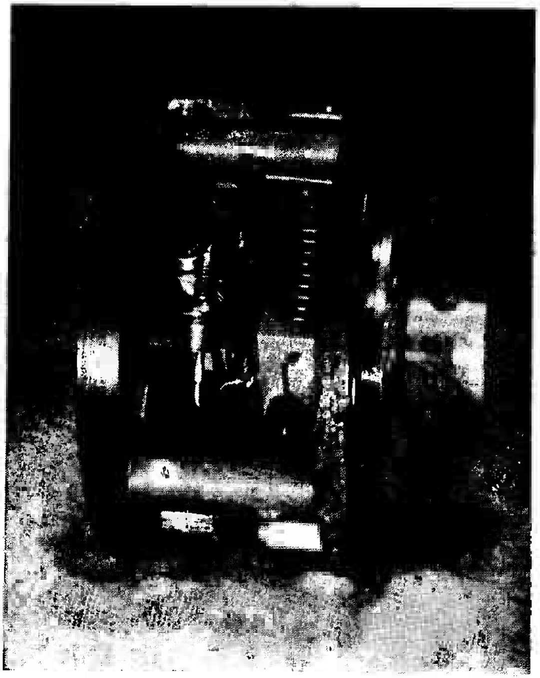
* Fig. 2 circuit.



conduct. Upon switching on, the initial surge of current flows through the slow contact, which is closed. As the slow speed is reached the slow contact opens, but this has no effect since a path exists through D_5 and the fast governor contact. As the speed increases, the slow contact is held continuously open by the centrifugal force of the higher speed. Upon reaching the fast speed the fast governor contact opens and commences to regulate at the fast speed. The printer thus runs at the fast speed.

Although, for the sake of a complete description, the above two cases begin with the motor switched off, power is not removed when changing speed in practice. One merely switches from one speed to the other at will by means of the speed change switch.

The 5,000pF capacitor in the modified governor is an interference suppressor. If it is not found necessary with a normal governor it is unlikely to be necessary with the modified one. Although an OA210 is used for D_5, any diode with a p.i.v. of 400 and a mean forward current of 0.4A or so would be suitable.[1] Trouble might be caused in the balance of the governor if a diode heavier in weight than an OA210 were used. For those who have 24 volt d.c. motors or similar, a germanium diode of adequate forward current rating would possibly be more suitable than an OA210, due to the possible higher forward current but lower p.i.v. requirements.[2] In any case it is worthwhile trying any available diode rectifiers which seem suitable, since failure of D_5 cannot result in any damage to the printer, but causes it merely to operate on one speed or the other continuously.

Mechanical Construction

Two methods of construction are shown in the accompanying illustrations, and that having the two mechanisms facing each other is the one whose construction will be described here. The remaining illustration is that of a governor built by F. Pankhurst, his method of construction resulting in a reduction of overall length and an assembly which is easier to balance.

Returning to the first illustration, it may be seen

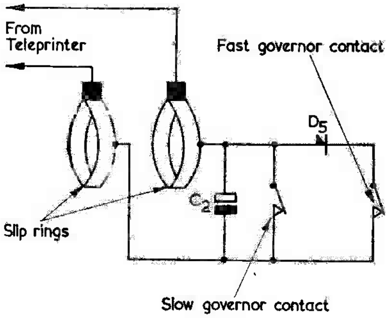


Fig. 2. The modified governor

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[1] Television h.t. rectifiers, such as the BY100, should also be suitable.—*Editor.*

[2] The author has in mind here such diodes as the GEX541 and GEX542 with peak inverse voltages of 80 and 160 respectively and maximum rectified currents (with a heat sink at 35° C) of 6 amps. Also possibly suitable are the OA31 with a p.i.v. of 85 and a maximum average forward current (with a heat sink up to 45° C) of 3.5 amps. A possibly suitable silicon rectifier is the BYZ13 with a p.i.v. of 200 and a maximum average forward current (at a case temperature of 25° C) of 6 amps. (This last rectifier is available at relatively low cost from home-constructor advertisers.)—*Editor.*

that the modified governor consists of two conventional governor mechanisms mounted facing each other. This mounting is achieved in the following manner. Three equidistant holes are drilled, spaced halfway between the outer slip ring and the edge of the governor. Long screws pass through these holes and engage in three corresponding tapped holes in the other governor. Spacers made from 1.4in ebonite tube fit over these screws. The unwanted hub is removed from the fast governor, and the unwanted slip rings cut down to reduce weight.

Once construction is completed the balancing procedure is carried out. It is necessary to temporarily fix the unwanted hub back into the recess of the governor. Short lengths of rod, of the same diameter as the motor shaft, are next fitted into the two hubs and locked in place by means of the grub screws. Two flat horizontal supports are then prepared and the governor placed between them so that it is supported by the rods in contact with the supports. The balancing procedure now consists of adding washers under the heads of existing screws, and if necessary, adding washers and screws to the unused tapped holes available, until no rotation of the governor occurs when it is placed on the supports in any position. When such a condition is reached, make sure all additional screws and washers are thoroughly tightened before trying the governor on the teleprinter. Although this procedure only achieves a static balance it is very effective. When running at printer speed no more vibration is detectable than is caused by a normal governor.

Conclusion

Up to the present time, three governors have been made using this circuit and are in use with Creed 7B page printers. No faults or difficulties have occurred.

The writer would like to acknowledge the help given by A. Fletcher in the mechanical construction and balancing procedure and to thank F. Pankhurst for the information on his governor.

Standard Noise Sources now available from Mullard

Noise sources that deliver an accurately known noise power over a defined waveband are now available from Mullard. At present the range comprises five types—one noise diode and four gas discharge noise generator tubes.

Noise Diode (type number 10P)

A diode behaves as a noise current generator if it is operated under saturation conditions. The value of the noise current can be calculated from the direct current flowing in the diode and the device can be used as an absolute noise standard at frequencies up to about 1,000 Mc/s or as a relative noise source at frequencies up to 4,000 Mc/s. It is limited as an absolute noise source at frequencies much in excess of 1,000 Mc/s because of the effects of stray capacitance and inductance, and electron transit-time. These effects are known respectively as transformation error and transit-time error. Transit-time error is significant at frequencies which are so high that the period of oscillation is short compared to the time taken by electrons to travel from cathode to anode.

The 10P is intended for use as an absolute noise source up to 1,000 Mc/s or as a relative noise source up to 4,000 Mc/s. In practice the diode would be mounted in a suitable co-axial system, the cathode being connected to the outer conductor and the anode to the centre conductor.

Brief Data

Filament Voltage	3V
Filament Power	4W
Anode Voltage (max.)	300V
Anode Current (max.)	15mA
Anode Dissipation (max.)	2W

For operation at 1,000 Mc/s the 10P requires an anode voltage of 50V and draws an anode current of 4.5mA. At 750 Mc/s V_a is 100V and I_a is 20mA. Overall dimensions, excluding flying leads, are 30mm length by 11mm diameter.

Neon-filled Gas-Discharge Tubes

At frequencies higher than those at which the noise diode is effective, the gas-discharge noise source can be used. With noise generators of this type the noise power delivered cannot be calculated exactly, but must be determined by calibration. They can be made with highly stable characteristics and are relatively insensitive to fluctuations in supply voltage and ambient temperature.

The four tubes available are intended for use in waveguide systems operating at 4mm, 8mm, 3cm and 7.5cm respectively.

Brief Data

Type number	95215	95216	K50A	K51A
Wavelength	4mm	8mm	3cm	7.5cm
Filament Voltage	2.2V	3.2V	2.0V	2.0V
Heating Time	15 sec.	30 sec.	15 sec.	15 sec.
Anode Voltage	240V	150V	165V	140V
Anode Current	75mA	75mA	125mA	200mA
Ignition Voltage	6,000V	2,000V	6,000V	6,000V
Noise Temperature	21,000°K	21,000°K	12,700°K	23,800°K
Overall Dimensions	222mm × 10mm dia.	230mm × 30mm dia.	255mm × 13mm dia.	514mm × 15mm dia.

NEWS AND COMMENT . . .

Safety on the Railways

By the time these notes appear, the controversial "Beeching Report", *The Reshaping of British Railways*, will be a month old.

As those who have read the report in full will be aware, its recommendations are based on figures obtained after considerable research by British Railways. Some of the figures are actual and some are estimated. It is pertinent to note, however, that the report pays no attention to a single, and statistically intangible, question: passenger traffic safety.

For many years British Railways have stated that signalling devices which advise the train driver *in his cab* of the signalling state along the line are under development. In point of fact, one signalling device of this nature has been in successful use in the Western Region (and, previously, the G.W.R.) since pre-war days, but it has not been taken up by other Regions. The Western Region signalling device operates by applying, to a third rail, either a.c. or d.c. according to the state of the track signal alongside. The different currents then actuate either a bell or a siren in the cab, and the driver is made fully aware of signalling conditions even if he cannot see the actual signals themselves.

The safety record for passenger traffic on British Railways is very high, but it is by no means impeccable. It is to be hoped that too great a preoccupation with cost-saving will not result in the curtailment of the installation programme for automatic signalling devices.

Modernising British Industry

"British industrialists would make bad bus passengers" (Dr. Beeching please note—*Editor*), says the editor of *Electronics Post*, in the spring issue, now available. "They have long been renowned for their preference always to be second in the queue—especially where new techniques are concerned."

Electronic control systems, for example, were exported to the United States in considerable quantities before interest could be aroused in Britain. Yet electronic control of contour milling machines does save money, as was strikingly demonstrated in the findings of a series of comparative tests recently conducted on behalf of the Board of Trade.

"Will Britain's manufacturers now develop into a race of enterprising queue-jumpers?" the editor asks. "With world competition always on the increase, it would be unfortunate if their excessive politeness caused them to miss the bus."

But, if they miss the bus, perhaps they can catch a Robotug. There seems no limit to the industries which can benefit from using these lively little driverless vehicles. How they speed the handling of shoes, scent and kitchen sinks is described in this issue of E.M.I. Electronics Ltd.'s profusely illustrated house journal.

Other features highlight the exceptional facilities for climatic and mechanical testing at the company's environmental test laboratories—a service which is now available to industry—and the world-wide demand for its television cameras and studio equipment.

Details of the latest instruments, components and tubes complete a particularly interesting issue. Copies can be obtained from Publicity Department, E.M.I. Electronics Ltd., Hayes, Middlesex.

Electronics Industry in Japan

There are no illusions in the West concerning Japanese achievements in the field of electronics. During the last decade progress there has been remarkable and is likely to continue. Currently the engineering industry of Japan ranks fourth in total production to U.S.A., U.K. and Western Germany. The value of the 1961 electronics production was more than ten times that of 1955.

In few industries can the costs of the materials be so low as in electronics. In addition, there is relatively low consumption of raw materials. The industry is therefore ideally suited to Japan where natural resources are somewhat limited. Japan has relatively abundant teenage female labour available whose teachability, good eyesight and deftness of hand contribute greatly to the production of reliable miniaturised equipment. This labour force is relatively inexpensive compared with the West—and with expert production technology—enables Japanese equipment to be cheap and highly competitive.

Cheaper Transistors ?

The *Daily Telegraph* recently contained a report from its special correspondent in New Delhi, Anthony Mann, on the making of transistors from a new substance.

At present conventional transistors are made from germanium which costs approximately £500 per pound. According to the report Professor S. Dutt, formerly head of the Chemistry Department at Delhi University, has confirmed that he has developed a method of making transistors from metallic rock found in Rajasthan. It is estimated that such transistors will be sold for less less than 6d. each, when produced commercially.

B.B.C. Disclaimer

The popularity of the TV programme TW3 and references in the popular press to a code or book of rules governing "frankness" in B.B.C. programmes has led to some confusion which is, no doubt, why the following disclaimer was recently issued.

"It has been suggested in various reports that light entertainment in television has been governed by a code or book of rules which has prevented reference to certain topics. The B.B.C. wishes to say that no such code or book of rules has ever been used in the Television Service.

"For many years it has been the practice of the Television Service to encourage producers to exercise their own judgment on matters of taste, referring for guidance wherever necessary to the Head of Department or even higher. This practice still applies, and there has been no change whatever in B.B.C. policy."

Curing Divorce ?

One would not readily associate divorce with an application of electronics but, judging from one of the forecasts in Hugo Gernsback's famous predictions, it could be possible.

The world is imagined as it might be in the year 2115, with a world average divorce rate of 88%! In this situation the authorities decide to use a small electronic machine, which is computerised, for testing couples wishing to marry. The candidates undergo various tests and answer a large number of questions. The questions and the tests are then integrated by the machine. If the machine's result shows negative the couple are not allowed to marry.

Hugo Gernsback is, of course, the editor and publisher of the American magazine *Radio-Electronics*.

The "NEOGEN"

A.F./R.F. SIGNAL GENERATOR

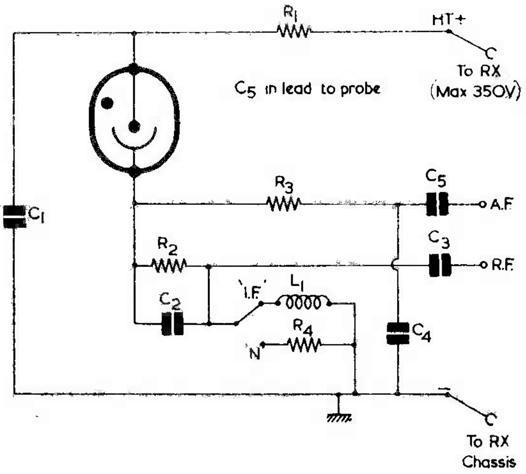
By **R. J. WARD**

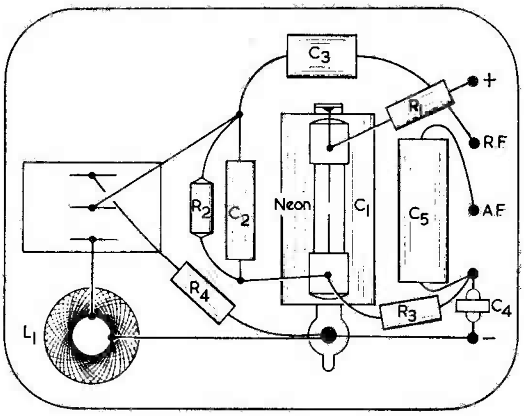
RECENTLY THE WRITER REQUIRED A SMALL portable a.f./r.f. signal generator. The idea of using several transistors was ruled out, because not only would an internal battery be required but the cost would be excessive. It was therefore decided to use a neon, the type employed being that used for checking for the presence of mains voltages.

The unit is cheap to construct, and can draw its power (only 100μA) from the h.t. line of the receiver under test.

Operation

Referring to the circuit diagram (Fig. 1) it may be seen that C_1 charges through R_1 until the neon striking voltage is reached; after which C_1 discharges through the neon, R_2, and L_1 or R_4 according to the position of the switch. C_1 then recharges and the cycle is repeated. R_2 is the a.f. load and R_3 and C_4 act as a low-pass filter. When the switch is in position "N", R_4 is in series with R_2, thus giving a higher a.f. output. The steep leading edge of the pulse is applied to R_4 by C_2. If the switch is in position "I.F.", L_1 oscillates briefly around 465 kc/s after each pulse. C_3 then passes the r.f. output to the appropriate terminal. As the r.f. is in short bursts which recur at a.f., a buzz is heard from the loudspeaker when it is applied to a receiver before the detector.





Components List

Resistors

R_1	1MΩ
R_2	5.6kΩ
R_3	100kΩ
R_4	27kΩ

Capacitors (all 350V wkg.)

C_1	5,000pF moulded mica with terminal lugs
C_2	100pF
C_3	100pF
C_4	20pF
C_5	0.05μF paper

Neon
See text

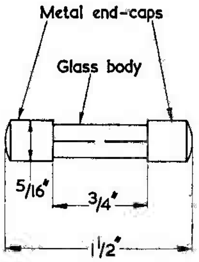
Coil
L_1 Single winding from 465 kc/s i.f. transformer

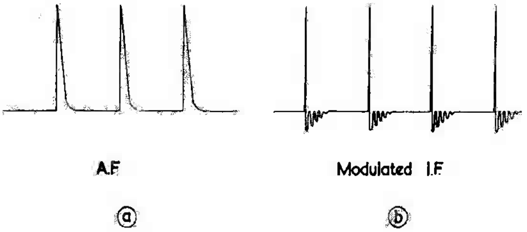
Switch
s.p.d.t. toggle

Case
See text

Construction

The components were fixed to the lid of a tobacco tin measuring 4½ x 3¼ x 1in, as shown in Fig. 2.





C_1 is a moulded mica component because it is required to have a high internal resistance. Also, it has end lugs, one of which provides an anchor for the neon.

The a.f. and r.f. outputs can be taken to sockets or wires may be brought through holes in the panel. The neon employed by the writer had the dimensions and instructions shown in Fig. 3.

Results

The a.f. output waveform is illustrated in Fig. 4 (*a*) and is strong enough to be heard in earphones held away from the head. When the switch is in the "I.F." position, the waveform is that shown in Fig. 4 (*b*). The wide band r.f. output is comparable with the strength of the medium wave Home Service programme in the writer's locality.

The R107 Receiver

For Amateur Use

By J. ANDERSON

The R107 receiver is currently available on the amateur market, albeit in small quantities, and is considered by many to be the best general-purpose receiver available in the range 1.2 to 17.5 Mc/s, especially in view of its current price.

It is, however, capable of some small improvements, as the following details will show. Firstly there is the appearance, which often leaves a great deal to be desired. After removing all the knobs, and the switches (by their centre-screws), as well as the plugs and the rack handles on each side of the panel, a coat of grey lacquer or enamel can be applied in very little time. When it has set (after a second coat if necessary) the knobs should be replaced temporarily whilst their positions are marked with a pin or scrap of Sellotape. The wording can then be reapplied with panel transfers, and a final coat of varnish applied. The switch knobs will often benefit from a coat of thin black paint as well. The rack handles can be painted a different colour (e.g. light grey for a dark grey panel, or brown for an "olive grey" panel), and replaced when dried. It is quite safe, incidentally, to paint over "anti-insect" varnishes.

Technical Improvements

The more technical improvements also concern the panel to a large extent. The first is concerned with the meter testing panel situated at the top centre. This is an efficient dust collector, and two hands are needed to hold the meter leads to it. If an eight-way single wafer rotary switch is available it can be used to select the individual test points to take the switch. A small metal panel is drilled and fitted as in Fig. 1, and the test leads from the receiver circuits connected to the switch points in sequence. The two wander-plug sockets shown will give a good grip for test prods. It is immaterial whether the switch used is break-before-make or not, as the test terminals are each connected via a 3kΩ resistor to the h.t. positive line, and the only effect on turning the switch will be a click in the loudspeaker. This small metal panel can be painted the same colour as the panel, and can have a series of transfer labels as suggested in Fig. 1.

There is often considerable advantage to be gained from a tuning meter. It is a simple matter to install such a meter, the first requirement being

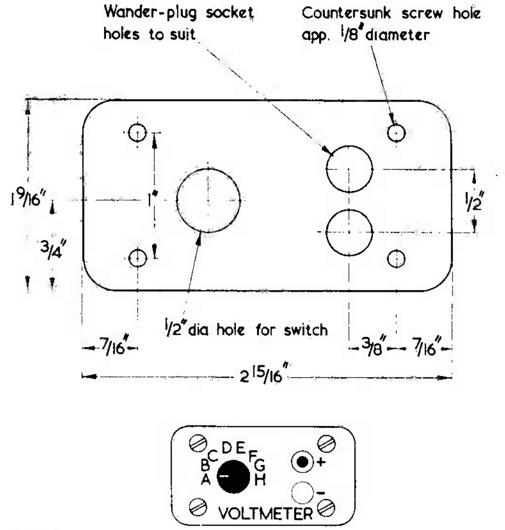


Fig. 1. The panel which replaces the meter test-point area on the original set. Also shown is the final appearance of the panel

to cut out a sheet of metal to the shape and dimensions of Fig. 2. Then, with a hacksaw (having first removed all the valves to avoid damage due to vibration) cut through the four metal areas separating the four holes covering the face of the loudspeaker, and fit the sheet in place. This converts the previous speaker aperture into a meter aperture. The loudspeaker will now, of course, have to be accommodated outside the set but, in view of the number of broadcast stations which can be received, this is not a bad thing, since the present speaker does not reproduce music very well and an external wooden case is preferable. The speaker cable required may be taken to the "Phone" socket (lower), and passed through this hole. A 5mA meter can then be fitted at the centre of the new metal sheet, and screwed into place.

The chassis must next be turned over. In the central i.f. unit (the second compartment from the rear) will be found a small tag-panel carrying two 5kΩ resistors. The one nearer the front of the set (R5C on the circuit diagram if this is available) should be removed, and about 14in of twin cable fitted across the two terminals. The other end of the cable can then be threaded up through the hole for the meter panel wiring, and forward between the i.f. transformers, to turn towards the power unit behind the front panel. The cable must then be fitted to the meter, one wire connecting to the negative terminal and the other to the positive terminal via the resistor taken from the tag-panel underneath. (See Fig. 3.) A 210Ω $\frac{1}{4}$ watt resistor shunts the meter, and it must be pointed out that the voltage across the meter will vary slightly from set to set. However, the arrangement shown in Fig. 3 should give a meter reading of about 4mA for no signal, and a dip falling to about 1.5mA when receiving a powerful transmitter.*

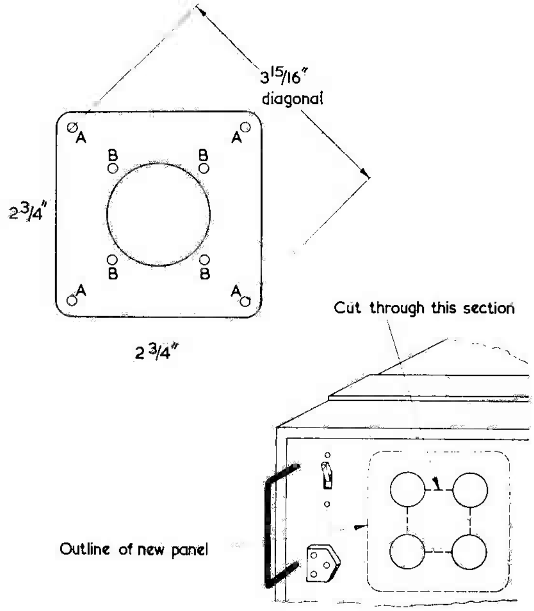


Fig. 2. Fitting a tuning meter panel. Holes "A" are countersunk and match the existing speaker holes. Holes "B" are for the meter mounting screws and should be appropriately positioned. The large hole in the panel takes the meter body

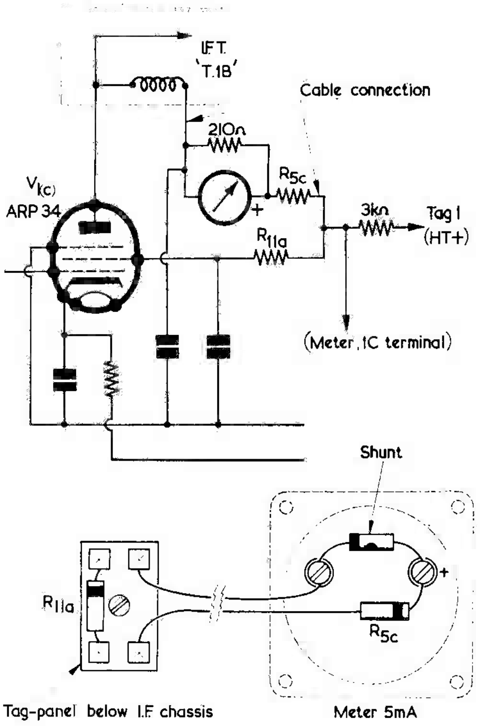


Fig. 3. The tuning meter circuit and connections

Other Modifications

Having fitted a tuning meter, cleaned up the panel and made a wooden case for the loudspeaker, there is little else to be done. If desired, a two-way rotary ceramic switch can be fitted in the r.f. connection between chassis units 1 and 2. This will enable an external feeder to feed a signal straight to the first i.f. amplifier (465 kc/s) via a coaxial socket fitted into the existing "open aerial" terminal aperture. Otherwise, it will be found very hard to improve on the set technically.

