THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 17 NUMBER 9
A DATA PUBLICATION
PRICE TWO SHILLINGS

April 1964

Transistorised Vibrato Unit

Model Control Pocket Wavemeter/Monitor ■ Tone-Operated Switching Circuit ■ 3-Transistor VHF Receiver ■ Electronic "Watch Dog"

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

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 batteries included free. Data for each receiver, 2/6 extra, refunded if you purchase the parcel.

THE SKYROVER

Controls: Waveband Selector, Volume Control with On/off Switch, Tuning Control. In plastic cabinet, size 10" x 6½" x 3½", with metal trim and carrying handle.

Can be built for **£10.19.6** H.P. Terms:—22/- dep. & 11 months at 21/-

P. and P. 5/– extra

THE SKYROVER DE LUXE

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

Can be built for **£12.19.6** *P. and P. 5/– extra* H.P. Terms:—26/– deposit and 11 months at 24/6

REALISTIC SEVEN

★ 7-transistor Superhet. ★ 350 milliwatt output into 4" high flux speaker. ★ All components mounteo 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", in Red/Grey, 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 2½" 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 79/6** 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 ¾" x ½". Clips to fingerboard–no screws. Complete with cable. LASKY'S PRICE **15/11** *P. & P. 1/–*

The "Sixteen" Multirange METER KIT

This outstanding meter was featured by *Practical Wireless* in the January 1964 issue. Lasky's are now able to offer the complete kit of parts as specified by the designer. The "Sixteen" Multirange offers the home constructor and serviceman an instrument that will meet most of his requirements for voltage, current and resistance measurement. There are 16 switched ranges: 9 for voltage measurement, 4 current ranges and 3 resistance ranges. All British components are used throughout. The instrument case is supplied with the meter movement built-in. The two scales are clearly printed in black on white and are very easy to read.

RANGE SPECIFICATION

D.C. volts: 0–2.5–25–50–250–500 at 20,000Ω/V.
A.C. volts: 0–25–50–250–500 at 1,000Ω/V.
D.C. current: 0–50μA, 0–2.5–50–250mA.
Resistance: 0–2,000Ω, 0–200kΩ, 0–20MΩ.
Basic movement: 40mA f.s.d. moving coil. With universal shunt full scale deflection current is 50mA.
Size/finish: Black plastic case 3¾" x 5¾" x 1¾".
Controls: 12 position range switch; separate slide switch for A.C.v olts—D.C. ohms; ohms zero adjustment pot. meter; meter zero.
External connections: Two 4mm sockets for test lead plus.
Power requirements: One 15V and one 1.5V batteries. Complete with all parts and full construction details.

This offer is exclusive to Lasky's!

LASKY'S PRICE **£5.19.6** *P. & P. 5/–*

H.P. Terms:—21/- dep. and 5 months at 21/-

Data and circuit available separately 2/6, refunded if all parts bought. Pair of batteries, 2/5 extra.

THE SPRITE

CAN BE BUILT FOR **79/6** *P. and P. 3/6 extra*

- ★ Six-Transistor Superhet Miniature Personal Pocket Radio
- ★ Long and medium wavebands
- ★ Ferrite Rod Aerial
- ★ I.F. Frq. 470 kc/s
- ★ 3" speaker
- ★ Printed circuit 2¼" x 2"
- ★ In Plastic Case. Size 4" x 2½" x ¾".

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and L.F. stages. Driver and output stages ready built with all components mounted on the printed circuit. The SPRITE pre-assembled, plus cabinet, speaker and all components for final construction, can be built for 79/6. Postage and package 3/6 extra. Data and instructions separately 2/6. Refunded if parcel is purchased. Real calf leather case, wrist strap, personal earphone and case for earphone and battery, 12/6 the lot extra. Make no mistake, this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

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.72, OC.75, OC.170, OC.171, OC.200—6/6; OC.25, 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.

33 TOTTENHAM COURT ROAD · W1
2 mins. Oxford St. Nearest Station: Goodge St.
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TAPE DECKS — CONTROL UNITS — TAPE AMPLIFIERS

COLLARO

D-83/4

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 & D83/4 TAPE DECKS. High quality mono/stereo tape decks.
D93/2, 2 track, **£36.15.0** **D83/4**, 4 track, **£29.8.0**

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**

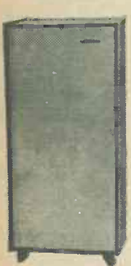
STEREO CONTROL UNIT. Model USC-1. Push-button selection, accurately matched ganged controls to ±1dB. Negative feedback, rumble and variable low-pass filters. Printed circuit boards. **£19.10.0**

Building these Heathkit models

Heathkit DAYSTROM

SPEAKER SYSTEMS

SSU-1



MFS

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.**

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.

AMATEUR EQUIPMENT

SB-10U

DX-40U

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

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**

RG-1

RA-1

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**

A wide range of American amateur equipment. See Mail Order Scheme.

All models also available assembled
Deferred Terms over **£10**

Send coupon for **FREE** *illustrated British catalogue of Heathkit range to:*

DAYSTROM LTD DEPT. RC.4 GLOUCESTER

Without obligation please send me (Tick here)
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FULL DETAILS OF MODEL(S) ....
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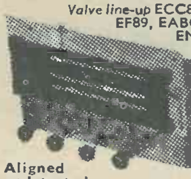
7 VALVE AM/FM RADIOGRAM CHASSIS

Three Waveband & Switched Gram positions. Med. 200–550m. Long 1,000–2,000m. VHF/FM 88–95 Mc/s. Phillips Continental Tuning insert with permeability tuning on FM & combined AM/FM IF transformers. 460 kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC & Neg. Feedback. 3 watt output. Sensitivity and reproduction of a very high standard. Chassis size 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.

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



Aligned and tested ready for use. **£13.10.0** *Carr. & Ins. 5/–.*

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		COLLARO STUDIO 3-SPEED DECK	
Twin-track	£7. 7.0	Twin-track	£10.10.0
Four-track	£9.10.0	Four-track	£14.10.0
Carr. 5/–		*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").

	Standard (PVC base)		Long Play (PVC base)		D'ble Play (Myiar base)	
3"	150ft. ...	3/9	225ft. ...	4/9	300ft. ...	6/6
5"	600ft. ...	11/6	900ft. ...	15/–	1,200ft. ...	25/–
5¾"	850ft. ...	14/6	1,200ft. ...	17/6	1,800ft. ...	32/6
7"	1,300ft. ...	17/6	1,800ft. ...	22/6	2,400ft. ...	42/6

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 2¼" 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.

RECORD PLAYER CABINETS

Contemporary style, rexine covered cabinet in two-tone maroon and cream. Size 15½" x 14¾" x 8¼", fitted with all accessories including baffle board and Vinair fret. Space available for all modern amplifiers and auto-changers, etc. Uncut record player mounting board 14¾" x 12¼" supplied **Cabinet Price 59/6.** Carr. and ins. 5/–.

2-VALVE 2 WATT AMPLIFIER
EZ80 and Twin stage ECL82 with vol. and neg. feedback tone control. A.C. 200/250V with knobs, O.P. Tfr., etc., ready wired to fit above cabinet. £3.4.0. P. & P. 1/6. 7" x 4" Speaker 15/6. P. & P. 2/–.

COMPLETE R/PLAYER KIT. As ill. inc. BSR UA14 Unit. New Bargain Price Now Only £11.10.0, 7/6 carr.

Now Available ! De luxe Record Player Kit

Based on Mullard's 3-watt amplifier with printed circuit and Bass Boost and Treble Controls and 8" x 5" High Flux Speaker and Garrard Auto-Slim Unit. Cabinet size, 17½" x 16" x 8". Send for full details; 3d. stamp.

Complete Kit £13.19.6 *carr. 10/–*

Volume Controls—5K–2 Megohms, 3" Spindles Morganite Midget Type. 1¼" 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. ¼" flatted spindle. Famous Mfrs. 4 for 10/– post free.

COAX 80 OHM CABLE
High grade low loss Cellular air spaced Polythene — ¼" diameter. Stranded cond. Famous mfrs. **Now only 6d. per yard.**
Bargain Prices—Special lengths:
20 yds. 9/–. P. & P. 1/6.
40 yds. 17/6. P. & P. 2/–.
60 yds. 25/–. P. & P. 3/–.
Coax Plugs 1/–. Sockets 1/–. Couplers 1/3. Outlet Boxes 4/6.

