THE **Radio Constructor**

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 17 NUMBER 12
A DATA PUBLICATION
PRICE TWO SHILLINGS

July 1964

MINIATURE

Top-Band Receiver

Simple Audio Generators ■ Portable Oscilloscope ■ Thermo-Electric Sensing Device ■ American VT Valve Equivalents

LASKY'S RADIO

FOR THE FINEST RANGE OF TRANSISTOR RECEIVERS

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

THE SKYROVER

Controls: Waveband Selector, Volume Control with On/off Switch, Tuning Control. In plastic cabinet, size 10" x 6½" x 3¼", with metal trim and carrying handle.

Can now be built for **£8.19.6**
P. and P. 5/– extra

H.P. Terms:— 20/- dep. & 11 months at 16/6

SAVE £2! HUGE PURCHASE OF COMPONENTS ENABLES US TO MAKE THIS GREAT OFFER

THE SKYROVER
and THE SKYROVER DE LUXE

GENERAL SPECIFICATION. 7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5V torch batteries. The SKYROVER and SKYROVER DE LUXE cover the full medium waveband and short waveband 31–94 M, and also 4 separate switched band-spread ranges, 13 M, 16 M, 19 M and 25 M, with band-spread tuning for accurate station selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.

SPECIFICATION: Superhet, 470 kc/s. All Mullard transistors and diode. Uses 4 U2 batteries. 5" Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. Band-spread Tuning. 500mW Output. Telescopic Aerial and Ferrite Rod Aerial.

WAVEBAND COVERAGE: 180–576 M; 31–94 M, and band-spread on 13, 16, 19 and 25 metre bands.

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

THE SKYROVER DE LUXE

Tone Control circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11½" x 6½" x 3", covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for **£10.19.6** *P. and P. 5/– extra*

H.P. Terms:—25/– deposit and 11 months at 20/–

REALISTIC SEVEN

★ 7-transistor Superhet. ★ 350 milliwatt output into 4" high flux speaker. ★ All components mounted on a single printed circuit board, size 5¼" x 5¼" in one complete assembly. ★ Plastic cabinet with carrying handle, size 7" x 10" x 3½", available in Blue/Grey or 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.

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

P. and P. 4/6

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

REALISTIC 'Seven' De Luxe

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

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

READY BUILT BARGAINS

BOY'S TRANSISTOR RADIO

Ready built, 2-transistor pocket radio. In attractive plastic case. Size only 4" x 2¼" x 1". Fitted with 2¼" loudspeaker. Socket for personal earpiece and telescopic aerial. Works from single PP3-type battery. Fully tunable over full Medium waveband. Supplied complete with earpiece, telescopic aerial, carrying purse and 9 volt battery. Ideal Birthday Present.

LASKY'S PRICE 42/-

with all accessories. **Post Free.**

6-TRANSISTOR POCKET RADIO

Fully built. 4" x 2½" x 1", with 2¼" speaker. Uses single PP3-type battery. Supplied complete with personal earpiece and leather case. Tunable over full Medium waveband.

LASKY'S PRICE 69/6
complete with all accessories. **Post Free.**

TRANSFILTERS by BRUSH CRYSTAL CO.

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

6/6 each
P. & P. 6d.

RECORDING TAPE SPLICER

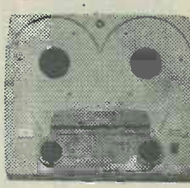
By famous manufacturer, all metal nickel plated construction. With separate razor blade—securely clamps tape while splicing.
Listed at 18/6 **LASKY'S PRICE 14/6** *Post Free*

GUITAR PICK-UP

Crystal—high imp. Size only 1½" x ⅞" x ½". Clips to fingerboard—no screws. Complete with cable.
LASKY'S PRICE 15/11 *P. & P. 1/–*

FAMOUS MAKE TAPE DECKS

MODEL R7 BY WELL KNOWN BRITISH MANUFACTURER



Two speeds—3¾ and 7½ i.p.s.; three high quality motors. Will record and replay **IN BOTH DIRECTIONS.** Fast forward and rewind. Supplied less heads, space is provided for fitting 4 heads of any type, to give full working in both directions on either 1, 2 or 4 track. Unit plate size 13" x 15", depth below top of plate 5¼". Will take 7" spools. Tape position counter fitted. For 200–250 volt 50 c.p.s. mains. Two-tone grey finish. Perfect order. Supplied less heads.

LASKY'S PRICE £9.19.6
Carriage and Packing 10/6 extra.

TAPE DECK MOTORS

Motors for the Collaro Studio Deck — new and unused. 200–250V A.C. Take-up, rewind and capstan. Listed at £2 5s. each. **LASKY'S PRICE 14/11** each. P. & P. 2/6.
Set of three 35/–. P. & P. 6/–.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size: 4" dia., x 2" high. 1" x ⅛" spindle.
LASKY'S PRICE 19/11. P. & P. 3/6.

TAPE POSITION INDICATOR

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

LAFAYETTE TAPE

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

5in double play, 1,200ft. Mylar base ...	15/–
5in long play, 900ft. Acetate base ...	10/–
5in standard play, 600ft. PVC base ...	8/6
5¾in long play, 1,200ft. Mylar base ...	15/–
5¾in double play, 1,800ft. Mylar base ...	22/6
5¾in long play, 1,200ft. Acetate base ...	12/6
5¾in standard play, 850ft. PVC base ...	11/6
7in standard play, 1,200ft. Mylar base...	12/6
7in long play, 1,800ft. Mylar base ...	19/6
7in double play, 2,400ft. Mylar base ...	25/–
7in long play, 1,800ft. Acetate base ...	15/–
3in message tape, 150ft	3/6
3in message tape, 225ft	4/11
3in message tape, 300ft	7/6

P. & P. 1/- extra per reel; 4 reels and over Post Free.
Full range of triple play tape available.

HI-FI TAPE RECORDER HEADS

High Impedance Record Play. Low impedance erase. Upper or lower track.
LASKY'S PRICE 29/6 Post free per pair. State track required when ordering.

MARRIOTT "X" Type ¼ track heads. Record/Play and Erase.
LASKY'S PRICE 4 GNS. PAIR
¼-Track heads Record/Play and Erase 59/6 pair.

HEADPHONES

S. G. Brown type F earphones—moving iron 2,000Ω. Hand-held type, but a headband could easily be fitted.
LASKY'S PRICE 14/6 PAIR *P. & P. 1/6*

TRANSISTORS
All New and Guaranteed

GET.S1, GET.S5, GET.S6—2/6; 837A, 874P—3/6; OC.45, OC.71, OC.81D—4/6; OC.44, OC.70, OC.76, OC.81 (matched pair 10/6)—5/6; AF.117, OC.75, OC.171, OC.200—6/6; OC.42, OC.43, OC.73, OC.82D—7/6; OCP.71—9/6; OC.28, OC.201, OC.204—15/–; OC.205, OC.206—19/6; OC.28—24/6.

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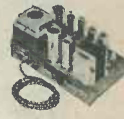
HI-FI AMPLIFIERS — TUNERS — RECORD PLAYERS

S-33  S-99  AT-6  MA-12 

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**

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

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

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

GOLDRING LENCO TRANSCRIPTION PLAYER. Model GL-58. With G-60 pick-up arm and Ronette 105 cartridge. **£18.19.2**

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

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**

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**

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

Heathkit DAYSTROM

Enjoy Yourself and Save Money

FOR THE INSTRUMENTALIST

PA-1

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

Legs optional extra 17/6 set of 4.

POWER AMPLIFIER MA-50. 50W output. **£19.18.0**

ELECTRONIC ORGAN

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

TRANSISTOR RADIOS

LATEST MODEL! "OXFORD" LUXURY PORTABLE. Model UXR-2. Specially designed for use as a domestic, car or personal portable receiver. Many features, including solid leather case. **£14.18.0**

UXR-2

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

UXR-1

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**

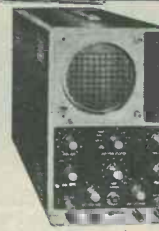
UJR-1

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

Money-back Guarantee

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

TEST INSTRUMENTS



IO-12U

New!

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

2½" PORTABLE SERVICE 'SCOPE. Model OS-1. This is a light, compact oscilloscope, ideal for servicing, etc. Dimensions 5"x 8"x 14½" long. Weight 10½ lb. **£21.18.0**

S-3U

ELECTRONIC SWITCH. Model S-3U (Oscilloscope Trace Doubler). Enables a single beam oscilloscope to give simultaneous traces of two separate and independent signals. Switching rates approx. 150, 500, 1,500, 5,000 and 15,000 c/s. Sig. freq. response 0–100 kc/s. ±1dB. Separate gain controls and sync. output. Sig. input range 0.1–1.8V r.m.s. **£12.18.0**

C-3U

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

RESISTANCE/CAPACITANCE BRIDGE. Model C-3U. Measures capacity 10pF to 1,000µF, resistance 100Ω to 5MΩ and power factor. 5–450V test voltages. With safety switch. **£10.10.0**

New! **DE LUXE LARGE-SCALE VALVE VOLTMETER. Model IM-13U.** Circuit and specification based on the well known model V-7A but with many worthwhile refinements. 6" Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Please send for full details **£18.18.0**

IM-13U

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**

V-7A

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**

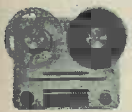
MULTIMETER. Model MM-1U. Ranges 0–1.5V to 1,500V a.c. and d.c.; 150µA to 15A d.c.; 0.2Ω to 20MΩ. 4½" 50µA meter. **£12.18.0**

RF-1U

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. **£13.8.0**

ALL MODELS ALSO AVAILABLE ASSEMBLED AND TESTED. PRICES AND FULL SPECIFICATIONS ON REQUEST

TAPE DECKS ~ CONTROL UNITS ~ TAPE AMPLIFIERS



COLLARO

D-93

FM-4

AM/FM

COLLARO "STUDIO" TAPE DECK. The finest buy in its price range. Operating speeds: 1⅞", 3¾" and 7½" p.s. Two tracks, "wow" and "flutter" not greater than 0.15% at 7½" p.s. **£17.10.0**

TRUVOX D93/2 & D93/4 TAPE DECKS. High quality mono/stereo tape decks.

D93/2, 2 track, **£36.15.0** D93/4, 4 track, **£36.15.0**

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

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

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

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

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**

Building these Heathkit models

Heathkit DAYSTROM

AMATEUR EQUIPMENT

SB-10U

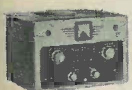
SINGLE SIDEBAND ADAPTOR. Model SB-10U. May be used with most A.M. transmitters. Less than 3W R.F. input power required for 10W output. Operation on 80, 40, 20, 15 and 10m bands on U.S.B., L.S.B. or D.S.B. **£39.5.0**

AMATEUR TRANSMITTER. Model DX-40U. Covers all amateur bands from 80 to 10 metres; crystal controlled. Power input 75W C.W., 60W peak controlled carrier phone. Output 40W to aerial. Provision for V.F.O. Filters minimise TV interference. **£33.19.0**

New Model RG-1

COMMUNICATIONS TYPE RECEIVER.

A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s – 1.5 Mc/s and 1.7 Mc/s – 32 Mc/s.
Send for full specification. **£39.16.0**



DX-40U

VARIABLE FREQUENCY OSCILLATOR. Model VF-1U. Calibrated, 160–10 m. Fundamentals on 160 and 40m. Ideal for our DX-40U and similar transmitters. **£10.17.6**

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. Send for spec. **£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. **£37.17.6**

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. **£79.10.0**

RG-1

RA-1

A wide range of American amateur equipment.

SPEAKER SYSTEMS

SSU-1

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.**

MFS

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**

HI-FI EQUIPMENT CABINETS

"GLOUCESTER"

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

Other models from our wide range include:—

NEW! SELF SUPPORTING AERIAL TOWER, Model HT-1. for Commercial TV, fringe TV reception, Radio Amateur use. 32 ft. high, square section (full erection instructions). HT-1G (gal finish) **£35.15.0.** HT-1 (red oxide finish) **£29.15.0.** Range of accessories, TV, VHF, FM aerials, etc.

All models also available assembled

Deferred Terms available in U.K. over £10

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FREE BRITISH HEATHKIT CATALOGUE ....
FULL DETAILS OF MODEL(S) ....
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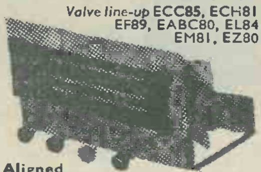
7 VALVE AM/FM RADIOGRAM CHASSIS

Valve line-up ECC85, ECH81 EF89, EABC80, EL84 EM81, EZ80



Three Waveband & Switched Gram positions. Med. 200–550m. Long 1,000–2,000m. VHF/FM 88–95 Mc/s. Phillips Continental Tuning insert with permeability tuning on FM & combined AM/FM IF transformers. 460 kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC & Neg. Feedback. 3 watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½"x 6½". Height 7½". Edge illuminated glass dial 11½" x 3½". Vert. pointer Horiz. station names. Gold on brown background. A.C. 200/250V operation. Magic-eye tuning. Circuit diag. now available.

Aligned and tested ready for use. **£13.10.0** *Carr. & Ins. 7/6.*

Comp. with 4 knobs—walnut or ivory to choice. Indoor FM aerial 3/6 ex. 3 Ω P.M. Speaker only required. Recommended Quality Speakers 10" Elac H/D, 30/–. 13½" x 8" E.M.I. Fidelity, 37/6 12" R.A. with conc. Tweeter, 42/6. Carr. 2/6.

TAPE DECK BARGAINS!

BSR MONARDECK Type TD2

Twin-track £7. 7.0
Four-track £9.10.0
Carr. 5/–

COLLARO STUDIO 3-SPEED DECK

Twin-track £10.10.0
Four-track (Michigan heads) £14.10.0
Carr. 7/6

New Boxed VALVES Reduced Bargain Prices

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

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		
16+16/450V	5/6	100+300/275V	12/6
32+32/450V	6/6		
1000/25V	3/9	2000+4000/6V	3/6

Ersin Multicore Solder 60/40 4d. per yard. Cartons 2/6, etc.

NEW BRITISH RECORDING TAPE

Famous Mfr. Bulk Purchase—Genuine recommended Tape Bargain. Uncond. Guar. Fitted Leader & Stop Foils (except 3").

St'd. (PVC base)		L.P. (PVC base)		D.P. (Milar base)		Triple Play	
3" 150ft.	3/9	225ft. ...	4/9	300ft. ...	6/6	3" 450ft.	12/6
5" 600ft.	11/6	900ft. ...	15/–	1,200ft. ...	23/6	4" 900ft.	25/–
5¾" 850ft.	14/6	1,200ft. ...	17/6	1,800ft. ...	29/6		
7" 1,300ft.	17/6	1,800ft. ...	22/6	2,400ft. ...	37/6		

Post and Packing—3" Reels 6d. Each additional Reel 3d. 4" to 7" Reels 1/–. Each additional Reel 6d.

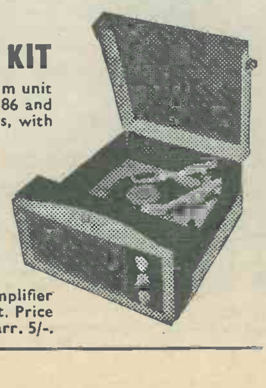
EMPTY TAPE REELS (Plastic): 3" 1/3; 5" 2/–, 5¾" 2/–, 7" 2/3.

PLASTIC REEL CONTAINERS (Casettes): 5" 1/9, 5¾" 2/–, 7" 2/3

Jack Plugs. Standard 2½" Igranic Type, 2/6. Screened Ditto, 3/3. Miniature scr. 1½", 2/3. Sub-min. 1/3. **Jack Sockets.** Open Igranic Moulded Type, 3/6. Closed Ditto, 4/–. Miniature Closed Type, 1/6. Sub-min. (deaf aid) ditto, 1/6. Stereo Jack Sockets, 3/6. Stereo Jack Plugs, 3/6. **Phono Plugs,** 9d. Phono Sockets (open), 9d. Ditto (closed), 1/–. Twin Phono Sockets (open), 1/3. **Grundig Continental.** 3 p. or 5 p. plug, 3/6. Sockets, 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.

DE LUXE RECORD PLAYER KIT



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Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief.
Size: 17½" x 16" x 8".

COMPLETE KIT Carr. & ins. 10/–. **£13.19.6**

Catalogue and Construction details 2/6 (free with kit).

FRONT SECTION, which houses amplifier and speaker, is detachable from cabinet. Price as separate unit for stereo, **£5.17.6.** Carr. 5/-.

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. 9/6 (100 k. to 2 Meg. only). ½ Meg. VOL Controls D.P. Sw. ½" flatted spindle. Famous Mfrs. 4 for 10/– post free.

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2/OC81	15/6	OA70	2/9
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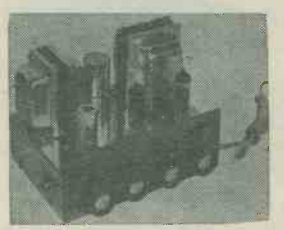
MULLARD "3—3" HI-FI AMPLIFIER
3 VALVES 3 WATT



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TECHNICAL SPECIFICATION—Freq. Response: ± 1dB. 40 c/s–25 kc/s. **Tone controls,** max. treble cut 12dB at 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.) **BARGAIN PRICE £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. Allen 12" with tweeter 42/6, WBHF10–12 **£4.7.6,** Goodmans Axiette **£5.5.0,** Axiom 10 **£6.5.0,** Audiom 51 **£8.10.0.** Carr. extra.

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sinclair NEWS

No. 4 JULY, 1964

We will pay you for your photographs!

Completely built Micro-6 sets are understandably a rarity at head office which is why a couple of our secretaries slipped into the test room to listen for themselves and got caught in the act by the works manager who had his camera handy. If you have any amusing or interesting pictures of the Micro-6 in use, let us see them. 3 gns. will be paid for each one published. All prints submitted will be returned.

DESIGNS WITH A PEDIGREE

It is but little more than a year ago that the name Sinclair Radionics appeared to the public for the first time, offering entirely new concepts in micro-radio receiver design. The impact was fantastic. There had never been anything like it before. Various other designs were introduced leading up eventually to the world's smallest radio—the Micro-6 and then the TR750 Power Amplifier. Today, Sinclair is the best known and most quoted name in anything to do with transistor designs for constructors.

TWO-FOLD TRIUMPH

There are two simple, but exclusive reasons behind this triumph—firstly the extraordinary efficiency of Sinclair Micro Alloy Transistors (Golden MATs). These make possible standards of performance far ahead of anything the public can obtain from other transistors. Secondly, there are the designs themselves. These come from a team accustomed to working to very high standards in transistorised electronics, for this group is but part of Sinclair Radionics Ltd. who are in fact industrial electronic consultants!

So we are well used to solving problems and every design we produce for you is exhaustively tested long before being advertised. That is why Sinclair Micro Transistor Designs have completely captured the imagination and enthusiasm of constructors everywhere. They have never had the chance to build to these professional levels in the transistor field before, to say nothing of the pleasure and satisfaction to be obtained from the wonderful performance of Sinclair designs.

IT COULD HAPPEN TO YOU!

There are other intriguingly efficient designs using MATs which are well worth trying. These will be found in the three books advertised on the following pages. In the meantime we learn that a number of constructors wearing Micro-6 receivers on their wrists, on being asked the time have replied with a somewhat far away look, "Half past Housewives Choice" or words to that effect. Why not? The Micro-6 on its "Transrista" strap is setting a new and original fashion in listening.

She finds Micro-6 irresistible

R.J.W., Ely, Cambs., who wrote this from hospital, states:

"I have completed one of your Micro-6 receivers but unfortunately it endeared itself to one of my female visitors. I have need, therefore, to build myself another. Although forced to lie in bed I found the kit quite easy to assemble and it helped pass a few hours for a number of days. I would appreciate it very much if you could send the kit as soon as possible. With the set that I completed, I found that the incoming signal was quite fantastic."

F.B., Ashford-in-the-Water, Nr. Bakewell, Derbyshire, writes:

"I have recently constructed a Micro-6 kit and found it a most rewarding experience. Even in this 'black spot' of reception areas the results are truly surprising. I am 50 years of age and this is my first venture in the field of practical electronics! Or had you already guessed?"

NOW TURN TO NEXT PAGES

sinclair **Micro-**

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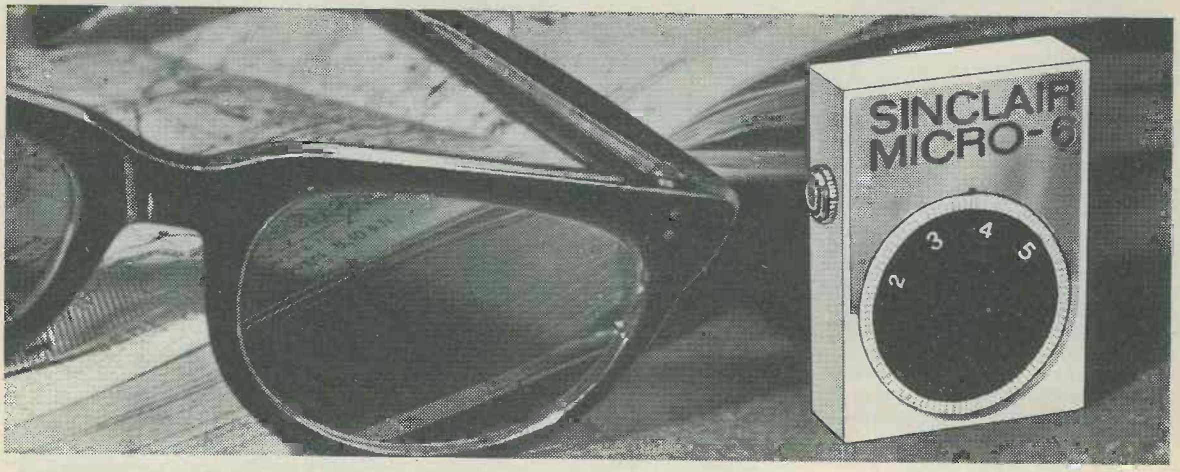

SINCLAIR MICRO-6 — *the world's smallest Radio*

SIZE $1\frac{4}{5}$" x $1\frac{3}{10}$" x $\frac{1}{2}$"

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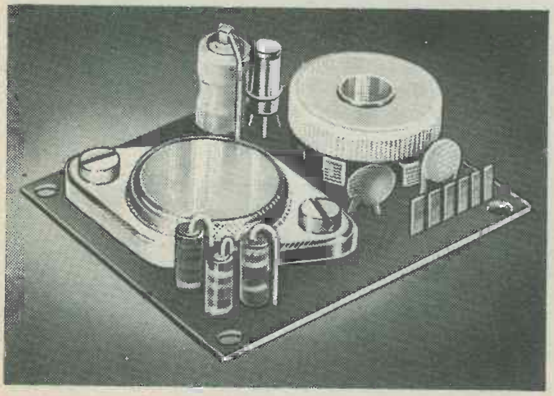
WEIGHS LESS THAN 1 OZ. COMPLETE WITH SELF-CONTAINED AERIAL AND BATTERIES

When you have built this wonderful set, you will find it your constant companion everywhere—indoors and out—in car, bus, train—wherever you want to listen. Its power is such that it ensures good reception under the severest operating conditions, yet it is so small that you can wear your Micro-6 like a wrist-watch! Tuning covers the entire medium waveband with bandspread over the higher frequency end to ensure better separation of Luxembourg, Continental and other stations. Listening is by means of the lightweight high quality earpiece provided (except when you want to use the set with the TR750 and a loudspeaker). The earpiece switches the Micro-6 on when plugging it in. THE SET IS SO WELL DESIGNED AND THE INSTRUCTIONS SO CLEAR THAT ANYONE CAN BUILD THE MICRO-6 AND HAVE IT WORKING IN A SINGLE EVENING: All parts including earpiece and instructions come to **59/6**

Mallory Mercury Cell Type ZM.312 (2 required)—1/11 ea.



SINCLAIR TR750
POWER AMPLIFIER
MAKES A CAR RADIO OF YOUR MICRO-6

This outstandingly successful power amplifier builds on to a printed circuit board 2" x 2" and includes its own volume control with on-off switch. The TR750 is primarily intended to provide powerful loudspeaker reproduction from the Sinclair Micro-6 or Slimline receivers, thus enabling owners of these sets to use them also for car radios, loudspeaker portables or domestic radios. Amongst many other useful applications, the TR750 makes an excellent record reproducer used singly for mono or paired for stereo.

Frequency response $\pm$1dB from 30 to 20,000 c/s. Transformerless output of 750 milliwatts for 10mV input into 2kΩ, using standard 25–35Ω speakers. Operates from 9–12V supply.

All parts inc. MAT and Magnagain Transistors and instructions come to **39/6** *Ready built for immediate use* **45/-**

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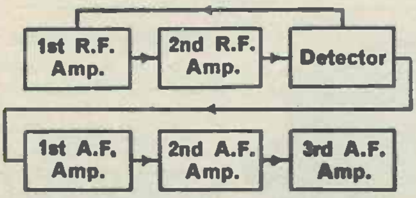

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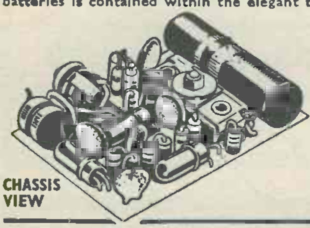

CHASSIS VIEW

WEAR IT LIKE A WRIST WATCH

The "Transrista" Strap holds the "Micro-6" securely in position when wanting to wear the set on the wrist. Elegantly styled in black or grey nylon, made specially to take this famous set. **7/6**

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MAT 101	Extra high gain, low level ...	8/6
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ADT 140	For FM, TV, VHF and UHF ...	15/–

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FOR TESTING ALL TYPES OF EQUIPMENT

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WITH THE MICRO-AMP

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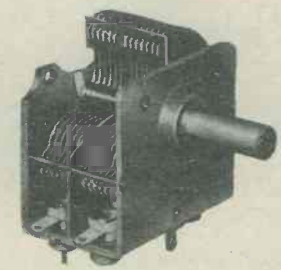

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JULY 1964

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Price Increase.
Owing to increased costs of production we regret that there will be a small increase in the price of this magazine, commencing with the next issue, August. In future the price will be two shillings and threepence per copy. Annual Subscriptions will be increased accordingly.

Some Observations on Simple Audio Generators

By A. S. Carpenter, A.M.I.P.R.E.

Notes that may help readers who are considering experiments with audio generators, and which are based on practical work carried out by the author

As is well known, any serious work or experimenting done on audio amplifiers requires the use of certain apparatus additional to the common general purpose test meter. The human ear is a relatively insensitive organ incapable of discerning low order distortion, and it is therefore generally desirable to permit the eye to check for deficiencies by displaying the output of an amplifier under test on a cathode ray oscilloscope.

It is immediately obvious that the combination of audio amplifier and oscilloscope is of little practical use unless some sort of input signal is applied to the amplifier. A waveform of known shape is required and this must be provided by an additional unit in the form of an audio signal generator. If a sine wave is fed into an amplifier from such a unit one might expect to see a similar waveshape displayed on a c.r.o. connected to its output. In actual fact, however, considerable degradation is likely, especially in poorly designed or cheap apparatus.

Other equipment may include a wattmeter, or output meter, and a sensitive valve voltmeter, etc., so it is immediately clear that the much used—and abused—general purpose testmeter plays but a small part in the scheme of things. Many keen hobbyists like to experiment from time to time with something different from the usual run of receivers and tuners, etc., and audio generators may be a suitable outlet for their energies.

An audio oscillator is not very difficult to construct and, as may be seen the simple "back fed" type shown in Fig. 1 requires only the triode valve, two resistors, two capacitors and a suitable transformer. The latter could readily be a physically small (since no d.c. flows in its windings) intervalve type having a ratio of 3:1. This circuit is reminiscent of simple reaction systems in which "T" is made a radio frequency transformer and where energy is fed externally from anode to grid of the valve and phased regeneratively.

Oscillations at audio frequencies can also be obtained from the transformerless circuit depicted in Fig. 2 and this circuit was described in an earlier issue of this journal.[1]

The heavy attenuation due to the phase shifting network may be lessened by utilising a Wien-type network connected up as shown in Fig. 3. In this circuit oscillation occurs due to the phase reversals which take place within the valves, the frequency of operation being decided mainly by the components R_1, C_1, R_2, C_2.

Although either of these circuits may be used and adjusted to give a good waveform at a selected frequency, their usefulness is limited by this condition.

Varying the Frequency

Audio oscillator construction is simple but it is not always easy to obtain a good waveform, particularly if the apparatus is intended to cover a wide range of frequencies. Of the three circuits mentioned that shown in Fig. 3 is probably the most useful where variable frequency working is required. The output is essentially a sine wave and, since the main frequency-determining components are R_1, R_2, C_1 and C_2, variable frequency operation is possible by making either the resistors or the capacitors variable in value. Switching adds further versatility to such a circuit, and can permit a coverage of, say, 20 c/s to 20 kc/s.

In the interests of efficiency high slope pentodes are normally used in conjunction with Wien networks, but triodes may be employed if a relatively low output can be tolerated. The use of double triodes, for example, allows economies in chassis space, and may well offer an attractive proposition to the home constructor. Unfortunately the output is limited when a sine wave is needed, and the 1 volt r.m.s. likely to result is inadequate for "squaring". It is, nevertheless, a comparatively simple matter to construct a suitable square wave

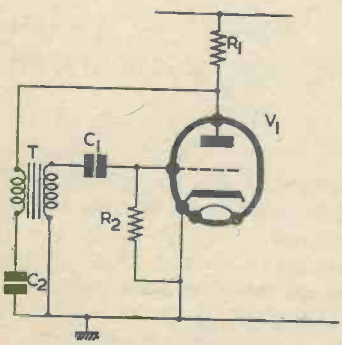


Fig. 1. A typical audio oscillator employing a feedback transformer

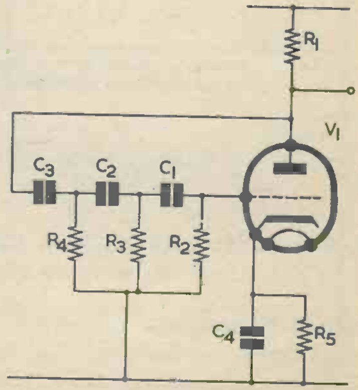


Fig. 2. A phase-shift audio generator

[1] A. S. Carpenter, "Fixed Frequency Audio Oscillator", *The Radio Constructor*, January 1964.

generator as a separate item, if this is needed.

The output—taken from between C_4 in Fig. 3 and chassis—might not always prove to be a good sine wave at any particular frequency, but it may be corrected by changing the value of R_4. If a 25kΩ variable and a 6.8kΩ fixed resistor are wired in series at this point a variable "form" control is obtained. When the cathode resistor is low in value a distorted, or square wave output, results; and this is made purer, at the expense of amplitude, by increasing the value of the resistance.

But even if these modifications are made to the basic circuit of Fig. 3, other problems arise. For example, the simple type of "form" control described, although attractive in that it offers a choice of sine/square outputs, suffers from the disadvantage that, in use, it affects the operating frequency and introduces inaccuracies to the scale calibration. Furthermore, loads dissimilar in value also affect the operating frequency to some extent, but this difficulty can, fortunately, be eliminated by using a cathode follower stage after C_4.

A Practical Unit

The circuit of Fig. 4 shows an experimental audio oscillator, recently constructed along the lines just discussed, which provides a sine wave output in the range of 20–20,000 c/s with reasonable accuracy, at moderate cost, and without involving the use of too many valves. No power supply is shown since it is intended that supplies be picked up from the workshop power pack.

The oscillator proper consists of the circuit around V_1, and this is similar to that discussed in connection with Fig. 3. Variable frequency working is incorporated, VR_1 and S_1 S_2 acting as fine and coarse controls respectively.

It may be noted that the capacitor values associated with S_1 are identical with those connected to S_2 and that the values in circuit are multiplied, or divided, by 10 each time the ganged switches are rotated.

As stated earlier the combination of capacitors and resistors in circuit largely decides the operating frequency, which may be found from

$$f_o = \frac{1}{2\pi\sqrt{C_1, R_1, C_2, R_2}}$$

or, more simply $f_o = \frac{1}{2\pi CR,}$

where $C_1 = C_2$, $R_1 = R_2$, and where the values are in farads and ohms. Thus, if S_1 S_2 is at position "2" and assuming maximum resistance to be in circuit via VR_1

$$f_o = \frac{1}{2\pi CR} \text{ or } f_o = \frac{10^6}{2\pi CR}$$

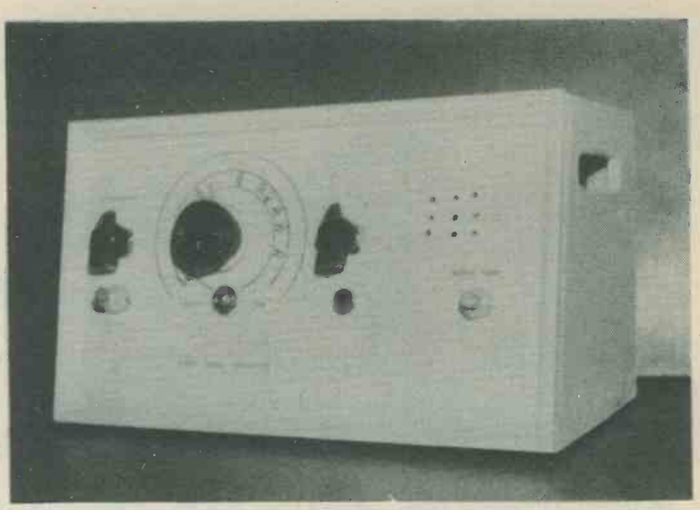
(CR in MΩ and pF values).