If an open aerial is being used, best results should be obtained by connecting it to the left-hand dipole feeder terminal, the right-hand feeder terminal being connected to the earth terminal. The open aerial terminal wires can then be traced back and removed, and the socket used for a converter input, as just suggested. Alternatively, a 2in length of wire can be attached to the back of the socket and twisted loosely round the feeder leads to provide a connection on the front panel for a wavemeter of the heterodyne type. Indeed, one constructor has been

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* A shunt of 210Ω gives satisfactory results with the author's receiver, the resistance of the meter employed being 20Ω. It may be necessary to vary the value of the shunt with some secondhand receivers, or with meters having different resistances.—EDITOR.

known to remove the d.c. power section, and cram a wavemeter type "D" in its place. However, this had the effect of feeding harmonics into the main supply when it was switched on.

If the set is purchased without the booklet, an effort should be made to buy or borrow one without delay, as the performance will be much improved by adhering to the installation and testing instructions provided. The voltages measured from the test panel and noted in it are for an Avometer model 7 on the 100 volt range, and different readings will be obtained when a different meter and an aged set meet. Examples of satisfactory readings using a 1,000Ω pen voltmeter on its 50V range are given below:

V1 ($_a$) 1 volt V2 ($_{a'}$) 14 volts V2 ($_b$) 12 volts
V1 ($_b$) 3 volts V1 ($_c$) 2 volts V1 (d) 4 volts
V2 ($_a$) 7 volts V2 ($_{b'}$) 27 volts

These figures are for Range 3 with a.g.c. out and no signal applied, and will vary in proportion with those given in the handbook for other ranges.

The twenty-first in a series of articles which, starting from first principles, discusses the basic theory and practice of radio

part 21

understanding radio

By W. G. MORLEY

IN LAST MONTH'S ARTICLE WE CONCLUDED OUR examination of tuned circuits by examining dielectric loss in the capacitor and the inductor, inductor efficiency, and practical tuned circuits.

We shall now carry on to the transformer.

The Transformer

When we introduced the subjects of self-inductance and mutual inductance[1] we saw that, if a coil is connected to a sensitive moving-coil meter, the needle of the latter gives a temporary deflection when a bar magnet is quickly lowered into the coil. The meter needle similarly gives a temporary deflection, but in the opposite direction, if the bar magnet is quickly removed. The reason for the deflections is that the moving magnetic field about the magnet cuts the turns of the coil and thereby induces a voltage in them. The polarity of the voltage reverses when the direction of the moving field reverses, this being indicated by the opposite deflection in the meter when the magnet is removed.

In our previous discussion, we next dispensed with the bar magnet and mounted a second coil above the first. To this second coil we connected a battery in series with a switch, and found that the moving-coil meter needle gives a temporary deflection in one direction when the switch is closed, and a temporary deflection in the other direction when the switch is opened. In this instance, closing the switch causes an expanding magnetic field to be built up around the second coil, the lines of magnetic force in this field cutting the turns of the first coil and inducing a voltage in them. When the switch is opened the field collapses, whereupon the lines of force cut the turns of the first coil in the opposite direction, inducing thereby a temporary voltage of opposite polarity.

This arrangement is, basically, a *transformer*, and is illustrated in Fig. 121. However, in Fig. 121, we dispense with the battery and switch, and apply an alternating voltage instead. The alternating voltage causes the magnetic field about the coil to which it is applied to be continually expanding, contracting and reversing in polarity, whereupon an alternating voltage having the same frequency is induced in the other coil. The induced voltage will then cause an alternating current to flow in a resistor, which we may designate a "load".

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[1] In "Understanding Radio", part 12, August 1962 issue.

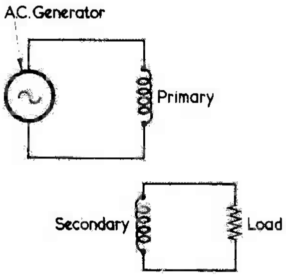

Fig. 121. The elements of a transformer. An alternating voltage applied to the primary causes a voltage of the same frequency to be induced in the secondary

At this stage we should now identify the two coils of the transformer of Fig. 121. That to which the alternating voltage is applied is called the *primary* of the transformer, whilst that connected to the load is known as the *secondary*. It is possible to have more than one secondary, each of which can be connected to a separate load. However, an individual transformer will, normally, have a single primary only.

Transformers employed in radio work fall into two categories, these consisting of transformers intended to work with alternating voltages at power and audio frequencies,[2] and transformers intended to work with alternating voltages at radio frequencies. It will be helpful to commence by examining transformers in the first category (i.e. power and audio frequency types) since the theoretical points involved with these components illustrate basic transformer theory more readily. We may then carry on to transformers intended for operation at radio frequencies.

Power and A.F. Transformers

Transformers which operate at power and audio frequencies almost always employ a tight coupling between the primary and secondary or secondaries. This tight coupling is achieved by using an iron core which passes through the primary and secondary coils; and examples of typical constructions are given in Fig. 122. In Fig. 121 (*a*) we have the primary and secondary coils wound on a single bobbin or former, the iron core passing through the centre of the coils and continuing around them on two sides. This shape allows a complete magnetic circuit to appear around the primary and secondary, and results in very tight coupling between the two. Fig. 122 (*b*) shows a modification, in which the magnetic circuit is completed on one side of the coils only; whilst Fig. 122 (*c*) illustrates yet another alternative, in which the primary is wound on one section of the iron core and the secondary on the other. In practical radio work the construction shown in Fig. 122 (*a*) is almost always employed, because the piece-parts required for the core are relatively easy to produce and assemble, and because the core shape can provide a very efficient coupling between the primary and secondary windings. Fig. 123 (*a*) gives the circuit symbol for an iron cored transformer, the presence of the iron core being indicated by the straight lines between

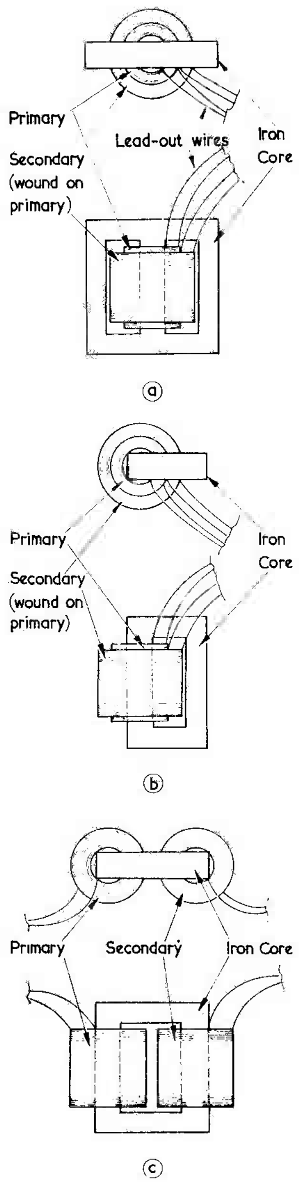

Fig. 122 (a). A typical construction for power and a.f. transformers

(b). An alternative construction, in which the iron core completes the magnetic circuit on one side of the windings only

(c). Another alternative. In this case the primary and secondary are fitted to separate sections of the core

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[2] In this country, the power frequency (i.e. the frequency of the a.c. mains supply wired into our houses) is 50 c/s. Audio frequencies range from some 30 to 20,000 c/s.

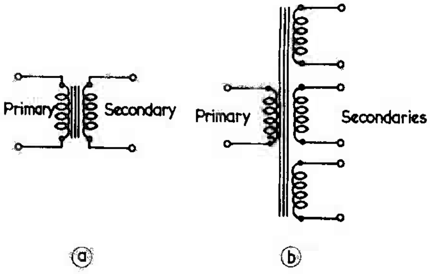
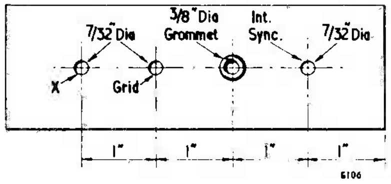


Fig. 123 (a). The circuit symbol for an iron cored transformer
(b). An iron cored transformer with three secondaries

the two coils. If a transformer has more than one secondary, these may be represented as shown in Fig. 123 (*b*).

In Fig. 124 we apply an alternating voltage to the primary of a transformer. The primary winding acts in the same manner as any other inductor, and it causes a magnetic field to be built up which expands, contracts and changes polarity in sympathy with the alternating voltage. Just as occurs in an inductor the varying field induces a back e.m.f. in the turns of the primary winding, this being equal to the applied e.m.f. (or, to be precise, very nearly equal) and 180° out of phase with it. Since the changing magnetic field also cuts the turns of the secondary coil it induces a voltage in this winding also, the induced voltage being, similarly, 180° out of phase with the applied alternating voltage.

Now, the back e.m.f. induced in any one single turn of the primary will be equal to the back e.m.f. induced in any other single turn of the primary. Since the secondary is in the same changing magnetic field as the primary, the voltage induced in any one single turn of the secondary will also be equal to that induced in any one single turn of the primary. The back e.m.f. at the ends of the primary coil is the sum of the induced voltages appearing across its individual turns. Similarly, the voltage appearing at the ends of the secondary coil is the sum of the voltages induced in *its* individual turns. In consequence, we can say:



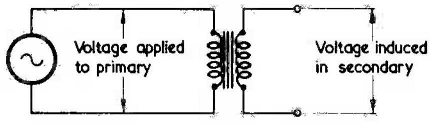


Fig. 124. Demonstrating the relationship between primary and secondary turns, as explained in the text

$$\frac{\text{Voltage across secondary}}{\text{Back e.m.f. in primary}} = \frac{\text{Turns in Secondary}}{\text{Turns in primary}}$$

However, we know that the back e.m.f. in the primary is, for all practical purposes, equal to the applied alternating voltage, so we can change our equation to:

$$\frac{\text{Voltage across secondary}}{\text{Voltage applied to primary}} = \frac{\text{Turns in secondary}}{\text{Turns in primary}}$$

This is an important finding but, before proceeding further, it may prove helpful to go once more over the ground we have just covered with the help of a numerical example.

Let us consider the state of affairs we have in Fig. 125, in which we have a primary winding of 1,000 turns and a secondary winding of 500 turns. An alternating voltage of 100 volts is applied to the primary. What voltage do we obtain from the secondary, and what are the intermediate steps involved in obtaining this voltage?

Firstly, our applied alternating voltage of 100 causes the production of a changing magnetic field. This, in its turn, induces a back e.m.f. in the primary which is, for all practical purposes, equal to the applied voltage, and which is 180° out of phase with it. The back e.m.f. has a value, in consequence, of 100 volts also. The voltage induced in any turn of the primary is equal to that induced in any other turn. Since the primary has 1,000 turns, the back e.m.f. of 100 volts corresponds to an induced voltage in each turn of $\frac{1}{10}$ volt. Each turn of the secondary has the same voltage induced in it as has each turn of the primary, whereupon each turn of the secondary similarly has $\frac{1}{10}$ volt induced in it. The secondary has 500 turns, with the result that the total voltage appearing across its terminals is 500 times the $\frac{1}{10}$ volt in each turn; that is, 50 volts.

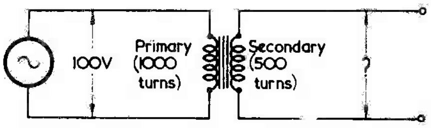


Fig. 125. A numerical example to illustrate the relationship between primary and secondary turns

We may, in consequence, say that the voltage induced in the secondary is half that in the primary, and that the reason for this is that the secondary has half as many turns as the primary. If the secondary had one quarter of the turns in the primary, the secondary voltage would be one quarter the primary voltage. If the secondary had twice as many turns as the primary, the secondary voltage would be twice the primary voltage. It will be noted that all these instances, together with our numerical example, agree with the equation:

$$\frac{\text{Voltage across secondary}}{\text{Voltage applied to primary}} = \frac{\text{Turns in secondary}}{\text{Turns in primary}}$$

The ratio between the secondary and primary turns of a transformer is known as its *secondary-to-primary turns ratio*. However, when referring to transformer turns ratio it is usual to quote the primary figure first, whereupon we would describe the transformer of Fig. 125 as having a *turns ratio* of 2:1.[3] Because the secondary voltage of the transformer of Fig. 125 is lower than the primary voltage, the transformer may be described as a *step-down transformer*. Had the secondary voltage been higher than the primary voltage (because the secondary had more turns than the primary) the transformer would be known as a *step-up transformer*. In practical radio work, both step-down and step-up transformers are encountered, and turns ratios are frequently as high as 80:1 (for step-down transformers) and 1:100 (for step-up transformers). It should be added that it is possible to employ a step-down transformer as a step-up transformer (and vice versa) by the simple process of applying an alternating voltage to the secondary and allowing the induced voltage to appear across the primary.[4]

Current in the Transformer

Up to now we have considered transformer operation in terms of voltage only. There must, obviously, be a flow of current in both primary and secondary windings, and we shall now carry on to consider such current. In doing so we shall, for the time being, assume that the transformer we employ is a "perfect" component, and that it exhibits no "losses" (which will be discussed later) and that its windings have very high inductance and zero resistance.

In Fig. 126 we apply an alternating voltage from an a.c. generator to our transformer, the secondary of which has a resistor connected across it. As before, the applied alternating voltage causes a changing magnetic field to be produced in the transformer, this inducing a back e.m.f. in the primary and a voltage in the secondary. The secondary is connected to a load resistor, which means that the induced voltage must now cause a current to flow. Further, since the current flows in a resistor, it will be in phase with the induced voltage in the secondary. The load current flowing in the secondary causes a new magnetic field to be set up in the transformer, this field altering in sympathy with the load current and, hence, the induced voltage in the secondary. The new field tends to oppose that resulting from the alternating voltage applied to the primary, with the result that the back e.m.f. is reduced. In order to bring the back e.m.f. to the same level as the applied alternating voltage, current (provided by the a.c. generator) has to flow in the primary to produce a field which cancels out that given by the load current. The field produced by the load current was in phase with the secondary voltage, so the cancelling field—and the current from the a.c. generator which provides it—is in phase with the primary voltage.

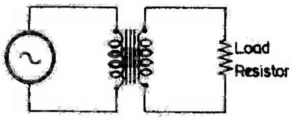


Fig. 126. Demonstrating the currents which flow in primary and secondary, as discussed in the text

Let us next halve the value of the load resistor, so that twice the secondary current flows. The field produced by the load current will now be twice as great, whereupon twice as much current must flow from the a.c. generator to provide the cancelling field. Had we increased the secondary current three times, the primary current would have had to be increased three times also, in order to bring the fields in the transformer back to equilibrium.

We have, in consequence, found two facts, Assuming a "perfect" transformer, primary current varies directly as secondary current. When secondary current increases, so does primary current. Also, when the load on the secondary is purely resistive in character (i.e. the current which flows through it is in phase with the voltage) the current in the primary is similarly in phase with the voltage. It is interesting to note, in passing, that the primary of the transformer appears to the generator as though it were a resistor itself.

In practice there is, of course, no such thing as a "perfect" transformer. A well-designed transformer may have a high primary inductance, but this will still allow some current to flow which, as in any other inductor, will lag by 90° on the applied voltage. "Losses", which may be considered roughly as additional resistance, cause the phase angle of lag to be shifted slightly from 90°. The field resulting from this current is not in phase with that produced by the secondary load current, and it complicates the simple relationship given with the "perfect"

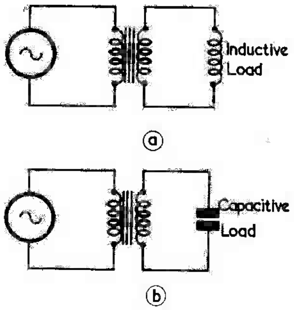


Fig. 127 (a). In this diagram the secondary connects to an inductive load
(b). Connecting to a capacitive load

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[3] Unless otherwise qualified, it may always be assumed that the first figure in the turns ratio corresponds to the primary.

[4] In practice, this course is only advisable when the applied voltage (and current) is of the same order as would normally be induced in the secondary. Even then, the efficiency given by the "reversed" transformer may be lower than that of a transformer specifically designed for the desired application.

transformer. However, normal secondary currents should produce fields which are considerably stronger than that resulting from the out-of-phase primary current, and the effect of the latter is reduced in proportion. It may be said therefore that, if a resistive load is connected to the secondary of a well-designed transformer having a high primary inductance, the primary current is very nearly in phase with the primary voltage, and that the primary current is very nearly proportional to secondary current.

If the secondary load is an inductor, as in Fig. 127 (*a*), the current in the secondary lags by 90° on the induced secondary voltage. By working back over the same steps as we used for the case of the resistive load, it can be shown that primary current will similarly lag by 90° on the applied voltage. This assumes a "perfect" transformer. With practical components, "losses" and other limiting factors will cause the current lag to be slightly less than 90°. When the secondary load is capacitive (Fig. 127 (*b*)), the secondary current leads on the induced voltage by 90°, with the result that (following the same steps as before) primary current leads on the primary voltage by 90°. With practical transformers this angle of lead will, again, be slightly less than 90°.

Primary and Secondary Polarity

People with practical experience of transformers may, occasionally, be confused at the fact that the induced secondary voltage is in phase with the back e.m.f. in the primary. This statement seems to conflict with the points they have learned through their own work with transformers.

A simple numerical example may help to ease confusion here. In Fig. 128 (*a*) we see a transformer comprising a primary and a secondary, both of which are wound in the same direction. The secondary is loaded by a resistor. To facilitate the explanation we assume that the two windings are wound side by side and in the same direction on a cylindrical iron core. The primary has ten times as many turns as the secondary, and so the transformer has a turns ratio of 10:1.

In Fig. 128 (*b*) we apply an alternating voltage of 100 to the primary, whereupon an a.c. voltmeter connected to the secondary indicates a voltage of 10, as is to be expected. In Fig. 128 (*c*) we connect the top end of the secondary to the bottom end of the primary and take further voltage readings. As before, we obtain a reading of 10 volts across the secondary. However, if we connect our meter across the combination of primary and secondary in series we obtain a reading of 110 volts. Since this reading is the sum of the primary and secondary voltages, it would appear that the two windings are "in phase". How, then, can it be said that the voltage induced in the secondary is, like the back e.m.f., out of phase with that applied to the primary?

To explain this apparent contradiction it is helpful to consider the transformer at one instant during the cycle, as in Fig. 128 (*d*). At this instant the voltage applied to the upper terminal of the primary is positive, and that applied to the lower

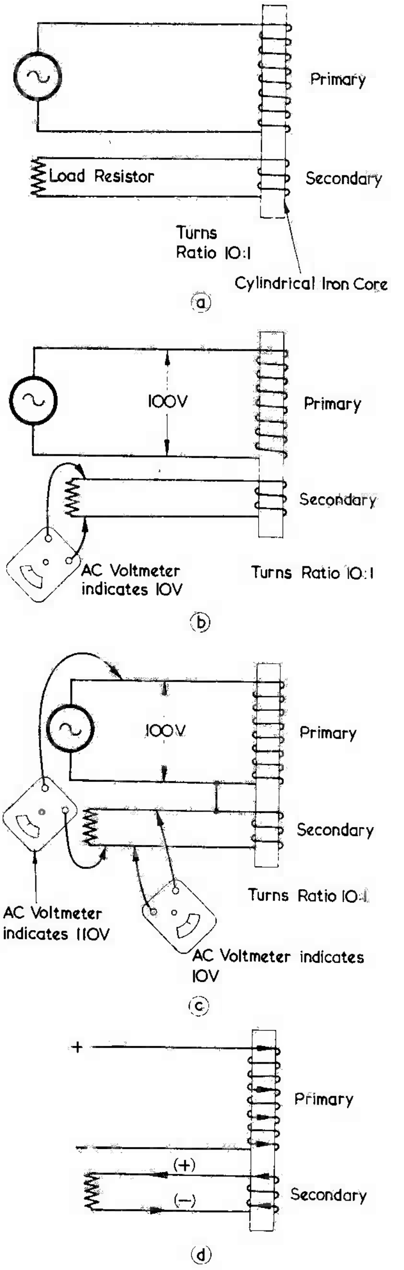

Fig. 128 (a). A transformer in which the primary and secondary are wound in the same direction. A cylindrical iron core is assumed

(b). If 100V is applied to the primary, 10V appears across the secondary

(c). When the primary and secondary are connected together, as shown here, 110V appears across their series combination

(d). Despite the fact that current in the secondary flows in the opposite direction to that in the primary, the two windings still appear to be "in phase"

terminal is negative. In investigations of this nature it is very convenient to assume that electric current flows from the positive terminal of a source of supply to the negative terminal,[5] whereupon the arrows shown on the primary winding indicate the direction of current flow. The current flow in the primary is in phase with the applied voltage, whereas the current flow in the secondary is in phase with the induced voltage which, as we have already noted, is out of phase with the applied voltage. So the current in the secondary flows in the opposite direction to that in the primary, this being indicated by the arrows on the secondary winding. At the same time, the secondary current flows externally through the resistor, and it follows the path indicated by the external arrows. The resistor looks upon the secondary as a "source of supply" whereupon, since the current flows through the resistor from the upper terminal of the secondary to the lower terminal, the upper terminal becomes positive. In consequence, the secondary winding gives all the appearance of being "in phase" with the primary winding. When, in Fig. 128 (*c*), we connected a meter across the primary and secondary in series, what we were actually doing was connecting it across two *sources of supply* in series. One source of supply was the a.c. generator feeding the alternating voltage to the primary, and the other source of supply was the secondary.