Condensers—S/Mica all values 2pF to 1,000pF 6d. Ditto Ceramic 9d. each, .005, .01 and .1, etc., 1/–. Paper Tubular 450V .001 mfd to .01 mfd and .1/350V 9d. .02–.1 mfd 1/–, .25 mfd 1/6, .5 mfd 1/9.

Close Tol. S/Micas—10% 5pF–500pF 8d. 600–5,000pF 1/–. 1% 2pF–100pF 9d. 100pF–500pF 11d. 575pF–5,000pF 1/6. **Resistors—Full Range** 10 ohms–10 megohms 20% ¼ and ½W 3d., ditto 10% 4d., ½W 5d. (Midget type modern rating) 1W 6d., 2W 9d. **Hi-Stab** 5% ¼–½W 100 ohms 1 megohm 6d. Other values 9d. 1% ½W 1/6. **W/W Resistors** 25 ohms to 10K 5W 1/3, 10W 1/6, 15W 2/–. **Pre-set T/V Pots. W/W** 25 ohms–50K 3/–. 50K–2 Meg. (Carbon) 3/–.

TRANSISTOR BARGAINS
Brand New—BVA 1st Grade

OC44	8/6	OC70	5/6
OC45	8/–	OC71	6/–
OC81D	7/6	GEX34	2/9
2/OC81	15/6	OA70	2/9
GET114	6/6	OA81	2/9
OC72	7/6	GEX13	2/9
AF117	9/6		

Speakers P.M.—3 ohms 2½" E.M.I. 15/6. Goodmans 3½" 16/6. 5" Rola 15/6. 6" Elac 16/6. 7" x 4" Goodmans 15/6. 8" Rola 19/6. 10" R. x A. 25/–. 9" x 6" Goodmans 22/6. E.M.I. Tweeter 22/6.

Speaker Fret—Expanded gilt anodised metal ¼" x ¼" diamond mesh, 4/6 sq. ft., multiples of 6" cut. Max. size, 4ft. x 3ft. 47/6. Carr. extra.

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

BONDACOUST Speaker Cab. Acoustic Wadding, superior grade, 1" thick, 12" wide, any length cut 1/6 per ft, 4/– per yd.
ENAMELLED COPPER WIRE—¼lb reels, 14g–20g, 2/6; 22g–28g, 3/–; 36g–38g, 4/3; 39g–40g, 4/6, etc.
TINNED COPPER WIRE—14–22g. 2/6 ½ lb.
PVC CONNECTING WIRE—10 colours (or chassis wiring, etc.)—Single or stranded conductor, per yd., 2d. Sleeving, 1mm. and 2mm., 2d. yd., etc.
KNOBS—Modern Continental types: Brown or Ivory with Gold Ring, 1" dia., 9d. each; 1½", 1/– each; Brown or Ivory with Gold Centre, 1" dia., 10d. each; 1½", 1/3 each. LARGE SELECTION AVAILABLE.

TRANSISTOR COMPONENTS

Midget I.F.'s—465 kc/s ⅝" diam.	5/6
Osc. Coil—⅝" diam. M.W.	5/3
Osc. coil M. & L.W.	5/9
Midget Driver Trans. 3.5:1	6/9
Ditto O/Put Push-pull 3 ohms	6/9

Elect. Condensers—Midget Type 15V 1mfd–50mfd, ea. 1/9. 100mfd. 2/–.
Ferrite Aerial—M. & L. W. with car aerial coupling coil, 9/3.
Condensers—150V. wkg. .01 mfd. to .04 mfd., 9d. .05 mfd., .1 mfd., 1/–. .25 mfd., 1/3. .5 mfd., 1/6, etc.
Tuning Condensers. J.B. "00" 208+176pF, 8/6. Ditto with trimmers, 9/6. 365pF single, 7/6. Sub-min. ¾" DILEMIN 100pF, 300pF, 500pF, 7/–.
Midget Vol. Control with edge control knob, 5kΩ with switch, 4/9, ditto less switch, 3/9.
Speakers P.M.—2" Plessey 75 ohms, 15/6. 2½" Continental 8 ohms, 13/6. 7" x 4" Plessey 35 ohm, 23/6.
Ear Plug Phones—Min. Continental type, 3ft. lead, jack plug and socket. High Imp. 8/–. Low Imp., 7/6. High sensitivity M/coil 8–10 ohms, 12/6.
Brand New. Mfrs. surplus 1st grade.
1 OC44 & 2 OC45, 15/6.
1 OC81D & 2 OC81, 15/–.
All above and OA81, 32/6, post free.

JASON FM TUNER UNITS
Designer-approved kit of parts:
FMT1, 5 gns. 4 valves, 20/–.
FMT2, £7. 5 valves, 35/–.
JTV MERCURY 10 gns. 3 valves, 22/6.
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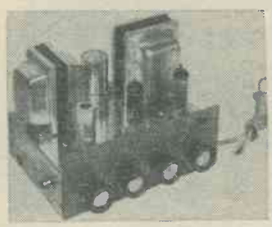
NEW JASON FM HANDBOOK, 2/6. 48 hr. Alignment Service 7/6. P. & P. 2/6.

TRIMMERS, Ceramic (Compression Type)— 30pF, 50pF, 70pF, 9d.; 100pF, 150pF, 1/3; 250pF, 1/6; 600pF, 1/9. Philips Concentric Type—2–10pF, 1/–; 3–30pF, 1/–.
METAL RECTIFIERS- STC Types— RM1, 4/9; RM2, 5/6; RM3, 7/6; RM4, 16/–; RM5, 21/–; RM4B, 17/6.

MULLARD "3—3" HI-FI AMPLIFIER
3 VALVES 3 WATT



3 ohm and 15 ohm Output.
A really first-class Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit. Valve line-up: EF86, EL84, EZ81. Extra H.T. and L.T. available for Tuner Unit addition. This is the ideal companion Amplifier for FM tuner units.

TECHNICAL SPECIFICATION—Freq. Response: ± 1dB. 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.

TRS Est. 1946

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sinclair NEWS

No. 1 APRIL/MAY, 1964

This is what Sinclair service means to you

WORLD LEADERSHIP

Within an amazingly short time, Sinclair Radionics has leapt forward to become a world-leader in its own specialised field of micro-electronic designs for the home constructor. The reasons for this are not hard to find, and even if, at first, they appear simple, they represent as much of a breakthrough in relations between customer and supplier as do the designs which we have introduced.

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Our object is to produce micro-electronic transistor designs which are not simply interesting to build, but which are well ahead of anything offered by our competitors. They are also technically ahead of any available manufactured products. To achieve these standards, we employ our own highly qualified team of electronic engineers, and when they have contributed their share to a design, we "marry" it to the services of an industrial design group to ensure that our cases are both elegant and functionally right. Developments on these lines are going on all the time in the carefully planned Sinclair programme.

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FEATURED ON THE FOLLOWING PAGES:

With the Micro-6, for example, building is actually proving easier than even we believed at first, and already there are thousands in use.

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How about you, the customer? We insist on your being completely satisfied in all your dealings with us. In fact, we have a special service department run solely to help and advise customers and to correct any errors in assembly which may have inadvertently been made. You need never feel that we will not be interested in your particular problem, no matter how slight it might appear to you. That we are genuinely willing and glad to be of help is something extra which even we cannot properly convey in the unique guarantee offered in our advertisements. We can only tell you of the hundreds of letters which we receive every week from all over the world praising both our service and our designs. *Full details of these appear on the following pages.*

Introducing **Mike Farrard** a rare character created for Sinclair Electronics by Ken Ward

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WITH SELF-CONTAINED FERRITE ROD AERIAL AND BATTERIES

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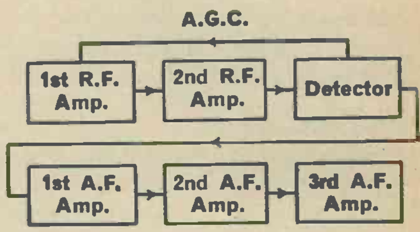
We knew that really efficient micro-size radio sets were always wanted; we knew how to get the very best out of modern transistors. After we had designed and field-tested the Micro-6 to our complete satisfaction, we released it for constructors only a few weeks ago. What even we hardly expected was the absolutely fantastic performance reports that are daily reaching us in ever-growing numbers from all over the country (and abroad too). Range, selectivity, power and quality—the four essentials to any good radio are here in more than generous measure—and you can easily build the Micro-6 in a single evening by following the interesting instructions manual.