Inserting these values, i.e., 500pF and 1M

$$f_o = \frac{10^6}{6.28 \times 500 \times 1} = \frac{10^6}{3{,}140}$$

$= 300$ c/s approximately

With VR_1 close to minimum, 3,000 c/s results, but in practice the frequencies are lowered somewhat due to circuit conditions and to the presence of R_1 and R_2. It is interesting to note, however, that both 400 c/s and 1,000 c/s are included in the same range—which is automatically multiplied, or divided, by 10 as S_1 S_2 is manipulated.



A view of the audio generator constructed by the author. The switch below the frequency selector dial is marked as selecting "sine" or "square wave", but this was later discarded and converted to S_4 of Fig. 4

It may be mentioned in passing that VR_1 consisted of a conventional 2-gang logarithmic track potentiometer in which the normal "top" end connections were left open circuit, thereby eliminating cramping at the high frequency end of the scale. Use of a higher grade component would normally be desirable or, as an alternative, fixed resistors in association with a variable twin-gang capacitor may be employed.

Waveshaping and Amplitude

It is found when using triodes that the cathode resistor of $V_{1(a)}$ must be fairly high in value if a good waveform is required and, although it is not difficult to generate a pure signal at say 1,000 c/s, at 100 c/s it is by no means easy to do so. Still greater difficulty is experienced as the frequency is lowered, and the

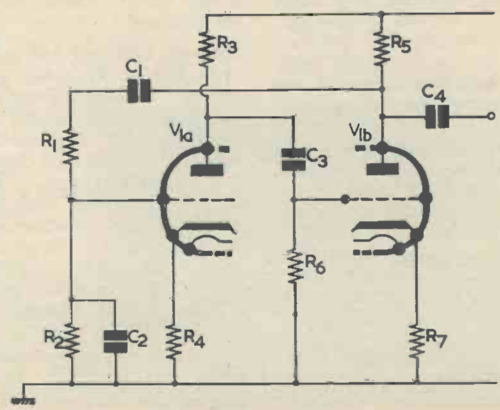


Fig. 3. An audio generator employing a Wien-type frequency-selective network

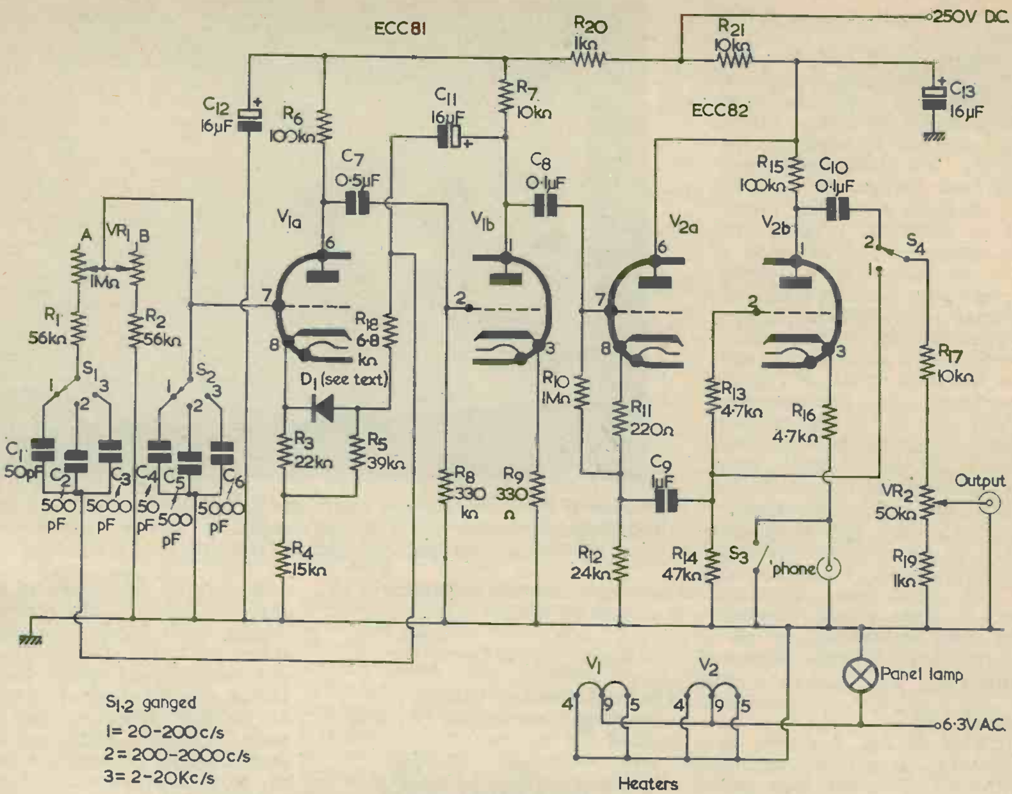


Fig. 4. The circuit of a complete audio generator offering frequencies from 20 c/s to 20 kc/s

valve usually sets its own limit. Acceptable low frequency sine wave forms can only be generated, it seems, if a low output is tolerable.

It has also been found that in a variable frequency unit of this kind amplitude varies considerably as VR_1 is manipulated, the output falling at the end of the scale associated with highest frequency. This is a well-known and familiar phenomenon but is obviously most undesirable when measurements are to be made to equipment under test. The usual way to overcome it is to employ a feedback circuit and use therein a temperature dependent element such as a thermistor. In the circuit shown a somewhat similar principle is involved, since D_1 is a junction diode which is temperature sensitive. Part of the output is fed back from $V_{1(b)}$ anode via C_{11} and R_{18} and affects the cathode circuit of $V_{1(a)}$ such that reasonably constant amplitude is maintained over the range in use. This, unfortunately, further attenuates the available output, but it is a desirable inclusion for the reasons given. A suitable diode can be obtained from one section of a junction transistor, the lead being connected to pin 8, $V_{1(a)}$ and the collector lead to the junction of R_5 and R_{18}. The emitter is left unconnected and R_{18} experimentally adjusted. If R_{18} is too low in value $V_{1(a)}$ will become cut off whereas, if a high value is used, control will not be obtained.[2]

Cathode Follower and Amplifier

In Fig. 4, $V_{2(a)}$ acts as a normal cathode follower, a high impedance being presented to the audio oscillator proper due to the heavy feedback across R_{12}. $V_{2(b)}$ amplifies the generated signal. The "phone" facility is useful and serves as a check on unit functioning, the item used being an ex-equipment low impedance insert paralleled by a simple push-to-make, push-to-break switch. The highest frequencies generated will only be available to bats (and, perhaps, cats!).

Outputs are made available by means of a simple potentiometer circuit and are selected by S_4, resistors R_{15} R_{16} and R_{17} being chosen experimentally to provide a 10:1 ratio output.

General

It is not proposed to give a detailed method of scale calibration here. The experimental model was first set up on Range 2 where accurate check-points are obtainable against B.B.C. tuning signals. If a correctly tuned piano is available this range can be reasonably well calibrated, using B.B.C. signals later for final checking. Middle C may be considered f=260 c/s, whereupon 2f (octave rise)=520 c/s, and so on. The output may also be applied to the c.r.o. If, for example, a 1,000 c/s waveform from the generator is displayed and the c.r.o. timebase set to lock with the fundamental and left, a further lock will result as the generator is slowly adjusted to a higher frequency, i.e., at 2,000 c/s

[2] The author employed an OC81 in the D_1 position, and states that this gave better results than an OA70. If the frequency control is swung suddenly hard over from one extreme to the other the output resets itself gradually and not instantaneously, thereby indicating a degree of dependence on temperature.—EDITOR.

and, again, at 3,000 c/s, etc.

Alternatively the c.r.o. may be set to 50 c/s together with the generator. (An accurate 50 c/s may be obtained from the a.c. mains supply.) If the c.r.o. is left at 50 c/s, multiples will be detectable at 100 c/s, 150 c/s, 200 c/s, and so on, and these may be marked in as required. It is essential to ensure that the c.r.o. is not itself initially set to a multiple.

A suitable scale may easily be made using indian ink and a bow pen with a piece of Bristol board. Legends are obtainable with the aid of Data Publications "Panel-Signs", and may be protected with clear nail varnish.

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.

Type 78 Receiver.—A. C. Evans, "Miskin", 1 Selsmore Cottages, Salterns Lane, Hayling Island, Hants, would like information on this U.S. Services receiver Ref. No. 10D/1307, with particular reference to power supplies and pin connections at rear of set.

* * *

Cossor Instruction Manual.—E. Shaw, "Sunningdale", Village Lane, Washington, Co. Durham, requires the loan or purchase of the manual for the Cossor TV Alignment Pattern Generator, model 1320.

* * *

Small Computor Circuit.—J. A. Barnard, Northload Farm, Theale, Wedmore, Somerset, is interested in constructing such a design (cost in region of £10 to £50) to be used for demonstration purposes. Can any reader supply a circuit or information?

Philips Radiogram, Type 572A.—J. Maguire, 30 Blessington Street, Dublin 7, Eire, urgently requires service sheet, circuit or any other information on this pre-war set.

* * *

Transmitter BC625A, Receiver BC624A.—A. J. Christ, 42A Albert Road, Morecambe, Lancs, requires service sheets or manuals.—A.M. Nos. T5017 and R5019 respectively).

* * *

Stuzzi Transistor Tape Radio Tuner.—G. F. Allen, 17 Finnemore Road, Hainault, Ilford, Essex, requires circuit diagram.

* * *

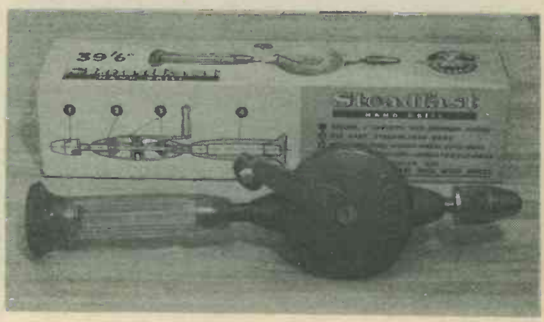
American "Knight-Kit" FM Tuner.—C. W. Falkner, Thames Valley Grammar School, Fifth Cross Road, Twickenham, Middx., request all technical data on this unit.

Trade Review . . .

THIS EXCEPTIONALLY FINE HAND DRILL IS SHOWN in the illustration herewith and it incorporates a fully enclosed double pinion bevel drive which prevents any accidental trapping of fingers or clothing and additionally protects the user from being soiled by any lubrication medium.

The drill has a keyless ¼in capacity self-centring chuck and a hollow translucent amber plastic handle in which spare drills may be contained, the handle being specially contoured for easy grip and control.

The hand drill weighs 1lb 15oz and has a length of 13in. The streamline body of the drill is die-cast and enamelled blue. The retail price is £1 19s. 6d. and is available from all ironmongers and tool dealers.



THERMO-ELECTRIC SENSING DEVICE

By David Aldous

Using a transistor as a temperature-sensitive element

THE UNIT DESCRIBED IN THIS ARTICLE IS A "THERMO-electric" sensing device. It was designed and built in order to gain experience with d.c. amplifiers and, also, to test the effectiveness of a transistor when used as a temperature-sensitive element. This last application makes use of the temperature/leakage current characteristic of the transistor.

The device consists basically of a transistorised d.c. amplifier following the transistor which functions as the temperature sensitive element. Varying leakage currents in the sensing transistor are then amplified so as to operate a controlled circuit incorporating, say, a meter or a relay.

Circuit Description

The circuit of the unit is given in Fig. 1. In this diagram TR_1 is the sensing transistor, and its base bias is controlled by R_1, R_2 and VR_1. Since VR_1 is capable of controlling the base bias, it functions as a "temperature range" control.

The collector of TR_1 connects directly to the base of TR_2, which provides the first stage of the d.c. amplifier. The main function of TR_2, apart from amplification, is to give a phase reversal to the signal from TR_1. An increase in leakage in TR_1 (due to an increase in its temperature) causes a decrease in collector current in TR_2. Because of the direct connection between the collector of TR_2

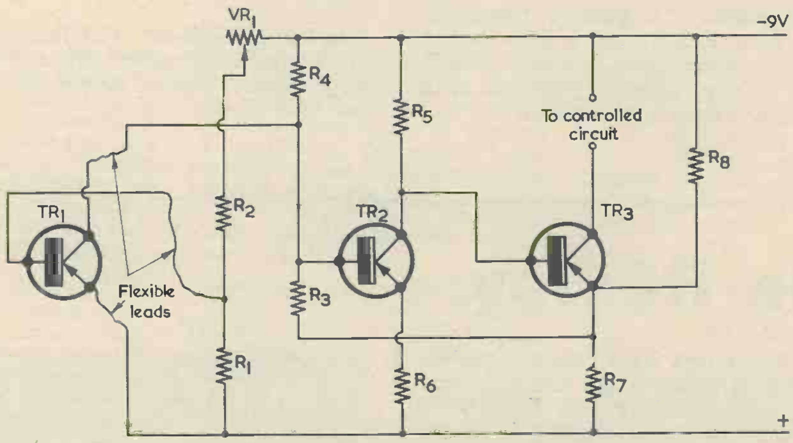


Fig. 1. The circuit of the temperature sensing device

and the base of TR_3, this decrease results in an increased collector current in TR_3. Thus, the overall effect is that increased collector current in TR_1 results in increased (and amplified) collector current in TR_3.

The resistors R_7 and R_8 form a potential divider across the supply and feed the emitter of TR_3, this taking up a potential which is only slightly below (i.e. slightly more positive than) that of TR_2 collector. The potential at the emitter of TR_2 is, similarly, only slightly below that at its base.

Thermal stabilisation of the d.c. amplifier is provided by returning R_3 to the base of TR_2. If, for instance, leakage current were to increase in TR_2, this would cause the potential at its collector and, hence, at the base of TR_3, to fall. The emitter potential of TR_3 would similarly fall, and this change would be passed back to the base of TR_2 via R_3, whereupon it would counteract the initiating increase in leakage current. Should there be an increase in leakage current in TR_3, the loop, via R_3 and TR_2, will cause a compensating drop in the potential on TR_3 base.

In operation, the "temperature range" control VR_1 is set to a value determined by the temperature of the surroundings of TR_1. Low values in VR_1 are required when the temperature is low, and high values when it is high. When heat is applied to TR_1 its collector current rises, causing a fall in the potential on TR_2 base. TR_2 collector current then decreases, resulting in an increase in collector current in TR_3. TR_3 collector current thus increases with temperature, and operates the controlled circuit accordingly.

The Sensing Probe

In use, TR_1 may be fitted into a "sensing probe", it being connected to the d.c. amplifier by three flexible leads as indicated in Fig. 1.

Components List

Resistors
(All fixed values 10% ¼ watt)

R_1	8.2kΩ
R_2	330kΩ
R_3	6.8kΩ
R_4	33kΩ
R_5	47kΩ
R_6	470Ω
R_7	1kΩ
R_8	10kΩ

Transistors

TR_1	OC81 or OC81D
TR_2	OC81
TR_3	OC81

Miscellaneous
10-way tagboard (see text)
9V battery
Controlled circuit components (meter, relay, etc.)

TR_1 is mounted in the desired position, after which VR_1 is adjusted as required. It is possible, with low settings in VR_1, to obtain an output signal for small changes in TR_1 leakage current at temperatures which are nearly as low as 0°C.

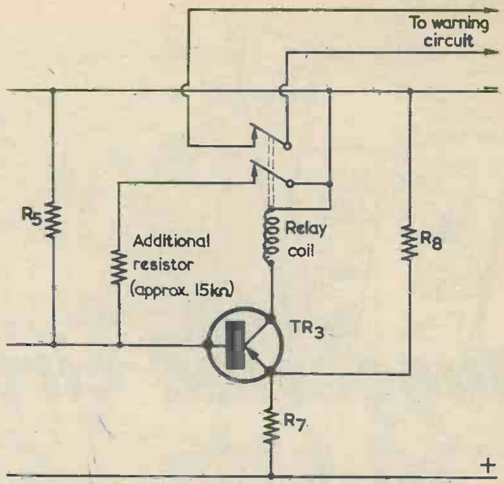


Fig. 2. A relay in the collector circuit of TR_3 may be made to "latch on" by means of a spare pair of contacts

Suggested Applications

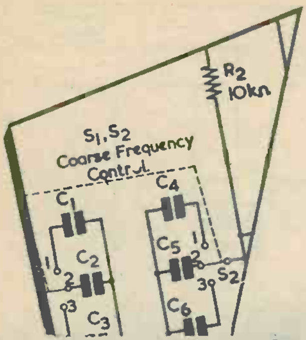
A number of applications may readily suggest themselves to the reader. A typical instance would consist of using the unit as an electronic "thermometer". In this case a meter having an f.s.d. of 1 or 2mA could be connected in the collector circuit of TR_3, VR_1 being replaced by a switch and a number of fixed resistors in order to give definite temperature ranges.

Another possible application is as a "thermal sentry". The sensing transistor would be mounted in proximity to the component or equipment under test, a relay being connected in the collector circuit of TR_3. Too high a temperature would then cause the relay to energise, whereupon it could switch on a warning light or other indicator. The relay could also switch off the component or equipment under test. A further idea would consist of employing a spare pair of contacts on the relay so that the latter "latched on" after being initially energised. A suitable circuit is shown in Fig. 2.

These are only two of the many possible applications for the device.

Construction

The prototype was built on a Bulgin 10-way tagboard (10 pairs) type C125, and this provided a very rugged method of construction as well as allowing a tidy layout to be achieved. This tagboard is convenient, also, since it it fitted with 6BA threaded fixing bushes. All components were mounted on the tagboard with the exception of the sensing probe and VR_1. Other methods of assembly may, of course, be used, and the parts layout is not in the least critical.



suggested circuits

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

No. 164 Tape Recording from A.C./D.C. Radios

One of the problems which beset tape recorder enthusiasts occurs when it is desired to obtain good quality recordings from mains-operated domestic a.m. receivers. The main difficulty is that, whereas it is conventional practice for tape recorders to employ isolated chassis, almost all domestic a.m. receivers have "live" chassis which are connected to one side of the mains supply.

Good quality a.f. is normally available at the diode load of the a.m. receiver, but this cannot be coupled directly to the input of the tape recorder without connecting together the two chassis. The recorder chassis, together with any exposed metalwork it may have which is at chassis potential, then becomes "live" and is a source of considerable danger. At the same time, without such a direct connection between the two chassis hum level may become intolerable.

Occasionally, this difficulty is overcome by feeding the tape recorder from the secondary of the output transformer in the radio receiver, this secondary being isolated from the receiver chassis. However, the isolation provided by the receiver output transformer may not necessarily be reliable, and there is the further disadvantage that the a.f. available at its secondary will have greater distortion than that appearing across the diode load, because it will have passed through a voltage amplifier and an output stage.

This month's Suggested Circuit offers a somewhat unconventional approach to the problem, in that it causes the signal for recording to be obtained from the i.f. amplifier of the receiver rather than from the diode load or any subsequent stage. The modulated i.f. signal is then amplified and detected in a separate add-on unit, after which it is ready for application, at good quality, to the input socket of the tape recorder. The circuit necessitates a very simple modification to the receiver, and it provides adequate isolation without the introduction of hum. On the debit side is the fact that the additional i.f. amplifier and detector unit employs a valve, whose heater and h.t. supplies have to be obtained from the tape recorder (or from a separate power supply). Nevertheless, the circuitry involved is very simple and straightforward, and many enthusiasts may consider that the benefits which are conferred well outweigh the power supply disadvantage.

The circuit may only be employed with tape recorders having isolated chassis.

The Circuit

Fig. 1 illustrates the modifications required to the a.m. receiver together with the circuit of the add-on unit.

As will be noted, the modulated i.f. is taken from the anode of the i.f. amplifier in the receiver by way of the 2pF capacitor C_1. (The i.f. amplifier shown in Fig. 1 follows the receiver frequency-changer, and immediately precedes the detector circuit.) The modulated i.f. is then passed, via two lengths of screened cable and a coaxial socket and plug, to the add-on unit, where it is applied to the grid of an EBF89. Resistor R_1 functions as grid leak and is returned to one of the EBF89 diodes, the latter providing bias for the pentode section by reason of its contact potential.

The EBF89 amplifies the i.f. signal in normal manner, and this is then fed, via IFT_1, to the detector circuit given by R_4, R_5, C_4, C_5 and the remaining diode. R_5 is a volume control, and the detected a.f. at its slider is passed to the tape recorder input circuits via C_7.

R_6 and C_6 provide decoupling from the h.t. circuits in the recorder. A secondary function is provided by R_6 in so far that its relatively high value ensures that the EBF89 pentode operates at an h.t. potential of the order of 100 volts. This relatively low voltage is permissible since the pentode is not required to offer a high degree of gain in the present application, and the resultant h.t. current drain from the tape recorder power supply becomes approximately 5mA only.

The three screened cables in the circuit diagram are earthed to different points in the general assembly. The outer conductor of the screened cable immediately following C_1 is earthed to the receiver chassis. The function of this screened cable is, primarily, to prevent undesired couplings between its centre conductor and earlier stages in the receiver. It is most important to note that the outer conductor of the coaxial socket mounted on the receiver is *not* connected to the outer conductor of this screened cable. The only connection which is made to the outer conductor of this socket occurs when the coaxial plug is inserted. The receiver coaxial socket is mounted on the back of the receiver and is the only additional component which appears outside the cabinet and which can be touched.

The screened cable coupling the input coaxial plug to the grid of the EBF89 takes its earth connection from the chassis of the add-on unit. The outer conductor of this cable also connects to the outer conductor of the coaxial plug which terminates it.

The remaining screened wire is that which carries the a.f. output of the unit to the tape recorder. In this case, the outer conductor of the cable is earthed to the outer conductor of its coaxial plug. To avoid the formation of hum loops, this screened cable is not earthed at any other point.

In Fig. 1 it is assumed that the tape recorder has a coaxial input socket but, in practice, the sockets employed may be jacks, 2-way sockets, or other types. The appropriate plug would then, of course, be employed instead of the coaxial type depicted in the diagram, the outer conductor of the screened cable still connecting to the earthy side.

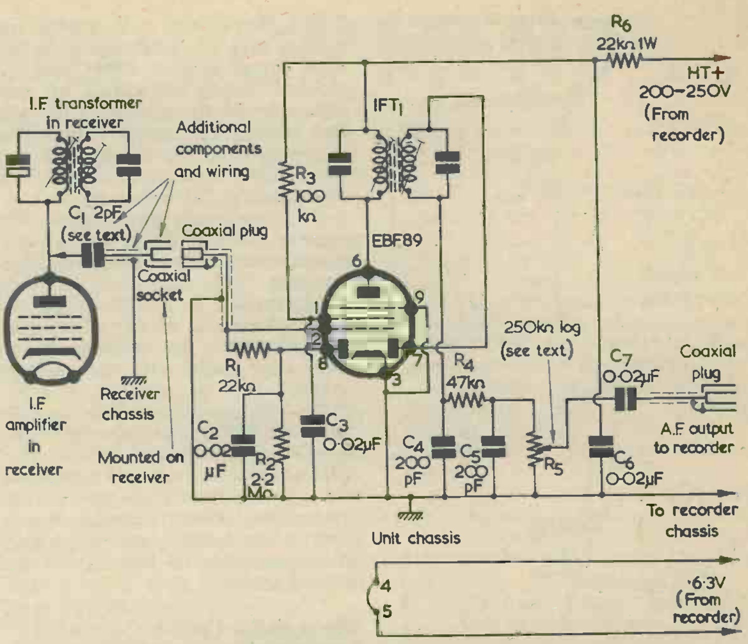


Fig. 1. The receiver modifications and the add-on unit. The latter consists of the components around the EBF89

Additional Points

There are a number of additional points which require a little further discussion.

The first of these is concerned with the fact that the pentode section of the EBF89 is biased by diode contact potential instead of by the more conventional cathode bias. Either method of biasing requires a resistor and a capacitor and so no saving in components is effected. On the other hand, the method employed in Fig. 1 has the marginal advantage that the cathode of the double-diode-pentode is at chassis potential, and that the feedback which tends to arise with double-diode-pentodes used in the present application becomes slightly reduced in consequence.

The intermediate frequency in the receiver will lie within the range of 450 to 475 kc/s, as is common with a.m. receivers. The i.f. transformer in the additional unit is a standard component intended for operation at these frequencies.

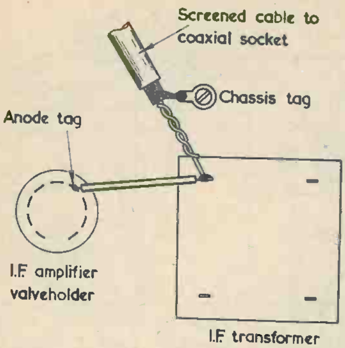
The a.f. output offered by the unit will be at a high level, being equal to, or somewhat in excess of, that available at the diode load of a standard receiver. The output of the unit will then connect to the appropriate input socket of the tape recorder. To avoid distortion, R_5 should have a value which is not greater than 25% of the input resistance at the recorder socket. The value for R_5 shown in Fig. 1 assumes a recorder input resistance of 1MΩ or more, and lower input resistances will necessitate correspondingly lower values in R_5. If a suitable gain control is already available in the recorder, the variable component shown in the R_5 position could be replaced by a fixed resistor, C_7 connecting to its junction with R_4.

There is only one direct connection between the additional unit and the receiver, this being made by way of C_1. The coupling provided by this capacitor will allow a small proportion (which may vary according to the self-capacitance of the interconnecting screened cables) of the i.f. voltage on the receiver i.f. amplifier anode to be applied to the pentode grid of the EBF89. The loss in i.f. level is then made good by the amplification offered by the EBF89 pentode.

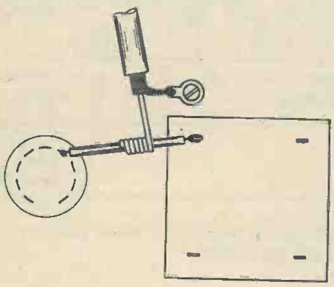
Mains modulation is feasible if a 50 c/s voltage should happen to become impressed on the grid of the EBF89, the worst conditions occurring when the receiver and tape recorder chassis have a potential difference of 250 volts a.c. between them. However, the 50 c/s a.c. voltage can only be passed to the EBF89 grid via C_1 and the self-capacitance of the screened cable in the receiver. These represent the upper half of a potential divider, the lower half being the very much smaller impedance offered by R_1 and C_2 in series.

Modifications to the Receiver

The modifications to the receiver consist of connecting C_1 to the anode of the i.f. amplifier and of fitting the screened cable and the coaxial socket. Care should be taken to ensure that neither C_1, nor any unscreened wires connecting to it, approach the grid circuit of the i.f.



(a)



(b)

Fig. 2 (a). A convenient method of providing C_1 is given by twisting two insulated wires together, as shown here. This enables a simple means of adjusting the capacitance to be effected during setting up. The wire insulation most be adequate for mains voltages
(b). An alternative method of obtaining the capacitance required in C_1

amplifier or any of the frequency-changer components. To meet this requirement, it will probably be preferable to connect C_1 to the appropriate tag of the i.f. transformer in the receiver, rather than to the anode tag of the i.f. amplifier valveholder.

C_1 could be a ceramic component, which must have a working voltage of 250 a.c. Its value may need adjustment during final setting up. In practice, however, it will be preferable not to use a physical component here, the capacitance being given by two insulated wires twisted together, as in Fig. 2 (*a*). If the receiver employs conventional wiring, the required coupling could alternatively be given by twisting an insulated wire around that connecting the anode tag of the valveholder to the i.f. transformer. (See Fig. 2 (*b*).) If a twisted pair is employed instead of a physical capacitor, the final capacitance it offers may be reduced during the setting up procedure by partly untwisting the pair and cutting off excess wire. The wire employed for the twisted pair must have insulation capable of withstanding 250 volts a.c.

The screened wire inside the receiver should have a low self-capacitance and be capable of withstanding 250 volts a.c. between conductors. It could consist of standard coaxial cable. The outer conductor may be earthed at any convenient point on the receiver chassis.

As was mentioned above, the outer conductor of the coaxial socket must *not* be connected to the outer conductor of the screened cable; and the only additional component in the receiver which appears outside the receiver cabinet, and which may in consequence be touched, is the coaxial socket.

The Add-On Unit

The circuit around the EBF89 and i.f. transformer may be built up in the form of a separate add-on unit connecting to the receiver and tape recorder by flexible leads terminated in plugs. The tape recorder would then need to be fitted with a power output socket offering chassis, h.t. positive and heater supply connections. The h.t. current consumption of the unit will be of the order of 5mA, as stated earlier. The heater requirement is 6.3 volts at 0.3 amps.

Low capacitance screened cable should be used for both the input and output leads to the add-on unit, and coaxial cable would provide a good choice here also. To prevent excessive losses, the input lead should not be longer than some 2ft or so. The power supply leads and the output coaxial cable should also be kept reasonably short.

If space allows, the additional unit could be fitted into the tape recorder cabinet itself, thereby eradicating the necessity for a power output socket on the latter.

The layout around the EBF89 is a little critical, and care must be taken to ensure that wiring and components in the pentode anode and detector diode circuits are kept well away from the wiring and components in the grid circuit.

Setting Up

After the unit has been constructed and the receiver modified, the circuit has to be set up. For this process the a.f. output of the unit should be coupled to an a.f. amplifier feeding a loudspeaker. Usually, the tape recorder can provide this facility.

The unit is then plugged into the receiver, and a modulated signal generator applied to the signal grid of the frequency-changer and adjusted to the receiver i.f. The cores of IFT_1 in the additional unit are then adjusted in the normal manner for maximum output and symmetrical response. The output of the signal generator must be reduced as alignment proceeds, and it has to be remembered that the receiver a.g.c. circuits will still be functioning normally. In the absence of a signal generator, the receiver should be tuned to a station, and IFT_1 adjusted for optimum response of that station. The loudspeaker of the receiver will, of course, still reproduce the same signal as is fed to the amplifier following the add-on unit.

If the a.f. output from the add-on unit is excessively high it may be reduced by reducing the value of C_1. In most cases this will involve the reduction of the capacitance in the twisted pair. The final value of C_1 should be that which allows the a.f. output of the additional unit to be commensurate with that available at the diode load of the receiver.

After the unit has been set up and C_1 finally adjusted, the unit input plug should be removed from the socket in the receiver. The i.f. transformer in the anode circuit of the receiver i.f. amplifier should then be realigned, in order to take up the additional capacitance to chassis introduced by C_1 and the screened lead to the coaxial socket. The adjustments required to this transformer should be almost negligibly small.

The Circuit in Use

The add-on unit should prove to be very simple to operate in practice. Before a recording session, the receiver is tuned in carefully to the desired station, after which the add-on unit is plugged into the receiver socket. Recording then proceeds in the usual manner. The receiver volume control and a.f. circuits will not affect the recording process, and the receiver loudspeaker may reproduce the programme at any desired level.

Due to the component values employed in the coupling circuit between the receiver and the add-on unit, it is extremely unlikely that modulation hum will be imposed on the a.f. signal fed to the tape recorder. However, should such hum occur it may be eradicated by reversing the mains connection to the receiver and/or the tape recorder.

NEWS AND COMMENT . .

"Pirate" Radio

The pros and cons of the ethics of the broadcasts from radio stations situated on ships moored off the Essex coast, outside territorial waters, continue to flow thick and fast.

There may very well be a good case for commercial radio in this country and for the setting up of local stations, rather like local newspapers, but "pirate" radio is a somewhat different proposition.

Some of the objections to "pirate" radio stations which may not be readily appreciated were outlined by Mr. Stephen Stewart, Director-General of the International Federation of the Phonograph Industry, in a letter to *The Times*.

His first point was that these stations are "pirating" the property of other people. He was, of course, referring to the royalties payable to composers, musicians, etc., but which are unenforceable against stations broadcasting from outside territorial waters. This matter has now been partly dealt with, as we understand that the proprietors of "Radio Caroline", and "Radio Atlanta", have voluntarily agreed to pay the appropriate fees to the Performing Rights Society. It should be noted that such payments are voluntary.

Secondly, Mr. Stewart stated that the "pirate" radio ships are broadcasting from outside territorial waters to escape the laws of England but expect the protection of international law on the high seas; although their action is expressly forbidden by the International Telecommunications Convention.