The same "in phase" relationship holds true with any other windings on a transformer, and these may similarly be connected in series to give addition of the voltages applied to them and/or the voltages induced in them.

Next Month

In next month's article we shall carry on to discuss the auto-transformer, transformer applications, eddy currents and hysteresis.

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[5] This assumption, which is frequently used in radio calculations, is a legacy from the days before it was found that electric current consisted of a flow of electrons from negative to positive. "Current" flowing from positive to negative is known as "conventional current".

Marconi Closed Circuit TV on Stern Trawler

The all-refrigerated stern trawler *Junella*, owned by J. Marr and Son Ltd., recently docked in Hull after a fishing trip of five weeks during which her skipper, Mr. Charles Drever, has been trying out a new electronic aid to fishing, closed circuit television.

Stern trawling, particularly in a vessel as big as *Junella*—240 feet long—presents new problems to the skipper. Because of the distance—180 feet—between the bridge and the operation of the fishing gear on the new stern trawler, it was felt that good use could be made of closed circuit television for observations that would normally be impossible; and therefore, following discussions between *Junella*'s owners and the Marconi International Marine Co. Ltd., a system was worked out and installed on a temporary basis.

Before her departure from Hull two Marconi closed circuit television cameras were mounted in waterproof housings at either end of the gallows bridge aft, with a third suspended from the deckhead in the fishroom. Two monitors were fitted side by side in the wheelhouse, one to show the fishroom scene and the other to show the view astern to where the trawl warps emerge from the water about 12 to 15 feet behind the vessel. The gallows bridge cameras each looked downward and inward in a "cross-eyed" manner to cover the stern and approximately 25 feet of water beyond. A Marconi engineer sailed with the *Junella* to supervise the television equipment, and to study the environment in which it was operating with a view to improving the design of the installation, where necessary, in possible future experiments.

Very severe weather conditions prevailed throughout the entire trip, and a heavy sea striking one of the camera housings carried the cover away, although the camera itself was unharmed. This camera was taken out of circuit and unshipped, and the system rearranged to use only one camera astern and one monitor in the wheelhouse, with provision for switching the monitor to either the gallows bridge camera or that in the fishroom. It then proved that the single stern camera was adequate, although it would have been better sited centrally and at a slightly higher point than the gallows bridge guard rails. The *Junella*'s owners state that although Skipper Drever was impressed by the television installation and its performance and reliability, it must be realised that this application is in its early stages and that, at this point, it would be premature to say what real benefit might be derived. However, it is hoped that experiments will be continued and that further close co-operation between the owners, the skipper and radio operator, and the Marconi Marine Company will result in the development of real advantages.

The Marconi Marine Company is now proceeding with the development of a more rugged camera housing for trawler use. With the increasing popularity of stern trawlers, and their greater size, it is apparent that this is yet another way in which electronics can be useful to the fisherman. Indeed, other applications suggest themselves on the modern trawler—observation of the winch and trawl deck area through a camera mounted on the mizzen mast or after bipod; or a view aft along the trawl deck and down over the stern ramp could be provided.

AMPLIFIER DUMMY LOAD UNIT

By **D. ALDOUS**

It is often necessary to check audio amplifiers with resistive dummy loads. Not only do such loads enable measurements to be made on high fidelity equipment but they also allow sound and television receivers to be tested at high a.f. levels without causing an excessive amount of noise. This last facility is especially useful in busy service workshops, particularly when these are close to showrooms or domestic premises.

The device described here is capable of providing a high wattage resistive load for all amplifier output impedances likely to be encountered in normal servicing work. Individual impedances are given with the aid of a 4-pole 5-way switch, which selects different series/parallel combinations of four resistors. A special feature of the circuit is that the maximum power dissipation possible with the small number of resistors employed is achieved at each switch position. The resistors used by the writer consisted of two 15Ω+15Ω surge limiting resistors, and are available as television service replacements at a cost of a few shillings only. These had a rating of 7.5W per section, but it is possible to employ four individual 15Ω 10W resistors instead, if desired. The latter would cause the power dissipations offered by the unit to increase by the appropriate factor.

The unit gives the following impedances:

60Ω at 30W
30Ω at 15W
15Ω at 30W
7.5Ω at 15W
3.75Ω at 30W

Components List

Resistors

R_1, R_2, R_3, R_4 Two 15Ω+15Ω surge limiting resistors, 7.5W per section. Welwyn type BTB3522 or equivalent. (See text)

Switch

4-pole, 5-way. 2-bank wafer, A.B. Metal Products type "H" or equivalent. (See text)

Sockets

Two 2-way sockets (or four 1-way sockets)

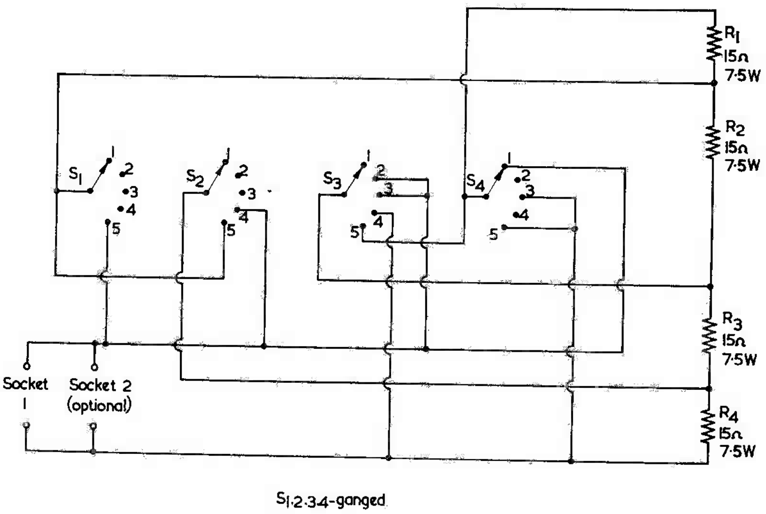


Fig. 1. The circuit of the dummy load unit

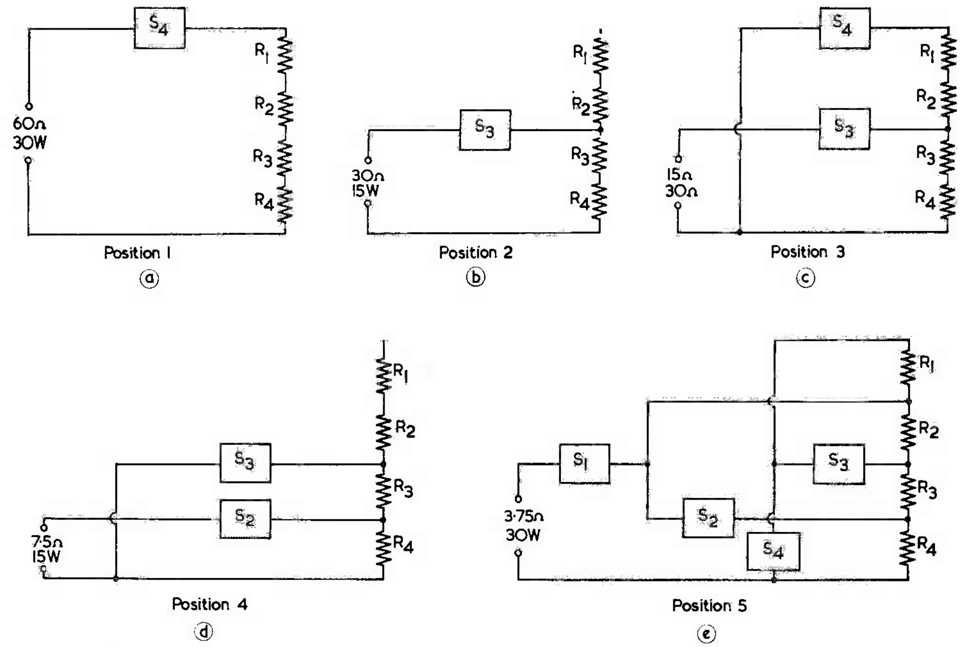


Fig. 2. Illustrating how the 4-pole switch selects individual values of impedance

The Circuit

The circuit of the unit appears in Fig. 1. In this diagram switches S_1 to S_4 are ganged, and select different combinations of R_1, R_2, R_3 and R_4. The amplifier output connects to Socket 1. Socket 2 is optional, but it is helpful to include this in the unit since it enables an oscilloscope or other instrument to be conveniently connected across the amplifier output.

The functions carried out by the dummy load switching are detailed in Fig. 2, wherein each circuit completed by a switch is indicated by a rectangular block. The switching combinations are as follows:

Position 1. Fig. 2 (*a*). All four 15Ω resistors are connected in series, offering a total impedance of 60Ω at 30W.

Position 2. Fig. 2 (*b*). R_3 and R_4 are connected in series, giving 30Ω at 15W.

Position 3. Fig. 2 (*c*). R_1 and R_2 in series (=30Ω) are paralleled with R_3 and R_4 in series (=30Ω), giving a total impedance of 15Ω at 30W.

Position 4. Fig. 2 (*d*). R_3 and R_4 are connected in parallel, offering 7.5Ω at 15W.

Position 5. Fig. 2 (*e*). All four resistors are connected in parallel, giving 3.75Ω at 30W.

Construction

The dummy load unit may be built into any convenient case, as layout is not critical. The writer employed a 2-bank wafer switch (2 poles per bank) as specified in the Components List, although any available alternative may be used in its place.

The 60Ω impedance offered by Position 1 may be dispensed with, if desired, whereupon resistor selection can be effected with a 4-pole 4-way switch instead of the 5-way switch shown in the circuit diagram.

Checking Loudspeaker Impedance

A secondary use for the unit is that of finding the nominal impedance of old or unfamiliar loudspeakers. The speaker to be checked is connected to an amplifier, and the voltage across its terminals measured with a low-range a.c. voltmeter or an oscilloscope. The speaker is then replaced by the dummy load unit and the impedance of the latter adjusted until approximately the same voltage appears across its terminals. The nominal impedance of the speaker will then be approximately equal to that indicated by the dummy load unit. Since the nominal impedance of loudspeakers is usually measured at 400 c/s, this frequency should be used when carrying out the test.

MARCONI MARINE EQUIPMENT FOR NEW ISRAELI LINER

The Marconi International Marine Co. Ltd. has received an order from the Zim Israel Navigation Co. Ltd. to supply a comprehensive range of communication equipment and radio aids to navigation to the new liner *Shalon*, being built at the French shipyard of Chantiers de L'Atlantique (Penhoet-Loire) St. Nazaire, and scheduled for completion later this year. The 23,000-ton liner is to have a specially designed communications console unit in which will be fitted an SSB transmitter and receivers for telephony and telegraphy working, including VHF. She will also have automatic direction-finding facilities.

Comprehensive Studio Control Unit

By M. J. PITCHER, B.Sc.

Part 2

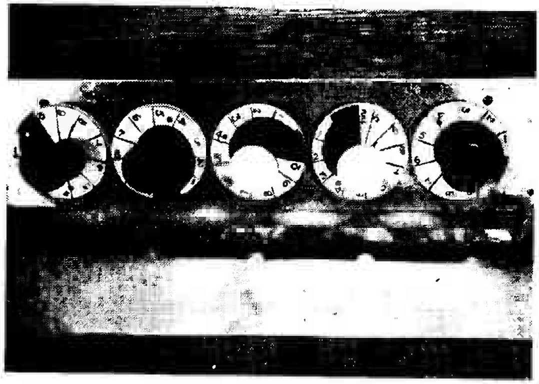
In which the author describes a compact and self-contained unit which provides "professional" control facilities for tape recording. It may also be employed with public address systems

By using this arrangement, rapid fluctuations, which may cause the needle to move violently from side to side, are avoided and the life of the meter is extended.

The rapidity with which the meter responds to the audio signals is determined by its mechanical design and the time constant of R_{24} and C_{13}. The value of C_{13} can be varied to suit the meter and the requirements of the constructor. The value chosen by the author produces a lively action for one meter and a more sluggish action with another. It is unlikely that this circuit can be used to read "peak" levels, but if the meter readings are employed in conjunction with the recording indicator of the tape recorder satisfactory levels should be achieved. With practice it is possible to set the gain controls so that, when a steady signal first brings the tape recorder indicator to peak setting, a four-fifths deflection is obtained in the meter. Programme levels can then be controlled to the four-fifths deflection point with no further reference to the tape recorder indicator.

The Controls

Amateurs who have had the opportunity of examining professional studio control desks are invariably impressed by the size of the control knobs, which are as large as door knobs. The object of such knobs is that of allowing comfortable and smooth operation. The "fades" which a studio manager can produce with such controls are made with the absence of jerkiness that mars much amateur work. A further asset in professional equipment is the provision of a large and very effective position indicator in the form of an opening, and closing, white sector which permits the control settings to be read at a glance.



Volume control indicators with masking strip removed

Equipment built for sale to amateurs is almost always designed to be small in size with the result that the knobs are small, or even miniature, and very inadequate provision is made for the assessment of the control setting. Small knobs require delicate rotation between the finger and thumb. If they are closely spaced, as is sometimes the case, smooth adjustment of adjacent controls is virtually impossible.

Much of the objection to small, closely spaced, knobs can be overcome by the use of necked types (i.e. types whose diameter increases with distance from the panel). The dial indicators visible in the photographs can also be used for fine control. The dials were made from 2in drive-drums, a design being painted on in such a way that rotation of the indicator shows an increase in volume as an increase in the area of visible white on the left.

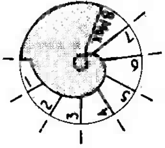
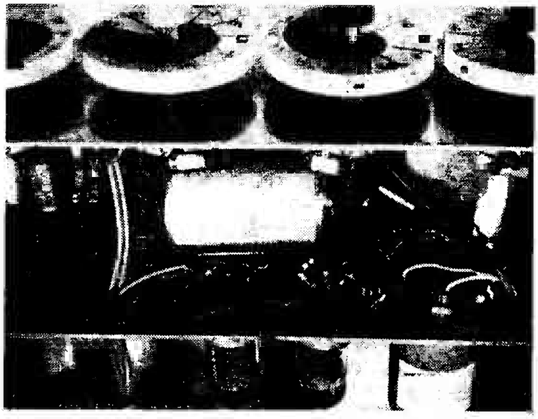


Fig. 6. Diagram illustrating marking for a 2in dial drive drum. Marking will vary according to angle of rotation of potentiometer used

The marking of a two-inch dial drive drum is shown in Fig. 6. The drum should first be given one, or two, coats of white paint, and, when dry, mounted on the control spindle. The grub-screw is tightened on the flat of the spindle, and the zero position marked to correspond with the position of the cover strip. The drum is next rotated to the maximum setting and that position is also marked on it. The pattern, shown in Fig. 6, can then be traced and marked on the drum, the shaded portion being painted black. Graduation marks and numbers can also be added and suitable positions are shown. Constructors may find that minimum and maximum positions do not correspond to those shown in the diagram. This is due to the fact that different makes of potentiometer have different angles of rotation, and an adjustment can easily be made.

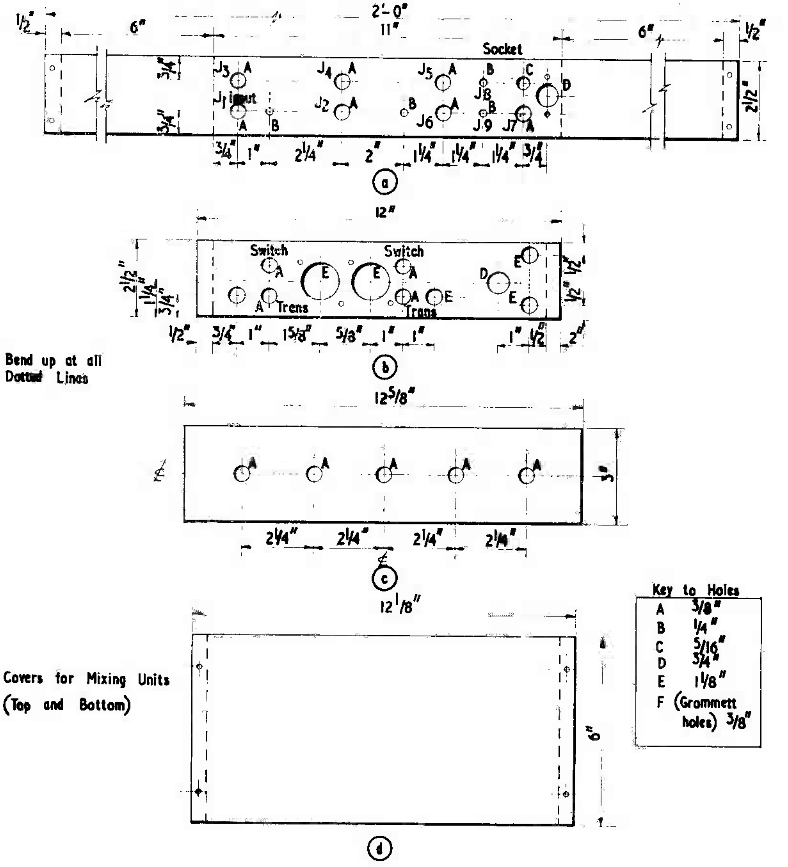
The use of knobs and indicators as first described comes close to professional requirements while, at the same time, producing a reasonably compact unit. Constructors who wish to make a unit that can be easily transported, and stored, should follow the design given. Others who wish to design a permanent installation where space is not at a premium can consider doubling the width and the depth of the front panel and fit much larger knobs.



A close-up of the microphone input switch

Hardware

The mixer chassis can be conveniently built up from a number of strips of 16 s.w.g. aluminium.



Key to Holes

A	3/8"
B	1/4"
C	5/16"
D	3/4"
E	1⅛"
F (Grommett holes)	3/8"

Fig. 7. The dimensions of the chassis employed in the control unit

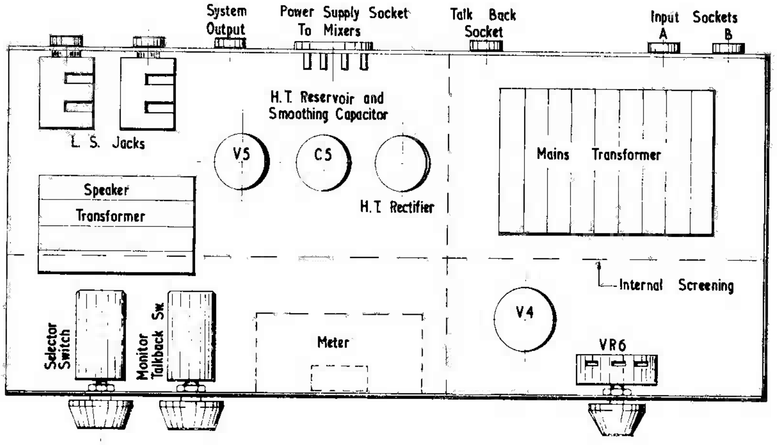


Fig. 8. The layout of the power pack, monitor amplifier and selector switch section. The chassis is formed in a similar manner to that for the mixing unit

Each is marked, and bent, at the dotted lines in Fig. 7 (*a*) and (*b*). The member, 7 (*b*), which carries the valves and other components should be marked while flat, and all drilling and hole-cutting carried out before bending.

The top half of the unit comprises the switching, monitoring and power unit circuits. The conventional box shape for the chassis can be achieved by bending a strip to form the back and sides, it being secured to the front panel by means of flanges. A flat sheet, which will carry the components, is drilled and secured to the previously bent back and sides by means of half-inch angle aluminium. The base of this section must also be covered with a sheet of aluminium to act as a screen. The postion of components is suggested in Fig. 8. It is felt that constructors may wish to use items which are already on hand; there is ample room for almost any item that is likely to be used.

The mechanical work described above can be very considerably reduced by the use of standard blank chassis. The size needed is 12 x 6 x 2½in. The mixer sections will need a strip of metal fixed across the length, to carry the valves, and the switching, monitoring and power unit chassis will need the addition of suitable strips to act as screens.

Wiring Up

Wiring the mixer amplifiers presents few problems. It is important to bear in mind that all grid leads should be kept short, and that signal-carrying leads should be run in screened cable. An earth bus-bar should be connected to the chassis at one point only, and cable screens should be returned to a single chassis connection.

Only two small tagboards are used. These carry some of the small components and use is made of the switch tags as soldering points. Resistors R_5, R_6, R_7, and R_8, are mounted directly on the potentiometers. The result is a clean layout which does not produce capacitative coupling between the stages and which prevents instability.

The use of single hole mounting microphone transformers is recommended if the unit is to be self-contained and have its own power pack. This type of transformer can be very easily rotated to minimise any hum which might be induced by the adjacent mains transformer. It will be found that rotation of the microphone transformer *in situ* will reduce hum to an inaudible level.

The gain of the monitor output stage is sufficiently high to cause instability if care is not taken with the wiring. The leads to the grid of $V_{4(a)}$ should be screened, and it is an advantage to place a metal strip between this valve and the output valve. It is also desirable to place metal screens around the switches, and to take some care in wiring these switches, as already mentioned.

The lead to the studio speaker should be of heavy duty cable if the distance is at all great. The power loss in thin cables can be quite considerable. For example: half the power supplied to a 3 ohm speaker can be lost in 20 yards of "2 amp" twisted flex.

Conclusion

Readers may feel that the construction of the complete unit would provide more facilities than they require at present. It is, however, an easy matter to reduce or add to the circuits which are built and put into use.

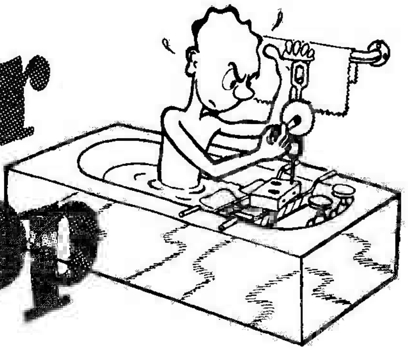
The equipment built by the author is housed in a wooden rack, but no details of this are given because it is felt that each constructor will have his own individual requirements in the matter of housing.

HOME OFFICE ORDER AWARDED TO PYE

The Home Office have awarded a contract to Pye Telecommunications Limited of Cambridge for three hundred 450 Mc/s point-to-point radiotelephone equipments for use in police, fire and civil defence.

Radio links based on this equipment, which is of new design, will handle speech or speech-plus-telemetry and are expected to find wide application in home and overseas markets. The emphasis in design has been placed on extreme reliability and ease of maintenance. Extensive use of solid state devices has been made.