SINCLAIR MICRO 6



UNIQUE 6-STAGE CIRCUITRY

The key to the success of the Micro-6 is in its brilliantly developed circuitry brought to a stage that only a thorough understanding of transistor behaviour could ever hope to make possible. The result is that within this minute assembly you have a set actually better in performance than that of most transistor superhets many times larger and costlier.

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You will be delighted with the way in which this is presented. The illustrations are exceptionally easy to follow, and stage-by-stage details show just how simple this set is to build.

ALL FOR ONLY 59/6

Price includes cost of all parts, elegant case, lightweight earpiece and plug, and instructions.

MALLORY ZM312 Mercury Cells, 1/11 each

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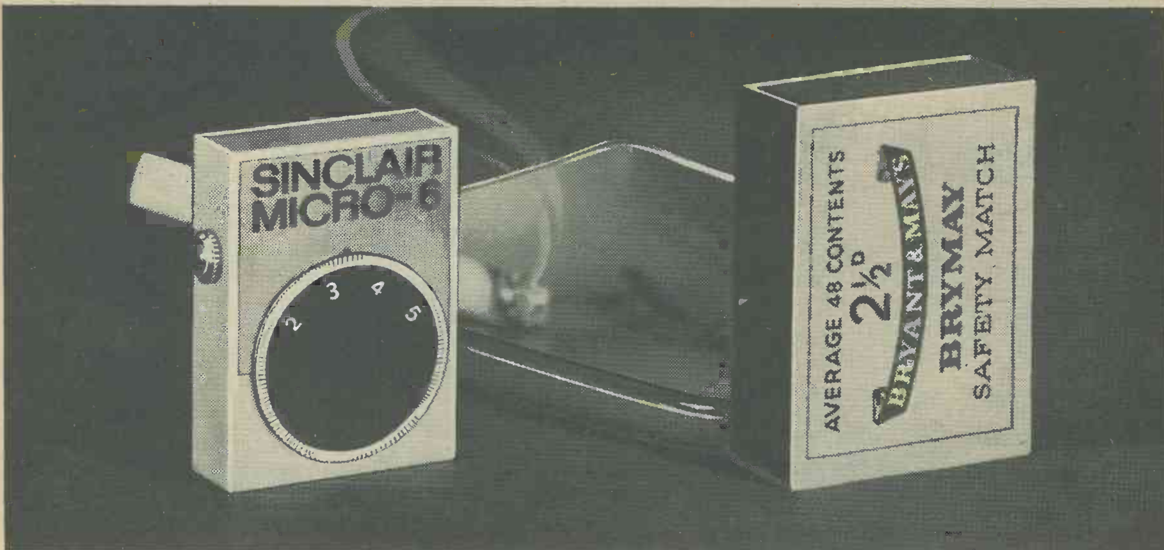
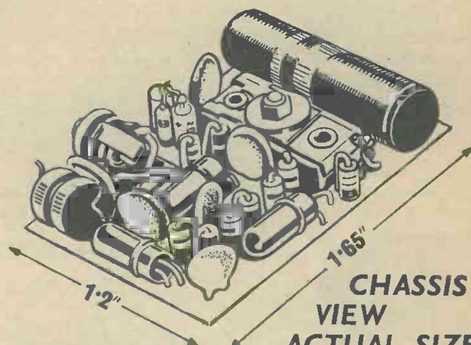


the world's smallest radio

YOU CAN BUILD IT IN AN EVENING

TECHNICAL DESCRIPTION

THE SINCLAIR MICRO-6 uses Micro-Alloy Transistors (MATs) in a completely new circuit comprising six stages. Two stages of R.F. amplification are followed by an efficient double-diode detector which drives a high gain three stage A.F. amplifier. Powerful A.G.C. is applied to the first R.F. stage to ensure fade-free reception of the most distant station, and tuning covers the entire medium waveband. This is widened out at the high frequency end to provide improved separation of Continental stations. The tiny ferrite rod aerial and earpiece socket were both specially designed for this set. This socket incorporates a switch which operates automatically on inserting the earpiece plug, and switches off when the plug is withdrawn. Listening is by means of the high-impedance lightweight earpiece provided. Quality of reproduction is outstandingly good. Instructions for building the Micro-6 set a new standard of clarity and simplicity. The diagrams are a masterpiece of technical illustration and the text contains all the information you require.



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MODEL CONTROL

Pocket Wavemeter-Monitor

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

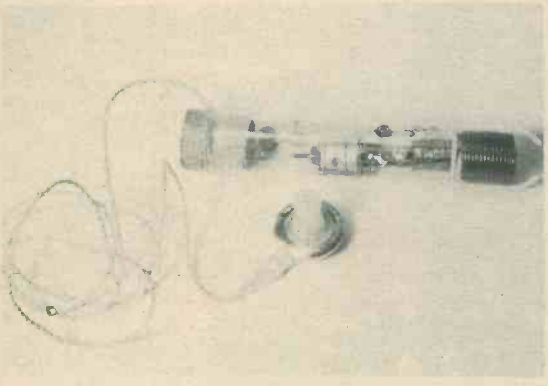
THE UNIT DESCRIBED HERE IS BUILT INTO A SEALED glass tube and can be used as a wavemeter, with bulb indicator, and listening device to check transmitter modulation tones on the 27 Mc/s model control band. It can be easily carried in the pocket, and is thus always available for use when operating a model or transmitter.

Monitor Circuit

The monitor circuit is shown in Fig. 1. L_1 is tuned to the Model Control band by means of the 30pF concentric trimmer C_1. L_2 is tightly coupled to L_1, and provides current to light the 6V 0.06A indicator lamp. Part of the voltage available is rectified by the diode, to give an audio output for the miniature earpiece.

L_1 consists of 13 turns of 18 s.w.g. enamelled wire, approximately 15mm inside diameter. The exact diameter can be adjusted to suit the test tube used. Turns are wound closely side by side, after having straightened the wire by pulling it taut. An object is chosen (on which to wind the coil) having a diameter such that the finished coil pushes readily into the tube. The outer lead-out wire is brought up inside the coil, and both ends are arranged to reach the trimmer tags. The long central trimmer tag is cut off to clear the lamp.

L_1 is 2 turns of 20 s.w.g., or similar, plastic insulated bell wire. After winding the turns, the loop is taken over the trimmer and its ends are bared and shaped to meet the lamp, which is then soldered on.



The completed unit

Resonance should be checked by holding the coil near a tuned transmitter. The trimmer is rotated until the lamp lights at greatest brilliance. If L_1 is of different dimensions than given the number of turns can be adjusted, if necessary. If the trimmer has to be unscrewed very far, a turn or two should be removed from L_1. If, on the other hand, the trimmer has to be screwed very far down, another turn or so may be needed on L_1.

The diode and 1000pF capacitor, C_2, are added as in Fig. 2. Insulated sleeving is placed on all leads. Wires should be clear of each other, and also clear of the trimmer. The whole assembly can then be inserted temporarily in the tube. A check of tuning should be made, to assure there is no difficulty in reaching 27 Mc/s.

The assembly is next removed, and coils L_1 and L_2 are cemented together. Rigidity is gained by cementing the lamp to the bottom of the trimmer. Coils and leads are also smeared with cement, and the whole is pushed into the tube and left until the cement has hardened.[1] Movement of parts after final tuning will upset the wavemeter calibration.

Tuning and Monitoring

A medium impedance personal phone is used for

[1] The cement used should have good dielectric properties. Polystyrene dope would be satisfactory.—EDITOR.

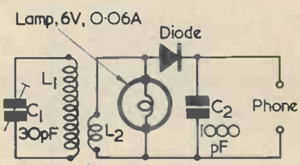


Fig. 1. The circuit of the monitor

Components List

Capacitors
- C_1 30pF, concentric trimmer
- C_2 1,000pF, ceramic

Inductors
- L_1, L_2 See text

Miscellaneous
- 1 germanium diode
- 1 6V 0.06A m.e.s. bulb
- 1 personal phone, see text
- 1 test tube, 4 x ¾in, with cork

listening, the thin flexible leads being soldered to the wires near the cork.[2] For use with a c.w. transmitter only, the diode, C_2 and phone may be omitted.

The monitor should be brought near the tank coil of a transmitter tuned to the middle of the 27 Mc/s Model Control band, and the trimmer very carefully adjusted, with a length of tube or rod made of insulating material, for resonance. For final adjustment, hold the monitor at such a distance that the lamp only just glows with the trimmer tuned correctly. The cork is then inserted, and a final check made.