His third, and probably most important observation, was that although only popular music was being broadcast, other stations could come into being and broadcast programmes containing obscene material or even subversive propaganda; they would have no licence to lose.

Our guess is that, in due course, a mainland station, or stations, will come into existence to meet the demand for round-the-clock "pop" music, and that such stations will mean the end of "pirate" radio with, or without, changes in international law regarding the use of the high seas.

Amateur Licences

Radio Amateurs, like the B.B.C. and I.T.A., have to keep within the terms of their licences, no "pop" music broadcasts for them, and many of the restrictions are understandable in the light of the foregoing remarks on the position of "Radio Caroline", etc. Frequency allocations, output power restrictions, the giving up of transmitting equipment in wartime are all obvious conditions in the amateur's licence.

With effect from 1st June amateur transmitting licences are to be issued in a revised form. The services of the Radio Society of Great Britain's G.P.O. Liaison Committee were utilised in effecting this revision. This is yet another instance of the work done by the R.S.G.B. on behalf of all radio amateurs and we strongly recommend those interested in short wave radio who are not already members of the Society, listener as well as transmitter, to send to them for the leaflet about membership mentioned in their advertisement on page 857 of this issue.

From the details given in the *R.S.G.B. Bulletin* we can mention a few of the changes in the licence conditions. The new licences are the Amateur (Sound) Licence A, the Amateur (Sound) Licence B (the new phone-only u.h.f. licence), the Amateur (Sound Mobile) Licence and the Amateur (Television) Licence. The Amateur (Sound) Licence B restricts use of the transmitter to frequencies above 420 Mc/s and is for phone-only.

Phone-only licences will have call-signs in the G8 plus three letter series. Amateur television stations will have G6 . . . /T calls.

Log keeping requirements have been extended. Amateurs are now specifically authorised to receive transmissions in the Standard Frequency Service. The use of recordings intended for entertainment is prohibited, of course, but special recordings of audio frequency tones can be used.

Presumably because of previous confusion on the issue, a new sub-clause has been added to the licence conditions making it clear that speaking into the microphone is operation of a station and is restricted to the licensee and other holders of U.K. amateur licences or the Amateur Radio Certificate issued by the P.M.G.

Audio-Visual Teaching Aids

A residential conference on audio-visual teaching aids will be held at Loughborough College of Technology from the 10th to 12th September next. Arranged by The Institution of Electrical Engineers Science and General Professional Group on Education and Training, the conference will cover such topics as educational and teaching films, closed-circuit television, calculus programming and teaching machines.

An introductory lecture on "Teaching devices" will be given by H. W. French, B.Sc., M.I.E.E., H.M.I., on Thursday evening, 10th September. The remaining programme will be devoted to short lectures followed by discussion.

A scientific exhibition will run concurrently with the discussion sessions. Offers of exhibits are invited within the following categories:

(*a*) Audio visual aids, including teaching machines, language laboratories, closed-circuit television, video tapes and loop films.

(*b*) Electrical engineering laboratory demonstration equipment.

(*c*) apparatus developed at teaching establishments, including laboratory and demonstration equipment for electrical engineering courses and general and special courses for technicians, and college-built audio-visual aids.

Those wishing to offer exhibits for consideration for inclusion in the exhibition should apply to the Secretary of the Institution for application forms as soon as possible.

Further information and registration forms are available from the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

I.E.A. Exhibition

Mr. L. S. Yoxall, Chairman of the Exhibition Committee of the 1964 Instruments, Electronics & Automation Exhibition held at Olympia at the end of May had many interesting comments to make on a successful event, we only have space available for one short topic.

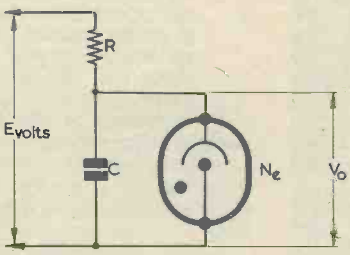
"Mr. Edward Heath, the President of the Board of Trade, noticed during his tour of the I.E.A. the youth of the technicians manning the stands. I will say that I was even more impressed by the low average age of the visitors, men in their late twenties and early thirties who are already in important executive positions. This accent on youth is most encouraging because these young men are already taking over the industrial reins that, we all believe, will guide us into an era of prosperity."

Automatic Variable Audio Oscillator

By D. B. Hulse, A.M.Inst.E.

THIS ARTICLE DESCRIBES A UNIQUE CIRCUIT EMploying the well-established neon relaxation oscillator, and it is mainly the result of a demonstration given to the author's class of electronic students. It was thought that the circuit, though relatively simple, could serve as a useful and reliable piece of equipment in almost every constructor's workshop.

Before entering into full details of the final circuit, it may be of some use to revise the fundamental principle of operation of the neon relaxation oscillator, the circuit of which is shown in Fig. 1.



Operation

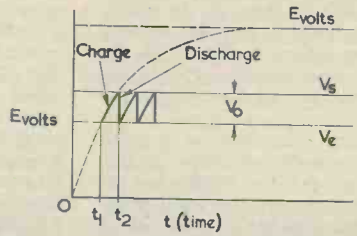
At the instant of application of d.c. supply voltage E, the voltage appearing across capacitor C will be zero; thus the whole of supply voltage E appears across resistor R. However, this condition soon changes, for capacitor C tends to charge towards voltage E. The mathematical expression relating to this condition is given by :

$$v = E\,(1 - e^{\frac{-t}{CR}}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \; 1$$

where v =instantaneous voltage across C
E =applied steady d.c. voltage
e =base of Naperian logs (=2.7183)
R =resistance of R (in ohms)
C =capacitance of C (in farads)
t =instantaneous time from zero (secs)

The product C× R is called the time constant and is usually denoted by t, the unit being seconds. It follows that when t=CR, the instantaneous voltage v, will be 63% of E.

Now, since neon lamp Ne is connected across C, there comes a time when the instantaneous capacitor voltage equals the striking or ionisation potential of the neon lamp. Thus, neon Ne will discharge capacitor C until its extinguishing potential is reached, whereupon the discharge ceases. Capacitor C now recharges, and the above process is repeated. The graphic interpretation is shown in Fig. 2, from



which it can be seen that the striking and extinguishing voltages, v_s and v_e respectively are represented by:

$$v_s = E\,(1 - e^{\frac{-t2}{CR}}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \; 2$$

and

$$v_e = E\,(1 - e^{\frac{-1}{CR}}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \; 3$$

From these two expressions, it can be shown that the frequency generated by the circuit of Fig. 1 is given by

$$\text{frequency, } f = \frac{1}{CR \log_e \frac{E - v_e}{E - v_s}} \quad \ldots\ldots\ldots\ldots \; 4$$

this being based upon a negligible discharge time relative to charge time.

From this expression, variations in the values of C, R or E will alter the frequency since, for a given neon lamp, v_s and v_e are virtually constant.

Thus, in order to alter the frequency of the oscillator we have three choices in variables. In the complete circuit, the main variable is the supply voltage, E.

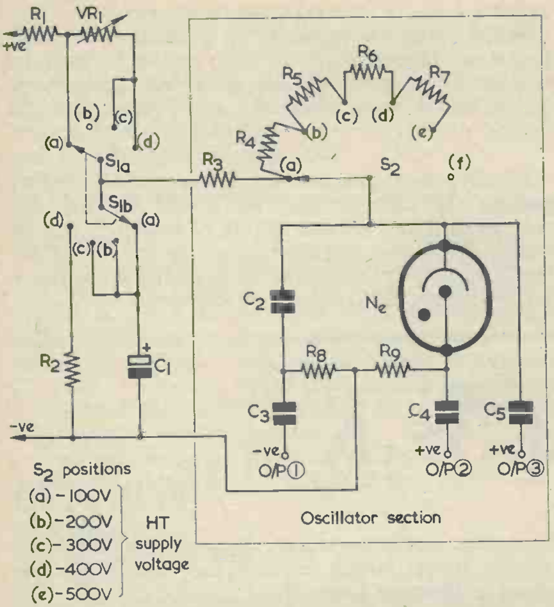
Final Circuit

The final circuit is shown in Fig. 3 and may appear to be quite unlike that of Fig. 1.

The principal features of the circuit are: (*a*) it produces three simultaneous outputs, (*b*) it generates audio frequencies from a few c/s to around 10 kc/s automatically, and (*c*) it requires no power supply but utilises the available h.t. voltage of the amplifier under test, with very small current drain.

Description

The main oscillator components are R_3 to R_9, C_2, neon Ne, and switch S_2. The positions of this switch are calibrated in terms of h.t. supply voltage rather than frequency. The reason for this is simply to provide the correct time constant, CR, for a given supply voltage, E, in order to cover the required frequency range (expression 4). If, for instance, the oscillator is connected to a 300 volt supply where previously it was connected to a 100 volt supply, changing S_2 from position (*a*) to position (*c*) will cause approximately the same range of frequencies to be generated as occurred before.



The three outputs available are produced simultaneously, since the discharge and recharge of capacitor C_2, via neon Ne, R_8 and R_9, produce waveforms as shown in Fig. 4. Note the wave shape of outputs 1 and 2. These correspond to the discharge of C_2 through Ne, R_8 and R_9, and have the appearance of steep-fronted pulses. These pulses are excellent for the testing of audio amplifier frequency response. Also, output 1 is in antiphase with output 2, although the two are approximately equal in magnitude, being at around 1 volt peak value each. Output 3 takes the form of a sawtooth, it being the charge and discharge voltage appearing across C_2. This output has a peak-to-peak value of around 12 volts, which is suitable for applying to the control grids of most output valves.

Low values are specified for C_3 and C_4 in order to preserve a steep-fronted wave pulse at outputs 1 and 2, even when these feed into high resistance loads of the order of 1MΩ. The low value chosen for C_5 is not primarily for the preservation of wave shape, but is mainly to ensure that different loads do not cause excessive frequency variation. Output 3 is best fed into a high impedance rather than into a low impedance.

The variable h.t. voltage is derived by operation of switch S_1. In position (*a*), capacitor C_1 is coupled to the h.t. line via R_1; thus, in a matter of seconds, C_1 will charge up to full h.t. voltage, and the frequency output will rise rapidly from the lowest to the highest frequency depending upon the setting of switch S_2, and the h.t. voltage. With switch S_1 placed in position (*b*), capacitor C_1 (which is charged to full h.t. voltage) releases its charge into the oscillator section, thus producing a "run down" in frequency. This takes effect for about 5 to 6 minutes. A frequency coverage is automatically provided, therefore, from about 10 kc/s to around

Components List

Resistors (20% unless otherwise specified)

R_1	47kΩ 3 watts
R_2	470kΩ 1 watt
R_3	820kΩ ½ watt
R_4	2.7MΩ ¼ watt
R_5	2MΩ ¼ watt
R_6	2MΩ ¼ watt
R_7	1.5MΩ ¼ watt
R_8	2.7kΩ 10% ¼ watt
R_9	2.7kΩ 10% ¼ watt
VR_1	2MΩ linear pot.

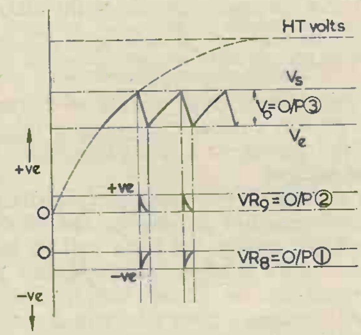
Capacitors

C_1	See text
C_2	500pF, 750V wkg, mica
C_3	10pF, 500V wkg, mica
C_4	10pF, 500V wkg, mica
C_5	20pF, 500V wkg, mica

Miscellaneous

*Ne	Hivac Neon Lamp, type CC8L
S_1	2-pole, 4-way rotary switch
S_2	1-pole, 5-way rotary switch
	M.E.S. lampholder if Hivac neon lamp is used

* If this lamp cannot be obtained, any other type whose V_s=70V and V_e=60V should be satisfactory.



a useful 20 c/s. Putting switch S_1 to position (*c*) couples C_1 once again to the h.t. line, this time via the variable resistor VR_1 and resistor R_1. Thus, by selecting a suitable value of resistance in VR_1 it is possible to govern the rate at which C_1 charges up towards full h.t. voltage. Since the oscillator section is connected across C_1, this rising voltage causes the oscillator to produce a frequency sweep from a few c/s to the highest audio tone around 10 kc/s, the time taken varying from around three seconds to several minutes. This condition is governed by the setting of VR_1, the h.t. voltage and the setting of S_2. Finally, in position (*d*) of switch S_1, capacitor C_1 is omitted from the circuit and is replaced by resistor R_2. This, together with VR_1, produces a potential divider whose midpoint is connected to the oscillator section. Thus, by adjustment of VR_1, manual control of frequency can be obtained.

Conclusions

With reference to the value of capacitor C_1, the author employed a 32μF, 600V d.c. working type, but the value is not critical and may consist of any figure from around 8 to 50μF, providing the d.c. working voltage is adequate. The former value will provide shorter "run-up" and "run-down" times and vice versa.

An alternative arrangement for outputs 1 and 2 is to replace resistors R_8 and R_9 by a potentiometer having a value of 5kΩ. The wiper may connect to chassis and the extreme ends of the track to C_3 and C_4. Such a control will enable the user to vary outputs 1 and 2 to suit his requirements.

When using the oscillator to produce a constant frequency (position (*d*) of S_1), switch S_2 may be employed to produce five different frequencies depending in value upon the h.t. voltage and the setting of VR_1.

Finally, two precautions are necessary before putting the unit to use: (*a*) check the h.t. rail voltage so that a correct setting of switch S_2 can be made, (*b*) *if the amplifier is of the a.c./d.c. type, check for a live chassis before connecting the negative lead or the result may well be a dangerous shock.*

A RADIO LARK

By M. LORD

HAVING LEARNED HOW TO TURN OFF AN ALARM clock whilst remaining asleep, the author was faced with a serious problem—how to wake up at a reasonable hour in the morning!

The solution to the problem is described below, and its success can be judged from the fact that for the last four months the author has been woken up within a quarter of an hour of the specified time, and without the traumatic shock of an alarm bell in full cry.

The Circuit

At a pre-determined time, a pair of contacts in an alarm clock are closed, energising a relay that switches on the power to a transistor radio tuned into the local station.

Reference to Fig. 1 will demonstrate that, with S_1 in the "on" position as shown, the closing of the clock contacts causes the relay coil to be connected across the 9V battery. Contact pair 1 then close and completes the power supply circuit for the radio. At the same time contacts 2 close and ensure that the relay remains energised until S_1 is switched off, no matter what the clock contacts do.

If S_1 is turned to the "off" position, the relay coil circuit is opened and prevents further drain from the battery, whilst $S_{1(a)}$ completing the receiver power circuit, ensures that the latter continues to function normally.

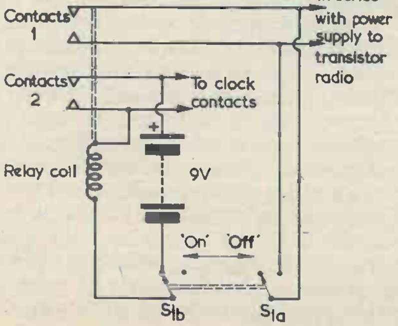


Fig. 1. The circuit of the "Radio Lark"

Modifying the Clock

If the alarm mechanism in the majority of clocks is examined, it will be found that, at the set time, a gear wheel ("A" in Fig. 2) springs forward, whether the alarm is set to ring or not. This forward motion is used to make contact between the frame and the contact strip mounted on it.

The contact strip can be made from one of the contacts of an old relay, bent so that when the gear wheel "A" is in its normal held-back position, there is about $\frac{1}{20}$in gap between it and the contact strip. The contact strip must, of course, be mounted in such a way that it is insulated from the metal clock frame. Two leads, one from the contact strip, and the other from the metal frame are then taken to a miniature jack socket mounted on the back of the clock.

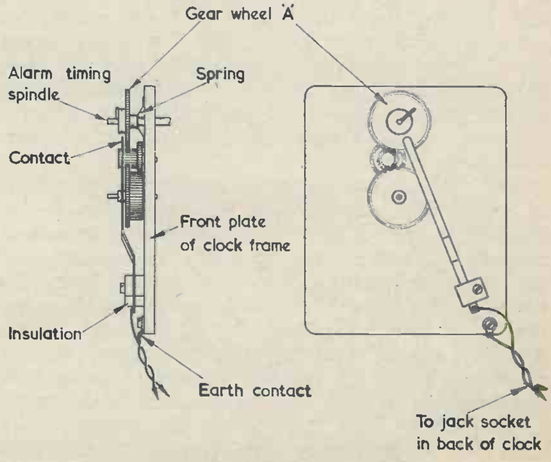


Fig. 2. Adding contacts to the clock

Components List

Relay—1,000Ω coil, with 2 sets of contacts, normally open*
S_1—2-pole, 2-way toggle switch
Miniature jack plug and socket
2 flat 4.5V torch batteries
½in plywood for case, wire, etc.

* The relay should be capable of energising at 9 volts.

Construction

The control unit is assembled, as shown in Fig. 3, in a small box made of ½in plywood, which can be used as a stand for the clock. The bottom of the cabinet must be removable to facilitate replacement of the two 4.5 volt torch batteries used to energise the relay. However, as the total drain is only about 9 to 10mA, the batteries will last for some three to four months with normal use.

Two grommets in the back of the case provide exits for the leads to the radio and the clock.

Operation

Normally, S_1 is kept in the "off" position. Before retiring, the clock alarm is set to the required time (with the button pressed down so that the bell will not ring in the morning) and the radio switched on and tuned in. S_1 is then switched to the "on" position, causing the radio to be switched off until the contacts in the clock close; whereupon your choice of programme creeps into the room to herald the start of another day.

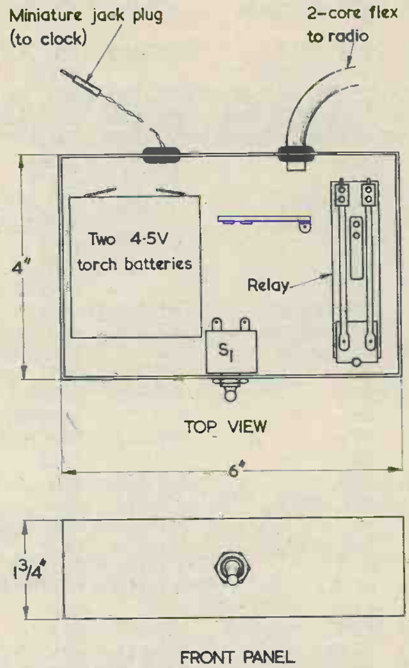


Fig. 3. The layout employed by the author

EDITOR'S NOTE—The device described in this article switches the battery supply to a transistor radio which is, of course, completely isolated from the mains supply. Because of the low insulation offered in relays which are available on the home-constructor market, we do *not* recommend that the device be used for switching mains receivers or other mains-operated equipment.

COMMERCIAL EQUIVALENTS of AMERICAN V.T. VALVES

By ALAN GUY

In our August 1963 issue we published details of surplus American electronic equipment coding. We now follow this with a detailed list giving commercial equivalents for surplus American valves

MANY CONSTRUCTORS MUST HAVE VALVES IN THE "junk box" which they are unable to use, because they cannot be identified. Such valves, removed from American ex-Government equipment, will probably have a VT number, and in this connection the following list may help in identification and make these items usable. The list has been compiled over a period of years from observation and recording details of valves possessing both the VT number and the commercial number, and it is hoped that it will be of use to those constructors who, like the author, are not fortunate enough to possess unlimited funds for their hobby.

VT No.	*Comm. Equiv.*	*VT No.*	*Comm. Equiv.*
VT-2	WE205B	VT-28	24, 24A
VT-4-B	211, 242A, 311	VT-29	27
VT-4-C	211 Special	VT-30	01A, 01
VT-5	WE215A, 215A	VT-31	31
VT-7	WX12	VT-33	33
VT-17	860	VT-34	207, F307
VT-19	861	VT-35	35/51
VT-22	204A	VT-36	36, 36A
VT-24	864	VT-37	37, 37A
VT-25	10	VT-38	38, 38A
VT-25-A	10 Special. 10Y	VT-39	869
VT-26	22	VT-39-A	869A, F369B
VT-27	30	VT-40	40

VT No.	*Comm. Equiv.*
VT-41	851, 951
VT-42	872, F353A
VT-42-A	872 Special fil.
VT-43	A45, 845, 945, WE284D, 384D
VT-44	32
VT-45	45
VT-46	866, 966
VT-46-A	866A, 966A
VT-47	47
VT-48	41
VT-49	39/44
VT-50	50, 585, 586
VT-51	841, PT841, 941
VT-52	45 Special
VT-54	34
VT-55	865
VT-56	56
VT-57	57
VT-58	58
VT-60	850
VT-62	801, 801A, 310
VT-63	46
VT-64	800, RK30
VT-65	6C5
VT-65-A	6C5G
VT-66	6F6
VT-66-A	6F6G
VT-67	30 Special
VT-68	6B7
VT-69	6D6
VT-70	6F7
VT-72	842, 942
VT-73	843
VT-74	5Z4
VT-75	75
VT-76	76
VT-77	77
VT-78	78
VT-80	80
VT-83	83
VT-84	84/6Z4
VT-86	6K7
VT-86-A	6K7G
VT-86-B	6K7GT
VT-87	6L7
VT-87-A	6L7G
VT-88	6R7
VT-88-A	6R7G
VT-88-B	6R7GT
VT-89	89
VT-90	6H6
VT-90-A	6H6GT, 6H6GT/G
VT-91	6J7
VT-91-A	6J7GT
VT-92	6Q7
VT-92-A	6Q7G
VT-93	6B8
VT-93-A	6B8G
VT-94	6J5
VT-94-A	6J5G
VT-94-D	6J5GT
VT-95	2A3
VT-96	6N7
VT-97	5W4
VT-98	6U5/6G5, 6U5, 6G5
VT-99	6F8G

VT No.	*Comm. Equiv.*
VT-100	807, RK39, HY61
VT-100-A	807, 807A
VT-101	837, RK44
VT-103	6SQ7
VT-104	12SQ7
VT-105	6SC7
VT-106	803, RKE8A, WE322A
VT-107	6V6
VT-107-A	6V6GT, 6V6GT/G
VT-107-B	6V6G
VT-108	450TH, WL450, HK854H
VT-109	2051, WL630
VT-111	2525D5, 5BP4/1808P4, 1802P4
VT-112	6AC7/1852, 1852
VT-114	5T4
VT-115	6L6
VT-115-A	6L6G, 6L6GA
VT-116	6SJ7
VT-116-A	6SJ7GT
VT-116-B	6SJ7Y Ceramic base
VT-117	6SK7
VT-117-A	6SK7GT
VT-118	832
VT-119	2X2/879
VT-120	954
VT-121	955
VT-122	WL530, 530
VT-124	1A5GT, 1A5GT/G
VT-125	1C5GT, 1C5GT/G
VT-126	6X5
VT-126-A	6X5G
VT-126-B	6X5GT, 6X5GT/G
VT-127	100TS
VT-127-A	100TS Modified
VT-128	1630, A5588
VT-129	304TL, WL525, HK304L
VT-130	250TL, HK454L
VT-131	12SK7
VT-132	12K8
VT-133	12SR7
VT-134	12A6
VT-135	12J5GT
VT-135-A	12J5
VT-136	1625
VT-137	1626
VT-138	1629
VT-139	OD3/VR150, VR150/30, VA150
VT-141	53L, WL531
VT-142	WE31DY1
VT-143	805, WE331A, 905, RK57
VT-144	813
VT-145	5Z3
VT-146	1N5GT, 1N5GT/G

VT No.	*Comm. Equiv.*
VT-147	1A7GT
VT-148	1D8GT
VT-149	3A8GT
VT-150	6SA7
VT-150-A	6SA7GT
VT-151	6A8G
VT-151-B	6A8GT
VT-152	6K6GT, 6K6GT/G
VT-152-A	6K6G
VT-153	12C8
VT-154	814, 12C8Y, RK47
VT-161	12SA7
VT-162	12SJ7
VT-163	6C8G
VT-164	1619
VT-165	1624
VT-166	371A
VT-167	6K8
VT-167-A	6K8G
VT-168-A	6Y6G
VT-169	12C8
VT-170	1E5GP
VT-171	1R5
VT-171-A	1R5 Loctal base
VT-172	1S5
VT-173	1T4
VT-174	3S4
VT-175	1613, 6L6GX
VT-176	6AB7/1853, 6AB7, 1853
VT-177	1LH4
VT-178	1LC6
VT-179	1LN5
VT-180	3LF4
VT-181	7Z4
VT-182	3B7/1291
VT-183	1R4/1294
VT-184	OB3/VR90, VR90
VT-185	3D6/1299
VT/187	F375A, 975A, GL512
VT-188	7E6
VT-189	7F7
VT-190	7H7
VT-191	316-A
VT-192	7A4
VT-193	7C7
VT-194	7J7
VT-195	CK1005, 1005
VT-196	6W5C
VT-197-A	5Y3GT/G, 5Y3GT
VT-198-A	6G6G
VT-199	6SS7
VT-200	VR105/30, VR105
VT-201	25L6
VT-201-C	25L6GT, 25L6GT/G
VT-202	9002
VT-203	9003
VT-204	3C24, HK24G
VT-205	6ST7
VT-206-A	5V4G, 274B
VT-207	12AH7GT
VT-208	7B8

VT No.	*Comm. Equiv.*
VT-209	12SG7
VT-210	1S4
VT-211	6SG7
VT-212	958
VT-213-A	6L5G
VT-214	12H6
VT-215	6E5
VT-216	816, 866JR, 2B26
VT-217	811
VT-218	100TH, RK38
VT-219	8007
VT-220	250TH, RK63, HK454
VT-221	3Q5GT, 3Q5GT/G
VT-222	884
VT-223	1H5GT, 1H5GT/G
VT-224	RK34
VT-225	WE307A, 307A
VT-226	3EP1/1086P1
VT-227	7184, KR7184
VT-228	8012
VT-229	6SL7GT
VT-230	350A
VT-231	6SN7GT
VT-232	1148, E1148, HYE1148
VT-233	6SR7
VT-234	HY114/B, NU114/B
VT-235	HY615, NU615
VT-236	836
VT-237	957
VT-238	956
VT-239	1LE3
VT-240	710A, WL538, 8011
VT-241	7E5, 1201
VT-243	7C4, 1203
VT-244	5U4G
VT-245	2050
VT-246	918, CE1, PJ23
VT-247	6AG7
VT-248	3CP1/1808P1
VT-249	CK1006, 1006
VT-250	EF50
VT-252	923
VT-254	304TH, WL535, HK304M
VT-255	705A, 8021, WE705A
VT-256	GL486, ZP486
VT-257	K7
VT-259	829
VT-260	VR75/30
VT-264	3Q4
VT-266	1616, 866JR, 660
VT-267	578, WL578
VT-268	12SC7
VT-269	717A, WE717A
VT-277	417, WL417
VT-279	GY2, D161831
VT-282	ZG489
VT-286	832A
VT-287	815
VT-288	12SH7
VT-289	12SL7GT

Transistor Tape Recorder Circuits

by C. Swires

PART 2

The concluding article of a two-part series describing tested transistor applications in home constructed tape recorders

The Level Meter

THE CIRCUIT OF THE LEVEL METER SECTION IS shown in Fig. 6. In this diagram, a.f. from C_{22} in Fig. 4 (published last month) is applied, via the pre-set potentiometer R_{41}, to the first transistor TR_{10}. This transistor and TR_{11} function in a conventional amplifier circuit, the output being fed to the bridge rectifier D_1 to D_4 and, thence, to the 0–100μA meter M_1. In the original, a small Japanese level meter was employed for M_1.

The pre-set potentiometer R_{41} is set up to adjust the gain of the amplifier to the requisite level, so that the required indications are given by the meter.

If desired, a suitable switch circuit and a series resistor could be added, these being wired up to allow the meter to read battery voltage as well.

Bias Oscillator

The bias oscillator circuit is given in Fig. 7, and this consists of a bottomed oscillator transistor providing a sine wave output at a nominal frequency of 58 kc/s, the frequency of oscillation being governed by C_{36}.

Coil L_5 is constructed on an LA1 pot core, employing the turns shown in the Table. The windings are made in successive layers on the bobbin provided with the core, in the same order as they appear in the Table, viz:

1. 5–6; 200 turns
2. 1–2; 5 turns
3. 3–4; 15 turns

In the author's version, all enamelled wires were brought out and colour coded by slipping short lengths of sleeving over them for identification. If the unit fails to oscillate, reverse the feedback winding (1–2) as this must be correctly phased.

Components List (Fig. 6)

Resistor
(All fixed resistors are ¼ watt 10%)

R_{41}	100kΩ pre-set potentiometer		
R_{42}	150kΩ		
R_{43}	10kΩ	R_{47}	68kΩ
R_{44}	27kΩ	R_{48}	10kΩ
R_{45}	2.2kΩ	R_{49}	4.7Ω
R_{46}	470Ω	R_{50}	1kΩ

Capacitors
C_{28} 50μF electrolytic 6V wkg.
C_{29} 10μF electrolytic 12V wkg.
C_{30} 100μF electrolytic 18V wkg.
C_{31} 8μF electrolytic 12V wkg.
C_{32} 50μF electrolytic 6V wkg.

Transistors
TR_{10} OC71
TR_{11} OC71

Diodes
D_1 to D_4 OA81

Meter
Moving-coil 0–100μA

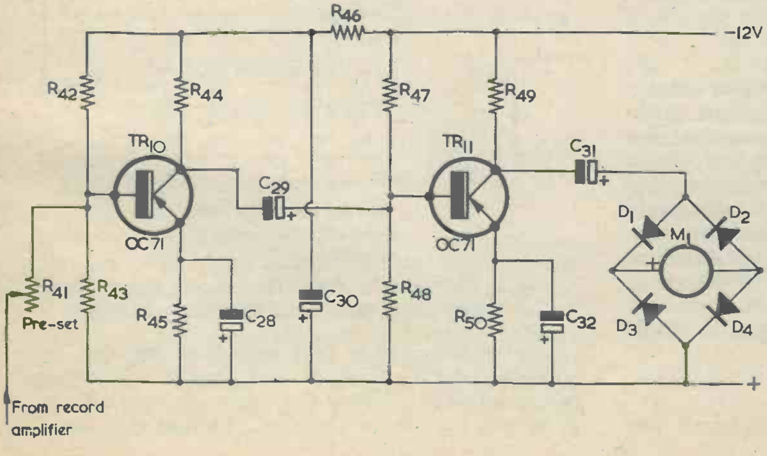


Fig. 6. The level meter circuit

Table
Windings on L_5. All wire is enamelled (see text for assembly instructions).

Winding	*Turns*
5–6	200 34 s.w.g.
1–2	5 24 s.w.g.
3–4	15 34 s.w.g.

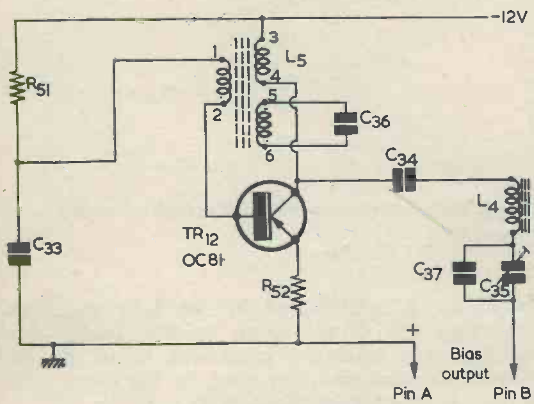


Fig. 7. The bias oscillator

Components List
(Fig. 7)

Resistors
R_{51} 22kΩ ¼ watt 10%
R_{52} 47Ω ¼ watt 10%

Capacitors
C_{33} 0.5μF paper
C_{34} 0.01μF paper
C_{35} 500pF compression trimmer
C_{36} 400pF mica
C_{37} 250pF mica

Transistor
TR_{12} OC81 or OC81D

Inductors
L_4 As L_3 (see text)
L_5 Oscillator coil (see text)

A filter is also fitted in series with the bias output, this consisting of the series tuned circuit given by C_{35}, C_{37} and L_4. The filter passes the bias frequency but rejects a.f., and it was introduced after trouble was experienced due to audio frequencies getting back into the oscillator and modulating it. This caused irregular waveforms and distortion of the oscillator output. Coil L_4 is the same as L_3, consisting similarly of 250 turns of 30 s.w.g. enamelled wire on a Mullard LA1 pot core, and having an inductance of 12.6mH. C_{35} is a 500pF compression trimmer.

Switching Circuits

The overall switching circuits employed are illustrated in Fig. 8. As will be seen, the only switching required consists of the application of power to the appropriate units in the recorder.

On playback, the power is switched to the playback amplifier, which then functions with its own head. No connections are made to the bias winding on the playback head.

On record, the power supply is fed to the record amplifier, the bias oscillator, and the level meter circuit. These then operate in conjunction with the recording head.

This method of switching has the advantage that input and output leads are not brought close together on the switch, and that the danger of instability due to unwanted couplings is therefore obviated.