In your Workshop



This month Smithy the Serviceman, aided as always by his able assistant Dick, delves into the mysteries of hybrid car radios

"Why do you call it a *hybrid* car radio, Smithy?"

"Because," replied the Serviceman, "it employs both valve and transistor circuits. A hybrid animal or plant is one which incorporates two different species."

"I see," said Dick, looking at the two units he had just carried over to his bench from the 'Awaiting Repair' rack. "So far as I can see, one of these bits of gear is the one you stick under the dashboard, because it's got the tuning dial and all the other controls on it. I'm not quite certain what the other unit is, though."

"That will be the transistor output stage," said Smithy. "The unit with the tuning dial and the other controls contains the r.f., i.f. and a.f. amplifier stages. This then couples to the transistor output stage via a length of multi-way cable and a plug and socket. The output stage finally connects to the speaker. Presumably, the speaker for this set is still in the car."

"Having a car radio in for repair," commented Dick happily, "certainly makes a nice change. We haven't had one in for ages."

Low Voltage Valves

Dick and Smithy sat and gazed reflectively at the radio on Dick's bench. They had had a busy day and had cleared almost all the outstanding work which was in for repair. In consequence they both felt justified in indulging in a little relaxation during the last half-hour before going home. It hardly needs to be added that, at Smithy's hand, was a large chipped blue and white cup of tea and that, at Dick's hand, was a half-pint beer glass, similarly charged. The Workshop utensils, disreputable as ever, continued to assist in making good the energy lost during the industrious hours of toil.

"One thing that puzzles me a little," said Dick, as a thought crossed his mind, "is how the valves get their h.t. Will this radio have a vibrator or a transistor d.c./d.c. converter?"

"There's no need for that sort of thing," replied Smithy, "the valves work with twelve volts h.t. only."

"*Twelve* volts h.t.?"

"That's right," confirmed Smithy. "These sets use a special range of valves which can work quite happily with only twelve volts on their anodes. However, it would be difficult to provide a high power for the speaker at this h.t. voltage, and so the output stage employs a transistor. The result is that the 12 volt supply in the car feeds the output transistor, provides h.t. for the valves, and supplies the heaters as well. Neat, isn't it?"

"It's certainly a change from the old vibrator jobs," agreed Dick. "Blimey, they *were* a source of trouble!"

"Not entirely," said Smithy. "The nuisance with vibrators was that their life was inevitably limited. Provided you swapped a vibrator when it *started* to go on the blink, you avoided the worst troubles. Anyway, vibrators are now becoming a thing of the past."

"What heater voltage do the valves in hybrid car radios require?" asked Dick.

"The conventional 6.3 volts," replied Smithy. "Also, they draw a current of 0.3 amps, as do many other standard 6.3 volt valves. Most hybrid car radios use four valves, and so they can be connected in series-parallel across the 12 volt car battery supply quite easily." (Fig. 1.)

"That seems easy enough," commented Dick. "What valve types are used?"

Smithy stroked his chin thoughtfully.

"The valves I've encountered myself," he remarked, "are the ECH83 triode heptode, the EBF83 double diode r.f. pentode, and the EF98 r.f. pentode. However, the receiver line-up which seems to be most popular with manufacturers of hybrid car radios doesn't use these valves in quite the manner you would expect from their functions."

"How come?"

"Well," said Smithy, "the hybrid car radios I've worked on recently start off by employing the heptode section of an ECH83 as an r.f. amplifier. This couples, via a circuit tuned to signal frequency, to the heptode section of a second ECH83. (Fig. 2.) The triode of this second ECH83 operates as oscillator, and mixing is carried out in the heptode

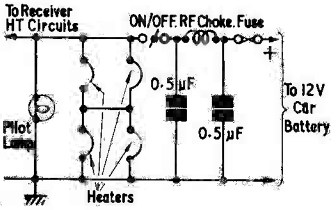


Fig. 1. When a 12 volt hybrid car radio employs four 6.3 volt valves, their heaters are normally connected in series-parallel, as shown here

section. The anode of the heptode couples to the first i.f. transformer and, thence, to the i.f. amplifier valve. This is the pentode section of an EBF83, whose anode couples into the second i.f. transformer. The latter then feeds one of the EBF83 diodes, which acts as the second detector. The detected a.f. is next passed to the triode section of the first ECH83, which functions as voltage amplifier. This, in turn, couples to an EF98 which acts as a driver amplifier for the output transistor."

The Serviceman paused.

"I'm not saying," he added after a moment, "that the line-up I've just described is the one you'll find in *all* hybrid car radios. Nevertheless, it's representative of those I've bumped into myself. If you examine the line-up, you'll find that it's not at all unattractive. You first of all have an r.f. stage, and this is a feature which is very desirable in a car radio."

"Why's that?"

"Because," replied Smithy, "signal pick-up on a car aerial is very weak, and, if possible, you want to amplify what little signal you *can* get before you apply it to the mixer. This helps in overriding mixer noise. Also, signal level on a car radio aerial is continually changing as you drive around, because of the different buildings and obstructions you pass. A car radio has to have very efficient a.g.c. to overcome these variations, and the r.f. stage helps to achieve this. Without the r.f. stage you could feed the a.g.c. voltage only to the mixer and i.f. amplifier grids. With an r.f. stage you can apply the a.g.c. to the r.f. amplifier grid as well, which means that you have greater control."

"I see," said Dick. "What are the other attractive features about the line-up?"

"You have," replied Smithy, "two i.f. transformers, of the intervalve type, which means that you have a high level of selectivity with a nice flat-topped response. So far as the a.f. stages are concerned you have both a triode and a pentode before you get to the output transistor. At the low h.t. voltage available you won't get as much gain from the triode and the pentode as you would from the corresponding high voltage types. Nevertheless, the overall gain from the two valves plus the transistor should be fairly close to that given by the usual triode-pentode you find in conventional mains-operated receivers."

Individual Stages

Smithy stopped and held out his cup, whereupon Dick dutifully stood up to replenish it. Smithy watched his assistant thoughtfully as he busied himself at the teapot.

"That kettle's getting a bit dirty, isn't it?" commented the Serviceman critically. "I bought it new just a few weeks ago, you know."

"You bought it last January," retorted Dick, flatly, "and you've never stopped talking about the darned thing since."

"Nevertheless," replied Smithy severely, "it should still be looked after properly. Dash it all, it's covered in grime."

"That's only on the outside," replied Dick, edgily, "the water you drink comes from the inside."

But Smithy had now risen and walked over to inspect the kettle under discussion.

"It's got a dent in it!" exclaimed the Serviceman aggrievedly. "Hang it all, I buy the Workshop a brand new kettle and the next thing that happens is that it gets a dent in it!"

"So what if it *has* got a dent," responded Dick irritably. "What difference does that make?"

"All the difference in the world," said Smithy grumpily. "Whereas previously we had a kettle which could hold its full rated capacity of water, we now have a kettle whose capacity is diminished by the volume taken up by that dent!"

Even Harry H. Corbett would have been envious of the glance which Dick turned on the unsuspecting Serviceman at that moment. Dick handed Smithy his replenished cup in stony silence.

"Shall we," he asked with icy politeness, after some moments had passed, "return to the subject we were discussing just now?"

"What's that?"

"Hybrid car radios," replied Dick, suppressing his irritation for the time being. "I was just about to ask you if the individual valve stages differed from those in more conventional receivers."

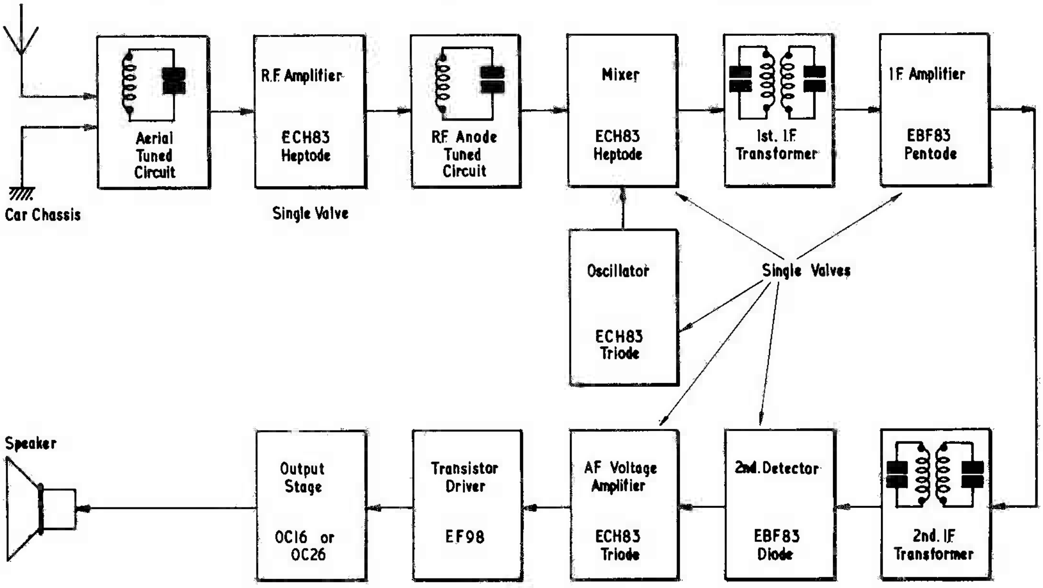


Fig. 2. The various stages in a typical 4 valve plus transistor car radio

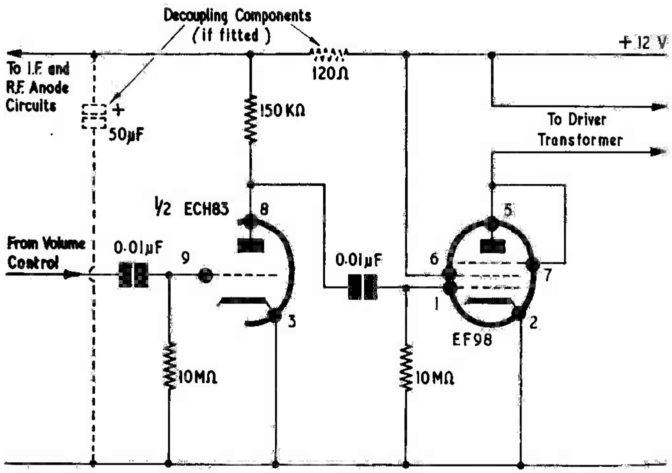


Fig. 3. A typical a.f. voltage amplifier and transistor driver circuit. Component values here and in Figs. 4 to 7 are representative of commercial practice

Smithy sipped his tea thoughtfully. "There *are* slight changes," he replied, "but nothing outstanding. It'll probably be easier to explain things if I work back from the a.f. stages."

Smithy put down his cup and pulled over a pad of papers.

"The triode and pentode a.f. stages," he continued, scribbling out a circuit (Fig. 3), "are fairly straightforward. When the EF98 is employed as a transistor driver, its suppressor grid is coupled to its anode and it functions as a tetrode. Both the screen grid and the anode are fed by the same h.t. line and, for 12.6 volts applied, the optimum anode load impedance is 6kΩ. The triode section of the ECH83 feeds the EF98 by the usual resistance-capacitance coupling, and you'll note that neither valve has cathode bias. Sometimes, there is a decoupling circuit between the EF98 anode load and the anode load of the triode and the other valves in the receiver. Alternatively, all the valves, including the EF98, may share a common h.t. positive line."

"What about the second detector?"

"That is also pretty conventional," said Smithy, scribbling another circuit on his paper (Fig. 4). "As I said just now, the normal form is to use an EBF83 in this part of the receiver. The pentode section operates as i.f. amplifier, whilst one of the diodes functions as signal detector. The remaining diode usually works as an a.g.c. detector, it being fed from the pentode anode via a low value capacitor. Sometimes, by the way, the pentode section of the EBF83 doesn't have its grid coupled to the a.g.c. line. The grid is returned, instead, direct to h.t. negative."

"There's something queer here," commented Dick, looking at Smithy's diagram. "The first i.f. transformer secondary couples to the grid of the EBF83 by means of resistance-capacitance coupling. Normally, the secondary winding would connect direct to the grid."

"That's right," agreed Smithy. "Resistance-capacitance coupling is used here so that the pentode may become biased by grid current. This is the same sort of biasing we had with the a.f. valves, whose cathodes are similarly returned direct to h.t. negative. In the present case, grid current biasing for the pentode is required if the a.g.c. line is at zero volts, or if the grid leak is returned direct to h.t. negative instead of being coupled to the a.g.c. line. Fair enough?"

"Sure," replied Dick. "What about the frequency changer circuit?"

"Again," said Smithy, "there is nothing very much out of the ordinary. (Fig. 5.) An ECH83 is used, and its triode section operates as an ordinary common-or-garden oscillator. The signal from the r.f. amplifier is applied to the signal grid of the heptode using the same resistance-capacitance coupling that we encountered with the i.f. pentode. An important point is that most car radios employ permeability tuning, and so both the oscillator and r.f. amplifier anode coils are tuned by having ganged iron-dust cores going in and out of them."

"Why not use a tuning capacitor?"

"I should imagine that permeability tuning arrangements are more robust and less liable to go out of adjustment than tuning capacitors," replied Smithy. "Don't forget that car radios receive a fair old bashing in the course of service. They get bumped around a great deal more than domestic radios which sit on a table in one room all the time."

"That seems fair enough," commented Dick. "Why is there a resistor connected across the r.f. anode tuned circuit?"

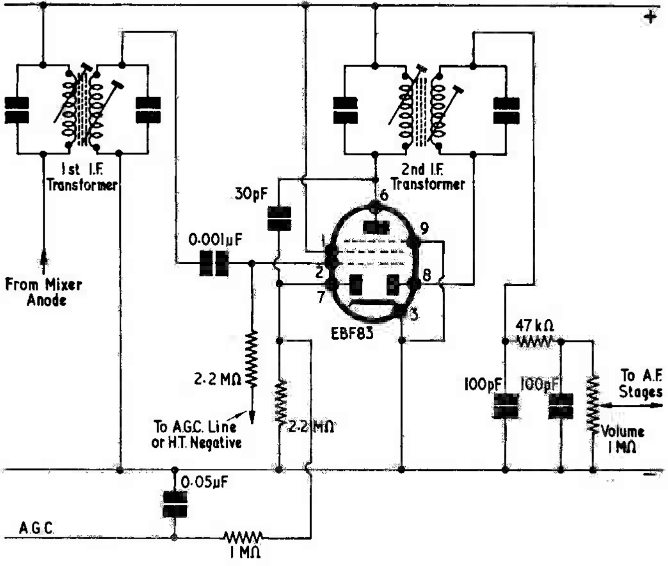


Fig. 4. The i.f. amplifier and second detector stages

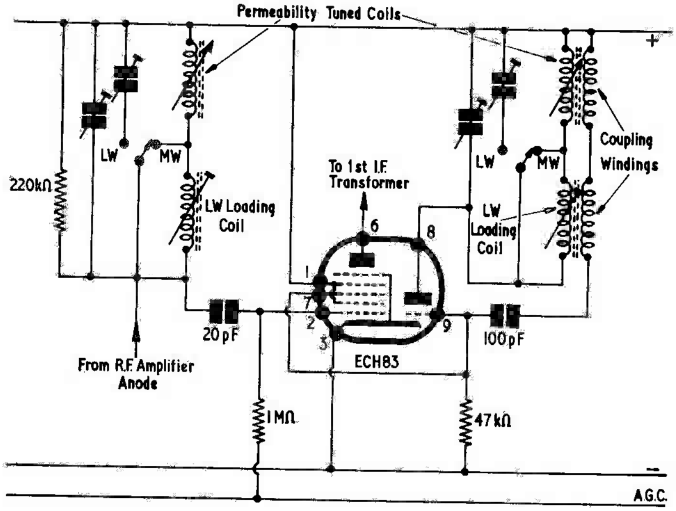


Fig. 5. A typical frequency changer stage. In some receivers the oscillator tuned circuit may appear in a Colpitts configuration. The permeability tuned coils shown here and in Fig. 6 will be adjusted from the front panel by a ganged core assembly

"I'm not too certain about that," confessed Smithy. "A relatively high value resistor across this tuned circuit is used in all the radios of this type I've encountered up to now, and it obviously provides a small measure of damping. It's possible that too high a selectivity in the r.f. anode tuned circuit may be more of a nuisance than an advantage, because it may affect the audio response and make accurate tracking needlessly difficult to achieve. At any event, it seems to be common practice to slightly damp this tuned circuit."

"The only valve circuit that's left," remarked Dick, "is that around the r.f. amplifier."

"That's right," said Smithy, "and the valve used here is the heptode section of another ECH83. This is the valve whose triode section follows the second detector. Unfortunately, it's difficult to be too precise about the aerial tuned circuit because there are rather wide variations in different receivers. In some sets the aerial is effectively tapped into the tuning capacitance on medium waves, (Fig. 6 (*a*), whilst in) others the medium wave aerial coil appears in a pi filter between the aerial and the heptode grid. (Fig. 6 (*b*).) With both arrangements, a loading coil may be put into circuit on long waves, and you get a top-end connection on this band. You will also find one or two filter coils in the aerial circuit which I haven't shown. The main problem in the aerial stage is given by getting the maximum amount of energy from the aerial to the heptode grid, and the design techniques employed to do this vary quite a lot with different receivers. Despite this, all circuits employ the coupling capacitor and grid leak arrangement we've noticed with the other valves, this enabling the heptode to operate with zero cathode bias as well."

The Transistor Output Stage

"This is all very interesting," said Dick. "Let's go to the other end of the set now and natter about the transistor output stage!"

"As you like," said Smithy. "What you are likely to encounter here is a single output transistor of the OC16 or OC26 class, the first of which gives about 2 watts output whilst the second gives about 3.3 watts. The transistor is mounted on a heat sink and, since it operates in Class A, offers quite low distortion. In a typical OC26 circuit (Fig. 7) you have a collector current of 600mA for 14 volts from the battery. A feedback resistor is connected between collector and base, and it guards against excessive drive from the EF98. Apart from that the circuit is quite straightforward, and any other points are covered in the appropriate transistor manual. For instance, the current *Mullard Maintenance Manual* gives all the operating conditions for the OC16 and the OC26 when used as an output stage in hybrid car radios."

"It all seems nice and simple and straightforward," said Dick. "There's just one point I'd forgotten to mention. What about tone controls in car radios?"

"If you have a tone control," said Smithy, "it may appear anywhere in the a.f. circuits of the tuner section. Usually, it's a simple top-cut arrangement consisting of a capacitor in series with a variable resistor. You may sometimes find a tone control circuit which falls more into the category of bass-boost than top-cut but, even so, it will still be quite a simple affair."

Back to Work

The pair fell into silence and stared once more at the two units on Dick's bench. With an air of satisfaction, accompanied by swallowing and lip-smacking noises which were very nearly as loud as those the B.B.C. adds to radio plays for tavern atmosphere, the Serviceman drained his cup and placed it regretfully on the bench beside him. Dick, likewise, emptied his glass. Silence fell once more.

"I suppose," said Dick tentatively, "we *ought* to have a go at repairing it."

"I suppose so," agreed Smithy, stirring out of his lethargy. "After all, that's what we're here for!"

"Right," said Dick keenly, his interest arising at the prospect of an unusual repair job. "What do I do first of all?"

"The first thing," said Smithy, "is to couple a speaker to the transistor output stage. You'll have to get out the service manual to find the impedance required if it's not marked on the transistor unit itself. Usually, though, the speaker impedance is of the order of 3Ω."

"Why connect the speaker first?" queried Dick.

"Because," replied Smithy, "you must never run the transistor output stage of a hybrid car radio without a speaker. If you don't load the output stage correctly, the first bit of a.f. that comes along may completely ruin the transistor because of excessive collector voltage. So, *always* make certain that the speaker of a hybrid car radio is connected, and *never* disconnect the speaker whilst the set is switched on."

"Okeydoke," replied Dick. "I'll watch that point. What about the supply?"

"There's another important thing there," said Smithy. "These 12 volt sets will work with either a positive car earth or a negative car earth. To change from one to the other you usually change over a number of connections on a terminal strip. Before you start any work on the set you must make certain what supply polarity it's set up for, and connect up accordingly. Apart from possible damage to the transistor, connecting up with wrong polarity may also break down the bypass electrolytics connected across the h.t. line."

"Right," said Dick. "I'll take care on that point as well. Where do I get a 12 volt supply from?"

"There's a 12 volt accumulator in the Workshop," said Smithy, "which I keep on trickle charge for just such eventualities as this."

"Isn't that," asked Dick innocently, "the spare battery for your car?"

"Not at all," replied Smithy firmly. "It's the Workshop accumulator for testing car radios."

"That's funny," remarked Dick, thoughtfully. "I seem to remember that, every now and again, you lug the battery out of your car and swap it over with the one in here."

"I only do that," said Smithy, "to ensure that the Workshop battery gets a bit of usage every now and again. It doesn't do a battery any good to have it fully charged all the time."

"Do you know what *I* think?" said Dick.

"What do you think?"

"I think you're working a fiddle," replied Dick, "by using Workshop gear to keep your banger going! I bet by now that you don't even know which battery is yours and which belongs to the Workshop!"

"I am *not*," snorted Smithy indignantly, "working a fiddle. My actions are perfectly reasonable and I am doing the Workshop battery a good turn by running it down every now and again. And, also, I *do* know which battery is mine."

"I've no doubt you do," said Dick darkly. "And I bet it won't be the one which has to be replaced when it's worn out either!"

"I see no point," said Smithy irately, "in pursuing this matter further. Let's get on with repairing this set!"

Variable Distortion

Chuckling to himself. Dick busied himself with connecting a loudspeaker of suitable impedance to the transistor output stage of the radio and to applying, with correct polarity, the battery of debatable ownership.

"What about an aerial?" he asked.

"About six feet of wire laid on the bench should be more than adequate," said Smithy. "We can't exactly reproduce the aerial conditions in the car here. When the set is fitted in the car there's an aerial trimmer which needs touching up to allow for the aerial-earth capacitance, but it would be pointless to adjust that trimmer in here."

Dick soon carried out Smithy's instructions and it was not long before the receiver had warmed up and was emitting an encouraging hiss from the loudspeaker.

Experimentally, Dick turned the tuning knob and selected the local Medium wave station. As the tuning cursor approached the correct setting the carrier sidebands became audible in characteristic manner. At the correct tuning point, however, the transmitted signal was reproduced with very heavy distortion.

"Turn down the volume a bit," commanded Smithy.

Obediently, Dick reduced the volume, and a puzzled frown appeared on his forehead as he found that the distortion decreased in proportion to volume. At a low volume setting the distortion was almost unnoticeable.