To adjust a tunable transmitter, hold the monitor near the tank coil and tune the transmitter for maximum brilliance on the monitor lamp. Keep the monitor at a slight distance so that the exact tuning point is most readily seen. Both modulated and c.w. transmitters can be checked in this way.

To check that a modulated transmitter is radiating the correct audio tones, use the earphone and bring the monitor near enough to the transmitter tank

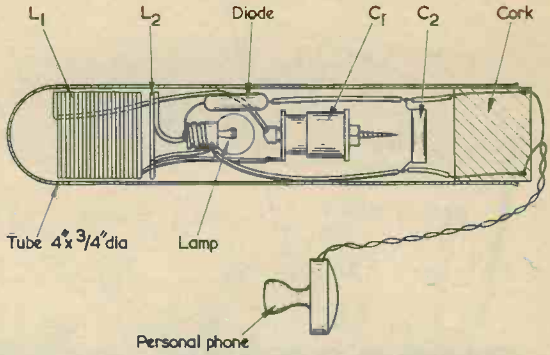


Fig. 2. The layout of components inside the glass test tube

coil to obtain sufficient volume.

With some transmitters, it may be inconvenient to reach the tank coil. If so, a coil of about 2 turns can be arranged in the aerial lead, and the monitor may be brought near this.

[2] An impedance around 2kΩ (corresponding to a d.c. resistance of approximately 500Ω for the average personal phone) should be satisfactory here—EDITOR.

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.

Wireless Set No. 31.—J. Allan, 35 Damask House, Flower House Estate, London, S.E.6, requires circuit or any data on this 18 valve equipment.

* * *

Bendix BC624A.—P. W. Dudson, 1 Raydon Street, London, N.19, would like to buy or borrow the circuit diagram.

* * *

Romac Radio Corp. TV Set Model No. 179/T.—J. McGrail, 494 Rochester Way, Sidcup, Kent, wishes to borrow or buy circuit or manual of this set.

* * *

R308 VHF Receiver.—B. Davies, 11 Hayes Crescent, North Cheam, Sutton, Surrey, wants to buy or borrow manual or circuit.

* * *

B44 Mk. II Tx/Rx.—A. E. Harvey, 39 Curlieu Road, Oakdale, Poole, Dorset, requires the circuit diagram, i.f. frequency, or any other details applicable to amateur use.

* * *

CR100 Receiver.—W. Edmondson, 13 Lindfield Gardens, London, N.W.3, requires circuit or manual.

"Diomatic" Frequency Controlled FM Tuner.—E. C. Wright, 59 Thanet Road, Ipswich, Suffolk, requires information on the aerial, oscillator, i.f. and discriminator and associated components of the a.f.c. circuit.

* * *

MCR1 Receiver.—L. O. Tully, 120 Victoria Street, Fairfield S3, Brisbane, Queensland, Australia, would like to know if the reader who answered his previous appeal has forwarded the MCR1 coils and if so, would he write again.

* * *

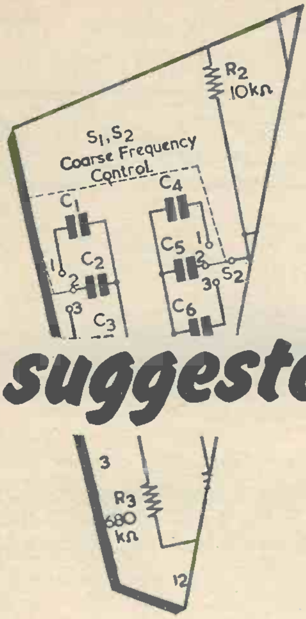
R107.—D. J. Clampin, 73 Thorogood Road, Clacton-on-Sea, Essex, would like to purchase or borrow the manual for this receiver.

* * *

Beam Echo Stereo Pre-amp SP21/2.—J. Broughton, 10 Lodge Grove, Yateley, Camberley, Surrey, wishes to purchase or borrow the manual.

* * *

Weston Valve Tester/Multi-range Meter.—R. Hicklin, 13 Clive Road, Heath Park, Romford, Essex, has acquired this American instrument, Model No. 774/4, 774/5 or 744/4? Manual or any information most welcome.



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. 161 Tone-Operated Switching Circuit

One of the more fascinating aspects of experimental electronics is that it is possible to take advantage of component configurations which, whilst employing inexpensive standard parts, offer unusual performances that are peculiarly their own. A typical example is given by the parallel-T network shown in Fig. 1. Provided that the output is unloaded, this network can offer infinite attenuation at a single frequency when $R_1 = R_2 = 2R_3$ and $C_1 = C_2 = \frac{1}{2}C_3$.

Under these conditons, the frequency at which i finiite attenuation occurs is given by $f = \frac{1}{2\pi R_1 C_1}$ where f is the frequency in cycles per second, R_1 is the resistance in ohms, and C_1 the capacitance in farads. (Alternatively, R_1 may be in megohms and C_1 in microfarads.)

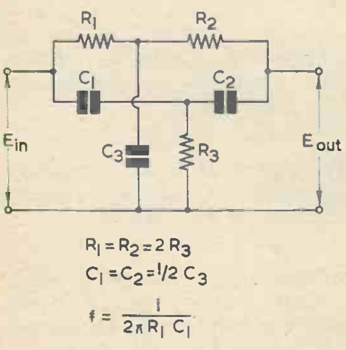


Fig. 1. The parallel-T network

This attribute of the parallel-T network is not of great use in conventional radio work, but it has several applications in test equipment. For instance, a distortion measuring instrument could employ a parallel-T network to completely filter out one frequency from the output of an a.f. amplifier. If a purely sinusoidal tone at that frequency is fed to the input of the amplifier, any harmonics introduced due to distortion in the amplifier will then appear, without the fundamental, after the parallel-T network. The level of such harmonics can be measured, whereupon the distortion introduced by the amplifier may be determined.

In this month's circuit, a parallel-T network is employed in a feedback loop to control the gain of an amplifying valve. At the frequency at which attenuation is infinite, feedback falls to zero and the valve is capable of providing full amplification, but at other frequencies the valve suffers a high level of feedback and its gain is considerably reduced in consequence. By coupling a microphone to the valve, together with a circuit capable of actuating a relay, it becomes possible to switch on an external circuit whenever a sound at the attenuation frequency is picked up by the microphone. Sounds at other frequencies do not cause the external circuit to be switched on.

The use of a parallel-T network in this manner is not new, and a recent instance appeared in the Danish magazine *Radio Og Fjernsyn*.*

The Circuit

The circuit of the tone-operated switching device appears in Fig. 2. In this diagram a crystal microphone, in parallel with R_1, is coupled to the grid of $V_{1(a)}$ via R_2. $V_{1(a)}$ is one half of a 12AX7 and its anode connects to a parallel-T network by way of C_4. The parallel-T network is given by R_3, R_4, R_5, C_1, C_2 and C_3, and it couples back to the grid of the valve. It will be noted that R_5 has half the value of R_3 and R_4, and that C_3 has twice the value of C_1 and C_2. These are the relationships required in the parallel-T network. The values shown in Fig. 2 for the network were chosen arbitrarily to give an attenuation frequency in the audio range, the actual frequency being 1.3 kc/s. Alternative attenuation frequencies may be obtained by adjusting the values in the network in accordance with the equation given above.

The anode of $V_{1(a)}$ also couples, via C_5, to the grid of $V_{1(b)}$. $V_{1(b)}$

* O.Baden, "Selektiv Tonerelae", *Radio Og Fjernsyn*, May 1963.