Fig. 8 also shows the five-way push button unit employed in the author's recorder. The two outside buttons switch motor circuits which provide fast wind and re-wind respectively, whilst the centre button provides a stop facility. In these last three positions, power is disconnected from both the playback and recording circuits.

If desired, the switching shown in Fig. 8 could be carried out by a three-way rotary switch separate from the tape deck switching circuits. In one position the rotary switch could feed power to the playback amplifier, in the central position it could cut off all power, and in the third position it could apply power to the record amplifier, bias oscillator and level meter.

Setting-Up Procedure

If an oscilloscope is available, this should initially be connected across the bias winding of the record head between terminal B of the record head and chassis. Trimmer C_{35} (Fig. 7) is then adjusted for maximum bias voltage as indicated by the oscilloscope.

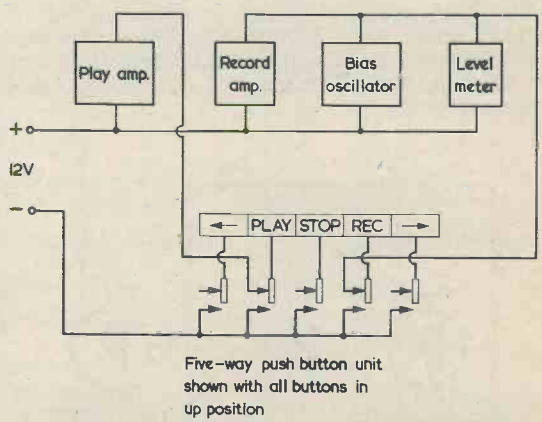
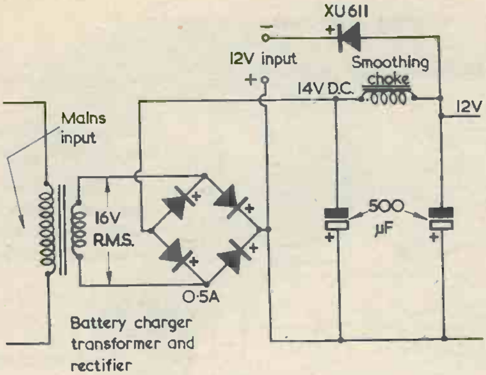
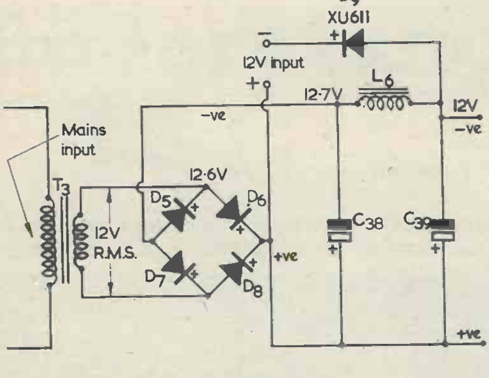


Fig. 8. Switching circuits. These do not include the switching circuit required for the tape deck motors

The oscilloscope is next connected between the collector of TR_9 (Fig. 4) and chassis, whereupon trimmer C_{27} is adjusted for minimum bias voltage, as shown by the oscilloscope. During this check



(a)



(b)

Fig. 9 (a). A mains power unit capable of feeding both the transistor and the motor circuits
(b). A mains power unit for the transistor circuits only

Components List
(Fig. 9 (*b*))

Capacitors
C_{38} 500µF electrolytic 18V wkg.
C_{39} 500µF electrolytic 18V wkg.

Diodes
D_5 to D_8 Selenium bridge rectifier (see text)
D_9 Silicon diode type XU611

Transformer
T_3 Mains transformer (see text)

Choke
L_6 Smoothing choke (see text)

no input should be applied to the record amplifier.

If no oscilloscope is available the recorder may be set up in the following manner.

Because of the two heads employed it is possible, when both record and playback circuits are switched on, to hear a recording a fraction of a second after it has been made. Firstly, a signal is fed into the record amplifier, this being preferably music. If the bias acceptor circuit is out of adjustment a weak and distorted recording will be heard. Adjust C_{35} (Fig. 7) until the distortion clears. This trimmer is then left at its optimum setting.

Trimmer C_{27} should now be adjusted for maximum audio output, this being the condition when the maximum amount of bias voltage is rejected by the rejector circuit.

If, during the setting-up procedure, it is found that the input level to the playback amplifier is obviously excessive, the gain of the recording amplifier should be turned down.

The level meter circuit has next to be set up. Probably the best method of doing this is to make a recording on the machine, and compare the playback level with that of a pre-recorded tape, or with that of a tape from a commercial model which has been recorded at correct level.

When the recording made on the transistor recorder is at the same level as the tape with which it is being compared, the variable resistor R_{41} (Fig. 6) should be adjusted to give a suitable reading on the level meter. The level meter scale may then be marked to indicate peak recording level, this being, preferably, at about three-quarters of f.s.d.

Power Supplies

The complete recorder may operate either from a battery supply or from a mains supply unit. In the original recorder, the 12 volt supply (whether from battery or mains) was required to feed the tape deck motors as well, the total current requirement being of the order of 400mA. For interest, the mains power unit circuit employed is shown in Fig. 9 (*a*). The mains transformer and bridge rectifier shown here were taken from a battery charger, the associated voltages being indicated in the diagram. The smoothing choke requires a *maximum* resistance of 5Ω and as high an inductance as possible. A minimum of 100mH is recommended.

For battery operation, a 12 volt d.c. input is connected as shown. The XU611 rectifier ensures that correct supply polarity is applied to the transistor and motor circuits.

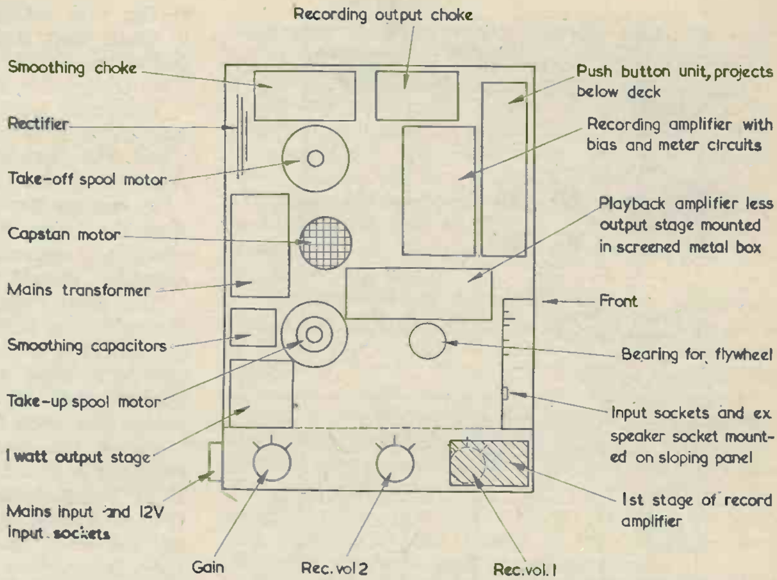
An alternative mains supply suitable for the transistor circuits on their own is shown in Fig. 9 (*b*). This circuit is basically the same as that of Fig. 9 (*a*) but there are some small changes due to the reduced current requirement. The mains transformer was salvaged from an old radio, and has an r.m.s. secondary voltage of 12. The rectifier is an 0.5 amp selenium bridge unit of the same type as is employed in Fig. 9 (*a*). The smoothing choke L_6 is a RadioSpare miniature having an inductance of 60mH and a resistance of 5.5Ω.

The XU611 diode in both Figs. 9 (*a*) and (*b*) is to prevent damage in case the external battery is connected with incorrect polarity. It may be omitted if no external battery is to be used.

Preventing Motor Interference and Stray Pick-Up

If the constructor intends to employ a battery-

Fig. 10. The layout, under the tape deck panel, employed with the prototype recorder



operated tape deck the following points, encountered by the author with his own machine, will very probably prove to be helpful in overcoming interference.

The prototype employed a capstan motor having a governor which operated a centrifugal switch. It was found that the governor circuit was the main source of interference, and all leads carrying low level signals (i.e. from the heads, etc.) had to be kept well away from the motor. It was also found helpful to connect a $0.01\mu F$ capacitor across the motor, and further capacitors of the same value at several points along its supply line.
motor, and further capacitors of the same value at several points along its supply line.

Another precaution consisted of placing a mumetal shield around the motor and of bonding this to the tape deck panel by way of a copper braid.

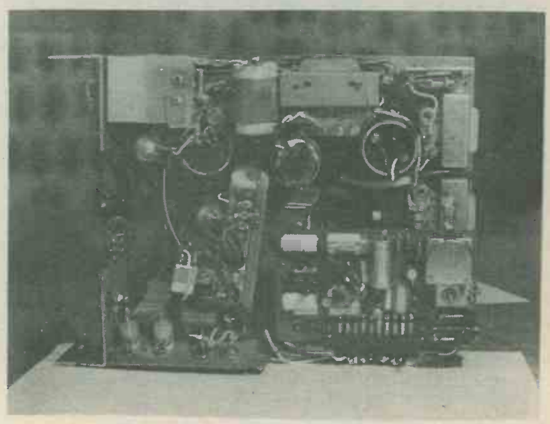
It was found advisable to screen at least the first two stages of the playback amplifier. As mentioned above, these two stages were mounted inside a small metal box. The associated components may be conveniently fitted on small tagboards inside the box.

The recording output choke, L_2 (Fig. 4) should be mounted well away from the mains transformer, or it will pick up hum and pass it into the recording head.

Initially, interference was also fed into the amplifiers by way of the supply voltage rails. Very thorough decoupling of the amplifier supply lines, as shown in the circuit diagrams, was employed to reduce interference from this source.

A Complete Layout

The complete recorder layout employed by the author is shown in Fig. 10. This is presented for interest only, but it nevertheless gives an idea of the manner in which the various sections of the recorder may be positioned in order to keep mutual interference at a low level.



General layout of units in the author's prototype. (Compare with Fig. 10)

Aerial Tower Contracts for B.B.C's Carmarthen T.V. and V.H.F. Relay Station

The B.B.C. has awarded a contract to the Cambrian Construction Company Limited, of Carmarthen, for the construction of the building for the Carmarthen TV and VHF sound relay station. A contract has also been placed with the J. L. Eve Construction Company Limited, of Morden, Surrey, for the erection of the 120ft aerial tower.

The new relay station is being built on a site about one mile north of Carmarthen. It will transmit the B.B.C. TV Service for Wales and the three sound programmes on VHF and provide improved reception for some 13,000 people in the town of Carmarthen. The new station is expected to be completed by the end of 1964.

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

part 34

understanding radio

By W. G. MORLEY

IN LAST MONTH'S CONTRIBUTION TO THIS SERIES WE discussed the practical construction of the moving-coil loudspeaker. We then carried on to the manner in which the baffle prevents attenuation of the lower audio frequencies due to compressions and rarefactions from the front and rear of the cone flowing into and cancelling each other. We concluded by showing that the cabinet of a conventional domestic radio receiver offers a measure of separation between the front and back of the cone and thereby acts, somewhat inefficiently, as a baffle.

We shall now carry on to examine other methods of housing the loudspeaker.

The "Infinite Baffle"

We have seen that, for adequate reproduction of the lower audio frequencies, it is necessary for the sound produced at the rear of the cone to be prevented from reaching the front, and vice versa.

It would seem, at first sight, that the simplest and most efficient method of obtaining separation between the front and rear of the cone would be given by completely enclosing the loudspeaker in a box, as shown in Fig. 222. Compressions and rarefactions produced at the rear of the cone cannot then possibly reach the front.

Unfortunately, the completely enclosed box raises a number of subsidiary problems, these being of particular importance if the loudspeaker is intended to provide a high quality response. We shall now examine these problems, working from the viewpoint of high fidelity reproduction.

As we shall see in more detail next month, all moving-coil loudspeakers exhibit resonances in their response, these causing the sound output to increase at the resonant frequency. If a high fidelity system were to employ an enclosed box loudspeaker housing in order to obtain efficient bass reproduction, it would be sensible practice to use a loudspeaker having a cone with a fairly large diameter, say 10in or so, in order to ensure that adequate low frequency reproduction was available in the first place. Such loudspeakers have resonant frequencies which lie, typically, in the range of 40 to 75 c/s.

When the loudspeaker is fitted in the completely enclosed box, a fixed quantity of air occupying a relatively small volume is presented to the rear of the cone. This small quantity of air has the same effect on the cone as would be given by stiffening the surround and speech coil centring device, and the result is that the resonant frequency of the loudspeaker increases. The increase in resonant frequency may be so high as to cause it to fall within the more readily perceptible range of audio frequencies. Resonances at such frequencies are undesirable, and it is partly because of this effect that completely enclosed boxes have not been extensively used in the past. A further point is that the additional stiffness offered by the enclosed volume of air reduces the efficiency of the speaker.

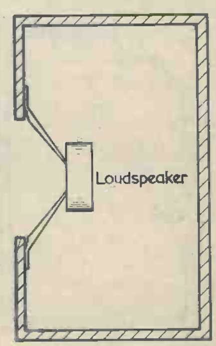


Fig. 222. The "infinite baffle". In this enclosure the loudspeaker is mounted in a completely enclosed box, the only aperture being that for the loudspeaker itself

It has to be remembered, nevertheless, that the completely enclosed box of Fig. 222 is only a scaled-down version of the situation which exists when the loudspeaker is mounted on a hatch in a wall between two rooms, as in Fig. 220.[1] In the previous instance, the room behind the loudspeaker also represented a completely enclosed box. It may be seen that the usefulness of the closed box principle depends to a very large extent upon the volume of the air enclosed, and that a very large box should not suffer excessively from the disadvantages just mentioned. Such a box would, however, be too large for installation in normal domestic surroundings.

Another feature of the closed box is that it is possible for resonances to be set up in the enclosed air, the frequencies at which these occur depending upon the size and shape of the box.[2] These could affect the reproduction from the loudspeaker, as they would modify the stiffening effect on the rear of the cone at the resonant frequencies. Their effect may, however, be considerably reduced by lining the interior of the box with rock wool, glass wool fibre, or any similar soft and sound-absorbent material.

Despite the shortcomings just discussed, small completely enclosed boxes for loudspeakers have been occasionally used for high quality and high fidelity reproduction in the past. One method of overcoming the loudspeaker resonance problem has consisted of using loudspeakers with resonant frequencies around 20 c/s. The increased resonant frequency introduced by the use of the box may not, then, be sufficiently high to become objectionable.

[1] Published in last month's issue.

[2] To be precise, these effects are normally described as being due to "standing waves". In Fig. 189 of "Understanding Radio" (Part 30, February 1964 issue) we saw that it was possible to set the air at resonance in a cylinder with one end open when the length of the cylinder was one half-wavelength at the frequency produced by a sound generating device positioned near the open end. Standing waves occur when a reflected wave augments a generated wave, as happened with the cylinder. In loudspeaker housings the reflections take place at the inside walls; and it is usual in this context to refer to "standing wave" conditions for the cases where reflected waves have a cancelling effect as well as when they have an augmentative effect. The instance where a reflected wave has a cancelling effect may be described as an "anti-resonance".

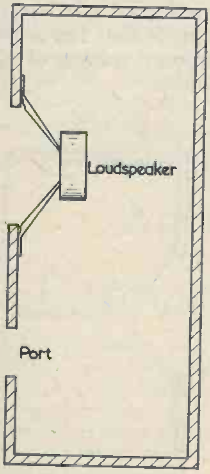


Fig. 223. The reflex enclosure. This is completely enclosed except for an aperture, or port, on the same surface as the loudspeaker aperture

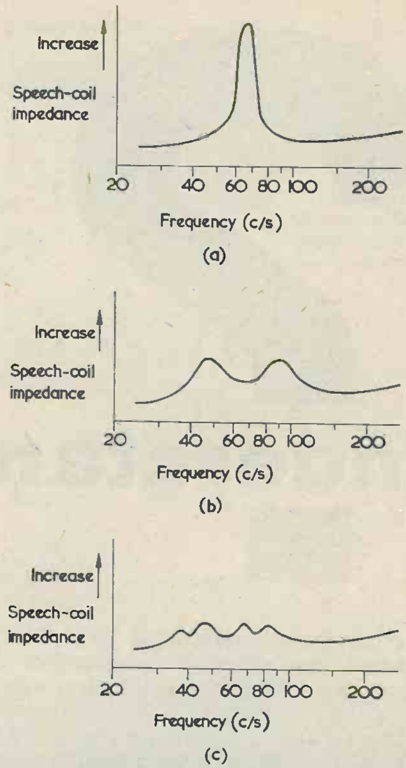


Fig. 224. Illustrating the effect on loudspeaker resonance of the reflex cabinet. The curve at (a) shows the very pronounced single resonant peak given when a typical loudspeaker is mounted on a flat baffle. The reflex cabinet may cause the single peak of (a) to be resolved into two smaller peaks, as at (b). In practice, the single peak will more probably change to three or more small peaks, as shown in (c)

In recent years there has been a re-appraisal of enclosed box design, this having been brought about by the increasing popularity of domestic high fidelity reproducing systems. This increasing popularity has offered a commercial spur to the design of small loudspeaker housings which are still capable of offering good reproduction. It has been found possible, by specifically designing the loudspeaker for use in the box, to obtain high fidelity performance in housings which have a total volume of 2 cubic feet or even less. Such units tend to have lower efficiencies (in terms of sound output for electrical power input) than do alternative housings employing different techniques, because of the small volume of enclosed air. However, this disadvantage is outweighed by the advantages of small size and good response.[3]

[3] Low loudspeaker efficiencies are, within reason, acceptable in high fidelity systems provided there are substantial compensatory advantages such as improved response or, as in the instance referred to here, reduced housing size. This is because it is relatively simple and fairly inexpensive to obtain an increased power from the equipment feeding the loudspeaker in order to make up for its loss of efficiency.

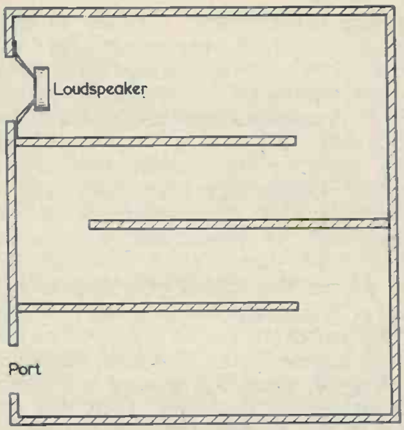


Fig. 226. The basic labyrinth enclosure

Because the completely enclosed box offers infinite separation of the air on either side of the loudspeaker cone, it is frequently referred to as an "*infinite baffle*". This term is not, however, strictly accurate. An "ideal" infinite baffle is given by a flat baffle with an infinitely large area, and which presents an infinitely large volume of air to the front and rear of the cone. The completely enclosed box does not present an infinitely large volume of air to the rear of the cone.

Another term which may be introduced at this stage refers to the housings in which loudspeakers are fitted, and which are intended to modify their performance as compared with that in free air or on a flat baffle. Such housings are referred to as *enclosures*.

The Reflex Enclosure

An alternative to the completely enclosed box is the *reflex enclosure* (which may also be referred to as the *vented enclosure*). The reflex enclosure is of particular value for high fidelity reproduction, and it offers important advantages when compared with the completely enclosed box.

A reflex enclosure has the typical shape illustrated in Fig. 223. It is completely enclosed except for an aperture, usually described as the *port*, on the same surface as the aperture for the loudspeaker.

The operation of the enclosure depends on the principle of the *Helmholtz resonator*. If a body of air is completely enclosed except for one small aperture it will exhibit a single resonant frequency. In the reflex enclosure the housing is given dimensions which cause the resonant frequency to be close to, or the same as, that of the loudspeaker fitted inside it. The resultant effect is that, at resonance, the motion of the cone becomes "damped", and the latter does not exhibit the increased amount of movement at this frequency that would be given if the loudspeaker were mounted on a flat baffle. Thus, the effect of loudspeaker resonance—increased output at the resonant frequency—is reduced.

Due to the fact that the air in the enclosure resonates at a single frequency, it can be considered as being approximately analogous to a tuned circuit. So, also, can the loudspeaker at its own resonant frequency.[4] In the reflex enclosure system these two "tuned circuits" are coupled together very tightly, with the result that we obtain rather the same effect as we saw when we examined over-coupled band pass circuits.[5] When mounted on a flat baffle, the response of the loudspeaker may offer a single peak, as shown in Fig. 224 (*a*). When it is mounted in the reflex enclosure the single peak, following our experience with over-coupled band pass circuits, may change to two smaller peaks on either side of the frequency corresponding to the previous peak, as shown in Fig. 224 (*b*). In practice, the analogy with band pass circuits is not quite as precise as this, as a number of other factors have to be taken into account, and the single original peak could quite possibly change to three or more smaller peaks, as shown in Fig. 224 (*c*).[6] Nevertheless, the new curve given by the reflex enclosure is obviously a considerable improvement on that shown in Fig. 224 (*a*).

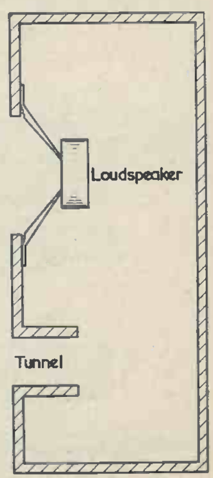
Another feature of the reflex enclosure is that, at and near its resonant frequency, the sound emerging from the port is 180° out of phase with that generated at the back of the loudspeaker cone. Without laying too much stress on the (somewhat simplified) tuned circuit analogy we have just mentioned, it is still reasonable to say that a phase reversal of this nature is what would be expected from the analogous electrical circuit. Since the

[4] Analogies with electrical circuits are commonly used in loudspeaker enclosure design. In the present instances, the analogous circuits would contain inductance, capacitance and a relatively high value of resistance.

[5] See "Understanding Radio" parts 27 and 28, November and December 1963 issues.

[6] In Fig. 224 the performance of the speaker is indicated by plotting speech coil *impedance* against frequency As will be explained next month, this method of measurement is very helpful in obtaining an approximate idea of speaker response, and is particularly useful in indicating resonant frequencies. It will be noted also that the horizontal frequency axis is graduated with a logarithmic instead of a linear scale (in which the graduations would be evenly spaced), and this point will be similarly discussed next month.

Fig. 225. It is frequent practice to fit a tunnel behind the port of a reflex enclosure, as shown here



sound from the port is 180° out of phase with that at the rear of the cone it is *in phase* with the sound from the front of the core. When the front of the cone produces a compression, the rear of the cone produces a rarefaction, whereupon the 180° phase reversal in the enclosure results in the appearance of a compression at the port. The sound from the port then augments that produced at the front of the loudspeaker cone.

Summing up it may be said that, if a loudspeaker is fitted in a reflex enclosure having a resonant frequency close or equal to that of the loudspeaker, two advantages accrue. The first of these is that the movement of the cone is "damped" at its resonant frequency, with the result that a single peak (such as that shown in Fig. 224 (*a*)) changes to two or more much smaller peaks (as in Fig. 224 (*b*) or (*c*)). The second advantage is that the reflex enclosure offers enhanced reproduction at frequencies around the resonant frequency, thereby improving bass response.

The resonant frequency of the reflex enclosure depends upon its internal dimensions, the area of the port and the thickness of the enclosure material surrounding the port. In Fig. 223 the thickness surrounding the port is that of the material from which the enclosure is made. Frequently, this dimension is effectively increased by fitting a *tunnel* behind the port, as in Fig. 225.

The Labyrinth Enclosure

An earlier design which is of interest in high fidelity applications is given by the *labyrinth enclosure*. In the labyrinth enclosure the rear of the cone is presented to what is effectively a long pipe or tube, this being folded to conserve space. An example of the folded pipe construction is shown in Fig. 226. The length of the pipe is normally made equal to one quarter of the wavelength of the lowest frequency it is intended to reproduce (or a frequency slightly lower), and it is preferable to have this frequency equal to the resonant frequency of the loudspeaker. Under these conditions there is some "damping" of cone movement at the resonant frequency, with a consequent improvement in response.

If the end of the folded pipe remote from the loudspeaker is brought out to a port on the same face of the enclosure as the loudspeaker aperture, there is an augmentation in sound output around the frequency at which it presents a half wavelength. This frequency is, of course, twice the resonant frequency of the loudspeaker. Since the length of the pipe is now a half wavelength, the sound emerging from the port is 180° out of phase with that being generated at the rear of the cone (because it has travelled through a half a wavelength in the pipe) and it is therefore in phase with that produced at the front of the cone. However, this effect may similarly occur for sound at $1\frac{1}{2}$ wavelengths, $2\frac{1}{2}$ wavelengths and so on. Also, the sound at the open end of the folded pipe will be *out of phase* with that produced at the front of the loudspeaker cone at frequencies corresponding to 1 wavelength, 2 wavelengths, and so on. Unless preventive steps are taken, the result may be a series of peaks and troughs in the frequency response of the loudspeaker and enclosure assembly—an obviously undesirable state of affairs. In practice, this shortcoming can be obviated by heavily lining the walls of the folded pipe with sound absorbent material, with the result that the only significant enhancement in sound output offered by the enclosure occurs at the half wavelength condition only.

An alternative approach to the labyrinth enclosure consists of looking upon the folded pipe merely as a means of taking up sound radiation from the rear of the cone. The folded tube may have the same length as in the instance we have just considered, but it is assumed that, due to the considerable loss in sound energy which occurs along its length, it is unimportant whether the end remote from the loudspeaker be closed or open.

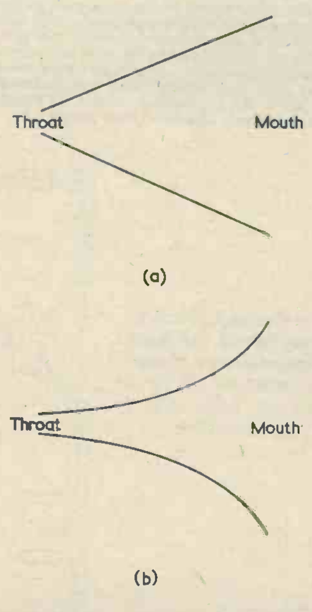


Fig. 227 (a). The shape of the conical horn (b). A typical example of exponential horn shape

The Horn

Although acceptable for domestic use, the methods of loudspeaker mounting and the various enclosures we have considered up to now all tend to be somewhat inefficient. A much greater efficiency is provided by the *horn*, which we shall now consider.

A simple horn may have the conical shape illustrated in Fig. 227 (*a*). A moving-coil loudspeaker is fitted at the *throat* and the horn then opens out to its widest section at the *mouth*. Better results are given by the *exponential horn* shown in Fig. 227 (*b*). The sides of this horn are curved instead of straight, and it gains its name because the continuing increase in cross-sectional area from the throat to the mouth follows an exponential function.[7]

The horn offers a high level of efficiency because it "matches" a small cone diameter to a large volume of air. It suffers from the fact that it is only effective above its *cut-off frequency*, this depending upon the mouth area and the degree of taper. Horns with large mouth areas and gradual tapers are necessary if reproduction at low frequencies is required. In this respect, the cut-off frequency of an exponential horn is about eight times lower than that of a conical horn with the same outside dimensions.

Because of their high efficiency, horn loudspeakers offer excellent results in public address work where it is necessary to provide sound coverage over wide areas. They are also used in cinemas and large halls. Because of the large size needed for adequate reproduction of the lower audio frequencies, horns having the basic shape shown in Fig. 227 (*b*) cannot be employed in domestic high fidelity installations. Nevertheless, some ingenious designs have been produced in which the horn is folded (in rather the same way as the pipe in a labyrinth enclosure is folded) thereby enabling a horn of large dimensions to be provided in a relatively small space. Where a tweeter and woofer combination are employed, it is occasional practice to employ a horn with the tweeter. Since the tweeter is only required to work at high audio frequencies it may employ a horn having small overall dimensions.

For almost all horn applications, the loudspeaker employed is specifically designed for coupling to the throat of the particular horn with which it is intended to be used. It will then frequently have a much smaller cone diameter than is encountered in loudspeakers intended for mounting in enclosures or on baffles.

Next Month

In next month's issue we shall carry on to various methods of diffusing the higher audio frequencies, after which we will return to the basic moving coil unit.

[7] $A_x = A_t e^{kx}$, where A_x is the area at distance x from the throat, A_t is throat area, k is "taper constant", and e is 2.718.

Studio Techniques in Magnetic Tape Recording

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

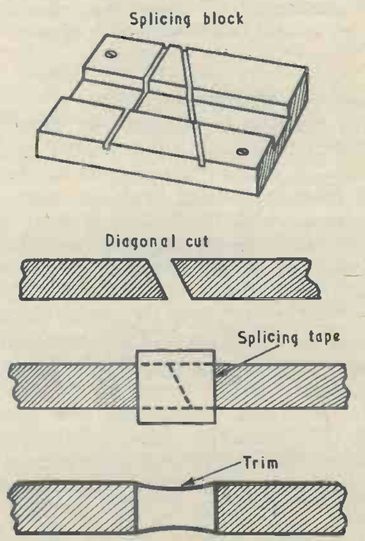
MAGNETIC TAPE IS THE FINEST KNOWN RECORDING medium in existence today, in fact many may not know that all disc material is first recorded on magnetic tape which can be edited and mastered with comparative simplicity. Note the comment "comparative simplicity". Whilst the techniques of editing and mastering are not difficult manually, they do require a considerable amount of practice, as well as keen imagination, to achieve perfection.

Such techniques that are used can, however, be adopted by the amateur recordist and, when correctly applied, greatly enhance recordings made on domestic and semi-professional recorders.

One must first become accustomed to the idea of cutting magnetic tape. Most people are reluctant to do this in view of the high cost of recording tape. To offset this, the fact remains that this is the only way to edit a tape and produce a professional finish and continuity which is free of annoying clicks, false starts, belated fades and so on.

Cutting and Splicing

So we must learn to cut and splice tape correctly and with the right sort of equipment. To begin with, so-called splicing fluid is difficult to use, and it should not, in fact, be used at all for normal editing. The only satisfactory method of splicing a tape after an unwanted piece has been cut out is to use a splicing block with a diagonal cutting slot. The diagonal splicing cut is made with a non-magnetised razor blade after which adhesive splicing tape (never use Cellotape or similar adhesive tapes) is applied and trimmed. Butt joints can also be made and are often necessary if the space between one point of the recording and the next is small. There are of course a number of semi-automatic splicers available which are invaluable in the



Correct method of making a diagonal cut and splice in magnetic tape studio, owing to the speed at which a splice can be made.

Tape splicing to a professional degree calls for practice, but the reward is an interesting recording with smooth continuity. To this end particular attention should be made to working with a script, particularly for documentaries, interviews, plays and the like, where speech, sound effects and music have to be mixed, cut in or cross faded. Many recording enthusiasts try to emulate the professional finish by using the "superimposing button" or "pause control". but neither of these can provide any more than a poor imitation of the desired effect. For example, so-called superimposing reduces the level of the pre-recorded material and will often introduce a thud or click. Pause button control makes the recording jerky and there is the risk of clipping the start or finish of a recording.

Part of the author's studio for recording, (left) Sony and Telefunken Studio recorders, (centre) audio generators and monitoring rack and (right) general purpose recorders, etc. Note that recorders are set at waist height on suitable benches

Mixers and pre-Amplifiers

The only method of successfully mixing several signal sources is by use of a proper microphone and signal mixer. Passive mixers comprising three or four paralleled volume controls may introduce noise and hum and severely attenuate all but high level signals such as those from a pre-amplified source. A well designed electronic mixer, or transistorised mixer, is essential if mixing of effects and music, etc., is to be carried out properly.

This leads now to the use of pre-amplifiers and/or mixers with tone controls. When mixing sound effects in music from gramophone records the proper pre-emphasis should first be applied for, without it (i.e., with the pick-up fed straight to a linear mixer), the signals will have excessive treble and no base. It is preferable to use a conventional pre-amplifier with R.I.A.A. characteristics for the pre-amplification of gramophone records. The output from the pre-amplifier, now linear, can then be fed to a high level input on the mixer. A mixer should, by the way, have at least two microphone (high or low impedance) inputs and, say, two high level inputs (high impedance for a maximum of 1 volt input).

Tone Controls

Conventional tone controls on a standard type of pre-amplifier or mixer are extremely useful when making a master tape from an original recording. They can be used, discreetly of course, for reducing noise level (hiss) and unwanted low frequency sounds such as wind noise and hum. A pre-amplifier with sharp cut-off at below 120, 60 and 20 c/s is useful here and, together with bass cut and lift and treble cut and lift, enables all kinds of signal correction to be applied during the recording of a master tape. It should be added that, before the master copy is made, all editing should have been carried out and the original checked right through for clicks, etc.

Monitoring

Now a few words about monitoring and auxiliary equipment. In all recording some method of monitoring the incoming and recorded signal is essential. To this end most semi-professional recorders have separate recording and replaying heads. The replay head can be coupled to an external amplifier and loudspeaker system or headphones for direct listening to the recording itself, but whatever external amplifier is used it must have the necessary C.C.I.R. replay characteristic.