"I know what's wrong," said Dick suddenly. "The output transistor circuit has gone up the wall! The transistor can only handle low signal levels before it introduces distortion."

"You mustn't," said Smithy severely, "jump to conclusions. See if you can tune in a weak signal."

Dick turned once more to the receiver and, after a few moments of concentrated searching, picked up a Continental station which was only just audible above the receiver background noise. He advanced the volume control. His frown deepened as he found that, even at a high

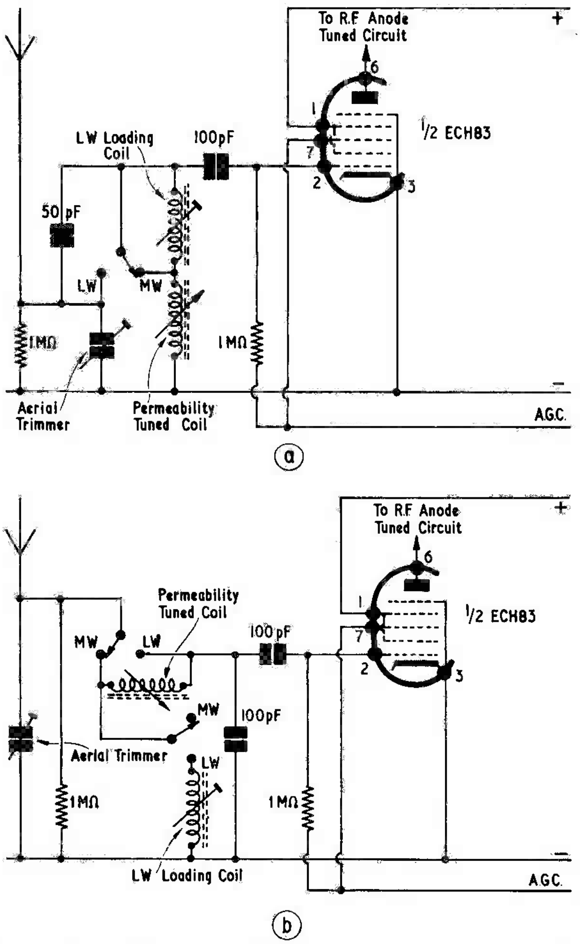


Fig. 6 (a). A simplified circuit illustrating a common method of aerial coupling. On long waves the aerial couples directly across the tuned coils, whilst on medium waves it taps into the tuning capacitance

(b). An alternative aerial coupling circuit, again shown in simplified form. On medium waves the permeability tuned coil appears in a pi filter between the aerial and the heptode grid. On long waves the aerial connects to the top end of the tuned coils

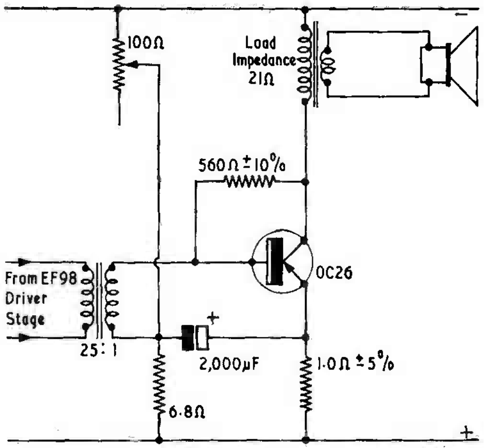


Fig. 7. Operating conditions for the OC26 when employed in hybrid car radios (as specified by Mullard Ltd.)

volume setting, distortion was almost negligibly low.

"This," he remarked, "*is* a turn-up for the book, and no mistake! How can you have distortion on strong signals and not on weak signals?"

"Very simply," replied Smithy. "It occurs usually because of a fault in one particular component. However, I don't want to be too dogmatic at this stage so, before going further, I would suggest that you whip the case off the tuner section so that I can have a go at its innards."

Dick withdrew the chassis of the tuner section, whereupon Smithy immediately sat down at the bench to examine it. After a short preliminary inspection he applied Dick's testmeter to a capacitor and gave a grunt of satisfaction. He next snipped the capacitor body from its printed circuit board, whilst Dick rummaged in the spares cupboard for a replacement. Smithy carefully soldered the new component to the projecting lead-out wires left from the previous capacitor, and switched the receiver on again. It now performed perfectly, and there was no noticeable distortion on either distant or local stations.

"Blimey," said Dick, impressed, "that was quick! What led you to that capacitor so smartly?"

"It was elementary, my dear Dick," replied Smithy. "All the clues pointed towards it. In this particular receiver the volume control is also the second detector diode load (Fig. 8), which means that a negative voltage proportional to signal strength appears at the upper end of its track. What had happened was that the blocking capacitor immediately following the slider had gone short-circuit. Thus, when you tuned in a powerful signal you had a relatively high negative voltage on the volume control, this being tapped off by the slider and passed to the following valve as negative bias. The negative bias increased as you advanced the volume control, and thereby caused the increased distortion. When you tuned in a very weak signal the negative voltage on the volume control track was much lower, and so you had correspondingly less distortion."

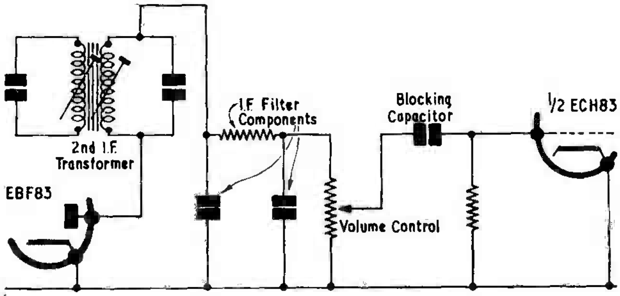


Fig. 8. Distortion in the car radio serviced by Dick and Smithy was due to a fault in the circuit shown here. (It will be noted that this diagram incorporates parts of Figs. 3 and 4)

Going Home

"Dash it all," said Dick. "Why does everything seem easy after it's been explained to you!"

"That's always the way," replied Smithy philosophically. "Anyway, it's time we packed up for the day, now. You can box up that car radio in the morning after you've given it a final check-through."

"Righty-ho," said Dick, cheerfully.

It did not take the pair more than a minute to ensure that all switches were safely off and to vacate the Workshop. The slamming of the Workshop door was followed by the slamming of Smithy's car door. His engine came to life at the touch of the starter button (as is to be expected when the car-owner keeps his battery in tip-top condition), and Smithy drove off. Dick walked slowly away in the opposite direction, his mind turning over the events of the day.

And, as the sun sank slowly in the West, the Workshop settled, for the night, into final silence.

CONTINENTAL CONNECTORS REDUCE EXPORT PRICES

A 10% decrease in export prices is announced by Continental Connectors Limited, associated with the Ultra Group of Companies, this taking effect from the beginning of April. The decrease applies to all United Kingdom manufactured components in all quality groupings.

An export target of 25% of total turnover has been set for the financial year which began on 1st April.

Hybrid T.R.F. Circuit

By Sir DOUGLAS HALL, K.C.M.G., B.A. (Oxon)

By employing an r.f. pentode in combination with an r.f. transistor, this receiver offers a high degree of gain together with smoothly controllable reaction

HYBRID CIRCUITS USING A MIXTURE OF VALVES and transistors are by no means new. Car radios using low voltage valves for all the stages except output, which employs a large power transistor, have been on the market for some time in both manufactured and kit form; and it is not uncommon for simple short wave detectors to be followed by audio frequency transistors to bring the output up to loudspeaker level. The idea has not prospered, (at any rate until very recently), because of the high price of good high frequency transistors.

The present article describes a receiver which uses transistors for high frequency amplification and output, together with a valve as detector. There are certain advantages to be gained from this arrangement, and experiments have proved that a sensitive and satisfactory receiver results from the circuit, which has been conceived by the author. This circuit is shown in Fig. 1. It should be mentioned that, although a valve is used as the detector, a high tension battery of only 13.5 volts is required, and that the filament consumes only 25mA at 3 volts. The initial battery requirements are a little more expensive than in the case of an orthodox all-transistor circuit working from 9 volts, but as the current consumption of the output transistor at the higher voltage available is only about half that normally encountered, the running costs are not increased. The total consumption from the 13.5 volt battery is about 8mA, and 31.5mA is taken from the 3 volt battery which supplies current for the output transistor as well as for the filament of the valve. Three 4.5 volt torch batteries at 1s. 3d. each, and a twin-cell torch battery at 1s. 6d., will give good service.

The R.F. Stages

TR_1 is a high frequency transistor and the values of the associated components are those for a Mullard OC44. It should be noted that this part of the circuit is drawn upside-down as compared with usual practice in order to link more conveniently with the detector stage. L_1 and L_2 comprise a Medium wave frame or ferrite rod aerial with the usual ratio of 5 or 6 to 1. The prototype uses a frame about 9 inches square, with 11 turns for L_1

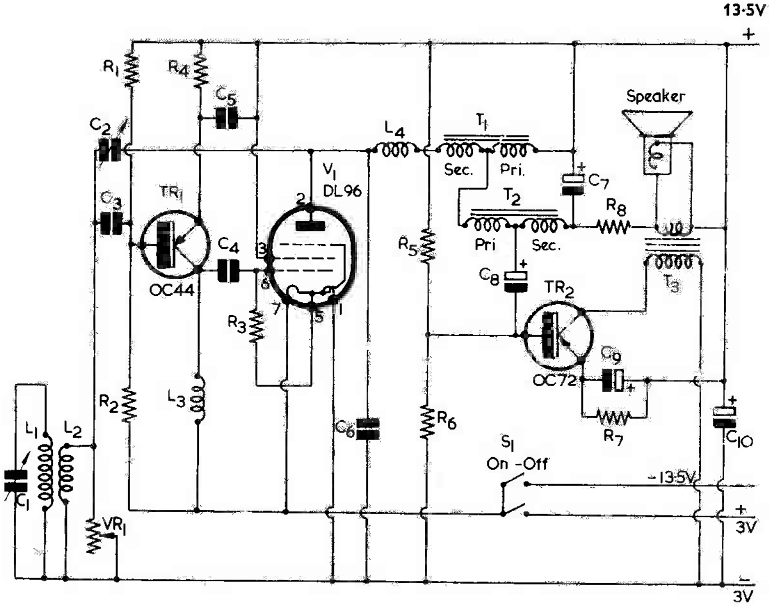


Fig. 1. The circuit of the complete receiver

and 2 turns for L_2. 34 s.w.g. wire is employed and the windings are pile-wound, as a result of which self-capacitance is on the high side and necessitates a rather smaller inductance than usual for L_1 in order to receive the Third programme on 194 metres. Consequently, the top limit with a 500pF tuning capacitor is about 460 metres. A lower capacitance frame aerial, or a ferrite rod aerial would, of course, enable the whole Medium waveband to be covered. Because of the form of reaction control used it is essential that L_2 should be a separate coil. If a tapping is used for the base connection of TR_1 there will be serious mistuning at low levels of VR_1.

L_3 is a choke which should not have too large an inductance but be of the type designed for use with transistors. About 2.5mH is right. The prototype uses a coil taken from an old 465 kc/s intermediate frequency transformer of the variety which was tuned, when it was part of the transformer, by a small capacitance air-spaced trimmer. Its inductance is in the region of 2.5mH (which is much larger than in the case of core tuned i.f. transformer windings, which would not be suitable).

In an all-transistor circuit the signal developed across L_3 would be heavily damped by the input circuit of the following transistor, which would have an a.c. resistance of about 1kΩ. But the input resistance of a valve is extremely high and R_3 causes virtually no damping across L_3. Accordingly a most useful increase of amplification is obtained from TR_1.

Because of the small high tension voltage available, the full amount is applied to the screen-grid of V_1, and the grid leak, which is taken to the filament tapping, has a lower value than is usual to step up anode current as a result of grid current. Reaction is taken from the anode of V_1 back to the base of TR_1. There is no phase difference over this double stage, and therefore no separate reaction coil is necessary. This allows a simple and effective reaction control to be used, consisting of a damping resistance, VR_1, across L_2. Unlike many reaction controls VR_1 acts as a true controller of volume since it brings about a short-circuit of the base emitter circuit of TR_1 (at high frequencies) when it is at its minimum position. C_2 is set up once only, and it enables R_1 to provide a smooth control with oscillation setting in somewhere about the mid-way position, assuming a log control. A log control is, incidentally, much to be preferred to a linear potentiometer in this position. The exact point where oscillation commences will vary with frequency. It will be found that the control has to be advanced rather further at the higher frequencies, since even good high frequency transistors such as the OC44 are less efficient as frequency rises. L_4 is a normal valve type reaction choke and is not critical in value.

When the critical reaction point is passed, the effect given is of V_1 oscillating, rather than TR_1. This produces a lessening of mutual conductance of V_1 with its grid becoming more negative, and a smooth control results. With a transistor as reactive detector, increased reaction increases the amplification and back-lash results, which means that critical reaction is exasperatingly difficult to obtain.

The A.F. Circuit

The low frequency load arrangement for V_1 may appear rather complicated. The output of this valve has an extremely high a.c. resistance of the order of at least 0.5MΩ, and the signal has to be transferred to the input of TR_2 which has an a.c. resistance of about 1kΩ. By using a suitable transformer it should be possible to obtain very high amplification from V_1 plus a useful degree of current amplification. What is needed is a step-down transformer with a ratio of about 22 to 1. To the best of the author's knowledge no suitable transformer exists, but it can be simulated by using an intervalve transformer in conjunction with a normal transistor input transformer. T_1 is a 1 to 3 intervalve transformer (a Radiospares miniature type in the prototype) with the two windings connected in series to produce an autotransformer with a ratio of 4 to 1. Only about 0.25mA of direct current will pass through the windings so core magnetisation is not a problem. T_2 is a 4.5 to 1 transistor input transformer with the windings similarly connected in series to give a ratio of 5.5 to 1. The overall result is a step-down ratio of 22 to 1.

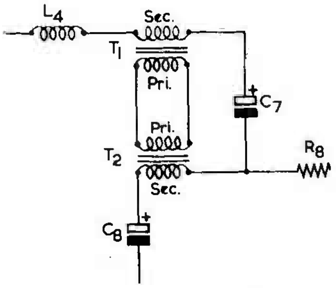


Fig. 2. An alternative method of connecting T_1 and T_2

We can say that if the input circuit of TR_2 reflects an impedance of 1kΩ into the secondary of T_2, the consequence impedance reflected into the anode load of V_1 is 484kΩ. Thus V_1 has a satisfactory load for its low frequency signal, which receives a further current step-up of 22 times before it reaches TR2. This is a very satisfactory arrangement and provides far greater amplification than could be obtained from a transistor as detector.

Some transformers are so constructed that the direction of the windings is not easy to follow. It is important, with T_1 and T_2, to ensure that the windings are joined together correctly and not in opposition, but an alternative circuit is shown in Fig. 2 which overcomes this difficulty. The overall ratio is reduced from 22 to 1 to 13.5 to 1 with a consequent fall in amplification, but this can be retrieved to some extent by using a 1 to 5

Components List

Resistors

(All fixed resistors ¼ watt)

R_1	22kΩ
R_2	15kΩ
R_3	470kΩ
R_4	3.9kΩ
R_5	6.8kΩ
R_6	47kΩ
R_7	220Ω
R_8	See text
VR_1	3kΩ pot, log track

Capacitors

C_1	500pF, variable
C_2	50pF, pre-set
C_3	330pF
C_4	330pF
C_5	0.01μF
C_6	50pF
C_7	50μF, electrolytic, 15V wkg.
C_8	50μF, electrolytic, 15V wkg.
C_9	50μF, electrolytic, 15V wkg.
C_{10}	100μF, electrolytic, 25V wkg.

Inductors

$L_{1,2}$	Medium wave frame or ferrite aerial (see text)
L_3	2.5mH choke
L_4	Valve type reaction choke
T_1	Intervalve transformer, 1:3 (see text)
T_2	Transistor input transformer, 4.5:1
T_3	Transistor output transformer, 18:1

Transistors

TR_1	OC44
TR_2	OC72 or red spot (see text)

Valve

V_1	DL96

Switch

S_1	d.p.s.t. on-off switch

Speaker

3Ω impedance

transformer for T_1. If a Radiospares miniature component is sued for T_1, the correct connection is obtained by joining together the two wires which are next to each other and close to the centre of the transformer, using the two outside wires for connection to L_4 and C_7 respectively. The primary and secondary leads are colour coded and clearly marked. With most transistor transformers it is easy to see the direction of the windings, so that the difficulty is not likely to arise with T_2.

A.F. Feedback

It will be seen that T_2 is linked to the output transformer, T_3, by C_7 and R_8. This is an arrangement which provides a modicum of *positive* feedback in TR_2, particularly of the lower frequencies, and therefore provides a useful bass boost without, as happens with most bass boost circuits, reducing the higher audio frequencies. The value of R_8 will depend on the characteristics of T_2, T_3 and TR_2, but will probably lie between 10 and 50Ω. In the prototype, using an ordinary red spot transistor, the value which provides an appreciable bass boost without introducing instability or distortion, turned out to be 18Ω[1]. The secondary of T_3 must be connected the right way round to provide positive and not negative feedback. The easiest way to set up this part of the circuit is to use a pre-set potentiometer of about 100Ω for R_8. Oscillation will take place when this is set too low in value, provided the secondary of T_3 is correctly connected. Otherwise there will be slight attenuation as R_8 is reduced in value. If an ohmmeter is available the correct setting of R_8 can be measured off and a fixed resistor of the indicated value can be substituted. This part of the circuit is useful but not vital. If it is not required C_7 and R_8 can be omitted, a direct connection replacing C_7.[2]

R_4 and R_7, which are stabilising resistances, have values to limit the voltage to 7 for TR_1 and 15 for TR_2. The values of R_5 and R_6 are such as to allow a current of 6.25mA to pass through TR_2. Different transistors may require slight modification to one or other of these resistances but the values shown will probably prove to be satisfactory.

It is always rather difficult to describe the degree of sensitivity of any circuit. Suffice it to say that in a not very favourable part of the West Country (except for an almost too powerful Home Service just round the corner) and using only the 9in square frame aerial, it is possible to obtain good speaker volume from the Home, Light and Third programmes during daylight. All Home stations have been received on the loudspeaker after dark, Welsh and Midland giving consistently good volume. Luxembourg can overload the output transistor after dark and about a dozen other European stations can always be received at good volume. Output is only about 40mW but this, with a sensitive 6½in speaker, is surprisingly satisfactory.

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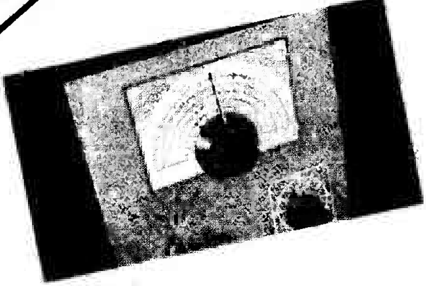
[1] The collector-emitter voltage for TR_2 of 15 may be excessive for some red spot transistors.—EDITOR.

[2] It may be noted that C_7 has no polarising voltage. It will in practice, however, still present an effective capacitance to the circuit. —EDITOR.

Cover Feature



An EF183 PRESELECTOR

By **JAMES S. KENT**

THERE MUST BE MANY READERS OF THIS MAGAZINE who operate short wave receivers either as a full time hobby (short wave listening) or as a sideline to the main interest of constructional work. Most of these receivers will, of course, already have one r.f. stage incorporated into the receiver design itself, and it largely is for this class of equipment that the unit about to be described was constructed; the requirement here being a tuned r.f. stage that would impart as much additional gain as could be achieved, this being followed by a cathode follower stage providing the maximum transfer of r.f. energy to the aerial coil of the associated receiver.

To the writer, the obvious choice of r.f. amplifier valve was one of the new frame grid types, bearing in mind that maximum gain was required at a reasonable cost, that simplicity in construction was needed, and that time was at a premium. The receiver itself was already complete with its own 6BA6 r.f. stage and the writer was somewhat loath to modify its "innards" in order to employ a different r.f. valve, especially in view of the loss of trade-in value with modified receivers. Additionally, of course, such modifications often result in unwanted side-effects unless much re-design work is undertaken and time spent in order to achieve a successful outcome to the venture.

The valve chosen was the Mullard EF183 variable-mu r.f. pentode having a slope of 12.5mA/V, this being approximately three times that of the existing 6BA6 r.f. stage in the receiver (4.4mA/V). It can be theoretically shown that the gain of an r.f. amplifier is approximately proportional to the mutual conductance (slope) of the valve used in such a stage, and it can readily be seen that the EF183 is an ideal valve for such an application.

The mutual conductance of these frame grid valves has been increased by a suitable choice of dimensions with respect to the control grid, these being wound with a very fine wire. This wire is closely spaced, and is placed very near the cathode so that the control grid exerts the maximum control over the electron stream.

The input capacitance of the EF183 is similar to that of more conventional r.f. valves, but it has the advantage over these that the signal-to-noise ratio at its output is considerably greater. This latter fact should prove to be of interest for those readers operating a receiver having no r.f. stage or to those contemplating the construction of a receiver which is to include an r.f. stage.

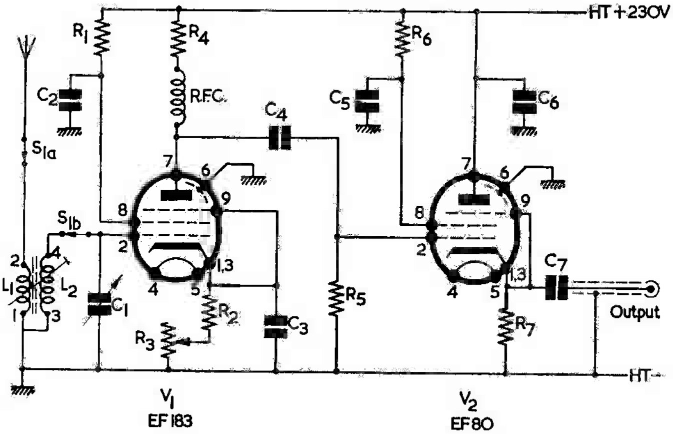
There is an inherent noise level in any receiver even under no-signal conditions, such noise being derived from the normal operation of the valves. Any signal received must therefore overcome the generated noise to become audible, and unless this condition is met, subsequent amplification is of no help. The noise level of the first stage is of great importance, and high gain is essential if only one r.f. stage precedes the mixer valve. Multigrid mixers such as heptodes and triode-hexodes have a notoriously high noise level with comparatively little gain, and the solution therefore is to precede such a stage or, indeed, an existing r.f. stage if it generates a high level of noise, with an r.f. stage having as low a noise level and high a gain as possible.