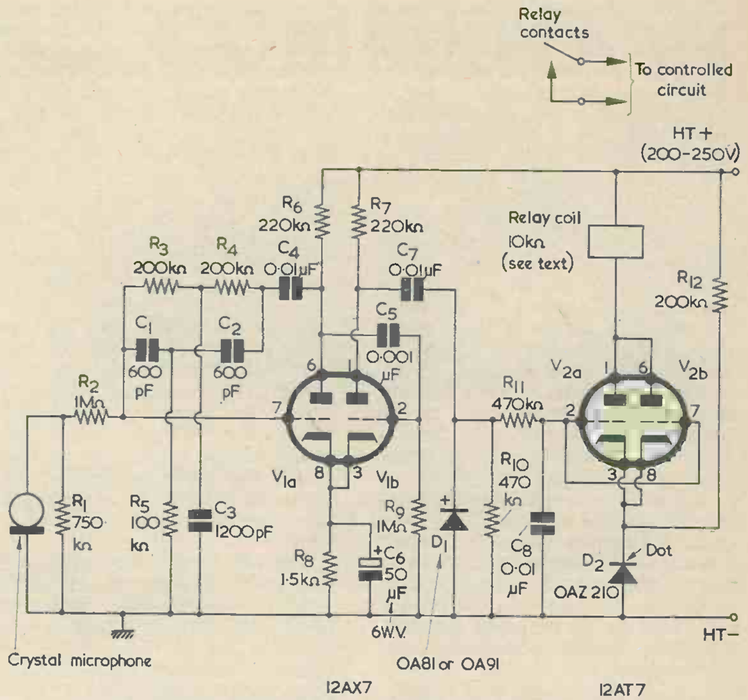


Fig. 2. Complete circuit of the tone-operated switching unit. This device causes the relay to energise for sound at 1.3 kc/s, and it may be made to operate at other frequencies by adjusting the values in the parallel-T feedback network between the anode and grid of $V_{1(a)}$

functions as a conventional a.f. amplifier, and its anode feeds into the shunt detector, D_1. Diode D_1 is so connected that a positive rectified voltage, proportional to the level of the a.f. signal fed to it, is passed to the low-pass filter R_{11} C_8. This positive voltage is then applied to the grids of $V_{2(a)}$ and $V_{2(b)}$.

V_2 is a 12AT7, this valve being chosen because of its short grid base. In the circuit, the two triodes of the valve are connected in parallel. The two cathodes are held at about cut-off level by the zener diode D_2, this maintaining the cathodes approximately 6 volts positive of chassis irrespective of anode current. In the absence of anode current, D_2 is held at its zener voltage by resistor R_{12}. The anodes of the 12AT7 couple to the h.t. line via a relay coil having a resistance of 10kΩ. It is assumed that the relay is capable of energising at some 10mA, whereupon its normally-open contacts may complete an external circuit.

When sound at frequencies other than the attenuation frequency is picked up by the microphone, the parallel-T network between the anode and grid of $V_{1(a)}$ causes this valve to offer very little gain. In consequence, only a very low level of a.f. is passed to $V_{1(b)}$ and to the following shunt detector. A small positive voltage may appear across diode D_1, but this is too low to allow V_2 to pass any significant increase in anode current. On the other hand, when sound at the attenuation frequency is picked up by the microphone there is zero feedback from the anode to the grid of $V_{1(a)}$, and this valve offers the full amplification of which it is capable. In consequence, a high level of a.f. is passed to $V_{1(b)}$ and a high positive voltage is applied to the grids of V_2. The anode current of V_2 increases to 10mA or more, whereupon the relay energises and the external circuit is switched on.

Results with the Prototype

In order to judge the effectiveness of the circuit, a prototype was made and checked out. The microphone employed was an Acos model type MIC40. The circuit was tested by the simple process of whistling at a distance of several feet from the microphone, and observing the resulting relay current.

With the particular 12AT7 and zener diode employed in the D_2 position there was, in the absence of signal, a relay current of about 0.4mA. Whistling at frequencies far removed from the attenuation frequency caused no perceptible increase in relay current. At frequencies close to the attenuation frequency, relay current increased by 1mA or so and, at the attenuation frequency itself, it rose to well in excess of 10mA. The range of frequencies over which relay current was in excess of 10mA was very small; so small, indeed, that it was difficult to maintain the frequency sufficiently steady for more than short periods of time.

Relay current did not increase perceptibly with loud transient noises, or when the microphone was tapped. Also, loud speech at a distance of a foot did not cause any increase in relay current. Loud speech with the microphone held in contact with the lips could, however, cause the relay to operate.

From these checks it would appear that the circuit is capable of actuating an external circuit only when sound at a particular frequency impinges on the microphone, provided that the instance does not arise where the sound input could be of the same high order as occurred in the last test. A desirable method of providing the actuating frequency would be offered by using an actual whistle instead of by attempting to whistle with the lips. When blown, such a whistle will have its own distinctive fixed frequency, and the components in the parallel-T filter can be adjusted in value to suit that frequency. It is worth noting that, provided a suitable microphone is employed, the whistle could be of the supersonic type. Other methods of operation may also suggest themselves to the experimenter.

Circuit Details

There are a number of circuit details which need a little further discussion, and these may now be dealt with.

It will be noted that the two cathodes of $V_{1(a)}$ and $V_{1(b)}$ are connected to a common bias resistor and capacitor. This method of connection functions satisfactorily in practice when it is not intended to provide amplification of the lower audio frequencies, and it results in a saving of components. To ensure attenuation of the lower audio frequencies, C_5 is given the somewhat low value of 0.001μF.

Hum is liable to be a little troublesome when the two sections of a high-gain double-triode such as the

12AX7 are employed in cascade, and its effect is reduced somewhat by the low value of C_5. Nevertheless, it would be advisable to keep all the components in the grid circuit of $V_{1(a)}$, including the parallel-T network, well clear of heater wiring. If the microphone is not mounted on the chassis it should be connected to it by way of screened cable.

Since it is unlikely that the crystal microphone will be expected to offer full output at frequencies below some 200 c/s or so, it becomes permissible to connect a lower value of resistance across it than would appear in conventional a.f. amplifier design. The value specified for R_1 in Fig. 2 will result in low frequency attenuation with normal crystal microphones. At the same time, it helps to reduce hum pick-up in the grid circuit of $V_{1(a)}$.

It is possible that high a.f. voltages may be applied to diode D_1, whereupon it becomes desirable to select a diode for this position which has a high peak inverse voltage rating. Both the OA81 and the OA91 have p.i.v. ratings of 115 volts at 25°C, and either would be perfectly satisfactory here.

Due to spread in the characteristics of both the zener diode (D_2) and the 12AT7 (V_2) it is possible that, under no-signal conditions, the 12AT7 may be either beyond cut-off or further within cut-off than occurred with the writer's prototype. If this is considered important, the situation may be partly eased by employing the more expensive OAZ203 instead of the OAZ210 specified. Both diodes have a nominal zener voltage of 6.2 at 1mA, but the OAZ203 has a tolerance on zener voltage of $\pm 5\%$ only, as compared with a $\pm 15\%$ tolerance in the OAZ210.

The relay employed should have a coil resistance of 10kΩ. This limits the maximum current flowing through the 12AT7 and the zener diode to some 20mA, with the result that zener diode dissipation is well within the maximum permissible figure for operation without a cooling clip. If a relay with a lower coil resistance is used, the resistance should be made up to the 10kΩ figure by means of an additional series resistor.

Apart from the components in the parallel-T network, none of the resistor or capacitor values are particularly critical. Resistor tolerances could all be $\pm 20\%$, and capacitor tolerances those associated with paper components. In the parallel-T network itself, it would probably be preferable to work to component tolerances of $\pm 5\%$.

As it stands, the circuit responds almost immediately when sound at the attenuation frequency is picked up by the microphone. If desired, the speed at which the relay energises (and de-energises after cessation of the sound) may be increased by increasing the value of C_8. This capacitor should not, on the other hand, be decreased in value by any large amount, as there would then be a risk of a.f. appearing at the grids of V_2. As there is no h.t. decoupling, this could result in instability or erratic operation.

A final point has to do with the range of volume levels over which the circuit is effective. As was shown by the results obtained with the prototype, the circuit can be made to operate when a very high signal level which is not at attenuation frequency appears across the microphone. This is due to the fact that the parallel-T filter does not offer the very wide range of discrimination (between a low level of attenuation and infinite attenuation) of which it would be capable if it appeared, say, between two amplifying stages. In the present circuit, the parallel-T network allows $V_{1(a)}$ to amplify at full gain at the attenuation frequency, and at very much reduced gain at other frequencies. With the component values shown in Fig. 2, discrimination will probably be in excess of 35 times, or 31dB.

Six New Marconi TV Stations for I.T.A.

Another contract to supply and install six completely new television stations has been awarded to The Marconi Company by the Independent Television Authority. These stations, which have been designed for unattended operation, will provide full television coverage for areas not already catered for by existing transmitters in a relatively simple and economical way.

Marconi's will now have supplied the complete transmitting equipment for twenty of the twenty-nine I.T.A. transmitting stations in addition to part of the equipment for a twenty-first station.