Monitoring of ingoing signals and, for that matter, recorded signals can only be successfully carried out in a room from which no sound can reach back to the microphone. On closed circuits, such as from a pick-up or another tape recorder, there are no problems with feedback. To this end speech can often be recorded first and then copied on to the final recording with effects and music, since the entire circuit is then closed to feedback of any description.

For special echo effects one can feed an extra replay head through a suitable frequency correction amplifier back to the main recording amplifier. The correction in the head amplifier should be approximately C.C.I.R. with roughly 10dB bass cut below 100 c/s, and 20dB cut above about 5,000 c/s, to prevent rumble and noise building up on the returned signals.

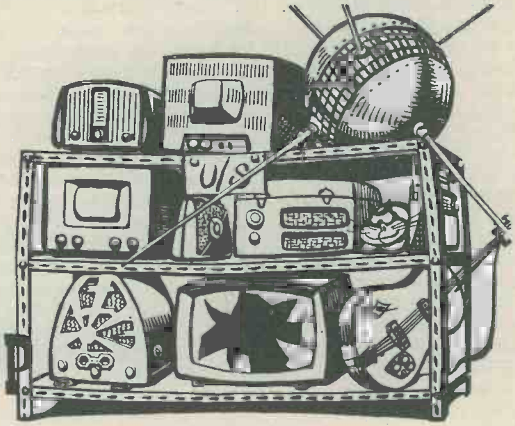
Equipment

Finally a few words about auxiliary equipment and layout. If two or three tape recorders are in use they should be reasonably close together for ease of operation. In the writer's studio five recorders are often in operation simultaneously, making it necessary to sometimes start or stop all five together.

Mixers and pre-amplifiers can be grouped together in a rack for ease of operation. It should not be forgotten that a large quantity of screened connecting leads with various kinds of screened plugs will be required. Inter-connection of equipment, especially between high impedance inputs and outputs, requires a little care as hum loops can easily be set up. For this reason it is sometimes necessary to earth different tape recorders and amplifiers through the interconnecting leads and employ one common earth line.

This article had been all too brief to cover the more subtle points about magnetic recording, but the hints which have been given, plus a little practice and experiment, should soon put the reader on the path to really successful and perhaps highly creative recording.

IN YOUR WORKSHOP



What could be easier than replacing a burnt-out Mains Transformer?

This month, Smithy the Serviceman helps his able assistant Dick to embark on this simple project. Unfortunately, as Smithy finds out very soon, Dick can never tackle a job of this nature in quite the same way as anyone else!

"THE IMPORTANT QUESTION WE have to ask ourselves," pronounced Smithy, "is what burnt it out in the first place?"

Smithy the Serviceman and his assistant gazed solemnly at the chassis which was now reposing on Dick's bench. The large radiogram cabinet from which it had been taken was pushed to one side, and two wires trailed from the twin speakers mounted at each end of its front surface.

"It's certainly a good burn-out," commented Dick. "I don't think I've ever seen a mains transformer which is so completely a charred wreck as this one!"

"That's the whole point," commented Smithy. "Now, there are, rough check, two things which can cause a mains transformer to burn out. One of these is a continuous small overload which results in its running above its specified rating over a long period of time. And the other is a suddenly applied overload which causes it to burn out in a matter of seconds. The problem is, which of these two caused the burn-out we've got here?"

Causes of Overload

"I would plump," remarked Dick promptly, "for the second cause of overload."

"I think I'd agree with you," said Smithy. "But I'd be interested to know your reasons."

"If the overload had been in existence for a long time," explained Dick, "that tranny would have been smelling to high heaven every time the set had been switched on for half an hour or more. Whereupon the cause of overload would have been found good and early, because there's nothing like a smell of burning to make the customers call in a service engineer!"

"That's exactly my own reasoning," said Smithy. "It seems, therefore, as though we'll have to start looking for something which would cause the other possibility—a sudden overload. Is there anything on the job ticket to give us a clue?"

"All that *our* job tickets say," commented Dick gloomily, "is 'Set u/s.' Still, I'll have a shufti."

Smithy's assistant found the label attached to the back of the cabinet, and his face took on an expression of utter amazement as he scanned its scribbled surface.

"Believe it or not Smithy," he said in a tone of wonder, "but we have actually received a communication from the Outside World. Just listen to this! 'Dial lamps suddenly went out, accompanied by loud hum from set. Programme gradually faded away and set was silent after about 10 seconds'."

"That's excellent," said Smithy enthusiastically. "If that report gives a true picture of what happened, it tells us exactly what to look for."

"Just like that?"

"Just like that!" confirmed Smithy cheerfully. "Everything points to a sudden short on the heater line. To start off with, the fault came on abruptly, which indicates a sudden overload. Secondly, the dial lamps went out. If there had been, say, an h.t. short, the dial lamps would still have stayed lit, even if their brilliance dropped a bit. Thirdly, the programme continued. If there'd been a sudden h.t. short it would have stopped dead."

"But that doesn't explain two other things," protested Dick. "For instance, how did the programme continue without any heater power?"

"Because," replied Smithy, "the valve heaters would still be hot enough to continue emitting for a short period. Also, despite the heavy overload in the heater circuit, the h.t. secondary of the transformer might still have supplied sufficient h.t. potential to cause some sort of signal to appear from the speaker. If the h.t. electrolytics were in good order, these would have held up the h.t. voltage for a short while, also."

"That doesn't explain my second query," objected Dick. "If there was a sudden heater short, how about the loud hum from the speaker?"

"That hum may not have come from the speaker," grinned Smithy. "It probably came from the transformer laminations!"

"Hey?"

"I'm quite serious," chuckled Smithy. "Don't forget that the primary current in a transformer increases when the secondary current increases. With the dead short on the heater line which I'm assuming, the primary current would have risen to a very high level indeed. This would cause a similarly high magnetisation of the laminations."

"That's all very well," protested Dick, "but where does the hum come in?"

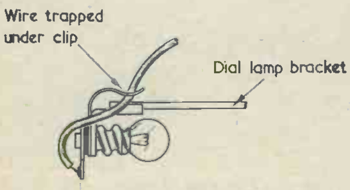


Fig. 1. A short circuit in the heater supply of the radiogram checked by Dick and Smithy was caused by a dial lamp lead being trapped under the lamp holder clip

"I'm leading up to that," said Smithy. "The magnetisation of the laminations will be at its strongest on each half-cycle peak. All the lam sections at one end of the coil will then have a North pole and all the lam sections at the other end of the coil will have a South pole. This occurs under normal conditions as well, of course, but as the magnetising force with the overload is now very much greater, the lams will suffer far more repulsion from each other than is normally the case."

"I get it," said Dick. "The lams will be undergoing much stronger repulsion forces than usual, and these will reach a peak 100 times a second. Since they're only clamped down tightly enough to cater for ordinary magnetising forces, the increased magnetising force causes them to give rise to an audible hum."

"That's the idea," confirmed Smithy. "Anyway, let's have a hunt around and see if we can discover . . ."

"I've found it already," interrupted Dick, who had been taking a quick look at the chassis. "One of the dial lamp leads is trapped under its clip." (Fig. 1.)

"Good show," said Smithy, examining the point indicated by Dick. "The wire insulation under the clip must have gradually worn away with time. The insulation on the wire going up to the lamp holder looks a bit cooked, too; and this pretty well confirms the fact that the short occurred here. It's a pity that the set-maker used rather thick wire for this connection."

"How's that?"

"If he'd employed the thinnish wire many manufacturers use to supply dial lamps," explained Smithy, "the wire would have probably burnt out first and saved the tranny."

How To Raise Difficulties

Smithy walked over to the cupboard and selected the service manual for the receiver.

"You'd better start replacing the heater wiring between the point where it shorted out and where it couples to the mains tranny," he called out, "it's insulation will be pretty unreliable now."

"I've already started," replied Dick. "Incidentally, I'm quite certain about that short now. The wire is well-nigh welded to the dial lamp bracket."

Smithy acknowledged this information with a nod and started rummaging in one of the mysterious boxes he kept at the bottom of the spares cupboard. After some minutes, he eventually produced a replacement mains transformer and carried it back to his bench.

"Nearly finished now," said Dick enthusiastically, as he busied himself with his soldering iron. "It was just a straight run from the dial lamp holder to the output valve socket, and that's the point where the heater lead from the tranny connected as well."

He turned round.

"Hallo," he remarked suspiciously. "What's that grubby-looking thing?"

"It's the replacement transformer," explained Smithy patiently.

Dick examined the component with a distrustful eye.

"Isn't it", he remarked, "a bit gash?"

"Gash?"

"Odd-job looking."

"Certainly it isn't," snorted Smithy indignantly. "It's a perfectly good transformer which offers exactly the same voltages and currents as the old one did."

"It looks", said Dick dispassionately, "pretty rough to me, anyway. The lams are all rusty."

"That won't stop it from working," replied Smithy irritably. "All that's wrong with it is that it's been in stock for a few years."

"A few years?" queried Dick. "Blimey, that tranny must have been part of the W/T gear on the Ark. When they weren't using it as a depth-sounding weight, that is."

"Nonsense," said Smithy heatedly. "Anyway I'll leave you to fit it on the chassis."

Dick picked up the offending component and held it up against the chassis.

"It doesn't", he grumbled, "even fit the same holes."

"*You* would raise difficulties", accused Smithy, "if you won first divvy on the pools. Both the transformers are upright-mounting types, so you've only got to drill an extra hole or two for the new one."

For one brief moment, it appeared to Smithy that he had finally overcome all his assistant's objections. But any fleeting sensation of triumph he may have felt was banished as Dick finally thumped the transformer down on the bench in disgust.

"The job," he stated flatly, "is impossible!"

"It's *what*?"

"It's impossible," repeated Dick, with conviction. "It's quite impossible to wire in this new transformer."

A look of complete disbelief spread over the Serviceman's face.

"Am I dreaming?" he queried incredulously. "Did you *really* say it was impossible to wire in that transformer?"

"I did," said Dick assuredly. "The job just can't be done!"

"And why not?"

"Just look at it," replied Dick, pointing a contemptuous finger at the component. "All the lead-out wires are the same colour. It's impossible to tell which are primary, and which are secondaries."

The Serviceman heaved a long drawn-out sigh.

"I must have heard everything now," he said heavily. "Hasn't it occurred to even the dimmest appendages of that numbskull organ which you call a brain that you can trace out the wires with an ohmmeter?"

"What's the use of that," replied Dick bad-temperedly, "if you don't know what the resistance of each winding should be in the first place?"

"You don't *need* to know," shouted Smithy heatedly. "You've just got to use a bit of commonsense. An attribute, I should add, which seems to be completely absent from *your* dim-witted make-up."

By now, Smithy and Dick had taken up attitudes on either side of the disputed transformer reminiscent of two dogs snarling over a bone.

"All right then," bellowed Dick belligerently. "*Call* me names, I don't care!"

"I shall," snarled Smithy. "You are a feather-brained nincompoop."

Dick stiffened.

"And you", he said slowly and carefully, "are a great hairy nit!"

With an expression of demoniac fury Smithy picked up the transformer and advanced upon his assistant. Alarmed, Dick moved hastily backwards.

"Now, take it easy, Smithy," he stammered apprehensively. "I didn't mean that. And it's no worse than what you've been calling me, anyway."

The Serviceman underwent what was patently a moment of intense self-control. He slowly relaxed and replaced the transformer on the bench.

"That's all right, boy," he said eventually. "I only picked it up to show you how to sort out the lead-out wires."

"Of course, of course," replied Dick hurriedly. "I'll get my test-meter switched over to an ohms range straight away."

It is usually around page 167 that Secret Agent 007 is rescued from the torture chamber. Thus it was with Dick, and his air of relief could not have been exceeded by the intrepid James Bond himself. With trembling fingers Dick plugged a pair of crocodile clip test leads into his meter and switched it to read resistance. Gradually the temperature dropped. The adrenalin seeped back to its accustomed places.

Tracing Transformer Connections

"There we are, Smithy," remarked Dick brightly. "The meter is all set up ready for you to use."

"Fair enough," grunted Smithy.

He pulled a pad of papers towards him and sketched out a circuit symbol for the mains transformer. (Fig. 2.)

"Right-ho," he said. "Now, the replacement transformer we are going to fit has a primary winding with taps at 200, 220 and 240 volts. The h.t. secondary is centre-tapped, and it offers 260–0–260 volts at 60mA. Finally, we have a 6.3 volt heater winding giving a current of 3 amps. O.K.?"

"Sure," said Dick.

His tone of voice was that of the dutiful underling who is eager to please.

"Now," continued Smithy, "the first thing I should mention is that, with mains transformers of the type used in radio work, it is usual to wind the primary on first, the h.t. secondary on next, and the heater winding or windings on last. The result is that the primary winding is on the inside, the h.t. secondary is in the middle, and the heater winding, or windings, is on the outside. This fact is often of help when you're trying to trace out the lead-out wires."

"You can't see where the wires come out of the winding on this transformer," objected Dick. "It's shrouded, and the lead-out wires come out through grommets at the bottom."

Smithy turned a glowering eye on his assistant.

"I *know* it's shrouded," he said shortly, "I was just starting off by speaking of general cases. Anyway, let's carry on to the business of sorting out the wires with the aid of an ohmmeter."

Smithy pulled the transformer towards him and splayed out its leads.

"A significant point", he remarked, "is that it's very common practice to use 'self-wire' lead-outs for the heater winding or windings. By that I mean that the winding wire is itself brought out as a lead-out. When this is done, heater winding lead-outs consist of single strands of thick insulated copper wire usually covered with sleeving, and they are very readily identified because the other lead-out wires are of the stranded flexible type. If you want to connect 'self-wire' heater winding lead-outs into circuit you have, of course, to cut back the sleeving *and* scrape off the enamel insulation as well. If a heater winding has a centre-tap, you will frequently find that the two halves of the winding are wound separately, the two inside ends being taken through a single piece of sleeving and joined together at the point where they leave the sleeving. This is very helpful, by the way, because it identifies a heater winding centre-tap straight away. In this case, it is important to remember that the only point at which the inside ends of the two windings connect together is actually at the ends of the sleeving. If you cut the wires back you must solder them both to the point in the chassis at which they are intended to connect. This ensures that the two inside ends of the winding still remain joined together."

"I see," said Dick. "So you start off by finding the thick single strand lead-outs, and you then assume that these are heater windings."

"That's right," agreed Smithy. "If you want to make absolutely certain, you can make a quick resistance check between the two ends, or between the two ends and the centre-tap if there is one. Windings which are intended to give 6.3 volts at 1 amp or more will have a resistance less than 1Ω. You may occasionally find resistances of 1Ω or very slightly more in heater windings which give 6.3 volts at 0.5 amps or less. But the actual value of resistance doesn't really matter because it will be very much lower than that given by the other windings."

"What happens if you've got more than one heater winding?"

"If the lead-out wires can't be identified," said Smithy, "you have to check which wire belongs to which winding by the ohmmeter check. This is, really, more of a continuity test than a resistance test."

Dick thought for a moment.

"The transformer *could* have a 6.3 volt and a 5 volt winding," he remarked. "How would you identify these?"

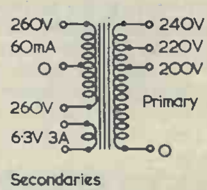


Fig. 2. The replacement mains transformer provided by Smithy

"It would be difficult to tell which was which from the ohmmeter test," said Smithy. "After you'd sorted out the leads for each of the heater windings you'd have to measure the a.c. voltages they give by applying a mains voltage to the primary later on, this being pretty well the last job you do in the process of identification. However, if the two windings were rated at different *currents*, you could probably spot the lower current one because the lead-out wire will be thinner."

"That seems easy enough," commented Dick. "Where do we go from here?"

"We carry on," said Smithy, "to finding which of the wires connect to the primary and h.t. secondary."

Smithy, now entirely engrossed in his subject, appeared to have completely forgotten the near-mayhem of several minutes ago. He drew the replacement transformer towards him and, after a quick visual examination, isolated the two stiff heater winding wires. He quickly touched the testmeter clips to their ends, and was rewarded with an indication of nearly zero ohms. He proceeded to apply the testmeter to the other leads.

"I begin", he pronounced, "by connecting one of the ohmmeter clips to any lead selected at random. I then find all the other leads which show continuity to that lead and group them all together. At this stage I don't bother about the actual resistance readings which the meter gives."

Smithy occupied himself for a few moments with the meter, and eventually separated four leads.

"Here we are," he said. "I've got four leads which show continuity to each other. Since the primary winding is the only one with four lead-outs, this must be the one I've got here. I now have to find which is the zero volt lead, and which are the 200 volt, 220 volt and 240 volt leads. Obviously, the highest resistance will appear between the zero and 240 volt leads, whilst the lowest resistance will appear between the 200 and 220 volt leads and between the 220 and 240 volt leads."

Smithy applied the test clips once more and grunted with satisfaction after several further seconds had passed. He tore four small pieces of paper from the pad, marked them "0", "200", "220" and "240", and passed them over the wires he had identified.

"That's that little job done," he said with satisfaction.

"What resistance readings did you get?"

"I'll just check finally," said Smithy, re-applying the clips. "I'm getting 40Ω between the zero and 200 volt taps, 44Ω between the zero and 220 volt taps, and 48Ω between the zero and 240 volt taps. (Fig. 3.) These readings are fairly representative of a reasonable quality transformer intended to give the secondary currents I referred to earlier. So we've got this part of the tranny sorted out."

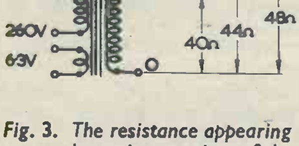


Fig. 3. The resistance appearing across the various sections of the primary winding

"Was it my imagination," asked Dick, "or did I get the impression that the meter needle was a bit sluggish when you took those resistance measurements?"

"It probably did take a little longer than usual to reach its final reading," confirmed Smithy. "There's a fair bit of inductance in the primary winding of a mains transformer, you know, and the function of inductance is to oppose changes in the current which flows through it."

"I see," said Dick, pleased. "It's always nice when you find some of the real basic theory turning up in practice."

"It is indeed," remarked Smithy, a sudden glint appearing in his eyes. "Anyway, let's see you repeat the readings I've just taken."

"That'll be a piece of cake," said Dick boastfully. "This is junior grade stuff!"

Carelessly, Dick picked up the testmeter clips and held them up against two of the primary leads.

"I told you it was a piece of cake," he pronounced, "I'm getting the same 48Ω reading that you had just now."

Dick released the clips, then gave a sudden yell and jumped away from the bench.

"Dash it all, Smithy," he said aggrievedly, "I've just got a belt!"

"That", chuckled the highly delighted Serviceman, "is *another* example of basic theory turning up in practice! If you'd paid proper attention to what I was doing you'd have seen that, when I disconnected the ohmmeter clips, I took care to keep my fingers away from the transformer leads themselves."

"But what", asked Dick, "gave me the belt?"

"The back e.m.f. in the transformer winding," said Smithy. "As soon as you disconnected the ohmmeter lead the field in the transformer collapsed and induced a high voltage in the winding. As, it seems, you noticed!"

"Well, you could have warned me about it," grumbled Dick. "It wasn't much of a shock, admittedly, but it made me jump because it was so unexpected."

"That", said Smithy dispassionately, "will give you a little bit of useful experience. You'd better try sorting out the h.t. secondary leads now."

With considerably more care, Dick applied the test clips to the remaining lead-out wires.

"I'll first", he said, "find three wires with continuity between them, like you did with the primary. There are only four wires left so this shouldn't take long."

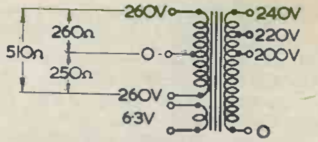


Fig. 4. The resistance of the h.t. secondary winding

Dick selected his three wires and bent them so that they laid alongside each other.

"I'm on the final stage now," he announced. "One wire gives 250Ω to the second wire and 260Ω to a third wire, whilst the second and third wires have 510Ω between them. So the first wire must be the centre-tap and the second and third wires the outside ends of the h.t. secondary." (Fig. 4.)

"You'd better mark the centre-tap lead-out with a bit of paper," said Smithy. "If you twist the three together, you'll then be able to locate the group and the centre-tap when you wire the transformer up. Incidentally, those resistance readings are pretty representative of what you would get from a 260–0–260 volt h.t. secondary rated at 60mA, such as this one is. You should note, also, that they are considerably higher than the primary resistances."

"There's something that puzzles me here," remarked Dick. "So far as I can see, the centre-tap isn't at the centre."

"How come?"

"Well," said Dick, "one half of the winding gives me 250Ω and the other half gives me 260Ω. If there was a true centre-tap, the resistance of each half would be the same."

"No it wouldn't," contradicted Smithy. "Don't forget that half of the winding is nearer the centre of the complete transformer winding than the other half, so it needs less wire for the same number of turns. In consequence it will show a slightly lower resistance."

"I never thought of that," admitted Dick. "You live and learn!"

"You do, indeed," agreed Smithy. "At any event, the transformer is now ready for wiring into the chassis. You would be well advised, however, to carry out a final resistance check on all windings after you've soldered up the joints and before you apply power."

"*Another* check?" questioned Dick. "What do you need that for?"

"Just to make certain that you don't damage anything," replied Smithy. "The risks resulting from an incorrect connection are very high. You might, for instance, accidentally apply the mains voltage to, say, the 200 and 240 volt primary tappings instead of to the correct primary points. (Fig. 5 (*a*).) Such a connection wouldn't do this section of the primary winding any good at all, and it could also cause some pretty hefty voltages to appear across the secondaries as well. You might also, by accident, get the centre-tap and one end of the h.t. secondary transposed. (Fig. 5 (*b*).) The result is that one half of the rectifier has twice the correct h.t. potential applied to its anode. It will then work as a half-wave rectifier and pass twice the correct potential to the h.t. electrolytics. The consequences of this incorrect connection are rather too awful to contemplate."

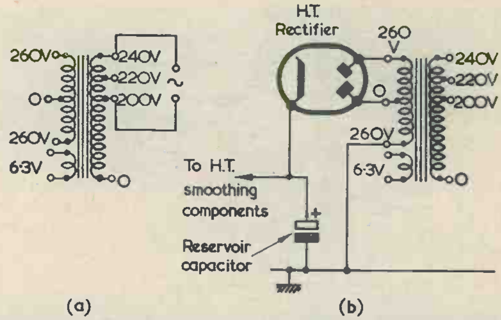


Fig. 5. Considerable damage may result from incorrect connection to a mains transformer because of inaccurate identification of the lead-out wires. In (a) the mains supply is applied to two of the primary taps instead of the correct points. In (b) the connections to one end of the h.t. secondary and the centre-tap are transposed

"I see your point."

"Now, before concluding," said Smithy, "I just want to mention another two types of mains transformer. The first is the type which used to be known as a 'converter' transformer because it was useful for Band III–Band I TV converters."

"I know the type you mean," said Dick. "'Converter' transformers usually have half-wave secondaries giving about 200 to 250 volts at 20mA or so, plus a heater winding."

"That's right," confirmed Smithy, "with these transformers you'll usually find that primary resistance is of the order of 100 to 300Ω and that secondary resistance is in the range of 200 to 500Ω. The primary should have the lower resistance of the two. The heater winding resistance will, normally, be of the order of 1Ω or less. The other type of mains transformer I wanted to mention also has a single secondary winding, but it isn't intended for feeding into a half-wave rectifier. It feeds, instead, into a bridge rectifier. (Fig. 6.) This is a very popular component with radio manufacturers at the moment, because it is cheaper than the full-wave transformer feeding a two-diode rectifier and because contact-cooled bridge rectifiers are now available at low cost. If a transformer of this nature is intended to drive a standard radio, radiogram or record-player, its h.t. secondary resistance will be of the order of 150Ω or so. Its primary resistance will be roughly around 40 to 50Ω or so, as with the full-wave transformer we checked just now.

"There's only one other point you haven't covered," said Dick, "and that has to do with finally sorting out different heater windings when there are more than one."

"So far as that is concerned", replied Smithy, "there isn't a great deal to add to what I've already said. If you've got, say, a 6.3 volt winding and a 5 volt winding you identify these after you've cleared up the other windings. You apply a mains voltage to the appropriate points on the primary and measure the heater secondary voltages off-load with an a.c. voltmeter. A point to watch here is that the off-load heater winding voltages will probably be some 0.2 to 0.5 volts higher than their nominal figures. This is because transformer manufacturers usually put an extra turn or two on heater windings to allow for loss of efficiency when the windings are loaded."

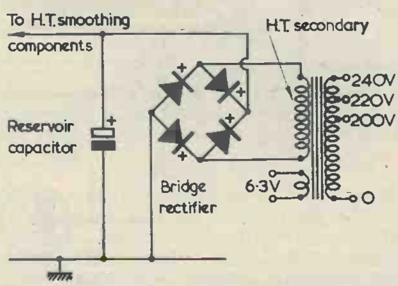


Fig. 6. The bridge rectifier h.t. circuit. The h.t. secondary provides the same voltage as would be given by either half of a centre-tapped winding feeding a two-diode full-wave rectifier

A Spare Wire

"That seems fair enough," said Dick. "Incidentally, I feel that I should apologise for what I said to you just now."

"Oh that!" commented Smithy. "I must say that it was hardly the way to address the senior member of the staff."

"You were," Dick reminded him, "calling me some pretty weird things as well, you know."

"Perhaps I was," admitted Smithy. "Anyway, you gave me the needle because you kept saying the job was impossible."

"It still is!"

It was as though the bull, tormented first by the picadors and then excited further to fury by the *chulos*, was once more facing the matador. Smithy rolled a bloodshot eye towards his assistant.

"Go on," he said, through clenched teeth.

"It's all right, Smithy," replied Dick soothingly. "I'm only pulling your leg. But there *is* one outstanding item which needs to be cleared up before I can finally connect up that transformer."

"And what is that?"

"There's a spare lead-out wire we haven't dealt with yet," said Dick, busy with the ohmmeter, "and it doesn't connect to any of the other wires at all."

Smithy gradually relaxed.

"Well," he conceded eventually, "I suppose you have a legitimate point there. That wire will connect to the screen between primary and secondary windings. Not all transformers have such a screen."

"What's it for?"

"To prevent capacitive couplings

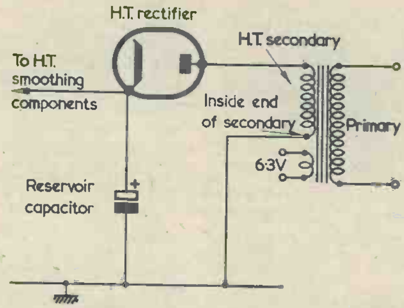


Fig. 7. If a mains transformer feeds a half-wave rectifier circuit, a reduction in mains-borne interference and modulation hum may often be achieved by ensuring that the inside end of the secondary (that nearer the primary) connects to chassis

between the primary and the h.t. secondary," replied Smithy. "It reduces the effects of mains-borne interference and modulation hum. You connect this screen to chassis. Usually, it consists of a single layer of copper or brass foil wrapped round on top of the primary, the ends being insulated from each other to prevent the formation of a shorted turn. I have also heard of a single layer of wire being used for the purpose as well, one end of the layer connecting to the lead-out whilst the other is left free. Which reminds me of an interesting little dodge you can use with those 'converter' transformers we were talking about a few moments ago. One end of the secondary of these transformers normally connects to chassis whilst the other goes to the h.t. rectifier. If you ensure that it is the *inside* end of the secondary which is connected to chassis (Fig. 7), the first winding layer of the secondary then acts also as a reasonably efficient screen, and can reduce the effects of mains-borne interference and modulation hum. Another way of looking at it is to say that the bulk of the capacitance between primary and secondary goes to the first few turns of the secondary, which are then either at or very close to chassis potential. Since transformers of this type rarely have a screen between primary and secondary, this little dodge can often pay dividends."

"That's a neat idea," remarked Dick. "I haven't heard of that one before."

"It's just", said Smithy modestly, "one of the many little pearls of wisdom which I drop from time to time. Anyway, are you now finally convinced that you can fit that dratted transformer?"

"Oh definitely," replied Dick airily. "Now that this little matter of the lead-out wires has been sorted out there's nothing holding me back at all!"

And, with this statement from his assistant, the sorely pressed Serviceman had to remain content. After all, as he reasoned to himself afterwards, Dick *was* trying.

That was the trouble.

Dick was so very trying.

Transistor Oscillator for F.M./I.F. Alignment

By N. H. C. GILCHRIST

THE OSCILLATOR DESCRIBED HERE WAS CONstructed recently for the purpose of aligning an f.m. tuner. It is powered by a dry battery, thus saving the expense and inconvenience of a power pack, as would be required for a valve oscillator.

The circuit diagram is given in Fig. 1, and will be seen to consist of a transistorised Hartley oscillator. This circuit was found to oscillate reliably with a 4.5 volt supply and uses very few components. Details of the oscillator coil are given

Components List

R_1	150kΩ ¼ watt
C_1	27pF ceramic
C_2	3–30pF concentric trimmer
TR_1	OC44
L_1	See Fig. 2
R.F.C.	2.5mH r.f. choke

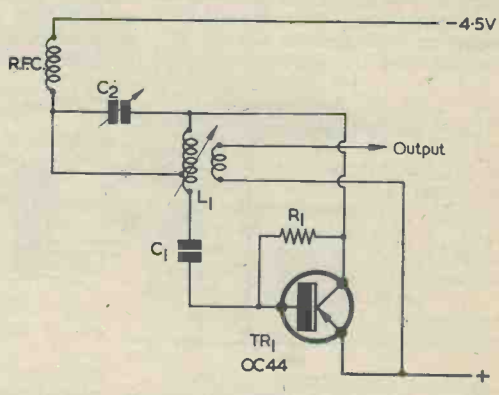


Fig. 1. The circuit of the oscillator

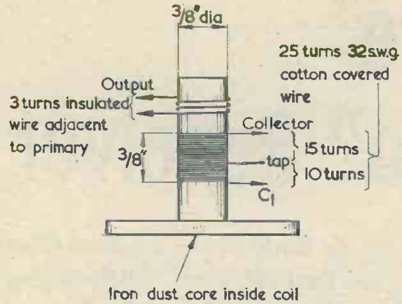


Fig. 2. Details of the oscillator coil

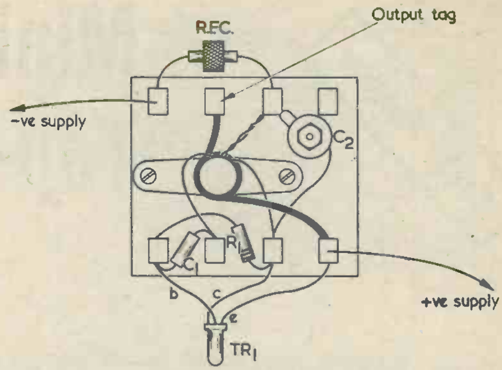


Fig. 3. The oscillator components mounted on a small tagboard

in Fig. 2. Stray capacitances may necessitate a slight adjustment to the number of turns, but the dust core and trimmer should allow a sufficiently wide tuning range to enable the optimum frequency to be found without trouble. It should not be necessary to have the core protruding from the coil, if made as described. In fact, oscillations may be weakened if the core is not inside the coil. The prototype still worked with the core removed, but with reduced amplitude.

When the oscillator has been built and the circuit checked, it may be connected to a 4.5 volt battery in series with a 0–2.5 or 0–5mA meter. The current consumption should be of the order of 0.5mA, and the circuit may be checked for oscillation by short-circuiting the concentric trimmer C_2, whereupon the current should rise to about 1.3mA. When the oscillator is feeding an f.m. tuner, current consumption will be about 0.6 or 0.7mA.

The oscillator may conveniently be constructed on a tagboard 2in square, and built into a small metal box. The latter serves to screen it and prevent hand-capacitance effects from altering the frequency of oscillation. The layout of components for the prototype on the tagboard is shown in Fig. 3.

The range of frequencies offered by the prototype lay between 10.5 and 11.5 Mc/s, and it was set up to operate at 10.7 Mc/s.

The OC44 is employed near its maximum usable frequency in this circuit. In consequence, it is possible that some OC44 transistors may offer a less efficient performance than is described here.—EDITOR.

MARCONI CAMERAS for B.B.C. Television Centre

The B.B.C. have placed another order with The Marconi Company for Mark IV 4½in image-orthicon television cameras for use in a new studio at the Television Centre which is due to come into operation during 1965. This new order is for six cameras incorporating full circuitry for both 405 and 625 line operation. The camera channels are engineered so that a single external switch will effect an instant change of line standard without any need for internal changes to the equipment.

This order follows one for three cameras from one of the independent television companies, and another for one camera for General Precision Systems, to be used in an aircraft flight simulator. Granada Television Network have also bought a two-camera outside broadcast unit from the Company. These three orders are all for the highly successful Marconi Mark IV camera, whose total sales now amount to well over 700. Marconi's are therefore still the only company to have received orders for image-orthicon cameras in the United Kingdom this year.