The cathode follower stage, consisting of an EF80 r.f. pentode, provides a gain of slightly less than unity but, with the relatively high gain available from the first stage, this is of little importance in this context. The main function of the cathode follower stage is to ensure that a correct impedance match, at all frequencies, is achieved between the EF183 and the receiver input terminals.

From the foregoing it will therefore be seen that the overall effect of the preselector is to provide a high r.f. gain with low noise level, together with a correct impedance match into the receiver.

Circuit

The circuit is shown in Fig. 1, from which it will



$S_{1a,1b}$ -Wavechange switch (see fig.3)

Fig. 1. Circuit diagram of the EF183 Preselector. L_3 L_4 connects to the wavechange switch in the same manner as L_1 L_2

be seen that it is a comparatively simple design capable of being constructed even by the beginner. Two coils are used but there is, of course, no reason why the frequency ranges should not be extended, according to requirements, by the addition of another coil or coils and a wavechange switch capable of handling such additions. Alternatively, a further coil could easily be included in the existing circuit, thereby utilising the 3-way switch specified to the full, the coil ranges being selected to cover those frequencies in which the operator is primarily interested. Other Osmor short wave coils (when tuned by a 500pF variable capacitor) have ranges thus: QA1 13–35 metres (23.1–8.6 Mc/s approx.) and QA3 35–120 metres (8.6–2.5 Mc/s approx.). The two coils included here are the Osmor types QA2 and QA4, these covering the frequency ranges 20–6 and 4.3–1.3 Mc/s (15–50 and 70–230 metres) respectively*

A further advantage of this design is that only a single gang variable capacitor and one set of coils is required, thus obviating the tracking difficulties which inevitably arise with multi-stage preselectors. The gain of the r.f. amplifier (V_1) is controlled by the variable potentiometer inserted in its cathode circuit(R_3), this being in series with the cathode bias resistor R_2. It should be noted that, with the

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* The ranges quoted are for a 500pF tuning capacitor. They will be slightly reduced when the coils are employed with the 410pF capacitor specified for the preselector.—EDITOR.

Components List

Resistors. (All ¼ watt 10%)

R_1	33kΩ
R_2	200Ω
R_3	5kΩ pot.
R_4	5kΩ
R_5	100kΩ
R_6	1kΩ
R_7	180Ω

Capacitors

C_1	410pF, single gang variable, Jackson Bros. type 5250/1 (without slow motion)
C_2	0.01μF
C_3	0.01μF
C_4	100pF ceramic
C_5	0.01μF
C_6	0.01μF
C_7	0.005μF

Valves

V_1	EF183 Mullard
V_2	EF80 Mullard

RFC

2.5mH (H. L. Smith & Co. Ltd.)

Coils

L_1, L_2	Osmor Type QA2
L_3, L_4	Osmor Type QA4

Chassis and Panel

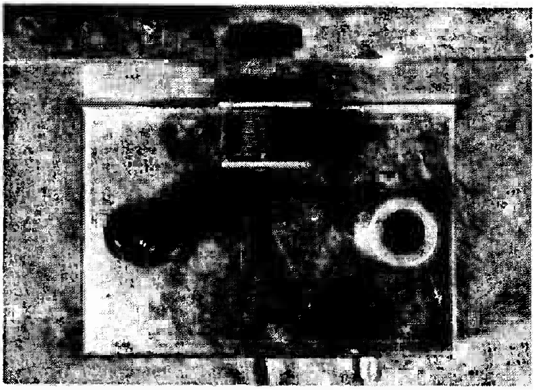
(H. L. Smith & Co. Ltd.)

Switch

$S_{1(a)\ (b)}$ See text

Miscellaneous

Valveholders (2) B9A, grommets, coaxial sockets (2), knobs, nuts, bolts, etc. (H. L. Smith & Co. Ltd.)



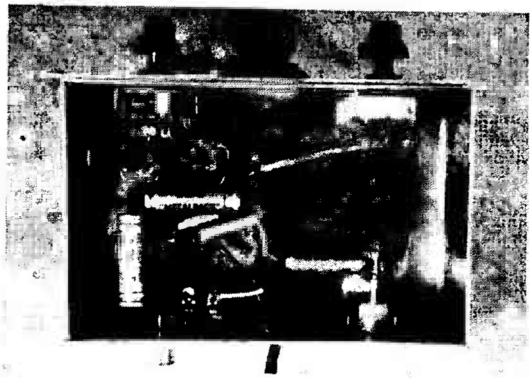
Above-chassis view of the preselector

EF183, both pins 1 and 3 must be used as the cathode connection. Further, the suppressor grid (G_3) should be connected externally to the cathode direct. The internal screening of the valve (pin 6) should be earthed direct to chassis.

The resistor R_1 is the h.t. screen grid decoupling component, C_2 being the bypass to chassis. R_4 and the r.f. choke provide the anode load, the resultant r.f. being fed, via C_4, to the grid of the cathode follower stage, V_2.

The V_2 stage has the great advantage that the output impedance is approximately 75Ω and in this respect it matches admirably into ordinary TV coaxial cable and, thence, to the receiver, most versions of which (and particularly communication types) will have an input impedance of around this figure. The value of C_4 (100pF) has been chosen by virtue of the high input impedance of the cathode follower stage.

The capacitor C_6 should be connected direct from the anode of V_2 to chassis. It will be noted that the EF80 has exactly the same valveholder connections as the EF183 and therefore the previous remarks with respect to external connections apply. The applied h.t. potential is 230V, this being obtained from a separate small power unit already supplying other ancillary equipment. The voltage and current requirements are quite small, heater current being 0.6A and h.t. current 20mA, and it may be possible to obtain the power needed from the existing receiver supply.



Below-chassis view of the completed unit

The output from the preselector is passed, via C_7, to the coaxial cable, the outer metal braiding of which will automatically connect together both the receiver chassis and the preselector chassis.

Construction

The chassis measurements are shown in Fig. 2

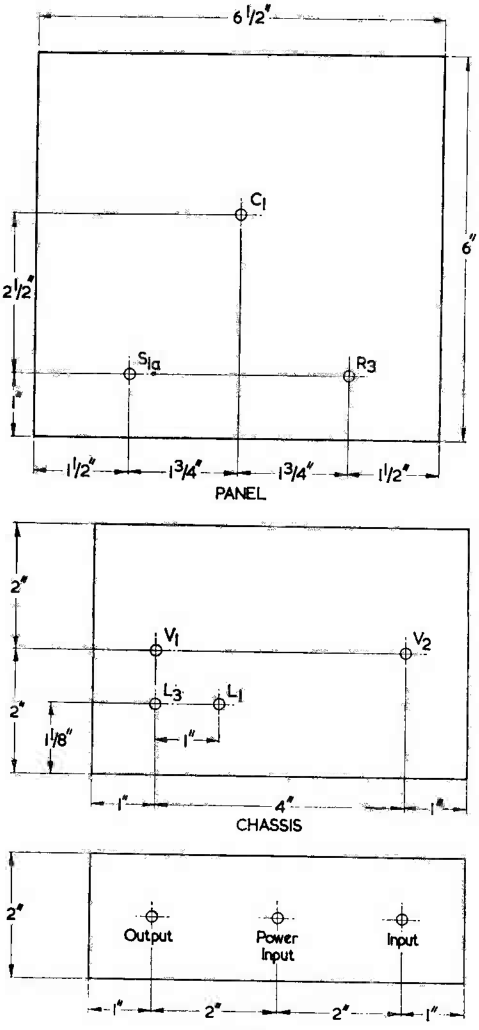


Fig. 2. Panel and chassis measurement details

and it is a good practice to commence drilling the front panel and, once this is completed, use it as a template for the two apertures required for $S_{1(a)}$ and R_3 on the chassis front apron. It should be noted that the panel is $\frac{1}{2}$in wider than the actual chassis and therefore a $\frac{1}{4}$in overlap will result at the two outer edges of the panel. When fitting C_1 it is required that three further holes be drilled through which three 4BA bolts will fit in order to secure the capacitor to the panel. The positions of these three holes depend on the position of the capacitor spindle and it may be helpful here to make the necessary markings on the rear of the panel where, with the rotor plates fully engaged, it is an easy matter to place a scribe through the two top holes in the capacitor frame. The third hole may then be measured from the capacitor itself and marked on the panel, this last hole being obscured once the capacitor is in position. When mounting C_1 to the panel, it will be found necessary to place three small rubber grommets between the capacitor frame and the rear of the panel, passing each bolt through the panel, the grommet and thence into the capacitor frame. As C_1 is now virtually "floating" on rubber, it must be remembered that its frame must be connected to chassis during the wiring-up process.

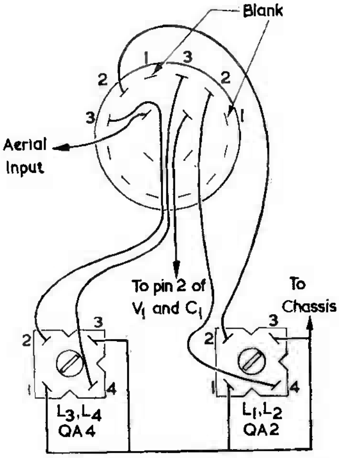


Fig. 3. Wiring details of the wavechange switch and the two coils

The various measurements and details shown in Fig. 2 are self-explanatory and the coils themselves are force-fitted into suitable sized apertures. Prior to securing the front panel to the chassis, an earth tag should be fitted to the latter in such a manner that it may be easily connected via a short length of wire to the frame of C_1.

A further hole should also be drilled and fitted with a small rubber grommet for the lead from C_1 to pin 2 of V_1.

Both valveholders should be mounted in such a manner that their pins 1 and 9 are nearest the left-hand edge of the chassis looking from the front of the chassis. A 4-way tagstrip (of the type having the two end tags connected to chassis) should be secured to the underside of the chassis—see illustration. Having placed the main components into position, wiring-up can now commence.

Wiring-up the Circuit

The best method to adopt here is to wire-up the tuned circuit in the first instance for, in this manner, one is able to ensure that all leads are as short and direct as possible. From Fig. 3 it will be seen that it is a simple matter to connect the wavechange switch to the individual coils, this being a point-to-point drawing showing all the required connections. It will be noted that half of the switch is unused, the type shown being to hand when construction commenced. A 3-way, 2-pole component would suit admirably where a switch has to be purchased in the first instance. On Position 1 of the switch the aerial input is disconnected from the circuit, this often being a desirable feature when various measurements under no-signal conditions are required or, when used by short wave listeners, a standby control is needed. On Position 2, L_1 L_2 is brought into circuit and on Position 3, L_3 L_4 is connected.

Having made the connections to the tuned circuits, the power input leads should be soldered into position, h.t.+ to a free tag of the tagstrip, l.t. and h.t.− to one of the earthed tags and the 6.3V heater line direct to the valve pins themselves. (Pins 5 in each case—pins 4 being connected to chassis). The remainder of the components should now be wired into circuit.

Once completed, the unit should be connected to the power supply and the receiver, whereupon it is ready for use.

Finishing the Panel

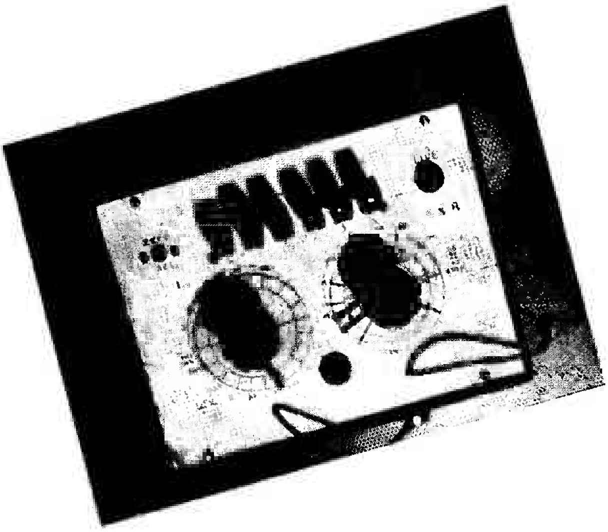
Panel-Sign transfers are fixed to the front panel once the construction has been completed. The small full-vision dial shown (uncalibrated at the time of photographing) is taken from Panel-Sign Transfers Set No. 2, as are the two lower transfers. This small dial (of which there are two in each Set No. 2) measures approximately 4 x 2¾in and is ideal for the purpose envisaged here. Calibration may easily be effected by the use of indian ink or, more easily, by an ordinary ball-point pen. In the latter case there is no reason why the amateur bands should not be marked with a blue/black pen and the broadcast bands with a red pen, thus making an attractive finish to the completed assembly.

NEW COAXIAL TETRODE FOR BANDS IV AND V

Mullard have announced a new coaxial tetrode (type number YL1140) intended for use as a high gain u.h.f amplifier at frequencies up to 900 Mc/s in the driver or output stages of television transmitters operating in Bands IV and V.

Under typical operating conditions in a Class B grounded-grid television transmitter operating at 800 Mc/s a power output of 500W can be obtained with a drive power of 50W. When used in this application the YL1140 requires an anode voltage of 2.5kV and a screen grid voltage of 500V. Anode current is 560mA. The heater is rated at 9V 10A.

The valve incorporates an integral radiator and requires forced air cooling. Maximum overall dimensions are 185mm length by 89mm diameter.



COMPREHENSIVE

Capacitor Checker

By J. C. FLIND

The "small capacitance measuring instrument" described in a recent issue by P. A. Robinson,[1] although excellent for measuring and testing capacitors of sizes usually employed in radio-frequency circuits, suffers from the fact that its range is limited to about 500pF. Constructors whose interests include amplifiers for audio-frequency work often need a means of testing capacitors up to, say 0.1μF—a common value for inter-valve couplings where a leak can be disastrous.

Range Extension

Fortunately, it is comparatively simple to extend the range of Mr. Robinson's design: the answer lies in adding a further switch position so that a suitable variable resistor can be brought into circuit to supplement the variable capacitor featured in the original instrument. The final circuit, which gives satisfactory results from zero all the way up to 0.1μF is given in Fig. 1.

Readers who refer back to the original article, where the principles of operation were fully explained, will see that the values of some of the resistors have been changed; this is because instead of the Osram "G" or "LN 1" neon bulb specified in Mr. Robinson's circuit the writer used surplus types (marked "10E/223", or in some cases simply "Osglim") obtained from G. W. Smith & Co.[2] It should be emphasised at this point that anyone building up an instrument of this nature will have to be prepared to do a little experimenting to ascertain the most suitable circuit values, as there is a considerable difference in characteristics between the various types of neon indicator. The striking voltage of these surplus neons was found to be about 100; they had no internal resistors, so the circuit was arranged such that a 240kΩ resistor is included in all ranges between the neon and the lower end of the mains transformer h.t. secondary. The indicator should last indefinitely as it cannot be damaged even if a short-circuit is applied across the test leads, and similarly it is impossible to get a really serious shock even if the operating precautions, detailed later, are ignored.

Circuit Operation

The revised instrument follows the original model in using two ranges to cover the smaller values of capacitor; the variable element is a 500pF single tuning capacitor, C_3, which happened to be available. On Range 1 (switch position 3) it is placed in series with a 1,000pF mica fixed capacitor, C_4, giving a total swing from zero to about 300pF, while on Range 2 (switch position 4) the same tuning capacitor is paralleled with a 300pF fixed component, C_5. Accordingly, the two ranges together cover from zero to 800pF, which proved sufficient with the neon indicator used to deal with capacitors up to a value of 1,000pF.

In Range 3 (switch position 5) the variable unit is the potentiometer R_5; it was found by experiment that in order to provide a sufficient degree of overlap with Range 2 this had to have a value of not less than 4MΩ. Furthermore, to avoid undue cramping of the scale, a logarithmic track was essential. Variable resistors to this specification are hard to find, so the writer employed a 2+2MΩ 2-gang volume control type with the elements connected in series as shown in Fig. 2, and this filled the bill. After deciding on a suitable maximum range for the instrument (in the writer's case 0.1μF), a further resistor, R_6 was inserted in series with R_5 so that, with a 0.1μF capacitor under test, the neon extinguished when R_5 was almost at the end of its travel. The required value for R_6 was found by experiment to be 240kΩ but, as was explained

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[1] P. A. Robinson, "Small Capacitance Measuring Instrument", *The Radio Constructor*, December 1961.

[2] G. W. Smith & Co. (Radio) Limited, 3-34 Lisle Street, London, W.C.2.

Components List

Resistors

R_1	10kΩ
R_2	470kΩ
R_3	240kΩ
R_4	10kΩ
R_5	See text
R_6	240kΩ

Capacitors

C_1	16μF 300V wkg.
C_2	16μF 300V wkg.
C_3	0–500pF, variable
C_4	1,000pF mica
C_5	300pF mica
C_6	0–100pF pre-set

Rectifier

W_1	250V, 20mA

Mains Transformer

T_1	Miniature type, secondaries 240V, 20mA and 6.3V, 1A (for panel light if desired)

Miscellaneous

Neon bulb—see text
Switch—see text
6.3V panel indicator bulb, with bulb-holder, etc.

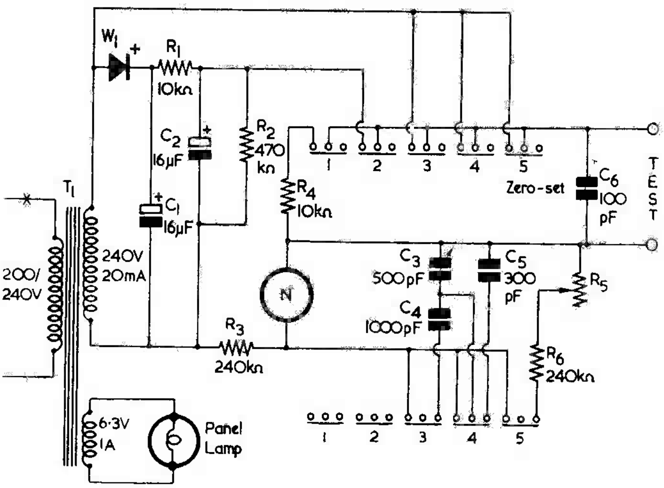

Fig. 1. The circuit of the capacitor tester. Range switching is achieved by a push-button unit (in which pressing a particular button causes the appropriately numbered contacts shown here to be short-circuited)

earlier, if a different type of neon indicator is used R_6 may have to be modified in value.

Capacitors under test can acquire quite high potentials, so it was decided to incorporate in the switching a position where the component could be disconnected from the a.c. or d.c. supply, and at the same time shunted by the 10kΩ resistor R_4, so ensuring complete discharge before the terminals have to be handled.

The range selector switch thus needs to have five positions. A standard two-pole six-way pushbutton unit happened to be available in the spares box, and this has proved ideal as it greatly speeds up the checking routine. The sixth position (omitted from Fig. 1) is available for later range-extension if required. In the meantime, in the prototype instrument, it has been paralleled with the highest capacitance range, and labelled "Resistance".

The switch buttons thus have the following functions:

No. 1: Safety position
No. 2: Leakage Test
No. 3: Capacitance measurement, zero to 350pF
No. 4: Capacitance measurement, 300 to 1,000pF
No. 5: Capacitance measurement, 800pF to 0.1μF
No. 6: Resistance measurement, 20kΩ to 2MΩ

N.B.—Resistances over 2MΩ can be measured on the 300/1,000pF scale, as in the original instrument.

Calibration

Before calibrating any of the ranges, set C_6 so that on the 350pF range the neon is just on the point of striking with the pointer at "zero" and the test leads disconnected.

Calibration, of course, has to be done by checking a number of suitable capacitors, and noting the readings. Standard capacitors of close tolerance can be obtained quite cheaply in the smaller sizes, but for larger values it is best to check as many as possible and accept a mean reading. The same procedure is followed in calibrating for resistance measurement.

Of course, two separate dials will have to be marked out, one for the two ranges handled by the variable capacitor, and one, which can be calibrated both in capacitance and in resistance, for the variable resistor. The photograph shows the layout and the main features quite clearly, and it will be realised that, while on Ranges 1 and 2 the values increase as the knob is turned clockwise, on Range 3 the reverse is the case. In practice this causes no inconvenience.

The requirement that the panel should have a really high degree of insulation was dealt with by doing without terminals altogether, and taking the test leads, of heavy duty flex, through small holes in the panel and terminating them with bulldog clips. This makes for easier and quicker handling of components under test.

Sequence of Operations

The sequence of operations, which thanks to the push-button switch can be run through very quickly, is as follows:

Depress Button 1 (safety) and connect the capacitor across the test leads.
Depress Button 2, and observe the neon flash,

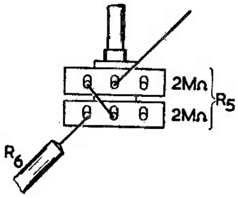

Fig. 2. Wiring up R_5

giving an indication of leakiness or otherwise. (In case of doubt, press Button 1 again, and after a couple of seconds, Button 2, when the single flash should be repeated.)

Depress Button 3, 4 or 5 according to the range required, and rotate the appropriate knob until the neon is extinguished, when the capacity can be read off on the scale.

Depress Button 1 again, and remove the component, which after a second or two will be discharged and safe to handle.[3]

An instrument like this can save an enthusiastic experimenter a lot of time and money as it is frequently necessary to know whether it is advisable to build into a new circuit a capacitor which has already seen service elsewhere. Often, in the absence of testing facilities, a new component is bought on the principle "better safe than sorry", in which case unnecessary expenditure is involved.

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[3] It should be pointed out that, in the instrument described previously, capacitor value indication occurred when the neon just flashed whereas, in the present article, value indication is given when the neon extinguishes.—EDITOR.

Rejuvenating a Midget Receiver

By R. B. Bernard

This article describes an interesting 1-valve reflex circuit, which may be built at low cost inside a "midget" cabinet

THE SPARE RADIO SET, SO USEFUL WHENEVER there is a diversity of opinions concerning the choice of programme, had finally given up the ghost. After all, it was a vintage a.c./d.c. midget receiver long past its prime. Before committing it to the dustbin, it was decided to see if any of it could be salvaged to form the basis of a new receiver.

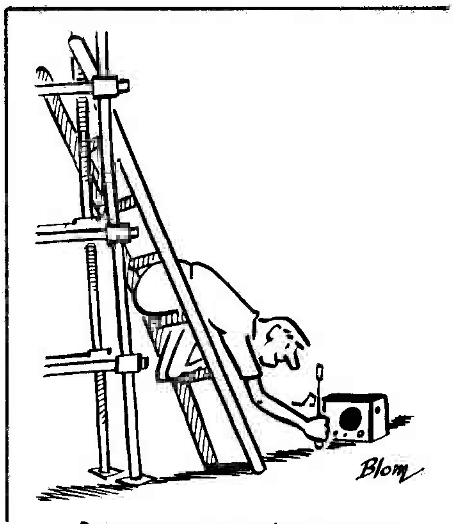
The cabinet was in fair condition, neat and small. Of the rest all that could be re-used was the shallow chassis, the 2-gang tuning capacitor, the volume control and switch, and the smoothing choke. After some consideration it was thought that it might be worth while to rejuvenate the set and that the new version should fulfil the following requirements:

1. Receive the Home and Light programme on Medium waves.
2. Be mains operated, so that there would be no bother with batteries.
3. Avoid the use of a line-cord.
4. Have an isolated chassis.
5. Employ no dangling aerial wires.