The six sites will be split into two groups. Installations at Caithness, Central Berkshire and Bedford will have four Marconi translators, Type BD.368, four 500W amplifiers, Type BD.377, plus all the associated feeder and ancillary equipment. The other three, to be installed at Dundee, Scarborough and the Isle of Man, will be equipped with dual translators and dual 500W amplifiers with the associated ancillary equipment.

Due to topographical conditions, it is inevitable that in many areas covered by national or regional services, there will be places where the signal strength is insufficient for normal domestic receivers. This Marconi translator equipment has been designed especially to provide a television service in areas such as these.

NEWS AND COMMENT . . .

Resale Price Maintenance

The Resale Prices Bill is certainly proving to be a controversial measure and it is difficult to assess whether its provisions will benefit the consumer in the long run.

Radio constructors are used to "shopping around" for components and government surplus equipment and the effect of the abolition of price maintenance would probably only be noticed by our readers where new equipment was concerned. At first sight it would seem very attractive to purchase a TV receiver at below the manufacturer's list price, but there are snags. If a retailer, or a manufacturer for that matter, has cut his margin of profit too drastically he must make his profit elsewhere if he is to remain in business, this might affect after sales service for instance.

The rules of the Radio & Television Retailers Association very wisely concern themselves with seeing that their members are all treated alike under the law as it stands.

The Association lists 8 specific actions which they consider are improper evasions of price maintenance. Some of them are the offering of cash discounts; gifts; aerials, replacement tubes, valves and components supplied without charge beyond the manufacturer's guarantee period; free insurance; inflated exchange values on part exchange, etc.

The foregoing indicates the difficulties in enforcing price maintenance. In the long run however, too much should not be expected from its probable abolition. Both manufacturers and retailers must make reasonable profits to remain in business. The fear is that in a price cutting war quality and services will suffer and that many smaller concerns will go the wall which, in the long run, may mean less variety of choice for the consumer. Also, no doubt, there will be those who mark up prices in order to knock them down again to give an apparent "bargain", and the like. Ending resale price maintenance is not the simple benefit it might appear and this fact is recognised in the Bill; clause 5 confers jurisdiction on the Restrictive Practices Court to order that particular classes of goods should be exempted goods.

R.S.G.B.

Mr. John A. Rouse has been appointed General Manager and Secretary to the Radio Society of Great Britain, in succession to the former General Secretary, Mr. John Clarricoats, O.B.E.

Mr. Clarricoats gave yeoman service to the Society for a period of no less than 37 years. This remarkable record was recognised by members of the Society at presentations made to Mr. Clarricoats of high class radio equipment and other items, including a cheque for £456, all subscribed by members and friends. Mr. Clarricoats has been elected the first Honorary Member of the Society.

New Ten-pin Valve Simplifies TV Set Design

A significant advance in valve construction is achieved in the latest Mullard valve to be supplied to television set manufacturers. The new valve type PFL200 is housed in a B9A sized envelope yet uses a ten-pin (decal) base. The base has the same pitch-circle diameter as the familiar B9A base.

The "decal" (B10B) base enables two completely separate pentode systems to be incorporated in one envelope. In the PFL200 one pentode system is intended for use as a high-gain video output stage, the other as a medium-slope voltage amplifier in, for example, sync separators or a.g.c. stages. By giving the two sections complementary electrical characteristics it is possible to simplify and hence reduce the cost of receiver circuitry.

Particular care has been taken in the pinning and in the screening between the two sections of the valve to provide independence of operation.

Output Section

The PFL200 "L" section is designed to operate as a high-gain video output stage capable of producing a large output voltage across a low value anode load resistor. This is particularly useful in switchable receivers operating on the new 625-line standard which require twice the bandwidth of the 405-line standard. To achieve high gain and thus allow the application of negative feedback, a frame-grid control grid has been used, and this gives the valve a slope of 21mA/V at 30mA.

Amplifier Section

The "F" section of the PFL200 is a voltage-amplifying medium-slope pentode and in receivers for the British market it is most likely to find applications as a sync separator. The valve has thus been designed to provide adequate current at a low anode voltage. In receivers intended for overseas markets where sync separation is usually effected by an interference-gated heptode circuit, the "F" section of the PFL200 can be employed with advantage as a high gain a.g.c. amplifier or as an intercarrier sound i.f. amplifier.

Grant for Computer Control of Printing

Following upon our remarks last month on the forecast of Instant Electronic Newspapers, has come the news of a grant of £28,650 by the Department of Scientific and Industrial Research, to London University to enable Dr. Michael P. Barnett to carry out research into the control of printing by computer. Unlike Instant Electronic Newspapers even the services of a compositor would not be required.

About half the grant will be used for the purchase of equipment including a photo-composing unit. Dr. Barnett is returning from the United States, where he is at present Director at the Co-operative Computing Laboratory of the Massachusetts Institute of Technology. ("Brain drain" in reverse?)

The application was considered at the first meeting of a new sub-committee of the Research Grants Committee of DSIR which has been set up under the chairmanship of Lord Halsbury to evaluate applications for grants to aid work on the computer sciences.

The research, which will form part of the programme of the University's Computer Unit, will be concerned with the application of a computer to the production of paper tape to control type-setting equipment or photographic printing processes.

Computer languages and programmes will be adapted to specify the format and editorial details needed to set up books and publications.

The London University Atlas Computer will be used to carry out the work, in conjunction with the S-561 photo-composing unit. This is the most suitable type-setting device at present available. It is relatively inexpensive and has the necessary flexibility for a wide variety of applications to be explored.

Simplicity and Sensitivity with Two Transistors

Sir Douglas Hall, K.C.M.G., B.A.(Oxon)

Reflex transistor receiver circuits are always of interest if only because they employ a single transistor which functions both as an r.f. and as an a.f. amplifier. In the design described in this article, an ingenious approach enables two transistors to carry out this dual function. Apart from the two transistors and the diode there are only ten components in the receiver circuit and, as the author points out, this is exactly twice the number of stages!

In designing this circuit the author aimed at great simplicity combined with sufficient sensitivity to guarantee reception of medium wave local stations on a personal earphone, using the smallest of ferrite aerials as the only means of pick-up. Two transistors are used, each wired as a reflex amplifier, and a crystal diode provides demodulation. Excluding the transistors and diode there are only ten components —and this is exactly twice the number of stages in the circuit!

The sensitivity is such that using a ferrite slab 1¾in long, ¾in wide and ⅛in thick, very considerable volume is delivered through a high impedance earphone of the deaf aid type from the local station. Also, and not quite so powerfully, a fair number of Continental stations can be picked up after dark. The prototype is contained in a plastic box available from Woolworth's stores for 1s., this measures 3⅝ x 2⅜ x 1⅜in. The case could be a good deal smaller, but the one used will take a No. 8 battery. Such a battery will give a phenomenal length of service as the total consumption is only 0.75mA.

Avoiding Instability

One of the difficulties in designing a double reflex circuit is to avoid audio frequency instability. With two common emitter amplifiers in cascade the audio frequency signal at the collector of the second is in phase with the signal at the base of the first. But in a double reflex circuit it is necessary for there to be some coupling between these two points, since the amplified radio frequency signal is passed to the detector and then, as audio frequency to the base of the first transistor for further amplification by both transistors. True, the coupling to the detector is designed for radio frequencies and therefore offers a very high impedance for audio frequencies; but most constructors have experienced audio frequency instability arising merely through stray capacitances. Coupling does not have to be much more than nominal to produce unwanted positive feedback when high efficiency transistors are used.

This circuit used MAT101 transistors. These are of the micro-alloy type recently described in this journal,* and they are exceptionally efficient at all normal frequencies. If two of them were used in a conventional double reflex circuit in which the detector is fed from the collector of TR_2, there would be hopeless audio frequency instability unless drastic steps were taken to reduce the maximum a.f. amplification available. But in this circuit the problem is overcome by using the second transistor as a common collector amplifier at radio frequencies, whilst it amplifies audio frequencies as a common emitter device. The first transistor is a common emitter amplifier at all frequencies.

*Sinclair, C. M., "The Advantages of Micro-Alloy Transistors", *The Radio Constructor*, September 1962.