The order from the B.B.C. increases still further the Corporation's considerable investment in 4½in image-orthicon cameras from Marconi's and other major suppliers and brings the total number of Marconi 4½in image-orthicon cameras supplied to the B.B.C. to over ninety.

Cover Feature

Miniature "Top-Band" Receiver

By David Noble, B.A.Hons.(Oxon)
and David M. Pratt, Dip.Tech.(Eng.)

A conventional circuit for 160 metres which may be easily adapted for other Bands

THE RECEIVER TO BE DESCRIBED IN THIS ARTICLE was designed with several purposes in mind. It was mainly made to be lent to young short wave listeners who, having passed the Radio Amateurs' Examination, required a receiver in order to prepare themselves for the Post Office Morse Test. The receiver is, therefore, self-contained and easily transportable. To make the receiver simple to operate, the number of controls is kept to a minimum while still attaining optimum performance. By using multipurpose valves and semiconductor diodes, the number of valves is reduced, and yet the performance is equal to, say, an eight valve receiver. Despite its compactness the sensitivity and selectivity on the range covered seem quite outstanding.

Because the receiver was primarily intended for Morse practice purposes, it was designed for the 160 metre amateur band on which the special Slow Morse Transmissions arranged by the R.S.G.B. are radiated. The circuitry of the receiver, however, lends itself to use on all amateur bands up to 30 Mc/s, and by a simple modification the receiver may be made to cover these other bands. A guide as to how this may be achieved is given later in the text.

Circuit

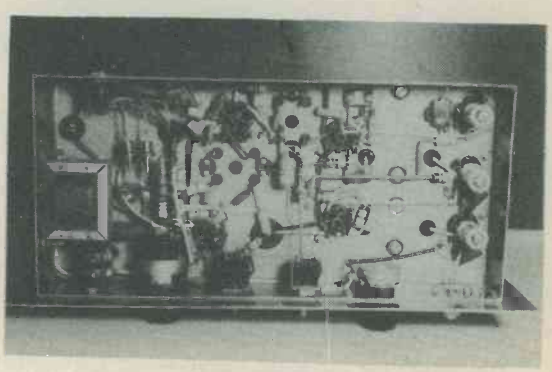
The circuit diagram is shown in Fig. 1. In this, the aerial is fed via the tuned circuit, L_1 and C_1 to C_3, to the control grid of the r.f. amplifier valve, V_1. This stage uses an EF85 and, as this is a variable-mu valve with a high slope, it provides a large amount of gain for small signals. The output from the r.f. amplifier is inductively coupled via L_2 to the control grid of the mixer stage. The triode section of the ECH81 frequency changer valve operates as the local oscillator, providing an output 465 kc/s above signal frequency which is fed to grid 3 of the heptode section. The 465 kc/s output from the mixer stage is taken from the heptode anode by means of the intermediate frequency transformer, IFT_1. The secondary of this i.f. transformer feeds the control grid of the i.f. amplifier valve, V_3. The control in the cathode of this valve is provided to enable the i.f. gain of the receiver to be varied. A limiting resistor, R_{12}, is also included in the cathode circuit, its purpose being to prevent the valve from drawing excessive anode current when the i.f. gain control is at minimum resistance. Output is fed via the i.f. transformer, IFT_2, to the signal and a.g.c. detector consisting of the OA79 germanium diode D_1. This rectifies the i.f. output from the i.f. amplifier, and feeds the audio pre-amplifier via the audio gain control, VR_2. It further provides a negative a.g.c. voltage which is applied to the control grids of the preceding stages, so reducing their gain when a strong signal is received. The i.f. is filtered from both the audio output and the a.g.c. line by the network C_{24}, C_{25}, C_{26}, R_{15} and R_{16}. Further filtering is provided on the a.g.c. line by C_{18} and C_{41}.

The volume control, VR_2, carries a double-pole switch, S_3, which is used to switch the mains supply to the receiver.

The audio stages utilise an ECL80 triode-pentode, V_5, using the triode section as a pre-amplifier and the pentode as the output stage. The output transformer is a Radiospares miniature type and matches the output valve into the internal 3Ω loudspeaker. A headphone jack is provided on the front panel for high impedance 'phones. The jack socket is arranged to switch off the internal 4in loudspeaker when the 'phones are plugged in.

C.W. Operation

A beat frequency oscillator is included to enable c.w. telegraphy reception to be achieved. This



The clean and tidy layout of the components under the chassis

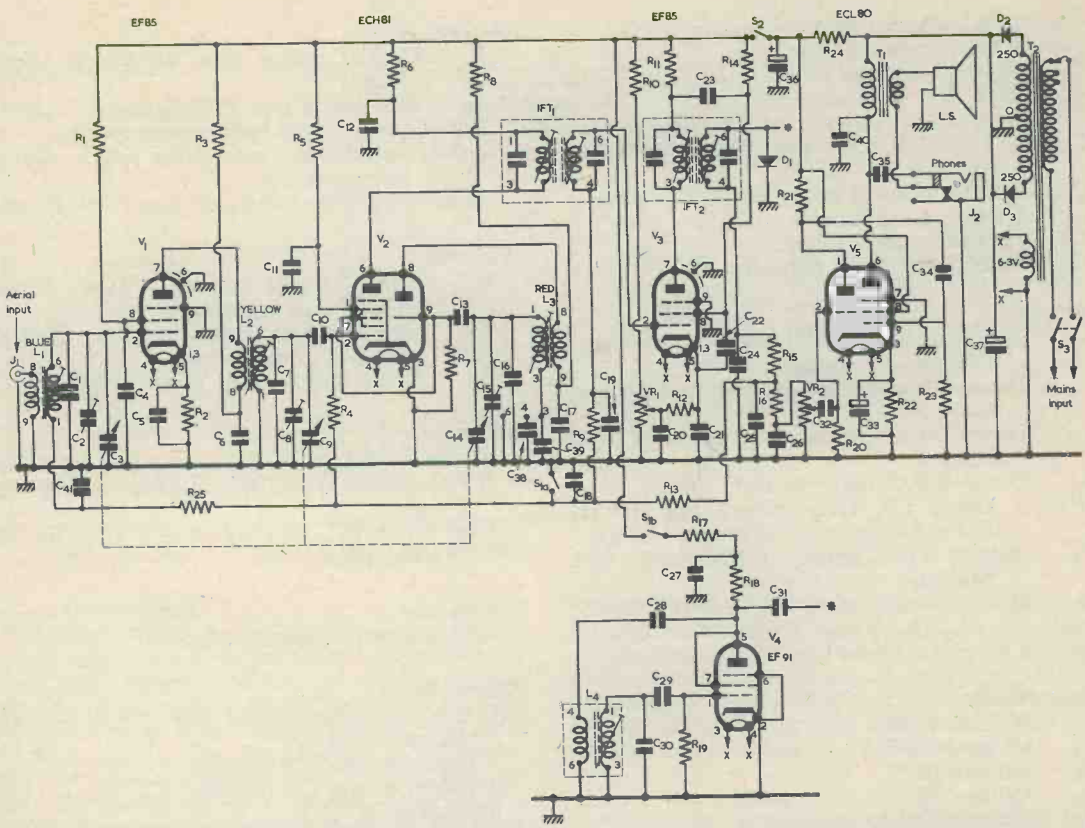


Fig. 1. The circuit diagram of the miniature Top Band receiver, C_{31} connects to the junction of IFT_2 and D_1

Components List

Resistors

(All fixed resistors ¼ watt unless otherwise specified)

- R_1 56kΩ
- R_2 180Ω
- R_3 1.5kΩ
- R_4 1MΩ
- R_5 33kΩ
- R_6 1kΩ
- R_7 47kΩ
- R_8 33kΩ
- R_9 100kΩ
- R_{10} 560kΩ
- R_{11} 1kΩ
- R_{12} 180Ω
- R_{13} 1MΩ
- R_{14} 68kΩ
- $R_{15, 16, 17, 18, 19}$ 47kΩ
- R_{20} 1.5MΩ
- R_{21} 100kΩ
- R_{22} 470Ω
- R_{23} 100kΩ
- R_{24} 1kΩ, 1 watt
- R_{25} 1MΩ
- VR_1 25kΩ potentiometer, linear track
- VR_2 500kΩ potentiometer, log track, with d.p.s.t. switch (S_3)

Capacitors

- C_1 220pF silvered mica
- C_2 4–60pF concentric trimmer, Mullard type E7879
- C_3 75pF variable, ganged with C_9 and C_{14} (see text)
- $C_{4, 5, 6}$ 10,000pF ceramic tubular
- C_7 220pF silvered mica
- C_8 4–60pF, as C_2
- C_9 75pF variable
- C_{10} 100pF silvered mica
- $C_{11, 12}$ 10,000pF ceramic tubular
- C_{13} 100pF silvered mica
- C_{14} 75pF variable
- C_{15} 4–60pF, as C_2
- C_{16} 220pF silvered mica
- C_{17} 10,000pF ceramic tubular
- C_{18} 0.1μF, 125V wkg., polyester
- $C_{19, 20}$ 2,000pF ceramic tubular
- C_{21} 10,000pF ceramic tubular
- C_{22} 4,000pF ceramic tubular
- C_{23} 2,000pF ceramic tubular
- $C_{24, 25}$ 500pF ceramic tubular
- C_{26} 100pF ceramic tubular
- C_{27} 10,000pF ceramic tubular
- $C_{28, 29}$ 100pF silvered mica

C_{30} 150pF silvered mica
C_{31} 4.7pF ceramic tubular
C_{32} 10,000pF ceramic tubular
C_{33} 25μF, 25V wkg., electrolytic
$C_{34, 35}$ 10,000pF, ceramic tubular
$C_{36, 37}$ 16+32μF, 350V wkg., single can electrolytic
C_{38} 3,000pF silvered mica, ±2½% (see text)
C_{39} 1,100pF silvered mica, ±2½%
C_{40} 1,000pF ceramic tubular
C_{41} 0.1μF, 125V wkg., polyester

Inductors

L_1 Denco miniature dual purpose coil, Blue, Range 3
L_2 Denco miniature dual purpose coil, Yellow, Range 3
L_3 Denco miniature dual purpose coil, Red, Range 3
L_4 Denco B.F.O. coil type BFO 2/465
$IFT_{1, 2}$ Denco I.F. Transformers type IFT.11/465 (or Radiospares "Standard" I.F's)
T_1 Output Transformer, Radiospares type "Midget"
T_2 Mains Transformer, 250–0–250V, 60mA; 6.3V, 2A, Radio Supply Co. Ltd., 5 County Arcade, Leeds 1

Valves, Diodes

V_1 Mullard EF85
V_2 Mullard ECH81
V_3 Mullard EF85
V_4 Mullard EF91
V_5 Mullard ECL80
D_1 Mullard OA79
$D_{2, 3}$ Mullard BY100

employs an EF91, V_4, in a simple anode feedback circuit oscillating at 465 kc/s. The output is loosely coupled by C_{31} to the second i.f. transformer, and the h.t. to the stage is switched on by means of $S_{1(b)}$. S_1 is a double-pole toggle switch, and $S_{1(a)}$ short-circuits the a.g.c. line to chassis when the b.f.o. is switched on. This is necessary to prevent the output from the b.f.o. from generating an a.g.c. voltage, and so limiting the reception of weak c.w. signals.

A miniature 250–0–250V., 60mA transformer is used for the power supply. Two silicon h.t. rectifiers are employed in order to save space and heater current. A smoothing choke is obviated by taking the h.t. for the output stage anode circuit from the reservoir capacitor, and using a wirewound resistor to provide the smoothing for the rest of the circuit.[1] Switch S_2 mutes the receiver by breaking the h.t. supply for V_1, to V_4 where it is opened.

[1] It will be noted in Fig. 1 that a common cathode resistor, R_{22}, provides bias for both the triode and pentode sections of V_1. Although this arrangement might appear to offer excessive bias for the triode it functions satisfactorily in practice at the h.t. voltage of 250 employed in the receiver. The relatively low value of 100kΩ for R_{23} is intentional; higher values may result in instability. Care should be taken to ensure that the correct mains tapping into T_2 primary is employed. If, for instance, a 250 volt mains supply is applied to the 200–210 volt tapping, the maximum p.i.v. for D_2 and D_3 might be exceeded.—EDITOR.

Sockets, etc.

J_1 Coaxial socket type L604/S/Cd (Belling-Lee)
J_2 Jack socket type P.72 (Igranic)
7 B9A valveholders, with centre spigot
1 B7G valveholder, with centre spigot, skirt and screening can
Mains input plug and socket type P360 (Bulgin)

Switches

S_1 d.p.s.t. toggle switch. Type 8370/K7 (N.S.F.) or equivalent
S_2 s.p.s.t. toggle switch. Type 8280/K16 (N.S.F. or equivalent
S_3 d.p.s.t. switch. (On VR_2)

Metalwork

Main chassis type "K", 16 s.w.g., 10¼ x 5 x1⅝in
B.F.O. chassis type "M", 18 s.w.g., 2 x 1⅝ x ¾in. F=¼in
Case type "W", 18 s.w.g., 11½ x 5¼ x 7in, with 16 s.w.g. panel

Loudspeaker

4in loudspeaker, 3Ω impedance

Miscellaneous

1 Epicyclic slow motion drive. Cat No. 4511 (Jackson Bros.)
2 Tagstrips type T19 (Bulgin)
2 Tagstrips type T20 (Bulgin)
Speaker grille
Knobs, grommets, screws, etc.

Components

Wherever possible, standard components are used throughout. The coils, L_1, L_2 and L_3 are Denco dual purpose coils. These coils are colour coded according to their purpose, and plug into B9A valveholders. A blue coil is used for the r.f. amplifier, while the heptode of the frequency changer uses a yellow coil, and the local oscillator a red one.

Denco miniature i.f. transformers may be used for IFT_1 and IFT_2, and the chassis drawing, Fig. 3 shows drilling details for these. In the prototype, however, Radiospares "Standard i.f. Transformers" were used, but these are slightly larger and require different drilling arrangements.

The b.f.o. coil is also manufactured by Denco, and the circuit employed for the b.f.o. is that recommended by the makers.

The tuning capacitor, C_3, C_9, C_{14}, is taken from the ex-Government RF27 unit and is chosen for its low-loss insulation and robustness of construction. In order to fit the capacitor on the chassis, the spindles will require shortening slightly. A small bush type coupler is recommended in place of the original flexible type. So as to avoid the consequences of mechanical misalignment, rubber grommets are used to provide a resilient mounting. An epicyclic slow motion drive is used, with a suitable pointer made from brass wire.

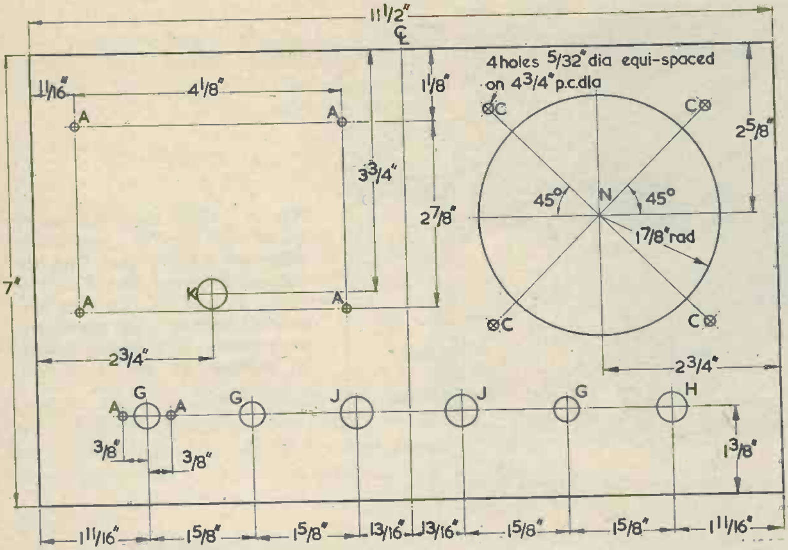


Fig. 2. Drilling dimensions for the front panel. Hole diameters are indicated in the Table. The material is 16 s.w.g. aluminium. The mounting holes for the speaker may vary in position from those indicated here

Use on Other Bands

The Denco Range 3 plug-in coils used in the r.f. circuitry are designed to tune from 1.67 to 5.3 Mc/s with a 300pF tuning capacitor. In order to achieve adequate bandspread a tuning capacitor of only about 65pF swing is used in the receiver, and fixed capacitors, C_1, C_7, C_{16}, are provided in parallel to bring the coverage to the 1.8–2.0 Mc/s amateur band. By the choice of a suitable value for the parallel capacitors, the receiver may also be made to tune the 3.5–3.8 Mc/s (80 metre) band. Similarly, Range 4 coils may be used for the 7 and 14 Mc/s bands, while Range 5 coils will cover the 14, 21 and 28 Mc/s bands.

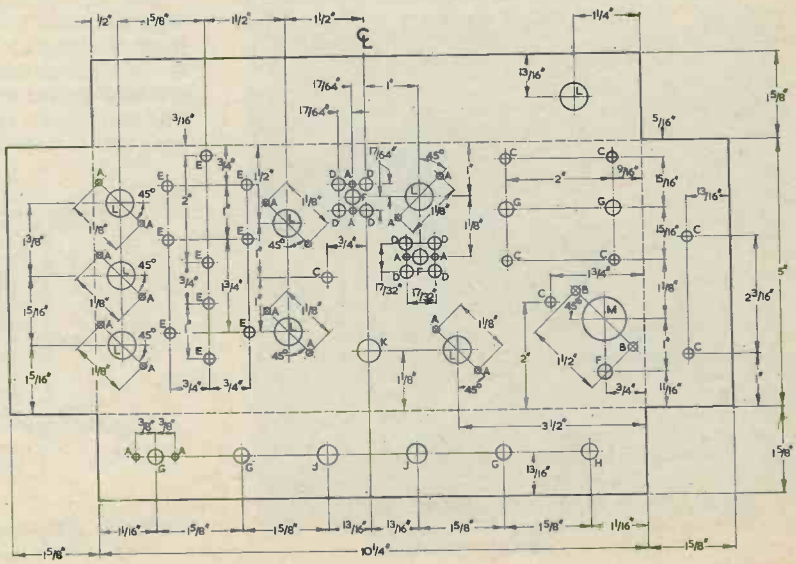
For the constructor wishing to make this receiver for several amateur bands, it is recommended that the parallel capacitors, C_1, C_7 and C_{16}, be connected across the appropriate solder tags on the coils themselves, a complete set of coils being used for each amateur band. With this form of construction the use of band-switching, which may prove complicated and inefficient, is not necessary.[2]

Chassis Construction

The receiver is built on a conventional 16 s.w.g.

[2] C_{39}, connecting to pin 3 of L_3 in Fig. 1, is the oscillator padding capacitor for Range 3. C_{38}, connecting to pin 4, is the padding capacitor for Range 4, and may be deleted if this range is not required. No padding capacitor is required for Range 5, the lower end of the tuned winding connecting direct to chassis via pin 6. If coils for other bands are fitted, it will be necessary to retrim C_2, C_8 and, perhaps, C_{15}.—EDITOR.

Fig. 3. Chassis drilling details. The material is 16 s.w.g. aluminium, and the sides are bent down along the dotted lines. The holes for C_{36}, C_{37} may vary in position and diameter for different versions of this component



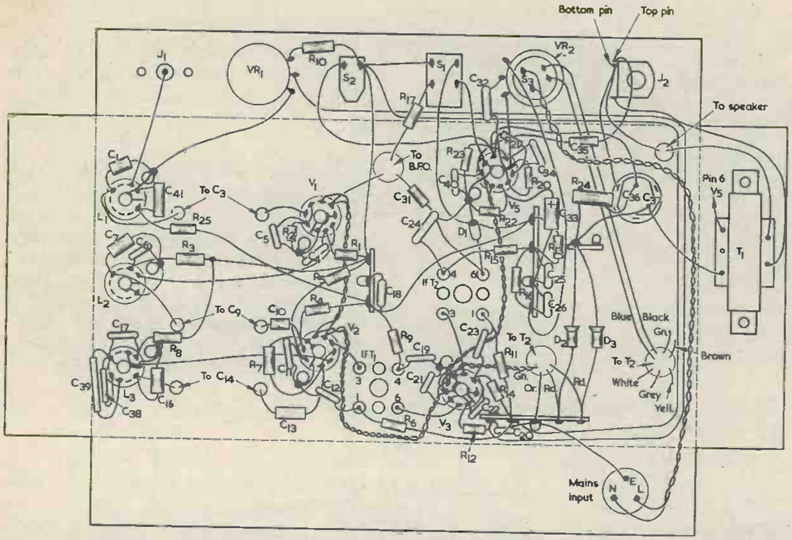


Fig. 4. How the receiver is wired up. The concentric trimmers C_2, C_8 and C_{15} are connected across pins 1 and 6 of L_1, L_2 and L_3, and they are omitted here to show the wiring underneath. The heater wiring is earthed at pin 4 of V_3

aluminium, 4-sided chassis measuring $10\frac{1}{4}$ x 5 x $1\frac{5}{8}$in. It is housed in a cabinet $11\frac{1}{2}$ x 7 x $5\frac{1}{4}$in with a front panel $11\frac{1}{2}$ x 7in. The metalwork may be obtained ready drilled from H. L. Smith and Co. Ltd. For readers who prefer to drill their own metalwork, the material can also be supplied blank.

Drilling details of the front panel and main chassis are given in Fig. 2 and Fig. 3 respectively, and the Table gives the various hole sizes. To give a neat appearance, the metalwork for the prototype was silver-hammer sprayed at a local cycle shop.

Assembly

The components are assembled as shown in Fig. 4. The space between pins 1 and 9 on the valveholders is indicated, and the recommended orientation of the valveholders should be followed in order to keep the various leads as short as possible. It will be found necessary to leave fitting the output transformer to the chassis until after the wiring associated with the smoothing capacitor has been completed.

In order to support several components four Bulgin tagstrips are used in the assembly of the receiver. Two of these are modified by removing one tag with a pair of wire cutters.

Wiring up of the receiver should not cause difficulty provided normal constructional techniques are used and leads are kept as short as possible. Work should be commenced with the heater wiring and power supply. It is then suggested that the rest of the wiring be carried out in order, commencing with the r.f. amplifier and ending with the a.f. amplifier.

Beat Frequency Oscillator

The b.f.o. is built on a small sub-chassis which is centrally positioned towards the front of the main receiver chassis. The fixing holes for the b.f.o. are not shown on the main chassis drawing as these are best drilled after assembly of the b.f.o. chassis. The sub-chassis is made from 18 s.w.g. aluminium, and the dimensions and drilling information are

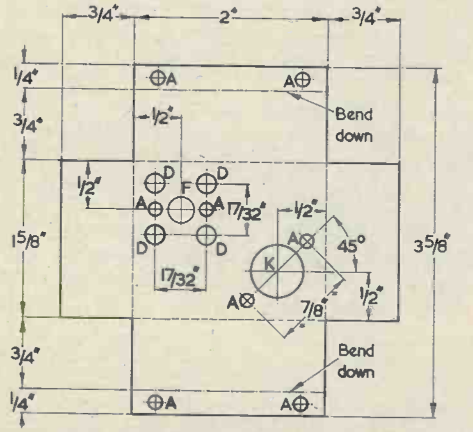


Fig. 5. Details of the b.f.o. chassis. The sides are bent up along the dotted lines (see Fig. 6). The material is 18 s.w.g. aluminium

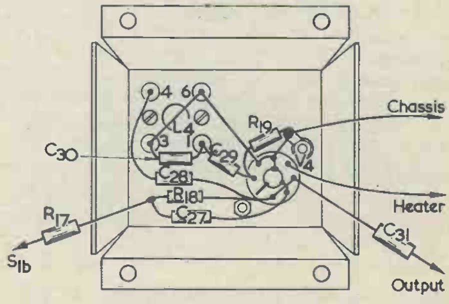


Fig. 6. Wiring diagram for the b.f.o. unit: C_{31} and R_{17} finally take up the positions indicated in Fig. 4

TABLE

Key to Holes on Chassis Drawings

A	$\frac{1}{8}$in dia. (6BA clearance)
B	$\frac{9}{64}$in dia. (5BA clearance)
C	$\frac{5}{32}$in dia. (4BA clearance)
D	$\frac{3}{16}$in dia.
E	$\frac{1}{4}$in dia.
F	$\frac{5}{16}$in dia.
G	$\frac{3}{8}$in dia.
H	$\frac{7}{16}$in dia.
J	$\frac{15}{32}$in dia
K	$\frac{5}{8}$in dia.
L	$\frac{3}{4}$in dia.
M	$1\frac{1}{8}$in dia.
N	$3\frac{3}{4}$in dia.

given in Fig. 5. Fig 6 shows the assembly of the unit using the recommended Denco b.f.o. coil. The four leads to the b.f.o. feed through a $\frac{5}{8}$in diameter rubber grommet in the main chassis.

Alignment

As with any superheterodyne receiver, optimum performance can only be obtained if a signal generator covering the i.f. and r.f. ranges is available for the alignment. The writers are not suggesting that it would be impossible to get the receiver working without a signal generator, but in order to obtain full benefit from a receiver of this kind, the use of an accurate signal generator is essential.

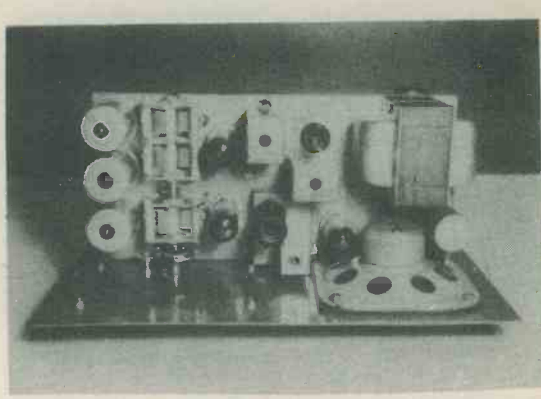
For those not familiar with superheterodyne alignment a suggested procedure is given for guidance, the i.f. circuits being lined up first.

A power output meter or a.c. ammeter is connected across the secondary of the output transformer, T_1. The i.f. and a.f. gain controls, VR_1 and VR_2 are set at maximum and the switch S_1, to the b.f.o. position. The b.f.o. valve, V_4, is removed from its holder.

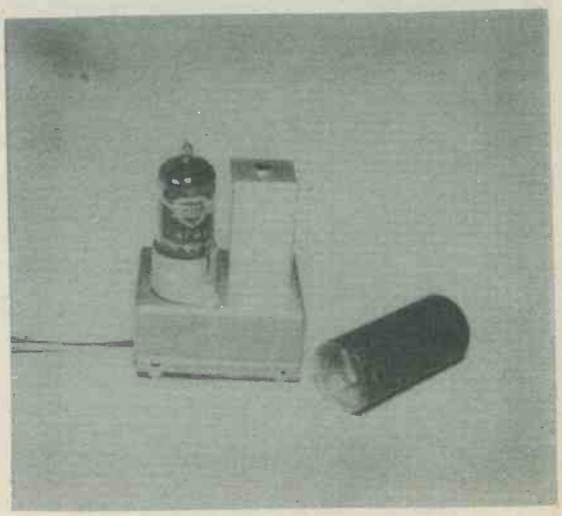
A modulated signal on 465 kc/s is then injected at pin 2 of the frequency changer valve, V_2, and its output increased until a signal is obtained on the output meter. Working back through the receiver, beginning with the secondary of IFT_2 and ending with the primary of IFT_1, the cores of the i.f. transformers are then adjusted for maximum. The output from the signal generator is reduced as necessary, keeping the output level as low as practicable. As the tuning of one coil may affect the tuning of another, the procedure is then repeated. The b.f.o. valve, V_4, is then placed in its holder and allowed to warm up. L_4 is then adjusted to give a comfortable beat note with the signal generator.

The r.f. circuits are next aligned. With the controls as they were for i.f. alignment. With the b.f.o. valve removed, the signal generator is now fed into the aerial socket, J_1. With the tuning capacitor set at 10° (vanes almost fully in mesh), and the signal generator set at 1.8 Mc/s, the core of L_3 is adjusted until the signal is heard. Now, with the vanes almost fully open at 170°, and the signal generator set at 2.0 Mc/s, the trimming capacitor, C_{15}, is adjusted until the signal is heard. This procedure is repeated until no further adjustment of either the core or the trimmer is required.

The core of L_2 is adjusted for maximum output



Looking down at the top of the chassis. The b.f.o. sub-chassis may be seen immediately behind the front panel



The appearance of the b.f.o. chassis

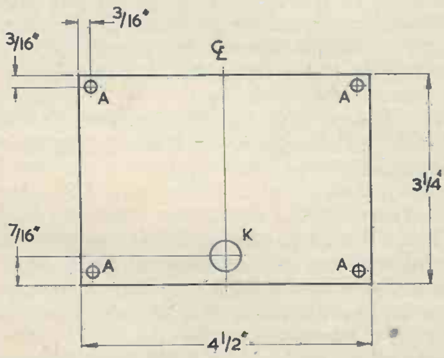


Fig. 7. The transparent dial cover. The material is $\frac{1}{16}$ in Perspex

of the 1.8 Mc/s signal at 10°, and the trimmer, C_8, is adjusted to peak the 2 Mc/s signal at 170°. These should be adjusted alternately until no improvement can be obtained.

Similarly, the core of L_1 and the trimmer, C_2, are adjusted for optimum output of the 1.8 and 2 Mc/s signals respectively.

While carrying out the alignment of the various circuits, the output from the signal generator should be kept as low as possible so as to prevent any stage from being overloaded.

The alignment is now completed and the b.f.o. valve may be replaced in its holder.

Conclusion

When receiving c.w. signals, the audio gain control should be set at maximum and the volume adjusted with the i.f. gain control. On telephony, however, the reverse applies, the volume being adjusted with the a.f. gain control.

With only a very short aerial connected to the input socket, stations in the 1.8–2.0 Mc/s amateur band will be heard very strongly. The performance of this receiver will be found to be superior to that of many commercial communications receivers. The receiver will be found ideal for the short wave listener wishing to build his own equipment, or for the licensed amateur who wishes to confine his activity to one band.

THE NEW DUAL-STANDARD TV SETS

By Gordon J. King, Assoc. Brit. I.R.E., M.T.S., M.I.P.R.E.

PART 3

This third article in our series on 405–625 line receivers deals with the tuner circuits and techniques employed for dual standard reception

LAST MONTH WE INVESTIGATED THE VISION I.F. channel response requirements for the 405 and 625 signals. It was shown that a passband of 8 Mc/s is required in the i.f. channel on the 625 standard owing to the fact that both the sound and vision signals are carried through it. On the 405 standard the passband is little more than 3 Mc/s, since rejectors are employed in the vision i.f. channel to put a deep trough into the response at the sound frequency.

It was intimated that dual standard receivers are designed essentially to give the correct 625 response characteristics and that the 405 response characteristics are provided by the switching in of suitably tuned rejector circuits. In that way, the response is narrowed and shaped so that it matches that of 405-line-only models.

Before we go on to look at the tuner units and the i.f. channels, it is worth noting that in some dual standard models, particularly those which were designed specifically to be later converted to "switchable" models, two i.f. strips are featured. One is the normal 405-line-only strip with its associated sound channel and the other (which was sometimes fitted afterwards, whne conversion was required) a suitably tailored 625-line-only strip complete with intercarrier sound section and (sometimes) its own detector and video amplifier. The "conversion unit" may also contain a flywheel controlled line oscillator section for 625 line use, as the higher velocity of the scanning spot coupled with the negative vision modulation of the 625 standard can influence the line synchronising if direct sync is used. We shall have more to say about that later.

V.H.F. Tuner

For the time being let us look at the tuner units themselves. In Fig. 10 is shown the circuit of a v.h.f. tuner used in some dual standard models. This is very similar to the v.h.f. tuner of 405-line-only models. We have a double-triode cascode r.f. amplifier at V_1 and a triode-pentode frequency changer at V_2, with the pentode as the mixer and the triode as the local oscillator.

The tuner shown has thirteen v.h.f. channel positions *plus* a "u.h.f." position.

The aerial signal is applied, via the isolating capacitor C_1, the static discharge resistors R_1 and R_2 and various i.f. and image rejectors, to the grid of the first triode section, the tuned circuit being selected by S_1 and S_2. The anode of the first triode is "loaded" by the cathode of the second triode in the conventional cascode manner. Bandpass coupling tuned circuits, selected by switches S_3 S_4 and S_5 S_6, feed the signal from the cascode anode to the mixer control grid.

The oscillator coil for the required channel is selected by switches S_7 S_8, with fine tuning provided by the variable element of C_{318}.

U.H.F. Tuner

In Fig. 11 is given the circuit of the u.h.f. tuner. This employs two triode valves, V_{16} and V_{17}, with the former serving as the r.f. amplifier, in the earthed-grid mode, and the latter as a self-oscillating mixer, also in the earthed-grid mode.

Owing to the nature of the signals ordinary coils cannot be used for tuning and in place are used resonant lines, called trough lines or lecher wires.