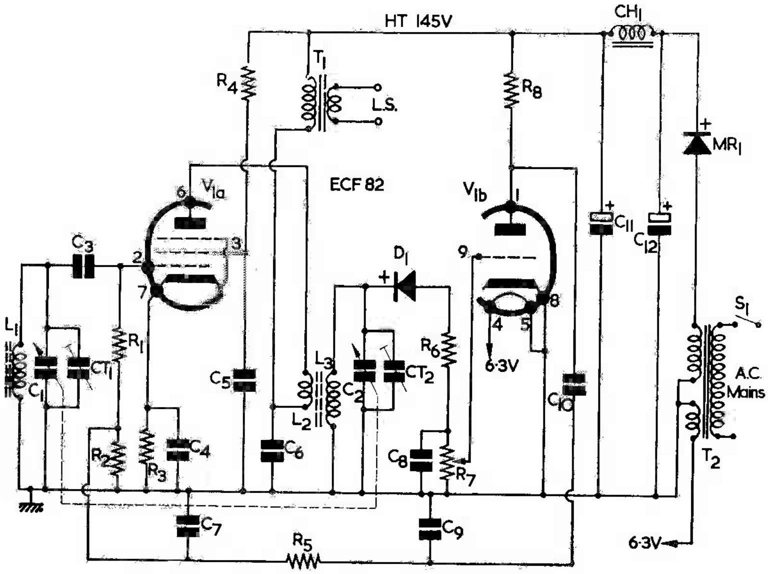
No doubt the first item could have been arranged by means of a switch and pre-set tuning, but this would not have saved a great deal of space. In any case the 2-gang tuning capacitor was already in its correct position.

For items 2, 3, and 4 a mains transformer was indicated, whilst the obvious choice for No. 5 seemed a ferrite rod aerial.

Unfortunately the introduction of even a small mains transformer on to the chassis left practically no room for anything else; in fact, there was space for just one miniature valve. For this reason, it was decided to experiment with a design employing only one valve.



Rejuvenating a midget receiver



Components List

Resistors

(All fixed values ¼ watt 20%)

R_1	100kΩ
R_2	220kΩ
R_3	47Ω
R_4	22kΩ
R_5	100kΩ
R_6	100kΩ
R_7	470kΩ potentiometer, log track (with switch)
R_8	68kΩ

Valves

ECF82 Mullard

Coils

L_1	M.W. ferrite rod aerial (see text)
$L_{2,3}$	M.W. r.f. transformer (see text)

Transformers

T_1	Speaker transformer 70:1
T_2	Mains transformer (see text)

Speaker

3Ω voice coil impedance, 5in round or as desired

Capacitors

C_1	500pF variable } ganged
C_2	500pF variable } ganged
C_3	200pF
C_4	0.1μF
C_5	0.1μF
C_6	0.002μF
C_7	0.002μF
C_8	200pF
C_9	200pF
C_{10}	0.01μF
C_{11}	16μF electrolytic, 275V wkg.
C_{12}	8μF electrolytic, 275V wkg.
$CT_{1,2}$	Trimmers (Mounted on C_1, C_2)

Diodes

D_1	GEX34 or similar
MR_1	Contact-cooled rectifier, 18RA.1-1-8-1 or similar

Choke

CH_1	Midget smoothing choke (see text)

Switch

S_1	s.p.s.t. (ganged with R_7)

As this would require to be of fairly high sensitivity, an ECF82 valve was chosen to operate in a reflex arrangement. There proved to be an added advantage in using this type of valve, for its warming up time is quite short.

Quite a simple circuit was evolved after a little experimenting with components on hand, and its operation is described here for the benefit of readers.

Circuit Description

Signals from the ferrite aerial, are amplified by the pentode section of the valve and r.f. transformer coupled to a crystal diode detector. (It should be noted that the negative end of the diode must be connected to the grid circuit of $V_{1(b)}$). The detector load forms the grid leak of the triode section and also functions as a volume control. From the triode anode the amplified a.f. is RC-coupled back to the pentode, which then operates as the output stage.

Component Notes

Component values are not critical. The mains transformer, which was recovered from a disused Band III television converter, produced only 150 volts h.t. This made it impracticable to employ a resistor for h.t. smoothing. However, the very small choke which had been rescued from the original receiver was put to good use here. Because of lack of space, this item had to be mounted directly on top of the mains transformer in the following manner.

The positions for the mounting holes of the choke were marked on top of the transformer clamp. The transformer clamp was removed from its core, the holes drilled and counter-sunk on the underside. Suitable screws were then inserted so that with the clamp refitted to the transformer these screws protruded. The choke was finally fixed to these with washers and nuts.

If 250 volts h.t. is available, a smoothing resistor of about 7,500Ω, 2 watts, may be used in place of the choke.

Standard components are quite suitable for the tuning coils, but home construction was employed instead. The aerial consisted of 60 turns of 30 s.w.g. silk-covered wire wound on a ⅜in diameter ferrite rod, 6in long. This was tested in circuit and a few turns removed in order to line up the tuning capacitor with its scale. The rod was simply mounted by means of a bracket to the back of the loudspeaker frame, this being the most convenient place.

The r.f. transformer consisted of a modified coil from a discarded 465 kc/s i.f. transformer, as its dimensions happened to be just right for it to be fitted under the chassis of the receiver, which is only ¾in deep. As a point of interest this transformer will be described.

The coils of the i.f. transformer were each wound in two "pies" about an ⅛in apart. The join between the "pies" was carefully broken, thus forming two separate coils. In fact, an r.f. transformer. Each coil was then checked in a tuned circuit and a few turns of wire removed until the required inductance was achieved.

Performance

Performance of the little receiver turned out to be very satisfactory with quite good selectivity and reasonable quality of tone. The B.B.C. Home (330m) and Light (247m) programmes were received with adequate loudspeaker volume, while Luxembourg (208m) came in at good strength after dark, aided by the directional properties of the aerial.

Tuning is aligned by adjusting the pre-set trimming capacitors, CT_1 and CT_2. The r.f. stage is first adjusted at the high frequency end, say 208m, then the aerial stage trimmed for maximum volume. The low frequency end, 330m or if possible 464m (Third), is next set in the same manner and the process repeated for best results.

As the gain of the ECF82 valve is very high, some instability may be experienced at the high frequency end of the band, especially if Luxembourg is required and the set is adjusted for maximum sensitivity. Careful separation of anode and grid wiring as well as of aerial and r.f. coils (the latter being mounted below chassis and the former above chassis, as mentioned earlier) is essential. If some loss of sensitivity can be tolerated the screen grid resistor R_4 may be increased in value, also the aerial could be tuned less sharply.

The recommended output transformer ratio is 70:1 used with a 3Ω speaker. Total h.t. current is only 13mA.

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[1] Low frequency alignment with purchased coils could be carried out by adjusting the position of L_1 in the ferrite rod and adjusting the core of L_2, L_3.—EDITOR.

NEW MULLARD VALVE SIMPLIFIES SSB TRANSMITTERS

A reduction in the number of driver stages required in SSB transmitters is made possible by a new 5kW tetrode (type number YL1120) introduced by Mullard.

This has been achieved by using a unique form of grid configuration which gives the YL1120 a highly linear characteristic. As a result 5kW of peak envelope power can be obtained without grid current or r.f. feedback and with an intermodulation product level of 38dB. Thus, using the new valve transmitter, designers are now able to reduce the number of driver stages needed for a given power output and yet maintain the high standard of linearity required in SSB transmitters.

Coaxial construction is employed to increase efficiency and maintain operational stability. Forced air cooling is necessary.

Under typical two-tone operating conditions at a frequency of 60 Mc/s the YL1120 requires an anode voltage of 5kV, a screen-grid voltage of 800V and a control grid voltage of 175V. Under these conditions the anode current is 1.3A and the peak envelope power 5.8kW. Grid current is zero and maximum intermodulation level at all drive voltages is 38dB.

This new 5kW valve augments the Mullard range of valves recommended for SSB operation.

Kit Review

The "Comet" All-Band Receiver

(A 2-Valve Design for the Beginner)

This review describes a simple receiver capable of being operated over the long, medium and short wavebands, and which is not only inexpensive but is also easy to construct—even by the absolute beginner in radio constructional work. For those beginners considering embarking on their very first constructional venture this design, we feel, would be an ideal choice. **—Editor.**

IT WOULD APPEAR THAT SIMPLE RECEIVERS, especially those operating over the short wave ranges, are always of interest to the radio fraternity. This probably arises from the fact that, to the old timer, nostalgic memories are evoked of early ventures; to many others, in addition to the memories, it is often the case that the youngsters either in the family or the club are seeking such a design.

The design featured herewith may be constructed, in the first instance, as a 1-valve receiver then converted, at a later date if required, into a 2-valve design. The beginner should note, however, that there is no reason why this receiver should not be constructed as a 2-valve design from the outset.

The receiver covers all the bands from 31.5 Mc/s to 150 kc/s (9.5 to 2,000 metres) in 5 ranges as shown in the Table. Range 4 coil is supplied with the kit, and other ranges can be added as required or when available cash permits.

For the beginner, it should be noted that no special skill, apart from soldering, is required. The chassis and panel are supplied ready drilled and punched in all respects. All components are of first class quality and the coils are wound on special low loss polystyrene formers having an adjustable iron dust core for maximum efficiency. The three variable capacitors are all air-spaced.

From the heading illustration, which shows the front panel, it will be noted that the controls are bandspread, tuning (bandset) and reaction. An on/off switch is incorporated, this interrupting the filament supply.

The front panel is finished in an attractive hammer blue, the legends and dials being printed in gold.

Circuit—1-Valve Version

The circuit of the 1-valve version is shown in Fig. 1, from which it will be seen that it is constructed around a 1T4 miniature variable-mu r.f. pentode. The low level r.f. signals picked up by the aerial are fed into the primary winding of L_1, being then induced into the grid winding of the coil and tuned by the variable capacitor C_3 (300pF main tuning) and C_2 (15pF bandspread). The tuned r.f. signal then passes, via the coupling capacitor C_4 (100pF) to the grid of the valve (pin 6). The resistor R_1 (1MΩ) is the grid leak. The amplified detected signal now appears at the anode of the valve (pin 2), positive feedback (reaction) being fed back to the grid via the third winding of the coil, the amount of reaction being controlled by the variable capacitor C_1 (150pF).

The resistor R_2 (47kΩ) is the anode load resistor, R_3 (10kΩ) decoupling this from the anode. The resultant audio signal is now fed via C_5 (0.1μF) to the outer sockets and, thence, into a pair of high impedance headphones. In this stage, the anode and screen-grid of the valve are strapped, forming an effective triode.

Components List

Resistors (all ½ watt)

R_1	1MΩ
R_2	47kΩ
R_3	10kΩ
*R_4	1.5MΩ
*R_5	15kΩ

Valves

V_1	1T4
*V_2	1T4

Capacitors

C_1	150pF variable
C_2	15pF variable
C_3	300pF variable
C_4	100pF ceramic
C_5	0.1μF
*C_6	0.1μF

Chassis and Panel

Fradan Radio

Coils

Fradan Radio

Battery

EverReady B114

On/Off Switch

S_1 s.p.s.t.

Miscellaneous

Valveholders, coilholder, sockets, battery plug, knobs, nuts and bolts, etc., Fradan Radio

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* Required for two-valve version only.

All components are available from Fradan Radio, 36 Leigh Road, Leigh, Lancs.

Assembly

This simple receiver is easily assembled provided the following instructions are carefully followed, these being detailed in order so as to provide the simplest method of construction.

Refer to Fig. 2 and fit the front panel to the chassis by means of two 6BA x ¼in nuts and bolts. Fit the aerial/earth and output sockets to the rear of the chassis, again using 6BA x ¼in nuts and bolts, and ensuring that an earth tag is fitted under one nut securing the output socket strip to the chassis (see Fig. 2 and the below-chassis illustration).

By means of its securing nut fit the on/off switch to the front panel (see heading illustration). Fit the valveholder from above the chassis into its chassis hole in such a manner that the space between pins 1 and 7 is towards the rear of the chassis. Secure a double earth tag under the securing nut nearer the rear of the chassis.

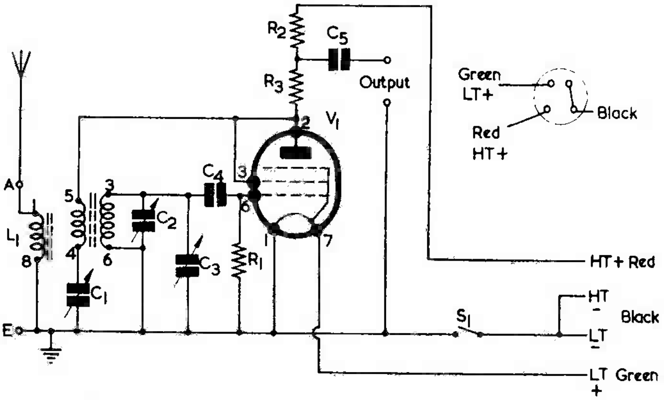


Fig. 1. Circuit of the "Comet" all-band receiver (1-valve version)

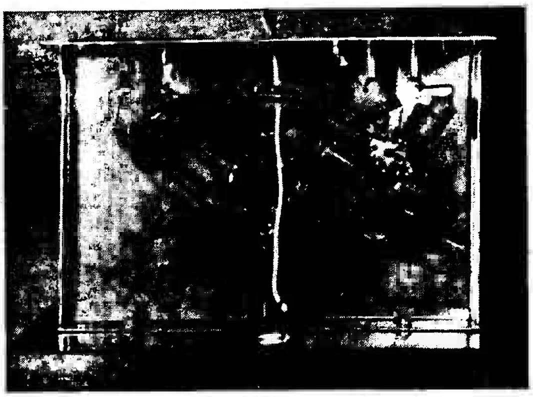
Fit the coilholder from below the chassis, ensuring that the spigot keyway is towards the rear of the chassis. Secure an earth rag under the nut nearer the front of the chassis, and the 3-way tagstrip under the nut nearer the rear of the chassis. Place into position the rubber grommet in the centre of the chassis rear apron.

Referring to Fig. 3, fit the reaction capacitor to the front panel and follow this by mounting both the bandspread and the tuning capacitors. Note here that the tuning capacitor is secured in position by means of the three 4BA bolts.

The mechanical assembly is now complete.

Wiring the Circuit

Using 26 s.w.g. tinned copper wire (refer to Fig. 2) connect one side of the switch to the adjacent earth tag. Similarly, connect one tag of the output socket strip to the adjacent earth tag and the "Earth" tag of the aerial/earth strip to one side of the double earth tag mounted with V_1. Using the same type of wire, connect pin 1 of the valveholder to the same earth tag, and connect pins 6 and 8 of the coilholder to the earth tag of the 3-way tagstrip.



Below-chassis view of the completed 2-valve version

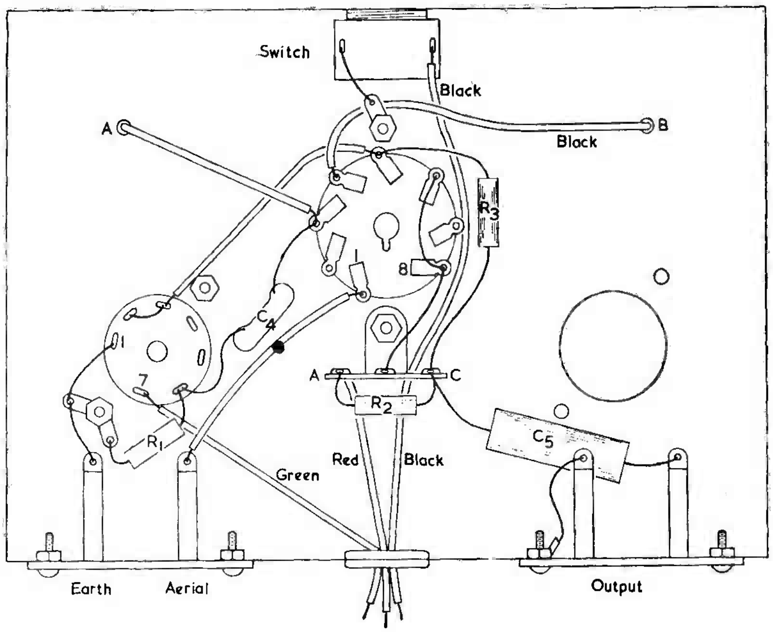


Fig. 2. Below-chassis point-to-point wiring details

Shorten the wire lead-outs of resistor R_1 (1MΩ, brown, black, green) to approximately ½in and connect from pin 6 of the valveholder to the adjacent earth tag.

Shorten the wire lead-outs of capacitor C_4 (100pF) as required, and solder one lead to pin 6 of the valveholder and the other lead to pin 3 of the coilholder.

Shorten the leads of R_2 (47kΩ, yellow, mauve, orange) to approximately ½in, and solder one lead to the left hand tag and one lead to the right hand tag of the 3-way tagstrip (tags A and C in Fig. 2).

Connect R_3 (10kΩ, brown, black, orange) between tag C of the 3-way tagstrip and pin 5 of the coilholder.

Solder C_5 (0.1μF) between tag C of the 3-way tagstrip and the right hand tag of the output socket (see Fig. 2). Cut the leads of this capacitor to a suitable length so as to make the connection short and direct.

Using the blue p.v.c. wire, cut a suitable length bare the ends, and join the "Aerial" socket to pin 1 of the coilholder.

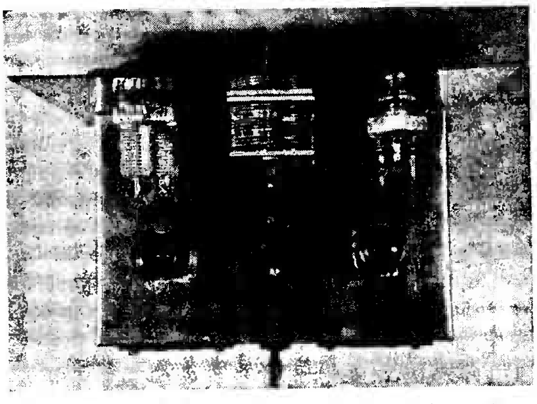
With the same type of wire, join pins 2 and 3 of the valveholder to pin 5 of the coilholder.

Cut a 3in length of the blue p.v.c. wire, pass one end through hole A and connect the other end to pin 3 of the coilholder. Cut a further 3in length, pass one end through hole B and connect the other end to pin 4 of the coilholder.

Coil Ranges

Range		
1	150 kc/s–525 kc/s	2,000 –570 metres
2	515 kc/s–1.5 Mc/s	583 –200 metres
3	1.67 Mc/s–5.3 Mc/s	180 – 57 metres
4	5 Mc/s–15 Mc/s	60 – 20 metres
5	10.5 Mc/s–31.5 Mc/s	28.5– 9.5 metres

Pass the remaining three p.v.c. leads through the rubber grommet, bare the ends and connect as follows: red lead to tag A of the 3-way tagstrip; green lead to pin 7 of the valveholder; and black lead to the switch. Connect these three leads to the battery plug pins as shown in the inset to Fig. 1. Note that this is viewed from the pin end, i.e. with the pins facing towards the constructor. It will be noted that both the negative (–) connections are joined at the battery plug and thus only one negative lead (the black wire connecting to the switch) is



The completed 2-valve version showing the main components above the chassis

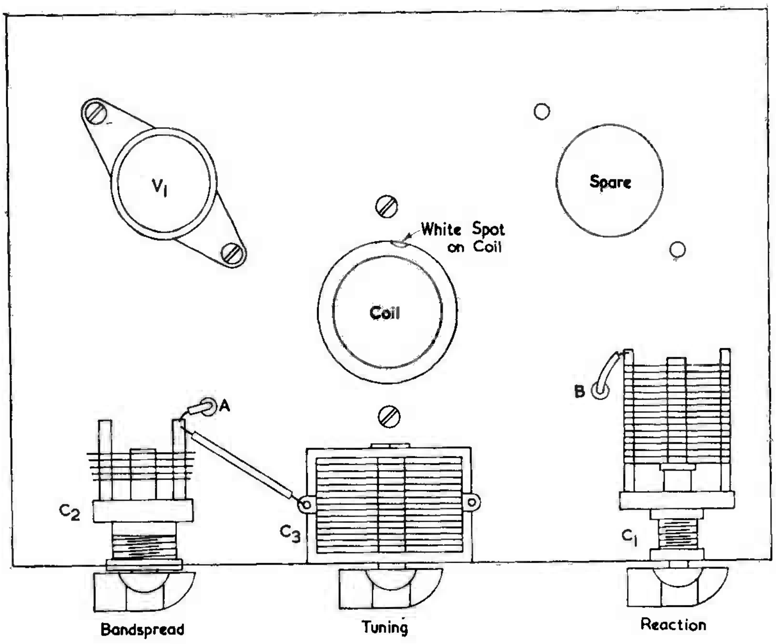


Fig. 3. Above-chassis wiring and layout

required. The connections to the battery plug pins should agree with those marked on the battery itself.

Dealing next with the wiring above the chassis, connect the lead from hole B to the tag of the reaction capacitor, C_1 (see Fig. 3). Next, connect the lead from hole A to the tag of the bandspread capacitor, C_2. Lastly, connect a lead from one tag of the bandspread capacitor to one tag of the tuning capacitor, C_3. Secure the three knobs to their respective spindles.

This completes the wiring of the 1-stage version.

Testing the Receiver

Carefully check the wiring of the receiver against the foregoing instructions and with Figs. 1, 2 and 3. Having ascertained that all is correct, plug in the valve and the coil and connect up headphones, aerial and earth. Switch on the receiver, and slowly rotate the reaction capacitor clockwise until a gentle rushing sound is heard in the headphones. Retaining the receiver in this condition (i.e. slightly over the oscillation threshold) slowly rotate the bandset (tuning) capacitor until signals are heard. In the oscillating condition, telephony signals will be heard as continuous oscillations whilst morse signals will be intelligible providing, of course, that the operator is able to decipher the code correctly. Assuming the signal to be that of a telephony transmission, slowly "back off" the reaction capacitor anti-clockwise until the oscillation ceases, whereupon the transmission will become clearly audible and intelligible.