The Circuit

If the circuit diagram is examined it will be seen that L_1 and VC_1 produce a capacitance-tapped tuned circuit, the tap (at positive supply line potential) being brought about by C_1 (in series with a small part of VR_1) and the base-emitter capacitance "seen" by the tuned circuit. Direct coupling from TR_1 to TR_2 is provided by way of R_2 and the radio frequencies are then further amplified by TR_2. But at radio frequencies the collector of TR_2 is at earth potential, owing to C_2, while the emitter is at high potential because of the choke L_2. The high frequency signal, which has now received two stages of amplification, is demodulated by D_1 and the low frequency signal resulting is then applied, through the tuned circuit, to the base of TR_1 for two further stages of amplification. At radio frequencies there has been a phase change of 180° through TR_1, but no further phase change through TR_2. A small part of the high frequency signal will be present at the output from D_1. This will have its phase changed again as a result of the capacitance tap in the tuned circuit, and will therefore find itself in phase with the original signal. Regeneration results. VR_1, in conjunction with C_1, regulates the amount of the radio frequency signal which can return to the tuned circuit and therefore acts as a reaction control.

It may appear from the circuit that D_1 has been connected the wrong way round, so that reaction will be spoilt by backlash as a result of TR_1 becoming more sensitive when the point of oscillation is approached. It is true that the base of TR_1 will become more negative in these circumstances and that, consequently, the amplification offered by this transistor will tend to rise. But this will also mean that more current passes through TR_1 with an increase in the voltage drop across R_2. The voltage drop will make the base of TR_2 more positive and hence reduce the amplification provided by TR_2. The effect of passing the critical reaction point is

Components List

Resistors

VR_1 5kΩ potentiometer, linear or semi-log track. See text.
R_1 470Ω ¼W 10%
R_2 6.8kΩ ¼W 10%

Capacitors

VC_1 500pF variable
C_1 100pF
C_2 1,000pF
C_3 100μF, electrolytic, 6V wkg

Inductors

L_1 Subminiature medium wave ferrite slab aerial. See text (T.S.L.)
L_2 2.5mH r.f. choke, type CH1 (Repanco)

Semiconductors

TR_1 MAT101
TR_2 MAT101
D_1 Germanium diode

Switches

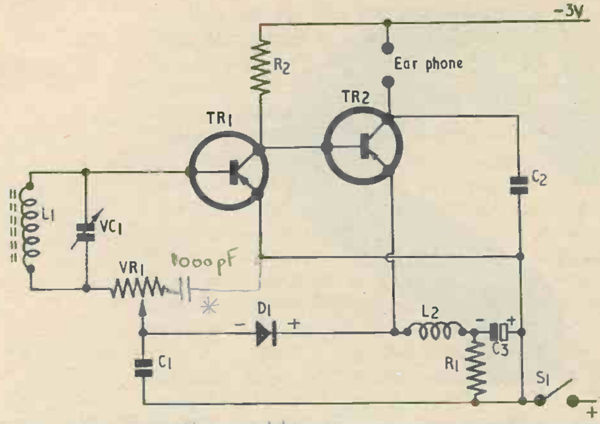
S_1 s.p.s.t. switch

Earphone

Miniature personal phone, type ER1600 (Henry's Radio Ltd.)

Battery

3 volt. Dimensions to suit case



* SEE p641

for TR_2 to oscillate, and not TR_1. Consequently the overall amplification is reduced as the base of TR_1 becomes more negative. These circumstances are suitable for smooth reaction, and this is borne out in practice. It will be found that the circuit can be held on the very threshold of oscillation with great sensitivity resulting. The "a.g.c." effect is most marked, fairly violent oscillation, deliberately brought about by advancing the reaction control too far, being stopped as soon as a local station is tuned in.

Any a.f. signal which finds itself across L_2 will be fed back to TR_1 out of phase, as the phase reversal brought about by the capacitance tap on the tuned circuit is clearly without effect at audio frequencies. There will, in fact, be a small amount of negative feedback since, although the inductive impedance of L_2 at audio frequencies is minute, there is a d.c. resistance of about 15Ω in the winding. This is small compared with the load in the collector circuit, and the practical effect is a very slight reduction in amplification accompanied by improved quality and complete stability.

Components

There is nothing very critical about the components, but it is important that the specified transistors be used. L_1 can be the main winding of any ferrite rod aerial. The one specified is very small and efficient, and it is easy to adjust the position of the winding so as to obtain the wave coverage which is wanted. The winding is fairly large and, in the prototype, it had to be slid partly off the ferrite slab in order to tune in the Third Programme on 194 metres.

VR_1 should be a linear control if possible, as this will prove much more satisfactory to use than one with log characteristics. But, if a miniature linear control is difficult to obtain, a semi-log type may be employed, such as the Ardente VC 1545. The latter is very small and is complete with battery switch.

The earphone should be of the high impedance magnetic type. The prototype works best with a personal phone type ER1600 which has a specified impedance of 7kΩ and a d.c. resistance of 1,600Ω. This is obtainable from Henry's Radio Ltd., complete with jack and socket. A standard 1kΩ impedance phone, which usually has a d.c. resistance of about 100Ω will work, but sensitivity will be reduced. The d.c. resistance of the phone should not be greater than about 2kΩ, and ordinary 4kΩ headphones may not be found satisfactory.

book review . . .

RADIO AND ELECTRONIC HOBBIES. By F. C. Judd, A.Inst.E. 165 pages, 5½ x 8½in. Published by Museum Press Ltd. Price 21s.

Mr. F. C. Judd is well known to regular readers of *The Radio Constructor*, and "Radio And Electronic Hobbies" represents the latest of his publications in book form. In this book, Mr. Judd has concentrated on including the widest possible range of constructional subjects with a minimum of theory. Included are the following subjects: radio receivers, audio amplifiers, transistor circuits, high fidelity and stereo, tape recording, electronic musical instruments, amateur radio transmitting, radio control, cathode ray tubes, aerials and test equipment. Also provided is a chapter devoted to suitable subjects for the school science classroom.

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

part 31

understanding radio

By W. G. MORLEY

IN THE FEBRUARY ISSUE WE INTRODUCED THE subject of sound reproduction, examining the nature of sound and the manner in which it is perceived by the ear. We then briefly discussed the operation of the carbon microphone and showed how this, in company with an energising battery and transformer, could produce an alternating voltage which varied in amplitude and frequency with the compressions and rarefactions of the sound at its diaphragm. We shall now carry on to the earphone.

The Earphone

There are several types of *earphone*, or *headphone*, these differing from each other by reason of their basic method of operation. By far the most common type is that in which a diaphragm made of magnetic material is directly affected by a varying magnetic field, and it is this type which we shall consider at this stage. It is instructive to note that earphones employing the magnetic diaphragm principle have been in use for a considerable number of years, and that they appeared in telephone work as "receivers" long before the advent of radio reception.

In one of its more familiar forms, the magnetic diaphragm earphone has the construction shown in Figs. 195 (*a*) and (*b*). In this diagram, a permanent horseshoe magnet is coupled to a pair of pole pieces which carry its magnetic field close to a thin diaphragm made of springy magnetic material. The case of the earphone is non-magnetic and is so dimensioned that, whilst the diaphragm is under stress due to the magnetic field, a small clearance exists between its inside surface and the pole pieces. Fitted to the pole pieces are two coils connected in series. When a current is passed through these coils in one direction, the resulting magnetic field adds to that offered by the permanent magnet. Conversely, when the current is passed through the coils in the opposite direction, the resulting magnetic field opposes that offered by the permanent magnet, and thereby reduces the effect of the latter on the diaphragm. In practice, the field due to the magnet is always considerably greater than the field due to the coils.

In the previous article we saw that we could obtain an electrical signal corresponding to a sound signal by means of a carbon microphone in conjunction with a battery and a transformer, and Fig. 196 shows the secondary of the microphone transformer (across which the signal appears) connected to the coils of the earphone.[1]

When sound impinges on the microphone of Fig. 196, an alternating voltage is induced in the secondary of the transformer and a corresponding current is caused to flow in the coils of the earphone. This current varies in sympathy with the frequency and amplitude of the original sound and, according to its direction, alternately strengthens or weakens the magnetic field between the pole pieces and the diaphragm. The centre of the diaphragm then suffers greater or less attraction to the pole pieces and, in consequence, vibrates in sympathy with the microphone signal. The result is that the diaphragm reproduces the sound which is initially applied to the microphone.

The vibration of the earphone diaphragm due to the varying current in its coils results in air vibrations which are perfectly audible. However, the apparent loudness of the sound from the diaphragm becomes enhanced if a cap such as that illustrated in Fig. 197

[1] Fig. 196 also shows the circuit symbol which is generally employed to depict a microphone.