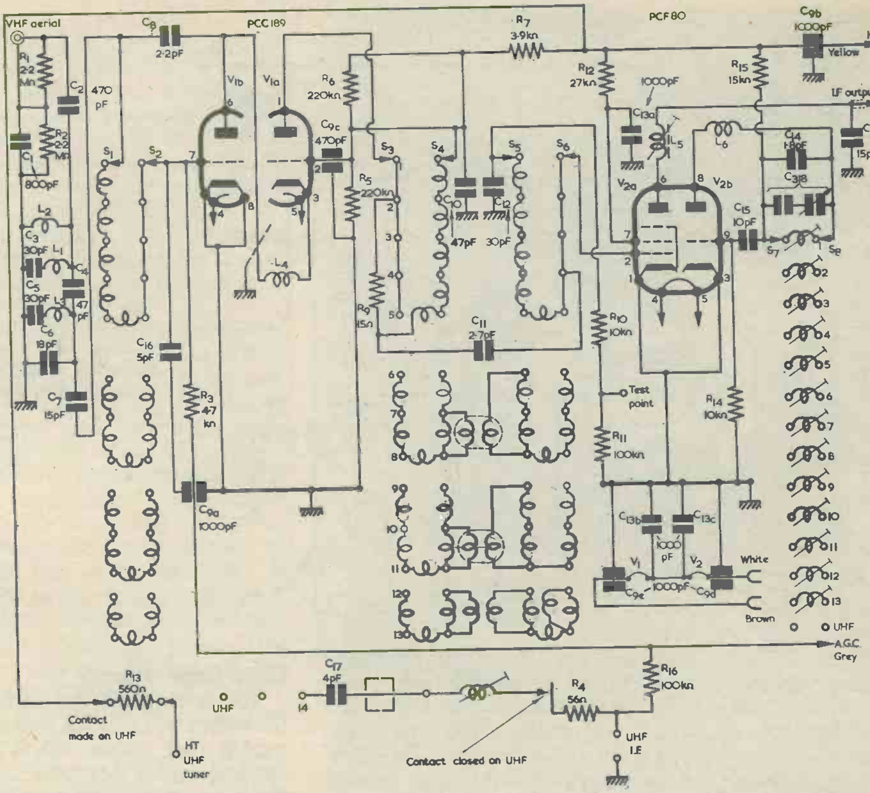


Fig. 10. Circuit diagram of a v.h.f. tuner used in dual standard receivers, showing also the u.h.f. i.f. input circuit

These wires are shown in the circuit by the extra thick lines. The aerial coupling wire, for instance, is between C_{203} and C_{204}, and the signal input wire connects to the cathode of V_{16}. The anode wire of the r.f. amplifier between C_{209} and C_{210} is bandpass coupled to the mixer input by the wire between C_{216} and C_{217} and the loop connected to V_{17} cathode. The oscillator wire is between C_{219} and C_{220}.

In other words, apart from the type of valves and circuit configuration, the lecher wires in Fig. 11 serve the same purpose as the inductors in the circuit of Fig. 10. The lecher wires are not switched, however. Instead they are tuned by variable capacitors, C_{227} tuning the signal input wire, C_{228} tuning the r.f. amplifier anode wire, C_{229} tuning the mixer input wire and C_{230} tuning the local oscillator.

These variable capacitors form a four-section tuning gang which is mechanically coupled to the u.h.f. channel selector knob. This is rather like the tuning gang (but smaller) in an ordinary radio set. Some of the lecher wires have trimmers at each end for ganging and padding, and they are adjusted in turn at the high and low frequency ends of the u.h.f. band to ensure a relatively linear channel coverage over the range of the tuning gang. These are, in fact, adjusted in a similar manner to the trimmers and padders in a radio set.

When resonated, the lecher wires have developed upon them a standing wave of the signal in the tuner, which is akin to the standing wave set up on a tuned aerial in the presence of a signal. Signal energy can thus be introduced or extracted by a coupling loop placed in proximity to the lecher wire. In practice, such a coupling loop may be formed by a section of the tuner chassis, upon which the r.f. connections are critically proportioned. In effect, the tuning capacitors tend to vary the length, and hence the resonant frequency, of the wire, and it is in that way the the u.h.f. channels are tuned. Either the channel selector knob itself is marked in channel numbers or some sort of tuning dial geared to a slow-motion drive, similar to those used in radio sets, is provided.

The u.h.f. aerial is coupled to the tuner through the isolating capacitor C_{200} on the centre conductor and C_{201} on the outer conductor, with R_{200} and R_{201} acting as static discharge components. The signal is, in fact, developed across a loop from whence it is coupled to the signal input lecher wire. In this section of the circuit there is a "three-stage" coupling arrangement. The signal across the input loop is low impedance, and the impedance is raised by the capacitively-tuned lecher wire. From here the signal is coupled into the relatively low impedance of V_{16} cathode circuit.

This gives a useful degree of input tuning, which would otherwise be impossible owing to the low impedance aerial coupling and cathode circuits. Early u.h.f. tuners, in fact, used only three variably-

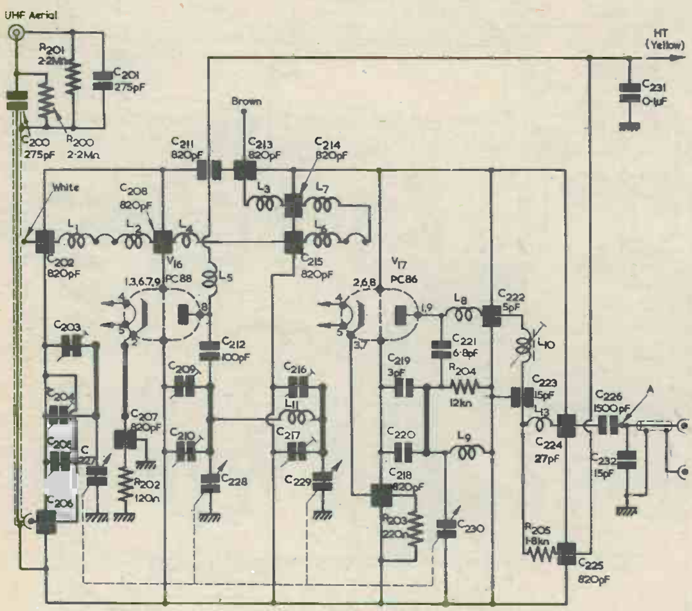


Fig. 11. Circuit diagram of a u.h.f. tuner used in dual standard receivers. Instead of coils, lecher wires are used. These are the thick lines trimmed at each end and, in some cases, tuned by a variable capacitor

tuned circuits, and omitted the input tuning. However, this proved entirely unsatisfactory owing to the high ratio of image (second channel) rejection needed on the u.h.f. channels. The planning authority recommend an image rejection in the order of 53dB (minimum) and this is possible only by the use of the four tuned circuits as contained in the tuner circuit in Fig. 11.

Image Rejection

The image rejection problem can be considered by assuming a vision i.f. of 39.5 Mc/s (the "standard") and the set working on Channel 23 where the vision carrier is 487.25 Mc/s, thereby giving an oscillator frequency of 526.75 Mc/s. Now, Channel 33 has a vision carrier of 567.25 Mc/s so, should this signal gain admittance to the mixer when the set is working on Channel 23, the resulting 1 Mc/s beat, arising from the production of a 40.5 Mc/s i.f. due to the Channel 33 signal, could give bad interference patterns on the picture.

Oscillator radiation is also another important point at u.h.f., and the tuned input circuits help to reduce this also. A further aid in this direction is the heavy screening surrounding the u.h.f. tuner. Should it be necessary to remove the case or shields, it is most important that they are securely fitted again before use. Apart from increasing the radiation potential, badly fitted screens could detune the critical alignment and considerably impair the tuner performance.

In the past, adequate screening of the v.h.f. tuner has been desirable in the interests of interference avoidance. In the future, however, it will assume a greater importance, since harmonic radiation from the v.h.f. tuner oscillator circuit can cause bad patterning on the u.h.f. channels.

High Slope Triodes

We have seen that there is quite a difference between a v.h.f. tuner and a u.h.f. tuner. It is worth noting that triode valves of the frame grid type become highly desirable at frequencies above v.h.f. No u.h.f. tuner of recent design features a cascode stage, for the noise performance of this is far inferior to that of a high gm (mutual conductance) triode, and the PC88 and PC86 valves, used as r.f. amplifier and self-oscillating mixer respectively, are very good high gm triodes.

To allow good "earthing" at the grid electrode at u.h.f., the PC88 has five grid connections and the internal structure of the valve is close to the bottom of the envelope. These multi-parallel paths for r.f. tend to reduce the residual inductance between the grid and its external circuit. The valve also has a very good screening efficiency between its cathode and anode, thereby avoiding feedback problems.

U.H.F. tuners are made by Mullard, Sydney S. Bird and Sons Limited (Cyldon), and others, but all the designs follow the lines discussed in the foregoing paragraphs. At u.h.f. the mechanical stability of a tuner is of great importance. To this end, most u.h.f. tuners are built into a substantial metal case of 16 s.w.g. material. The case is partitioned by steel plates to form the necessary troughs to accommodate the input and output coupling circuits and the tuned lecher wires. Oscillator radiation is kept to a minimum by the use of a copper foil gasket between the top cover and the case itself. This is held under pressure by a rubber or p.v.c. pad clamped under the top cover plate.

Tuner Stability

Although the frequency of the u.h.f. local oscillator is several times above that of its v.h.f. counter-part, the frequency drift should be no greater. This represents one of the biggest problems in the design of u.h.f. tuners, and to assist in its resolution some tuners incorporate an automatic frequency correction (a.f.c.) system. One of the Mullard u.h.f. tuners, for example, features this facility. A.F.C. permits press-button channel selection, an attribute which would otherwise be impossible at u.h.f.

The effects of oscillator drift in a v.h.f. tuner are well known, and consist of detuning of the sound and sound-on-vision interference accompanied by a loss of picture quality.

On the 625 standard, however, the intercarrier signal at 6 Mc/s is always held at a constant frequency in spite of oscillator drift. This is because the intercarrier signal is created by the beating of the sound and vision carriers, and these are always held at very accurate frequencies at the transmitter.

Nevertheless, oscillator drift can prove embarrassing since, for one thing, it can disturb the balance of the f.m. sound section and thus introduce considerable harmonic distortion (rather similar to that caused by a detuned f.m. radio receiver). It can also upset the balance of the sound and vision signal levels at the vision detector and produce harmonic distortion and/or intercarrier buzz. This latter symptom is rather similar to that of the "vision-on-sound" interference experienced on 405-line-only sets due to intermodulation and misalignment of the sound i.f. channel.

The aim at the present for u.h.f. tuners is to keep the oscillator drift below ± 200 kc/s for a 10% change in supply voltage or a 30° C rise in temperature above ambient. Although this drift is about twice that allowed for v.h.f. tuners, it is very good bearing in mind the much higher frequency. Undoubtedly, the oscillator stability performance of u.h.f. tuners will improve as more are made, as it has done so far as v.h.f. tuners are concerned, making it now possible to eliminate the fine tuning control!

There is another factor with u.h.f. tuners which is less important with v.h.f. tuners, and that is the signal handling characteristics of the r.f. stage. When the four channels of a local group are all carrying signals, the tuner will, in effect, receive four signals together at almost the same level. Owing to the small degree of selectivity between the aerial and the r.f. amplifier valve, this valve will also receive four signals simultaneously (in practice, the tuned signal will be a little higher than the others of the local group). Now, if this valve is running hard (that is, receiving strong signals) some degree of non-linearity is probable and this can cause inter-modulation of the four sound and four vision signals, giving rise to picture patterns and sound buzz.

The aerial will not help much in this respect, of course, since as we saw in Part 1 of this series most u.h.f. aerials are purposely designed to embrace all the channels of a local group! Tuner a.g.c. may eventually be required, but so far manufacturers are not catering for this.

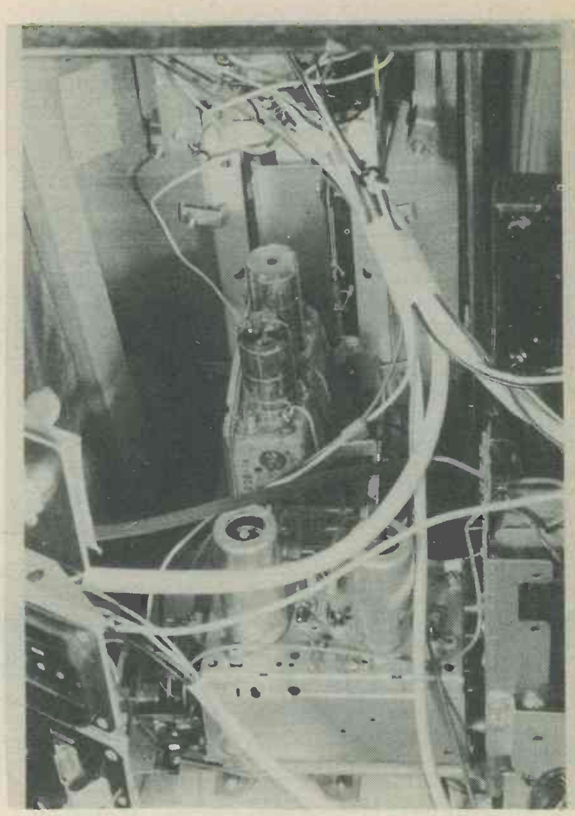


Fig. 12. A view of the v.h.f and u.h.f. tuners in a dual standard set. The u.h.f. tuner is towards the front of the cabinet, where the rear of the tuning scale can clearly be seen

U.H.F. Coupling

If we look again at the circuit of Fig. 10 we shall see that the i.f. output of the u.h.f. tuner is coupled in between chassis and the junction of R_4 and R_{16} at the bottom right-hand corner of the circuit.

When S_6 is in the "u.h.f." position, the u.h.f. signal is applied to the signal grid of $V_{2(a)}$ via an inductor and u.h.f. switch contact. R_{16} then acts as the grid leak. Actually, this network forms a secondary i.f. coupling unit.

The primary i.f. coupling network is contained in a screened section of the u.h.f. tuner, and comprises L_{10}, L_{13} and associated components. Apart from tuning the required i.f. signals, this network acts as a low-pass filter, since it lets through the relatively low-frequency i.f. signals whilst blocking the u.h.f. signals and oscillator frequencies. Coaxial cable is used to couple the output of the u.h.f. tuner to the mixer input switched circuit of the v.h.f. tuner.

Also, in the "u.h.f." position of the v.h.f. tuner, h.t. is fed from the main h.t. line of the v.h.f. tuner, through R_{13}, to the u.h.f. tuner, this being removed in the "v.h.f. channel" positions. The h.t. supply to the v.h.f. r.f. valve and local oscillator sections is also removed in the "u.h.f." position due to switches S_3 and S_7 S_8 turning to "blank" tags.

It will be understood, of course, that the gain of a u.h.f. tuner is lower than that of a v.h.f. tuner. This, coupled with the fact that the u.h.f. aerial signal is nearly always below the level of the v.h.f. aerial signal, means that some extra lift should be given to the i.f. signal before it is passed on to the i.f. amplifier channel. This is the reason for coupling the u.h.f. i.f. signal through the mixer section of the v.h.f. frequency changer valve. Approximately equal level signals are then obtained at the i.f. channel input from both the v.h.f. and u.h.f. transmissions.

The i.f. output circuit of Fig. 10 is fairly conventional, L_5 being the i.f. coil and C_{18} the coupling capacitor (producing a form of pi coupling). The i.f. signal is fed out at low impedance through coaxial cable, and at this point appears the 405 line sound and vision intermediate frequencies when the v.h.f. tuner is in the "v.h.f. channel" positions and the 625 line sound and vision intermediate frequencies when the v.h.f. tuner is in the "u.h.f." position.

The characteristics of the signals at the i.f. output are closely similar to those of the transmission (see Figs. 5 and 6 of Part 2), but the carrier frequencies are, of course, replaced by the intermediate frequencies and the relationship of the sound and vision signals is reversed due to the fact that the local oscillators of the tuners are working *above* the frequencies of the incoming signals.

In Fig. 12 is shown the u.h.f. tuner at the front and the v.h.f. tuner at the rear (that is, in the foreground) of a conventional dual standard receiver. Note the rear of the u.h.f. tuning scale, which uses pulleys and a drive-cord arrangement as in radio sets.

Next month we shall see how the vision i.f. amplifier is switched to accommodate both standards.

(*To be continued*)

Versatile Portable Oscilloscope

PART 1

by P. Cairns, A.M.I.P.R.E., G3ISP

THE INSTRUMENT DESCRIBED IN THE FOLLOWING pages is a simple and extremely versatile oscilloscope using a three inch cathode ray tube. The final design shown was evolved only after a considerable number of other circuits had been tried and rejected. The writer has used this oscilloscope on various types of radio and electronic pulse work for the past few months with considerable success.

Circuit Diagram

As will be seen from the circuit diagram in Figs. 1 (*a*) and (*b*), a relatively simple circuit is employed using miniature all-glass valves, with single ended deflection on both X and Y plates. All the valves, with the exception of the rectifier, are of the same type, this making any future replacements both cheap and simple. Keeping the cost to a minimum was a major consideration throughout the design and no special or difficult-to-obtain components are used. The complete c.r.o. can be built for less than £10 and if a careful search is made on the surplus market, for less than £5. Many of the refinements often included in larger and more elaborate oscilloscopes are left out, as a lot of these are rarely used anyhow. The omissions are stabilised h.t. lines, switching for direct connection to the deflection plates, push-pull amplifiers on one or both deflection systems, a compensated switched Y attenuator, and facilities for external triggering. These omissions do not detract from the usefulness and versatility of the c.r.o., whose complete specification is shown in the Table. It will be seen that this specification compares favourably with many commercially produced oscilloscopes.

The cathode ray tube used is a 3BP1 and it can be bought quite cheaply on the surplus market, complete with mu-metal screen. A particularly fine focus can be obtained with this tube.

The functions of the various stages are quite straightforward. V_2 and V_3 comprise the Y amplifier, these two triode-connected pentodes being a.c. coupled in cascade, whereupon a high overall amplification factor is obtained. To achieve a reasonably wide bandwidth, however, the gain is reduced by using low values of anode load (R_{10}, R_{15}) and negative feedback is applied by means of the un-bypassed cathode resistors (R_8, R_{13}) and the common load resistor R_{11}. R_{11} is decoupled by a low value capacitor, C_5, to increase the h.f. response of the amplifier. Large values of coupling capacitor (C_3, C_4, C_6) are used to give a good l.f. response. The response of the amplifier is shown in the graph in Fig. 2, the gain being 100, the sensitivity approximately 175mV/cm. and the response −3bB between 5 c/s and 110 kc/s, with a useful gain up to 400 kc/s. The square wave response is particularly good, rise times of 1μS being accepted without overshoot.

A straightforward gain control (R_7), is used, as the compensated attenuator originally tried out was rather difficult to set up to obtain the best square wave response. It also occupied more space and required quite a number of extra components. Either coaxial socket or ordinary plug and socket inputs are available.

The synchronising stage, V_4, is a simple amplifier, and adequate decoupling from h.t. ripple, etc. is obtained by R_{32} and C_{17}. A small part of the output signal from the Y amplifier is taken via R_{16} and C_{16} to the sync. control R_{29}, which can be adjusted to pass just sufficient input signal to lock the timebase. The sync output signal is fed to the timebase through the coupling capacitor C_{18}.

The timebase, V_6, uses a Miller-Transitron circuit and gives a good sawtooth waveform having a linear sweep with rapid flyback on all ranges. The four coarse ranges are selected by S_3, which switches into circuit the integrator feedback capacitors C_{19} to C_{26}. The fine control R_{39} allows sweep speeds to be covered which fall between the four coarse steps, ample overlap being allowed between steps to compensate for differences in component tolerances and circuit time constants. The output sawtooth waveform to the X amplifier is via the internal/external switch S_4. The sync signals are fed to the suppressor grid of V_6 thus locking the timebase scan sweep to the signal under observation. Diode D_4 clamps positive signal tips at chassis level, thus synchronising occurs mainly on negative signal components. This helps to prevent double synchronising.

The diode V_5 provides flyback suppression. During flyback periods the screen grid of V_6 is driven negative, and this allows the diode V_5 to conduct. The resultant negative pulse developed across the load resistor R_{33} is applied to the c.r.t grid via the blocking capacitor C_{15}. This means that the c.r t. grid is driven beyond cut-off during flyback periods. During the scan sweep the screen grid of V_6 is going positive. The cathode of V_5 also goes positive with respect to its anode and the diode becomes non-conducting.

The X amplifier, or timebase amplifier, V_7, employs a straightforward R-C circuit, the valve being triode-connected. The input signal, either external (if the c.r.o. is being used for Lissajous figures and the like), or the internal from timebase, is passed via the coupling capacitor C_{27} and gain control R_{41}. The latter serves as the X expansion control. Large value coupling capacitors (C_{27}, C_{28}) and a rather high value cathode bias resistor (R_{42}) are used in this circuit to preserve maximum timebase linearity on the slower sweep speeds. Though the overall gain of this stage is only in the region of 10, it was found to be adequate for practical applications, linearity being considered rather more important than gain.

The X and Y shift controls, R_{47} and R_{19}, are both alike, consisting simply of the centre section of a resistor divider network. Their purpose is to alter the d.c. potential on the respective c.r.t. deflection plates. Isolation from the signal source is provided by the high value resistors R_{45} and R_{17}. The shift controls are decoupled also through C_{29} and C_7, this helping to prevent pick-up and extraneous signals reaching the deflecting plates from these parts of the circuit. Due to the rather long time constants in these circuits and the large coupling capacitors employed, a slight delay in the action of the shift controls is unavoidable. However, to obtain an instant shift action would involve extra circuitry, components and d.c. coupled amplifiers, which the slight advantage of an instant shift control action does not really warrant.

The power unit is conventional, a standard 350–0–350 volt, 60mA transformer being suitable. Three 6.3 volt heater windings are used, that for the amplifier and timebase valves being centre-tapped to chassis to reduce hum. A full-wave rectifier is used for the h.t. supply with L-C smoothing. R_1 and R_2 are limiting resistors. R_3 gives a certain amount of loading and acts as a discharge path for the smoothing capacitors if the h.t. supply to the rest of the circuit should become broken. The total h.t. current drain under average working conditions is in the region of 35mA, the h.t. line voltage being about 345.

TABLE

Complete Specification For The Oscilloscope

Y Amplifier	5 c/s to 110 kc/s −3dB. Gain over flat portion of frequency characteristic=100. 50% down at 150 kc/s. Useful gain up to 400 kc/s. Maximum sensitivity approximately 175mV/cm. Very good square wave and pulse response. No overshoot with rise times up to 1µS.
Timebase	175mS/cm to 50µS/cm in four switched ranges. Approximate ranges: range one, 175–10mS/cm; range two, 20mS–500µS/cm; range three, 5mS–250µS/cm; range four, 2mS–50µS/cm. Fine control gives ample overlap on all ranges. 100% flyback suppression on all ranges. The X gain control gives trace expansion of approximately 8 screen diameters.
X Amplifier	3 c/s to 25 kc/s −3dB. Gain approximately 10. 50% down at 35 kc/s, useful gain up to 50 kc/s. Switching facilities for external use.
Synchronising	Continuously variable from zero to over sync.
Internal Cal.	50 c/s square wave. 3 volt peak-to-peak amplitude. Exact 1:1 mark-space ratio. Rise time better than 5µS.
Dimensions	Height 9in. Width 8¾in. Depth 14in.

Astigmatism Control

A pre-set astigmatism control, R_5, is connected in a divider network across the h.t. supply. It allows the A3, Y2 and X2 plates to be pre-set to the same mean d.c. potential as the X1 and Y1 plates. This gives an improvement in focus, as

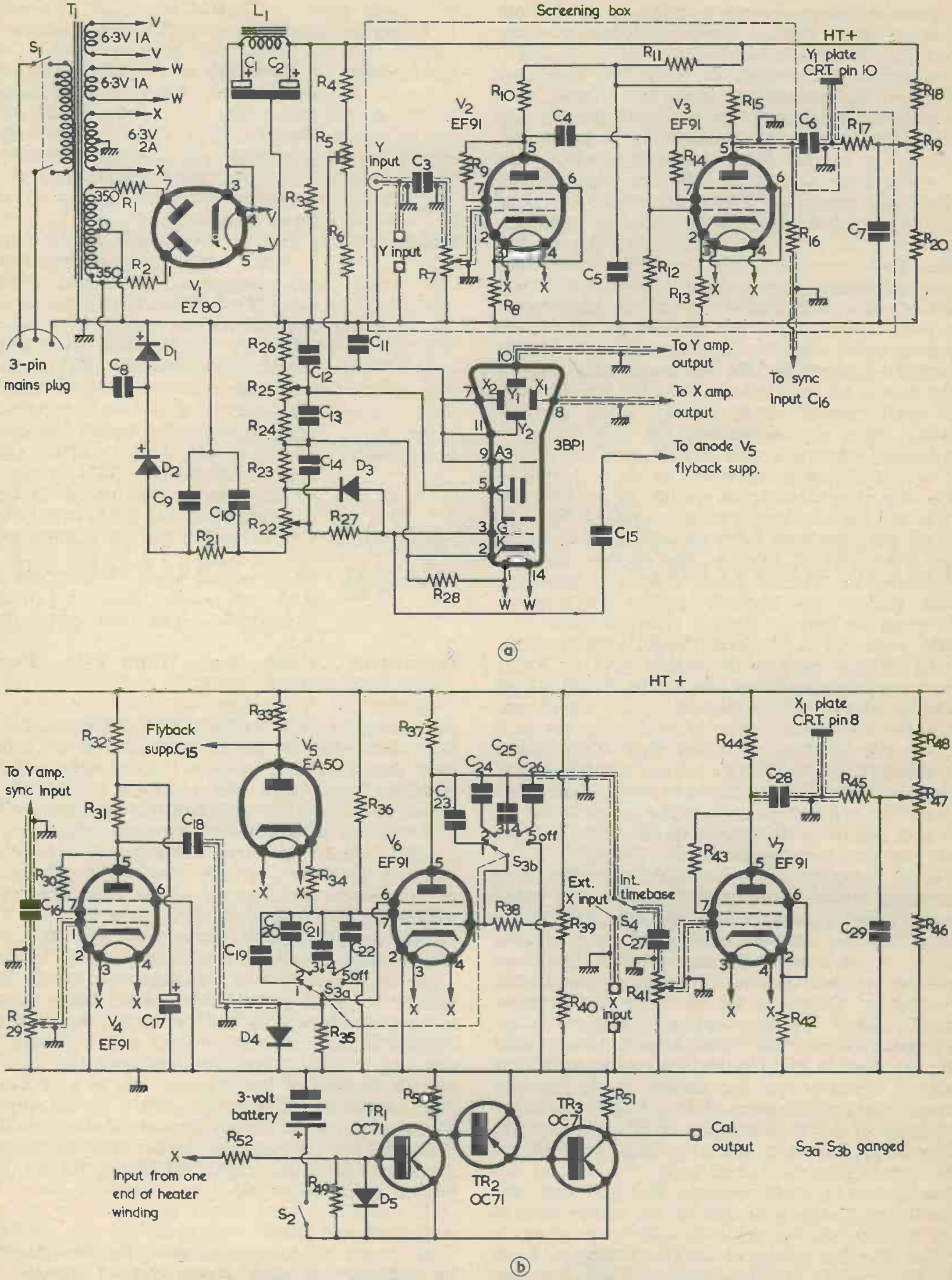


Fig. 1 (a). The circuit of the power supply and c.r.t. section of the oscilloscope, together with the Y amplifier
(b). The timebase and calibrator sections

Components List

Resistors

(All fixed resistors 10% $\frac{1}{2}$ watt unless otherwise stated)

$R_{1,2}$ 470Ω 1 watt
R_3 100kΩ 1 watt
R_4 22kΩ
R_5 100kΩ potentiometer, linear
R_6 56kΩ
R_7 1MΩ potentiometer, log.
R_8 820Ω 5% high stability
R_9 100Ω
R_{10} 22kΩ 2 watts, 5% high stability
R_{11} 5kΩ 2 watts, 5% high stability
R_{12} 1MΩ
R_{13} 820Ω 5% high stability
R_{14} 100Ω
R_{15} 22kΩ 2 watts, 5% high stability
R_{16} 330kΩ
R_{17} 1MΩ
R_{18} 6.8kΩ
R_{19} 250kΩ potentiometer, linear
R_{20} 47kΩ
R_{21} 100kΩ 1 watt
R_{22} 50kΩ potentiometer, linear
R_{23} 3.3kΩ
R_{24} 220kΩ 1 watt
R_{25} 500kΩ potentiometer, linear
R_{26} 150kΩ 1 watt
R_{27} 47kΩ
R_{28} 100kΩ
R_{29} 1MΩ potentiometer, linear
R_{30} 100Ω
R_{31} 22kΩ
R_{32} 82kΩ
R_{33} 470kΩ
R_{34} 330kΩ
R_{35} 22kΩ
R_{36} 22kΩ 2 watts
R_{37} 47kΩ 2 watts
R_{38} 220kΩ
R_{39} 1MΩ potentiometer, linear
R_{40} 27kΩ
R_{41} 500kΩ potentiometer, linear
R_{42} 3.3kΩ
R_{43} 100Ω
R_{44} 22kΩ 2 watts
R_{45} 1MΩ
R_{46} 47kΩ
R_{47} 250kΩ potentiometer, linear
R_{48} 6.8kΩ
R_{49} 220kΩ
R_{50} 56kΩ
R_{51} 2.2kΩ
R_{52} 3.3kΩ

Capacitors

$C_{1,2}$ 32+32μF electrolytic, 450V wkg.
C_3 0.25μF paper 750V wkg.
C_4 0.25μF paper 350V wkg.
C_5 220pF silver mica 350V wkg.
C_6 0.25μF paper 350V wkg.
C_7 0.1μF paper 350V wkg.
C_8 0.5μF paper 500V wkg.
$C_{8,10}$ 0.5μF paper 1 kV wkg.
$C_{11,12}$ 0.1μF paper 350V wkg.
C_{13} 0.1μF paper 500V wkg.
C_{14} 0.1μF paper 350V wkg.
C_{15} 0.1μF paper 500V wkg.
C_{16} 0.001μF paper 350V wkg.
C_{17} 8μF electrolytic 350V wkg.
C_{18} 0.001μF paper 350V wkg.
C_{19} 0.25μF paper 350V wkg.
C_{10} 0.05μF paper 350V wkg.
C_{21} 0.01μF paper 350V wkg.
C_{22} 0.002μF paper 350V wkg.
C_{23} 0.5μF paper 350V wkg.
C_{24} 0.1μF paper 350V wkg.
C_{25} 0.02μF paper 350V wkg.
C_{26} 0.005μF paper 350V wkg.
$C_{27,28}$ 1μF paper 350V wkg.
C_{29} 0.1μF paper 350V wkg.

Inductors

T_1 Mains transformer. 200–250 volt primary. Secondaries: 350–0–350V 50mA; 6.3V 2A centre-tapped; 6.3V 1A; 6.3V 1A. (Radiospares "Heavy Duty" mains transformer or equivalent)
L_1 Smoothing choke. 10 henry. (Radiospares "Hygrade" Smoothing Choke or equivalent)

Valves

V_1 EZ80, EZ81 or 6V4
$V_{2,3,4,6,7}$ EF91, Z77, 6AM6
V_5 EA50

Cathode Ray Tube

Type 3BP1 with mu-metal screen and base

Transistors

$TR_{1,2,3}$ OC71

Diodes

$D_{1,2}$ rectifiers type K3/40 or K3/45
$D_{3,4,5}$ OA81

Switches

S_1 d.p.s.t. toggle switch
S_2 s.p.s.t. toggle switch
S_3 2-bank Yaxley switch, 1-pole 5-way each bank
S_4 s.p.d.t. Yaxley switch

Valveholders and Sockets

1 B9A valveholder with screening can
5 B7G valveholders with screening cans
5 input sockets
1 coaxial socket

Miscellaneous

1 3-volt pen torch battery
10 pointer knobs
Grommets, tagboards, tagstrips, etc.

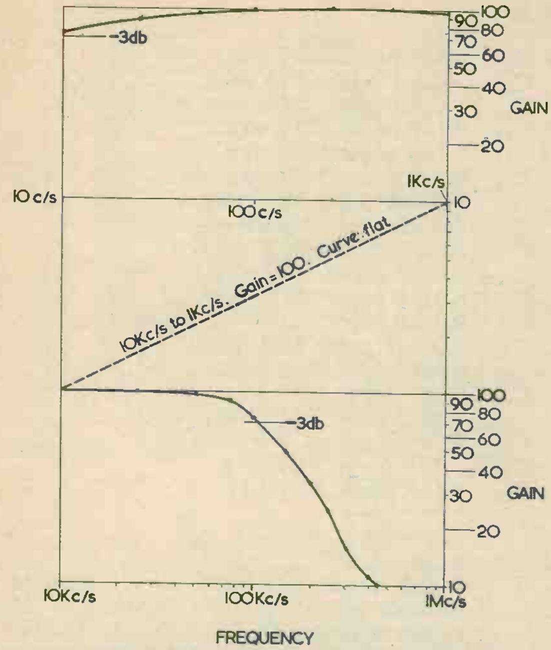


Fig. 2. Characteristic curve for the Y amplifier, with frequency plotted against gain. The curve was taken with an input of 200mV peak-to-peak (output 20V peak-to-peak). The maximum undistorted output is 270V peak-to-peak

the best focus is only obtained when all four deflection plates are at the same potential as A3.