When tuning the short waves with a receiver of this nature—usually termed a "straight" receiver as opposed to a superheterodyne (wherein the incoming frequency is changed to an intermediate frequency)—the aim should be to retain the receiver just near the point of oscillation at whatever frequency the tuning capacitor is set. These two controls (reaction and tuning) should be operated "in step" and the beginner will soon master this knack with a little practice. In such a condition it will be found that the receiver is at its most sensitive and selective state. Having found the transmission required, or alternatively the band edge of the desired band, further tuning should be carried out with the bandspread capacitor. Finally, peak the signal by the judicious use of the reaction control, bringing this right up to, but just short of, the point of oscillation.

Circuit—2-Valve Version

The circuit of the 2-valve version is that of Fig. 4 added to that of Fig. 1. It will be noted from Fig. 4 that the signal is fed to the audio amplifying stage of V_2 via the capacitor C_5 of Fig. 1. The resistor R_4 (1.5MΩ) is the grid leak, the signal being applied to the grid and appearing, greatly amplified, at the anode, from which it is passed via C_6 (0.1μF) to the output sockets of the receiver. R_5 (15kΩ) provides an anode load.

The addition of the amplifying stage greatly increases the available audio output and, in effect, increases the range of the receiver in consequence. The illustrations herewith show the completed 2-stage receiver both above and below the chassis.

Adding the Second Stage

Fit the second valveholder into the appropriate hole from above the chassis, ensuring that the space

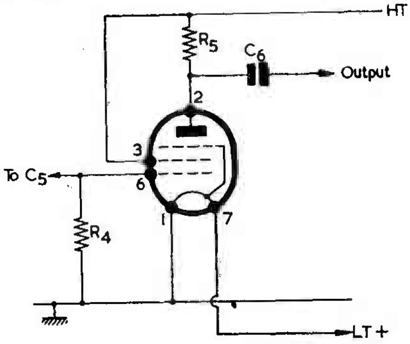


Fig. 4. Circuit of the additional stage

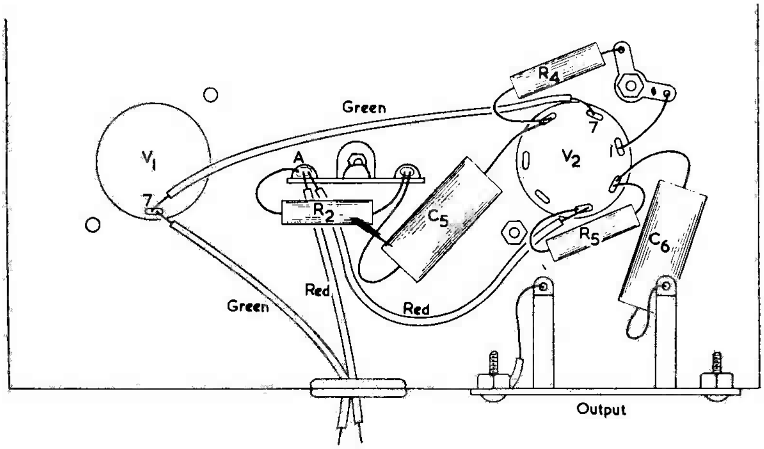


Fig. 5. Below-chassis point-to-point wiring details of the added audio stage

between pins 1 and 7 is towards the front of the chassis (see Fig. 5). Secure a double earth tag under the nut nearer the chassis front.

With a short length of bare wire connect pin 1 of the valveholder to the earth tag.

Using a suitable length of green p.v.c. wire, bare both ends and connect pin 7 of V_2 to pin 7 of V_1.

Disconnect C_5 (0.1μF) from the output tag and connect the free end to pin 6 of the V_2 valveholder.

Shorten the leads of R_4 (1.5MΩ, brown, green, green) to approximately ½in and connect this between pin 6 of the valveholder and the earth tag.

Bare the ends of a length of red p.v.c. wire and connect this between tag A of the 3-way tagstrip and pin 3 of the valveholder.

Shorten as necessary the wire lead-outs of R_5 (15kΩ, brown, green, orange) and connect between pins 2 and 3 of the valveholder.

Connect C_6 (0.1μF) between pin 2 of the valveholder and the output socket to which C_5 was previously soldered. Suitably shorten the leads of C_6.

Carefully check the foregoing with the added stage wiring instructions and with Figs. 4 and 5. Fit V_2 into its holder and switch on.

The 2-valve receiver is now complete.

RADIO TOPICS . . .

by "Recorder"

"I look forward earnestly to the day when some reform of the American system of school education enables them to produce enough scientists of their own, so that, in an amiable free trade of talent, there may be an adequate interchange between our country and theirs, and not a one-way traffic."

Thus spoke Lord Hailsham, the Minister for Science, in the House of Lords on 27th February. Perhaps unwittingly, he also showed exactly why it is that scientists are leaving Britain for the United States in such large numbers.

The "Brain-Drain"

What has been described as the "brain-drain" is, at the time being, causing our legislators a considerable amount of worry. After having received their education in this country, many of our scientists emigrate to the United States; as a result of which Britain suffers two losses. The first of these is that the considerable amount of money which has been spent on the scientists' education is not only forfeited but is being effectively applied, in reverse, to projects which may well be in competition with similar projects here. The second loss is even greater, and is given by the creative contribution to our scientific and technological progress which has left our shores. In a country whose greatest asset should be invention and development, this second loss may well be unmeasurably high.

Why *do* the scientists emigrate? I would suggest that the main reasons are that they obtain more money overseas, enjoy an enhanced position in the community and (as is reported) have much improved research facilities. So far as the lures of increased salary and status are concerned, it seems to me that scientists, in addition to their other commitments, have a definite responsibility to provide the best they can for their families. If the best occurs in America, who can blame them for going to America? The fact that improved research facilities are available in the United States also offers a very real reason for the drift. A dedicated scientist is always in search of the truth, whether he works in the field of biology, chemistry or electronics. If the instruments he requires in his researches are not immediately available he has to waste his time in improvisation, or in the manufacture, himself, of the equipment he requires.

And so we return to Lord Hailsham's statement. What Lord Hailsham is saying is that our system of education is better than America's, with the result that the Americans, who cannot produce enough scientists of their own, grab as many of ours as they can. In other words, we're the mugs. We spend extensive sums of money in educating our scientists and, just when we're ready to expect a return from our investment, they are snapped up by the Americans. The phrase "it's just like taking candy from a child" sprang to many people's minds immediately after the Skybolt-Polaris *débacle*, and it certainly seems applicable to the "brain-drain" situation as well.

There is, of course, one very simple way to stop the loss of our scientists to the United States. Unfortunately, it is too glaringly obvious to be taken up. The solution is, quite simply, to offer our scientists salaries and research facilities in this country which are as good as those in America. We would obtain a partial solution, I'm sure, if we only increased the research facilities, since this would at least obviate one of the main frustrations our scientists have to undergo. Increased research facilities involve the spending of money but, unlike the vast sums which are spent (quite rightly) on welfare, such money would be directed towards improving our position in the future. The Americans are spending large amounts of money on research because they have faith in the outcome. We should have a similar faith.

It seems to be a great pity that the one person in this country who has the power to advance our scientific development finds himself powerless in one important field, because the Americans haven't yet got round to reforming their system of school education.

Ultra Radio Show

Turning to a quite different subject, I see that Ultra Radio and Television Ltd. are putting on their own Radio Show this year. This development is due to the absence of a National Radio Show.

The Ultra Show will be open to the trade only, and will be held at the new Hilton Hotel in Park Lane, London, from 26th to 30th August. Apart from a full display of domestic entertainment products, Ultra will also be demonstrating u.h.f. transmission techniques, and will have engineers on hand to discuss servicing and allied problems with dealers.

Cross Talk

I wonder how many readers had their radio receivers switched on just after lunch on 11th March? If they did, they should still remember the time when the B.B.C. got its Light and Home Service programmes well and truly mixed together.

I turned on my own v.h.f.-only receiver at 1.15 and, on tuning to the Light programme, found that the advertised "Music Hall" was accompanied, at about three-quarters of full level, by the Home Service's "Desert Island Discs". Wondering what particular gremlin had found its way into my receiver to cause such peculiar results, I retuned to the Home Service. Whereupon I found that "Desert Island Discs" was accompanied, at about three-quarter level,• by "Music Hall"! One takes the reliability of the B.B.C. so much for granted that I was, by now, mentally working my way (without, I must add, a great deal of success) through all the possible receiver faults which could cause this phenomenom.

Another f.m. receiver was available and so I turned this on also, to find that the same situation prevailed Finally, I switched on a transistor radio, and discovered that the same mixture as on v.h.f. was going out on both the local Medium wave Home Service transmitter and the Long wave Light programme transmitter. Happily convinced, by this time, that my receivers were working normally, I leaned back and waited to see how long this quite fascinating state of affairs would continue.

The signals were eventually prised apart at 1.30, after which the two services reverted to their own respective programmes, pure and unadulterated by competition from the other. At 1.45 an announcer mentioned the break-through, and stated that the B.B.C. engineers had got the fault finally "nailed".

What intrigues me most about the situation is the length of time the fault persisted. Presumably, *all* the B.B.C. Home Service and Light programme transmitters were radiating this curious admixture of signals, yet at no time was any announcement made during the fault, nor was there, apparently, any attempt to stop the combined programmes from being put out. Still, it isn't every day you get two programmes for the price of one!

Successful Camera Exports

Marconi's Wireless Telegraph Company Ltd. announce yet another overseas order for their very successful Mk. IV 4½in image orthicon cameras incorporating English Electric pick-up tubes. The Ampex Corporation of America has placed a further order for 28 complete camera channels.

This new contract brings the total number of sales of Mk. IV cameras in the Americas to 323, of which 184 have been ordered for use in the U.S.A., not only by various broadcasting authorities but also by the United Nations, the U.S. Navy and the U.S. Army. Mk. IV cameras are in operation in the Pentagon.

World sales now approach the 600 mark. In all, thirty overseas countries have bought Mk. IV cameras, these including Japan, the U.S.S.R., Austria, Norway, Finland, Denmark, Hungary, Yugoslavia, Mexico, Poland, Germany, Kenya and the Lebanon.

Two Drilling Dodges

It isn't often, these days, that I indulge in anything which could rightfully be called precision mechanical engineering, but I did employ a little tip the other day which is worth passing on.

With the aid of a power drill, I was making a hole in a fairly thick piece of metal and, when I'd finished, I found that it was just a shade too tight for the spindle I wanted to pass through it. It would have been quite out of the question to use the next size drill to widen the hole, as its diameter would then have been too great. In consequence, I tried out a dodge which had been passed on to me years ago and in which, quite frankly, I did not have a great deal of faith.

The dodge is to slip one or two thicknesses of thin paper into the hole before applying the drill. The paper gets broken up as soon as the drill enters the hole, but the pieces remaining still provide bulk, and they cause the sides of the drill to press more tightly against the sides of the hole. At any event, I tried out the idea and I was delighted to find that it worked exactly as had been described to me. The hole was as accurately drilled as before, but the presence of the paper had caused it to widen by just the few odd "thou" I needed for clearance for the spindle.

It's a very simple idea, but it's one that I now recommend as being well worth trying out.

Another drilling dodge has to do with ¼in control knob bushes having tapped grub screw holes Quite often one obtains such bushes from broken knobs, spindle couplers, and the like, and they are extremely useful for jobs where holes have to be drilled for a limited depth, or where damage may occur if the drill passes completely through when a hole is finished. All that is required is to fit the bush over the drill and gently tighten it in the required position with the grub screw, or with a longer screw passed through the grub screw hole. The bush will then prevent the drill from passing too far into the hole.

Direct Measurement of Capacitance and Inductance

By M. J. Darby

ALMOST ALL CONSTRUCTORS OF AMATEUR RADIO equipment possess a number of capacitors and chokes which have no capacitance or inductance value marked on them (or which have a marking which has become obliterated). Sooner or later such components usually find their way into the rubbish bin—yet they may be perfectly satisfactory.

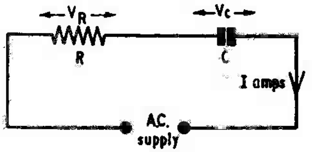
The ideal method of ascertaining the value of a component is by means of an expensive commercial a.c. bridge. Few constructors possess such an instrument, however, and it is unlikely that they would wish to spend a very long time constructing one—it would be much more economic to discard all unmarked or illegibly marked capacitors and chokes.

There is, however, an extremely simple method of measuring the value of such components with quite reasonable accuracy providing that their value is not too small. The only apparatus required is a suitable a.c. meter and a resistor of a suitable known value. The measurement can be performed in a few moments, but a few simple mathematics are required to calculate the result. Those readers who wish to avoid the algebra can do so by merely substituting their own experimental values in either equation 1 or 2 as appropriate.

Capacitance

NOTE: This method cannot be used for electrolytic capacitors. The voltage of the a.c. supply should be somewhat less than the working voltage of the capacitor.

The capacitor should be connected in series with a suitable resistor and the combination connected across a 50 c/s a.c. supply as shown in Fig. 1. The a.c. supply may be either the mains or a 50 c/s a.c. supply derived from the mains by means of a transformer. The a.c. voltages across the capacitor (V_C) and across the resistor (V_R) are then measured by means of an a.c. voltmeter. The resistance of the meter should be much greater than the resistance R and also much greater than the impedance of the capacitor. Generally a 1,000 ohms per volt meter (i.e. a full scale deflection of 1mA) will be satisfactory for capacitance values down to about 0.01μF, but it is essential that an a.c. meter is used.



Let the current flowing through the circuit be I amps, the voltage across the resistor be V_R, the voltage across the capacitor be V_C and the impedance of the capacitor be X ohms at 50 c/s.

$$I=\frac{V_R}{R} \qquad X=\frac{V_C}{I}$$

Eliminating I,

$$X=\frac{V_C}{\left(\frac{V_R}{R}\right)}=\frac{V_CR}{V_R}$$

$$\text{But } X=\frac{1}{2\pi fC}$$

$$\therefore\ C=\frac{1}{2\pi fX}\quad\frac{V_R}{2\pi f\ V_CR}$$

$$f=50\text{ c/s}$$

$$C=\frac{V_R}{100\pi\ V_CR}=\frac{V_R}{314\ V_CR}\text{ Farads}$$

$$\therefore\ C=\frac{1{,}000{,}000\ V_R}{314\ V_CR}\text{ Microfarads.... Equation 1}$$

Substitution of the measured voltages and the value of R in this equation enables the unknown capacitance value to be calculated.

If a 240 volt supply is being used to measure a capacitance of between about 0.01μF and 2μF, a suitable resistor would be 10kΩ, 5 watt, 5% (or, if possible, 1%). A 50kΩ 1 watt resistor is more suitable for capacitance values of less than 0.01μF, but values of less than 0.0005μF can only be measured accurately if a very high resistance voltmeter is available. An electrostatic voltmeter would be ideal. A resistor of smaller power rating than those mentioned can be used if the measurements are carried out quickly. A lower supply voltage and a lower value of R should be used if the capacitor has a value much greater than 2μF.

The supply voltage does not equal V_R+V_C unless these quantities are added vectorially. It is not therefore possible to measure either V_C or V_R and to obtain the other voltage by simple subtraction from the supply voltage; both V_C and V_R should be measured separately.

It can be seen from equation 1 that the unknown capacitance is calculated from the ratio V_R/V_C. The actual voltages need not be known; only their ratio is required. Any error in the a.c. voltmeter will not cause inaccuracy providing that the percentage error is the same for each of the two measurements; such errors are likely to be caused by a poor meter rectifier. If no a.c. voltmeter is available, a 0–1 milliammeter may be used in conjunction with a small meter rectifier and a suitable series resistor.

In order to ascertain how the theory worked out in practice, the writer used a number of capacitors of various marked values together with a resistor marked 10kΩ, 2 watt, 5% and an a.c. voltmeter (1,000 ohms per volt). The a.c. supply, derived from a transformer, was about 240 volts. The results obtained are shown in Table 1, the values in the third column being calculated by means of equation 1. The agreement between the calculated and marked values is rather remarkable, especially as some of the capacitors were marked ±20%! The accuracy of measurement of the 0.004μF capacitor was not very great owing to the small value of V_R. A larger value of R would have improved this.

TABLE

Results obtained using the circuit of Fig. 1 for various capacitors and a series resistor of 10kΩ

V_C	V_R	Calculated Capacity (μF)	Marked Value (μF)
71	208	0.93	1
184	149	0.26	0.25
225	65	0.092	0.1
232	37	0.051	0.05
235	3	0.0041	0.004

Alternative Method

If an accurate a.c. ammeter reading from, say, 0–1mA is available, the values of certain sizes of capacitor may be measured by inserting the capacitor in series with the meter across a 50 c/s supply of known voltage.

Example: Let us suppose the meter gave a reading of 700μA and the supply voltage was 230.

$$X=\frac{V}{I}=\frac{230}{700 \times 10^{-6}}$$

$$C=\frac{I}{2\pi fX}=\frac{700 \times 10^{-6}}{2\pi \times 50 \times 230} \text{ Farads}$$

$$C=\frac{700}{2\pi \times 50 \times 230} \text{ Microfarads}=0.0094\mu F$$

This alternative method should only be used when the first method cannot be employed, as it is not usually so convenient or so accurate. In addition a faulty capacitor could lead to meter damage.

Chokes

A very similar method can be used to measure the inductances of chokes of about 0.5 Henry or more. The fact that all chokes possess some resistance complicates the problem somewhat. The circuit used is that shown in Fig. 2 in which the choke is represented by the inductance and resistance within the dotted lines.

It is not possible to measure the voltage V_L but only the voltage across the actual choke, i.e. V_{Ch}. Let us assume, as a first approximation, that the resistance of the choke is negligible (i.e. $V_L=V_{Ch}$). Using the notation of Fig. 2,

$$I=\frac{V_R}{R}$$

Let X=reactance of choke.

$$X=\frac{V_L}{I}=\frac{V_L}{\left(\frac{V_R}{R}\right)}=\frac{V_L R}{V_R}$$

$$X=2\pi f L$$

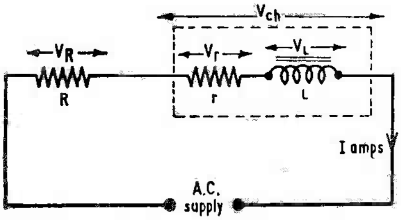
$$L=\frac{X}{2\pi f}=\frac{V_L R}{2\pi f V_R} \text{ Henries}$$

If $f=50$ c/s,

$$L=\frac{V_L R}{314 V_R} \text{ Henries..............Equation 2}$$

Example: For a certain choke, when R=10kΩ and $V_R=235$, $V_{Ch}=46$. Assuming $V_L=V_{Ch}$ and substituting these values in equation 2, it is found that L=6.2 Henries. The actual choke used was marked 5H, 0.2 amp.

An assumption has been made that the internal resistance of the choke is negligible. In order to



ascertain if this assumption is reasonable, let us assume that the choke in the above example has a resistance of 200 ohms and calculate the inductance using the same results by an exact method. In actual practice the resistance of the choke will probably be considerably less than 200 ohms and any errors due to this will be less than that calculated below.

$$I = \frac{235}{10{,}000} = 0.0235 \text{ amp.}$$

$V_r = Ir = 0.0235 \times 200 =$ approx. 5 volts.

In order to find V_L we have to subtract 5 volts from V_{Ch} be vector methods because there is a 90° phase difference between V_L and V_R.

$$V_L = \sqrt{V_{Ch}^2 - V_R^2} = \sqrt{(46)^2 - 5^2} = 45.7 \text{ volts}$$

Using this value in equation 2, the inductance again comes to 6.2 Henries (to two significant figures). This shows that the approximation was fully justified; it is only necessary to use the exact method when the resistance of the choke is extremely high.

If the inductance of a choke measured by the above method is, say 20 Henries, it should not be assumed that it will be suitable for use in any piece of equipment for which a 20 Henry choke has been specified. For example, a power pack may require a choke which has an inductance of 20 Henries when a current of 100mA is passing through it. A choke which has the required inductance when an a.c. current of a few milliamps is passing through it (as when the choke is used in the Fig. 2 circuit) may have a very much smaller inductance when an appreciable d.c. current is passing because the hysteresis loop of the iron in the core of the choke tends to flatten out with increasing current.

One should not therefore be surprised if an inductance marked 10 Henries is found to have a much larger value when it is measured by the method described. Inductance values of iron cored components should always be specified at stated d.c. currents.

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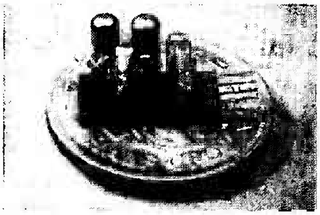

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continued from page 771

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Continued on page 775

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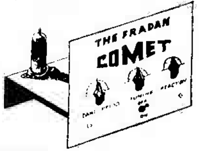

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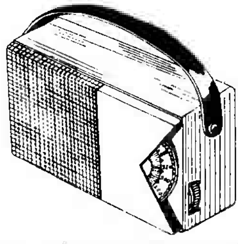

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SMALL ADVERTISEMENTS

continued from page 773

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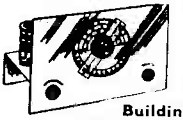

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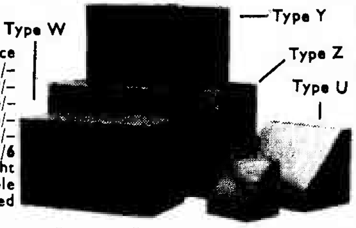

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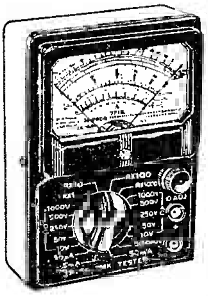

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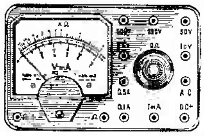

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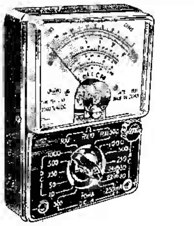

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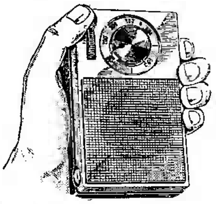

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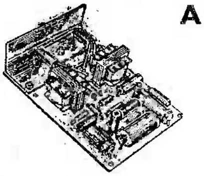

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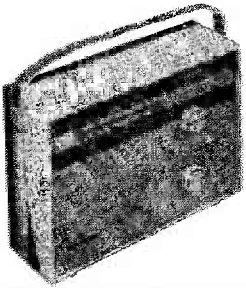

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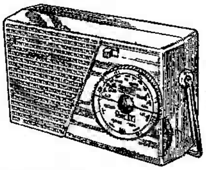

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