The e.h.t. voltage is derived from one half of the secondary winding, C_8, D_1 and D_2, forming a half-wave voltage doubler circuit, smoothing being provided by R_{21}, C_9, and C_{10}. The e.h.t. chain is made up of resistors R_{22} to R_{26}, the various c.r.t. electrode voltages being tapped off at suitable points. The grid bias is varied by means of R_{22}, this being the brightness control, the brightness increasing as the control is moved nearer the cathode potential. R_{23} prevents the grid from reaching the cathode voltage and obviates the possibility of its passing grid current which could damage the c.r.t. R_{27} provides isolation between the incoming flyback suppression pulse and the e.h.t. chain. The diode D_3 is a further safeguard for preventing the grid from being driven positive should a component break down. The diode conducts if the grid goes positive with respect to cathode and therefore acts as a safety device.

The focus is controlled by the potential on A2, R_{25} serving as focus control. Both the brilliance and focus potentiometers, anode A3, and the cathode are decoupled to chassis via C_{11} to C_{14}, this minimising interference to the trace due to stray pick-up. The c.r.t. heaters are fed from their own winding on the transformer, this being "tied down" to the cathode by R_{28} and so preventing heater-cathode insulation breakdown problems.

The e.h.t. output voltage should be in the region of 750 volts negative with respect to chassis, the current taken by the resistor chain and c.r.t. being less than one milliamp! As A3 will be between 200 and 250 volts positive with respect to earth, the total voltage across the c.r.t. should be just under 1kV. Care should therefore be taken when working with the instrument "live".

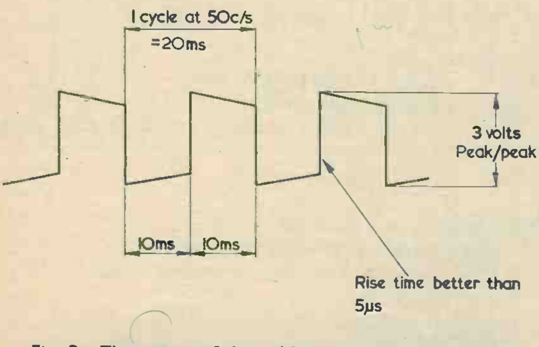


Fig. 3. The output of the calibration unit as viewed on the oscilloscope. The slight slope on upper and lower edges is due to the l.f. response resulting from the a.c. couplings in the Y amplifier. All corners should be clean cut, with no overshoot or rounding

Internal Calibration Unit

Finally we come to the internal calibration unit. Whilst this is not essential to the working of the oscilloscope, it is well worth incorporating. It consists of three transistors d.c. connected in cascade, the overall amplification being extremely high. The input is fed with a sine wave from the main heater supply. The diode D_5 and the base-emitter diode of TR_1 provide symmetrical clipping of each half of the sine wave. The resultant semi-square wave is then amplified to such an extent that the final output developed across R_{51} is an almost pure square wave. The 3 volt peak to peak output is the same value as the battery supply, since TR_3 is driven fully between cut-off and bottomed conditions. The output is symmetrical, having a mark-space ratio of 1:1, and a rise time of less than 5μS. Also, no ringing or overshoot (see Fig. 3) occurs as the complete circuit is d.c. coupled. Due to the absolute symmetry and constant amplitude of the output the unit can be used for both time and amplitude calibration. It may also be used externally for testing audio equipment, etc. As the unit is switched on only when required, by means of S_2, and takes only a couple of milliamps of current, its operating life is virtually the shelf life of the battery. Since this is only a three volt pen-torch type, replacement is both simple and cheap.[1]

To be Continued

[1] Since the voltage from point X swings about chassis, and the reference voltage for diode D_5 and TR_1 emitter-base diode is three volts positive of chassis, a 50:50 clipping action may not occur. It seems feasible that squaring is the result of TR_1 and the subsequent transistors switching on and off.—EDITOR.

RADIO TOPICS . . .

by Recorder

SINCE, IN ALMOST ALL PARTS OF the U.K., it is nowadays possible to obtain reliable f.m. reception of the B.B.C. Home, Light and Third programmes, the construction of Band II f.m. tuners employing switched station selection offers considerable attraction. Instead of having to carefully adjust a variable capacitor to tune in the required station, one merely turns a switch. The desired programme is then not only immediately available but is accurately tuned in as well.

An excellent example of a switched tuner is given by the "Crystella" crystal-controlled unit, which was described by Sir John Holder in our February and March issues of last year. This employed the Standard Telephones and Cables crystal unit type 4434, in which three crystals are mounted in one envelope. These crystals control oscillator frequency and ensure that exactly the correct intermediate frequency is fed to the i.f. amplifier and discriminatoı stage.

An Ingenious Approach

An alternative, and ingenious, approach to the construction of switched f.m. tuners has been originated by one of our readers, Mr. M. F. Trowbridge of Sturminster Newton. Mr. Trowbridge has sent us the appropriate details, and I am happy to pass these on here. I should add that this alternative project is best tackled by constructors who have had some experience with television turret tuners, and who can tackle the coil adjustments required.

Basically, Mr. Trowbridge's tuner consists of a modified TV turret tuner of the PCC84–PCF80 type followed by a conventional 10.7 Mc/s i.f. strip and discriminator. The original i.f. transformer in the turret tuner is removed and is replaced by a new 10.7 Mc/s component. Also, all the coil segments are removed, three of these being rewound to receive the local Home, Light and Third signals respectively. The secondary of the new 10.7 Mc/s i.f. transformer is coupled to the 10.7 Mc/s i.f. strip, whereupon the whole assembly comprises a complete switch-tuned f.m. tuner.

The prototype model used a conventional Cyldon turret tuner which had originally been employed to convert a B.B.C.-only receiver to 13 channel operation. It is important to note that the conversion details which follow apply to this particular tuner only. They will not apply to other makes of tuner, nor can they necessarily be guaranteed to apply to other Cyldon tuners in the same category. Constructors should be prepared to experiment a little, if necessary.

The first process in the modification of the turret tuner consists of removing the existing i.f. transformer and of fitting the new 10.7 Mc/s transformer. In the prototype, a standard Jason component, type L4, was used here. Fig. 1 (*a*) shows part of the circuit around the pentode section of the PCF80 in the original prototype tuner, whilst Fig. 1 (*b*) shows this after modification.

When mounting the 10.7 Mc/s i.f. transformer, it is unimportant whether the anode coil is at the top or the bottom of the former so long as opposite ends of the coils are made "live" to the signal. However, the transformer should be positioned so that leads are as short as possible in order to avoid instability. Holes are drilled in the side of the turret tuner as necessary to take the various interconnecting wires.

Wiring Modifications

Several wiring modifications need to be carried out. In the prototype tuner a resistor (R_{12} in Fig. 1 (*a*)) was wired across the grid coil

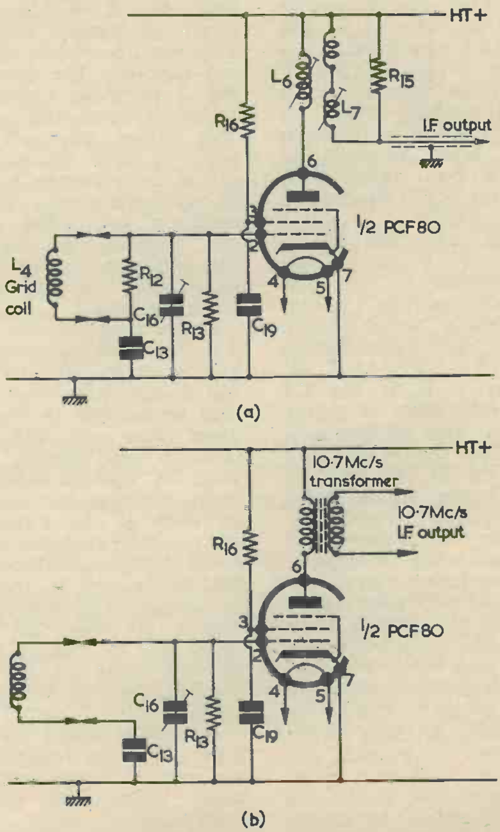


Fig. 1 (a). Part of the circuit around the PCF80 in the prototype tuner (b). The circuit modified for switched f.m. station selection

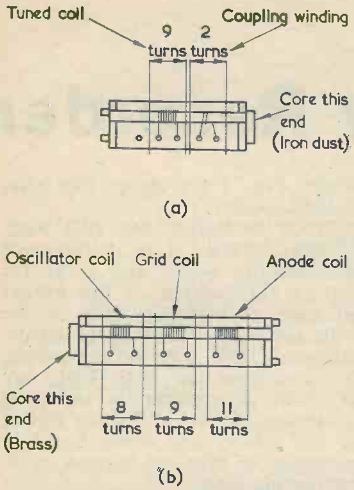


Fig. 2 (a). An aerial coil segment rewound for f.m. operation
(b). A modified oscillator and band-pass segment

feeding the pentode section of the PCF80. This resistor (usually 47kΩ) should be removed to give a reduction in r.f. bandwidth.

The cathode of the PCC84 r.f. amplifier may be returned to a separate gain control circuit. If fitted, such a circuit can be removed, the cathode being returned to chassis via its bias resistor. (A typical value for a PCC84 cathode bias resistor is 100Ω).

The existing tuner will almost certainly employ P-type valves, these being intended for operation in a series heater chain at 0.3 amp. The PCC84 has a heater voltage of 7 and the PCF80 a heater voltage of 9. Since the 10.7 Mc/s i.f. strip will very probably use 6.3 volt valves, this raises a power supply problem. One solution consists of replacing the PCC84 and PCF80 with an ECC84 and an ECF80, the heater wiring being changed as required. With the prototype tuner the problem was overcome by rewinding the secondary of a 6.3 volt heater transformer to give an output of 9 volts tapped at 7 volts, and by applying these two voltages to the valves accordingly. Pin 4 of each valve was connected to chassis and the appropriate supply applied to pin 5. Ferroxcube beads were fitted, as close to the valveholder tag as possible, in the leads to pin 5 of each valve. (I would suggest that, if the pin 5 tags were by-passed to chassis via a 1,000pF ceramic capacitor in the usual manner, the beads might not be necessary).

The h.t. supply to the modified turret tuner is of the order of 200 volts.

It is necessary for the 10.7 Mc/s i.f. transformer on the turret tuner to be connected to the first valve in the following 10.7 Mc/s i.f. strip by very short leads. The chassis of the turret tuner has, therefore, to be bolted to that of the i.f. strip at an appropriate position. This is, in any case, essential before the coils can be rewound.

Three complete sets of coil segments have to be made up, these catering for the local v.h.f. Home, Light and Third transmissions. All three sets of coils are wound with the same number of turns.

To prepare a new coil segment, remove the existing wire from a Band I segment, carefully noting the positions of the coils on the former and also the direction of the turns. The coils are then rewound using either the same wire or wire of an equal gauge, making sure that the direction of turns is the same as for the original coils. Fig. 2 (*a*) shows a rewound aerial coil segment and Fig. 2 (*b*) a rewound band-pass and oscillator coil segment. The details given in Fig. 2 are those applicable to the prototype tuner and, as I said a little earlier, may not necessarily apply to other tuners. The aerial coil in the prototype was tuned by an adjustable core as, also, was the oscillator coil. The anode and grid windings on the band-pass and oscillator segment were tuned by moving the turns of the coil along the former.

Before aligning the new coils it is first of all necessary, of course, to line up the 10.7 Mc/s i.f. strip and discriminator stage. It should then be possible to align the new turret tuner coils with the aid of received aerial signals. The three local f.m. stations should be tuned in by adjusting the oscillator core on each of the three band-pass and oscillator segments, such adjustments being carried out with the fine tuning cam in the middle of its swing. The signals are then peaked up with the aerial coil cores, and by altering the spacing between turns on the band-pass windings and the distance between them.

It may be added that oscillator drift should be negligible, due to the original design features of the tuner when used at television frequencies.

Aluminium Foil

As most of us must have discovered, things in electronics now and again turn out to be not quite what we had expected. So it is with some of the insulating materials which we occasionally use, and it would appear that especial care has to be taken with products whioh are not specifically lintended for electrical purposes.

In the article "Tailor-Made Tagboards", which appeared in our May issue, it was suggested that either Paxolin or Formica be employed for the insulating panels which form the basis of the boards. This has prompted a comment from some of our readers, and notably G3MQT, who warns that not all types of Formica and similar materials (as obtained from do-it-yourself shops), are suitable for this purpose. It appears that heat-resistant types may have a thin sheet of aluminium foil sandwiched in the material, which can then cause short-circuits between any eyelets, rivets or bolts inserted through holes in the board.

When incorporated, the aluminium foil can be seen by splitting a piece of the material with a sharp penknife. It may also be detected by laying a lighted cigarette on the surface of the material. If the material burns no foil is present, whilst if it doesn't burn this means that the foil is incorporated. The function of the foil is to conduct the heat away.

It should be added, incidentally, that pencil markings should not be used for marking out actual tag positions. The graphite tracks remaining can cause high resistance leaks between tags.

The moral seems to be that great care should be exercised when using materials for insulation which are not specifically intended for the purpose, and that it would be best to play safe and employ one of the acknowledged insulating products such as Paxolin.

Before concluding on this particular subject, I think I should make the additional point that the range of materials which we, in the home-constructor field, designate by the trade-name "Paxolin" is usually referred to, in electrical and electronic engineering, as "synthetic resin bonded paper" or "s.r.b.p.". Since the latter term is largely unknown amongst amateur constructors, we tend to employ the more generally used word, "Paxolin".

Coil Wire Gauge

I started off this month with an item concerning television tuners, and it seems as though I'll be finishing on the same subject as well!

If you look inside a television turret tuner employing wound coils (as opposed to printed circuit coils) for the air-cored band-pass anode and grid windings, you will often find a quite noticeable difference in the gauge of wire employed for the different Band III channels. The anode and grid coils for one Band III channel may employ winding wire which is significantly thicker, for instance, than that used for the coils on the neighbouring channel.

There is a reason for this, and it may well be of interest to constructors and experimenters who work at frequencies where air-cored coils in tuned circuits have less than 4 turns or so.

At Band III frequencies, very little inductance is required in the anode and grid band-pass tuned circuits. Since a straight piece of wire can have significant inductance at Band III it is necessary to ensure that as little inductance as possible is "lost" in the chassis wiring between the appropriate tuning capacitances and the points to which the ends of each turret coil proper are soldered. This is why turret tuners are laid out so that the valveholder tags are very close indeed to the fixed contacts which connect to those on the rotating turret.

Even with these precautions it may still happen that the grid and anode band-pass coils proper have only 2 turns each for most of the Band III channels. How, then, does the coil designer cater for the individual channels in the Band?

Let's assume that, for Channel 10, both the anode and grid coils of a television tuner require 2 turns each of, say, 18 s.w.g. wire. What happens when the designer starts work on the corresponding coils for Channel 11? Less inductance is required here, since Channel 11 is 5 Mc/s above Channel 10, but he can't get it by such a simple expedient as reducing the number of turns to, say, 1¾. This is because the ends of the coil *must* solder to the contact pins moulded into the segment, and so he must still design a coil having 2 turns! Also, of course, the coils are air-cored, and so he can't play around with iron-dust or metal slugs. With a bit of luck, he may be able to get the reduced inductance by increasing the spacing between the 2 turns he's forced to accept.

Channel 12 comes next, another 5 Mc/s higher, but it will now almost certainly be impossible to get the further reduced inductance which is required by once more increasing the spacing between turns, as this spacing will have come to its limit on Channel 11. So the designer reduces inductance by the simple process of winding his 2 turns with thicker wire, say 16 s.w.g. The inductance of a thick wire is less than that of a thin wire and the difference is sufficient to be of importance when the coil has only 2 turns or so. On Channel 13, the coil designer may be able to get another 5 Mc/s higher, whilst still retaining the 2 turns he's forced to accept, by falling back on increased spacing once more, or by going to a thicker wire again.

The same process occurs for channels below Channel 10. In this case the designer can obtain his increases in inductance, corresponding to downward steps in frequency of 5 Mc/s per channel, by decreasing spacing between turns where possible, and by using thinner wire. It is possible that, at one point, he may be able to change over from 2 turns of a thin wire for one channel to 3 turns of a thick wire for the next to obtain the requisite 5 Mc/s step downwards in frequency.

This brief description offers a somewhat simplified example of v.h.f. turret tuner design for air-cored coils which have very few turns, and where the designer has to face the problem of providing a small change in inductance without deviating from a whole number of turns. It offers the important lesson that it is possible to effect quite significant changes in coil inductance whilst retaining the same geometry by simply using a different gauge of winding wire. The inductance goes up if a thinner wire is used and it goes down if a thicker wire is used. This little tip may well be of use to experimenters working at these frequencies. It also provides an additional reason why it is very desirable to use thick wire to connect a tuning capacitor to a coil which has only a few turns. If you use thin wire, quite a lot of the tuned circuit inductance may appear in the connecting wire!

I should mention that the effect I've just described only becomes really significant when an air-cored coil has less than 4 turns or so. Above this number of turns it is usually possible to obtain any small shifts in inductance which may be required from air-cored coils with "whole number turns" by varying the spacing along the former. Altering the winding wire gauge has less effect as the number of turns increases.

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continued from page 857

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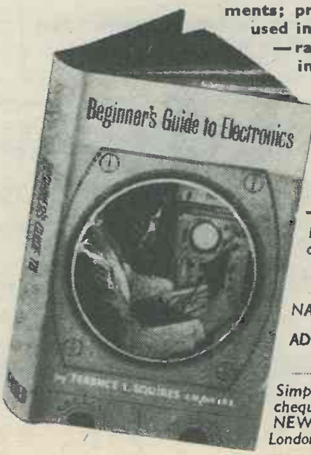

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DM16HL Dual Impedance ...	£7. 7.0
100C Crystal with Stand ...	£1.19.6
Adjustable Table Stand (P.P. 2/–)	£1. 5.0
FS3 Telescopic Floor Stand (P.P. 3/6)	£2.15.0

MAINS AND BATTERY RECORD DECKS

ALL COMPLETE with ARM and CARTRIDGE

★ BSR UA14 4-speed	£5.19.6
★ BSR UA15 4-speed	£6.19.6
★ Garrard Autoslim 4-speed ...	£6.10.0
★ Unplugable Head Version ...	£6.19.6
or Stereo Version	£7.19.6
★ SRP10 4-speed or BSRGU7...	£5. 0.0
★ Garrard AT6 with Stereo Cartridge, 4-speed	£10.19.6
★ AT6 with EV26 or Sonotone Head	£11.19.6
★ AT6 with Mono Head ...	£10.10.0

P. & P. 3/6 any type above

★ 9V Star, 45 r.p.m.	£1.19.6
★ 45 and 33 r.p.m. Star, 9V ...	£4.12.6
★ 45 r.p.m. Garrard 6V ...	£1.15.0
★ 4-speed B.S.R., 9V	£5. 5.0

P. & P. 2/6 any of above

We can supply from stock most of the components and items specified on circuits published in this and other magazines and radio books. Let us quote for your circuit.

TRANSISTORS, CRYSTALS, VALVES AND COMPONENTS

THE LARGEST RANGE OF THE ABOVE ITEMS IN THE COUNTRY

We stock far too many types to list here. See our Catalogue for full selection

RETURN OF POST SERVICE

A SELECTION FROM OUR STOCKS

See Catalogue for full details

Sinclair Micro-6 (to build)	59/6
Sinclair TR750 Amplifier (to build) ...	39/6
Sinclair Micro Injector (to build) ...	27/6
Tape Jack Tuner (Full Med. Wave) ...	29/6
10-Watt Horn Tweeter	29/6
20-Watt Super Tweeter	69/6
Two-channel Mixer for Mics/Pu's ...	15/–
1 to 200 Mc/s Field/str. Meter ...	69/6
$\frac{3}{4}$-Watt 4-transistor 9V 3Ω	49/6
5-hole Chassis Punch Kit	49/6
Headphones 2kΩ 12/6; 4kΩ	14/6
Stereo Stethoscope Headset, 8+8 arm	25/–
Resistor Substitution Box	37/6
Crystal Mono Stethoscope Headset ...	10/6
Magnetic Mono Stethoscope Headset...	12/6
Transistor Signal Injector	39/6
Fully Disappearing Car Aerial	35/–
Test Lead Kit with Pouch	8/6
Capacitor Substitution Box	29/6
De Luxe Stereo Headsets with junction box	£6
4-channel Transistor Mixer	59/6
3-Transistor MW Superhet Tuner ...	82/6
4-Transistor MW/SW Superhet Tuner	£7.9.6
PP3 9V Batt. Eliminator	18/6
Transistor Telephone Amplifier ...	65/–
8+8Ω Stereo Headphones	62/6
Crystal Lapel Microphone	12/6
2kΩ Magnetic Lapel Microphone ...	8/6
Crystal Contact Microphone	12/6
2kΩ $\frac{1}{2}$ track Tape Head	15/–
2kΩ 1" diam. Mag. Mic. Insert... ...	15/–
MCI Crystal Mic. Insert	5/–
Earphones, Crystal or Magnetic Complete with Jack and Socket. ...	5/–
Telephone Recording Attachment ...	12/6
50–0–50μA Edgewise Meter	25/–

★ TRANSISTOR POCKET RADIOS ★

Ready to use, complete with Battery, Leather Case, Earphone. P.P. 2/– any type.

6-Transistor De Luxe	69/6
7-Transistor Zephyr	79/6
6-Transistor MW/LW	£5.19.6

NOMBREX PORTABLE TRANSISTORISED TEST EQUIPMENT

R.F. I.F. Gen. 150 kc/s to 350 Mc/s	£9.10.0
Resis. Capacitance Bridge ...	£8.5.0
Inductance Bridge	£18
1 to 15V 100mA Power Supply	£6.10.0
10 to 100,000 c/s Audio Gen. ...	£16.15.0

DETAILED LEAFLETS ON REQUEST

SPECIAL OFFERS

★ Miniature 6 pole 2-way Push-on Release-off Switches 6/–, P.P. 6d.
★ Miniature 3-button 6-pole 2-way Switch Unit 5/–, P.P. 6d.
★ ACOS 45 Hand Microphone **19/6**
★ 3" square 3Ω Speaker **12/6**
★ $2\frac{1}{2}$" Plastic Cone Tweeter **17/6**
★ 4 Fig. 3/6V Pulse Counter **15/-**

HENRY'S RADIO LTD

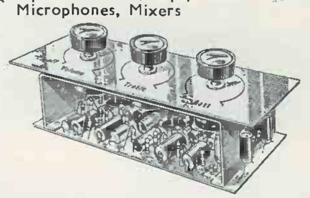
303 EDGWARE ROAD LONDON W2

PADdington 1008/9

Open Monday to Sat. 9–6. Thurs. 1 o'clock

7-TRANSISTOR RECORD PLAYER PORTABLE AMPLIFIER

★ 4 watt peak output
★ Full Treble and Bass boost and cut
★ 40 c/s to 20 kc/s ±3dB
★ Inputs for Pick-ups, Radio Tuners, Microphones, Mixers



★ 9–12V mains or battery operation for 3–5Ω speakers (mains unit **49/6** extra)
★ Size only 6" x $2\frac{1}{2}$" x 2". Ideal for mains or battery, portable or domestic record player, grams, etc., or car.

Built Ready To Use £5.19.6 P.P. 2/–

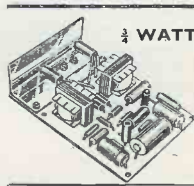
GARRARD 2-TRACK BATTERY TAPE DECK

9V operated, 2 track, 2 speed. Brand new, fitted heads, etc. Supplied complete with cassette. Brand New.

£11.15.0. P.P. 3/6

FM VHF TUNING HEART

Printed circuit construction, fully tunable 85 to 105 Mc/s. Completely screened. Requires UCC85 (**8/6**), R.F. stage and osc./mixer stage.
Brand new in maker's cartons **15/–**. P.P. 1/–



$\frac{3}{4}$ WATT 4 TRANSISTOR AMPLIFIER

★ Improved Version. $1\frac{1}{4}$ watt peak output. ±3dB 70 c/s to 12 kc/s. Output to 3 ohm speaker 9 volt operated.

Built and Tested		Kit of Parts
49/6	**OR**	**39/6**
P.P. 1/6		P.P. 1/6

● NEW LOW PRICE ●

Details on request.

MINIATURE PANEL METERS

*0–50μA (D.C.) **39/6**; *0–5mA (D.C.) **27/6**; *0–500μA (D.C.) **32/6**; *0–300V (D.C.) **27/6**; *0–1mA (D.C.) **27/6**; "S" Meter **35/–**.
All Brand New Boxed.
*Available Clear Plastic Front or Black Moulded. State which.

METER BARGAINS

50μA $2\frac{1}{2}$" square MC	35/–
0–100μA $2\frac{1}{2}$" f. D.C.	35/–
1mA $2\frac{1}{2}$" flush round	30/–
0–500μA 2"	15/–
0–500μA $2\frac{1}{2}$" flush mounting, D.C....	20/–
$2\frac{1}{2}$–0–$2\frac{1}{2}$mA, $2\frac{1}{2}$", flush, D.C. ...	12/6

QUARTZ CRYSTALS

100 kc/s **15/–**; 500 kc/s **15/–**; 455 kc/s **12/6**; 456 kc/s **15/–**; 27.255 Mc/s **15/–**.
Twin Crystal, 1 Mc/s, and 100 kc/s **22/6**.
Over 800 frequencies in stock

NEW CATALOGUE
84 PAGES, 10" x $7\frac{1}{4}$"
Up to date with new items and many price reductions.
Fully detailed and illustrated,
Price 2/6 post paid

We can supply from stock most of the components and items specified on circuits published in this and other magazines and radio books. Let us quote for your circuit.

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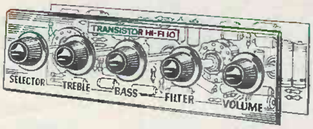
TRANSISTOR HIGH FIDELITY EQUIPMENT

FOR MAINS OR BATTERY OPERATION

MONO FULL FUNCTION PRE-AMPLIFIER/CONTROL UNIT

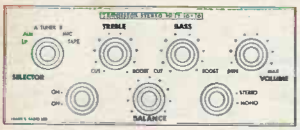
PRICE **£5.10.0** P.P. 2/–

★ Dark brown and gold front panel plate **8/6**



For use with transistor power amplifiers as below or valve amplifiers —hum free—high sensitivity—8 inputs between 1.5mV and 300mV, with full equalisation. For all pick-ups—microphones, tuners—tape replay. Separate treble and bass with cut and boost—4 position low pass filter. Volume, 40 c/s and 20 kc/s, etc. Output 250mV. Overall size 9" x 2½" x 2". Battery operated (2½mA) or from power supply. Signal to noise ratio 70dB at 10 watts with power amplifier. Supplied built and ready to use.

INTEGRATED STEREO PRE-AMPLIFIER



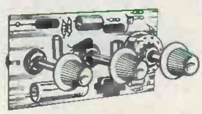
Two channel version of above with addition of balance and mono/stereo controls. Overall size 9" x 3¼" x 1⅝" deep. Designed to feed two 10 watt power amplifiers as below. Supplied built and ready to use. 5mA current.

PRICE **£10.19.6** P.P. 3/6

★ Dark brown and gold front panel plate **15/–**

MULTI-INPUT PRE-AMPLIFIER

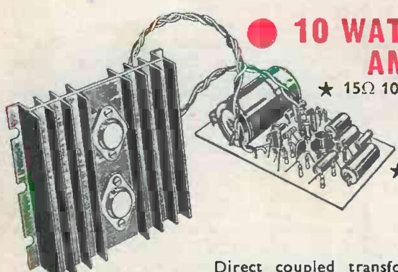
For use with the transistor power amplifier or as a general purpose pre-amplifier. A simplified version of the full function pre-amp. 8 inputs from 1.5mV to 300mV. Input selector, tone and volume controls. Size 5" x 2½" x 2". Ideal for public address systems, for microphones and pick-ups.



PRICE **65/–** P.P. 1/6

★ Dark brown and gold front panel plate, **6/6**

10 WATT POWER AMPLIFIERS



★ 15Ω 10 watt 40V supply. **£5.19.6** P.P. 2/6

★ 3Ω 10 watt 24V supply, **£5.10.0** P.P. 2/6

Direct coupled transformerless design. Sensitivity 100mV from 10kΩ or less source for 10 watts output. Response ±1dB 40 c/s to 10 c/s. 0.25% total distortion at 10 watts. Push-pull class B output. 60dB feedback. Two versions available for 3Ω to 4Ω and 15Ω to 16Ω output. Battery or mains supply operation. For use with mono or stereo preamplifiers as above. Supplied built and ready to use. The 24V version is suitable for 12V operation with an output of 3/4 watts.

MAINS POWER PACKS

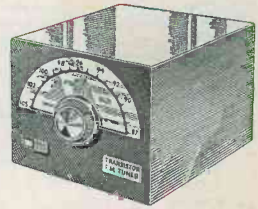
PS245. Single amplifier, 24V – **59/6** PS24. Two amplifiers, 24V – **69/6**
PS402. Single amplifier, 40V – **59/6** PS40. Two amplifiers, 40V – **69/6**

DETAILS WITH CIRCUITS OF ABOVE UNITS ON REQUEST (TRADE SUPPLIED)

VHF FM TRANSISTOR TUNER

★ **Mullard 5-Transistor.**
★ **4 Diodes.**
★ **Full coverage 87 to 105 Mc/s.**
★ **AFC and AVC.**
★ **Over 1V output.**

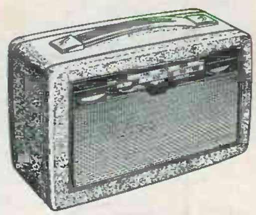
Printed circuit design of high sensitivity and quality. Output for valve or transistor amplifiers. Size 3½" x 2¼" x 3". Simplified building instructions. Operates from 9V 9–10mA. All parts sold separately. Complete with dark brown and gold panel plate.



TOTAL COST £7.19.6 P.P. 2/6
(Cabinet assembly 20/– extra)

Detailed Circuit Book on Request

NEW! "CONVAIR" PUSH-BUTTON PORTABLE/CAR RADIO



★ **New printed circuit 6-transistor design. Over 700mW push-pull output.**
★ **Push-button selection of MW and LW with full tuning on both wavebands.**
★ **A new design with amazing performance at a realistic price.**
★ **New attractively designed portable cabinet with horizontal tuning and all stations marked.**

Total Cost of ALL Parts £7.19.6 P.P. 3/6 (Batteries 6/– extra)

ALL PARTS SOLD SEPARATELY **(available June/July)**

FOLLOWING A LINE OF QUALITY AND VALUE IN PORTABLES

CONTESSA PORTABLE

AS PREVIOUSLY ADVERTISED

COST OF ALL PARTS **£9.19.6** P.P. 3/6

BUILD A QUALITY PORTABLE TAPE RECORDER

Complete in every detail
★ Pre-built units—Collaro Studio Decks—Portable Cabinets with Speakers. 6 valve designs

TWO TRACK
Total Cost £26 P.P. 8/6

FOUR TRACK
Total Cost £30 P.P. 8/6

ALL MARTIN AUDIO-KITS IN STOCK

★ **Leaflets on Request** ★

SPECIAL TAPE OFFER

Scotch Boy 3¼" 300ft L.P. Tape. Complete with spare spool.

Only 5/6 P.P. 1/–

Minigram Transistor Portable Record Player

★ Made by well known British manufacturer. Features ready built 4 transistor printed circuit, 1 watt amplifier, elliptical speaker and volume control. Low current Starr constant speed 45 r.p.m. turntable with crystal pick-up. Strong moulded two-colour cabinet with handle. Plays anywhere on long life 9 volt battery. Requires less than half an hour's work to connect up using ready built units and easy instructions.

TOTAL COST 79/6 P.P. 5/– (Battery 3/9)

Or Amplifier with volume control and 5" x 3" Speaker, 4-Transistor, **35/–**. P.P. 2/–
9V Starr Player with Pick-up **39/6**. P.P. 2/6
And Two-Tone Case **5/–**. P.P. 2/–

RECORD/REPLAY/ERASE TAPE HEADS

Marriot Type R/RP/3 ½ track record-replay head and Mullard type TS erase head with mounting post.

Bargain Offer **15/– Pair.** P.P. 1/–

★ **700Ω IMPEDANCE** ★