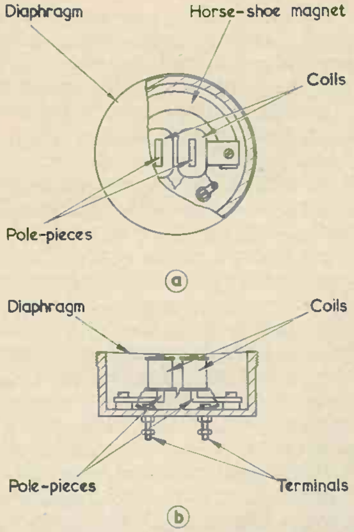


Fig. 195. The construction of a typical magnetic diaphragm earphone. The cap is not shown here. A top view is given in (a), wherein the diaphragm is partly cut away to show the internal components. A sectional view is given in (b).

is fitted. This cap causes a small chamber having a depth of approximately 0.04in to be formed in front of the diaphragm. The small volume of air in this chamber is then compressed and rarefied by the vibrating diaphragm, causing proportionally larger compressions and rarefactions to appear at the aperture in the centre of the cap. It should be noted that the chamber does not cause any actual increase in sound power, despite the fact that its presence results in an apparent increase in the loudness of the sound from the diaphragm. Its action may be likened to that of a transformer, in so far that it matches the "sound impedance" of the vibrating diaphragm more efficiently to the "sound impedance" of the outside air. This matching effect approaches an optimum when the earphone is held up against the ear, as it is, of course, intended to be.

In some earphones having the basic construction illustrated in Fig. 195, the cap may have several smaller holes at the centre, as shown in Fig. 198, instead of the single central aperture. The effect of the cap in providing a small acoustic chamber is, nevertheless, the same.

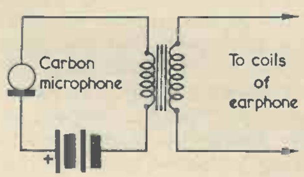


Fig. 196. Coupling a carbon microphone to the earphone

The Reason for the Permanent Magnet

An important feature of the earphone is given by the presence of the permanent magnet. It might be thought, at first sight, that a permanent magnet is not necessary, and that it would be possible to obtain a satisfactory audible sound from the diaphragm by reason of the varying current in the coils on its own. This assumption is, however, incorrect, and it is necessary to include the permanent magnet if correct operation is to be obtained. There are two reasons for this. The first, and more important, reason is that the permanent magnet imparts a considerable degree of sensitivity to the earphone. It can be shown that the force of attraction, or "pull", on the diaphragm due to the magnetic field at the pole pieces varies according to the square of the flux density, B^2. This flux density is comprised of two components, one of these being due to the permanent magnet and the

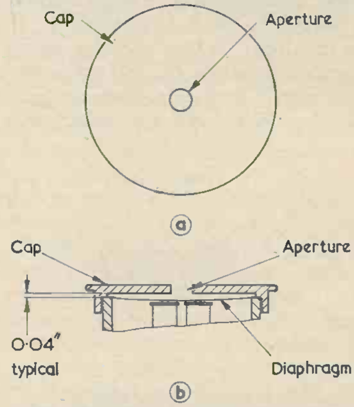


Fig. 197. To enhance the apparent loudness offered by the diaphragm, a cap is screwed on to the case, causing a small chamber to appear in front of the diaphragm. A top view of the cap is given in (a), whilst (b) shows the cap fitted to the earphone of Fig. 195 (b)

other due to the alternating current in the coils. Let us call the first flux density B_M and the second flux density B_C. When the flux density due to the coils assists that due to the magnet, the total flux density is B_M+B_C, whereupon the pull on the diaphragm becomes proportional to (B_M+B_C).[2] Similarly, when the flux density due to the coils is in opposition to that due to the permanent magnet, the pull on the diaphragm becomes proportional to $(B_M-B_C)^2$. If an alternating signal current flows in the coils, therefore, the pull on the diaphragm becomes proportional to $(B_M \pm B_C)^2$ or, if we remove the brackets and square the expression, to $B_M^2 \pm 2B_MB_C+B_C^2$.

If no signal current is applied to the coils, the pull on the diaphragm is proportional to B_M^2 because B_C is then equal to zero. It follows from this that the pull due to the signal current is proportional to $\pm 2B_MB_C+B_C^2$.

[2] Flux density was discussed in "Understanding Radio" part 22, June 1963 issue.

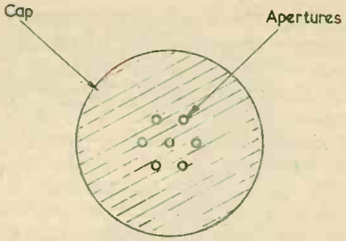


Fig. 198. Some earphone caps have a number of small apertures instead of the single central aperture shown in Fig. 197

Let us now see what happens if we dispense with the permanent magnet and rely on the flux density due to the coils on their own. As soon as we dispense with the magnet the flux density B_M becomes zero, whereupon the term $\pm 2B_MB_C$ similarly becomes zero. The diaphragm is, then, only affected by the flux density corresponding to B_C^2. In practice, it is possible to make the flux density due to the magnet very many times greater than that due to the coils, with the result that the expression $\pm 2B_MB_C+B_C^2$ becomes considerably larger than B_C^2 on its own. Since, with the permanent magnet, the pull on the diaphragm is proportional to a much greater quantity than is given by the coils on their own, it follows that the permanent magnet imparts a very high degree of sensitivity to the earphone.

The second reason for the desirability of having a permanent magnet is that, without it, the diaphragm would vibrate at twice the frequency of the alternating current flowing in the coils. This point may be more readily appreciated if we initially examine the simple alternating current of Fig. 199 (*a*), assuming that this flows in the coils of an earphone which does not have a permanent magnet. If we start at point A in Fig. 199 (*a*) we have the instance when the current is at zero. In consequence, there is no magnetic field in the pole pieces and the diaphragm is at rest. As we proceed from point A to point B, the current increases, with the result that the diaphragm suffers increasing attraction towards the pole pieces. After point B the current decreases, whereupon the diaphragm suffers a decreasing attraction until, at point C, it is once more at rest. From point C to point D we have an increasing current in the reverse direction, but this change of direction is not perceived by the diaphragm, which once more suffers increasing attraction towards the pole pieces. From D to E the current decreases again, and the diaphragm once more returns to its state of rest.

In Fig. 199 (*b*) we assume that the alternating current is applied to an earphone fitted with a permanent magnet. We assume, also, that the half-cycle from A to C results in a flux density which assists that due to the permanent magnet. In consequence, the diaphragm suffers increasing attraction towards the pole pieces from points A to B, and decreasing attraction from points B to C. After point C, the flux density due to the alternating current opposes that from the magnet, and the diaphragm continues to suffer decreasing attraction until we reach point D. After point D, it starts to suffer increased attraction and this continues until point E. At point E the diaphragm is in the same condition as it was at point A.

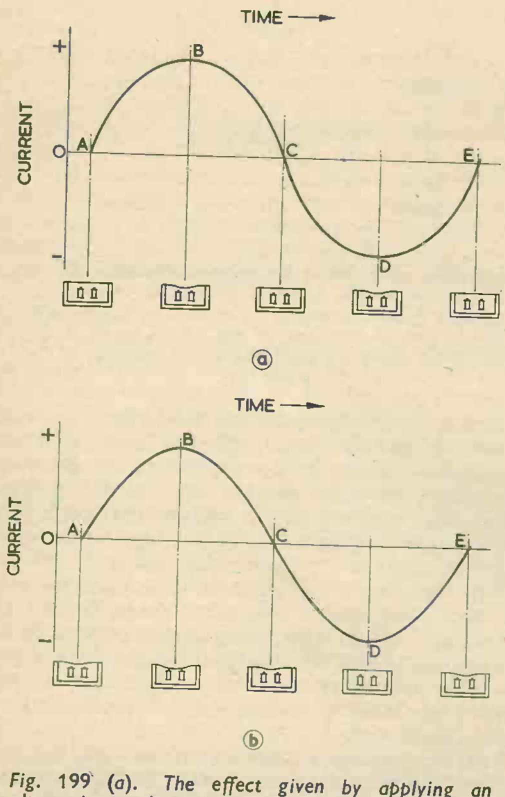


Fig. 199 (a). The effect given by applying an alternating voltage to an earphone without a permanent magnet. The displacements of the diaphragm are shown in exaggerated form.
(b). A more correct effect is given when the earphone has a permanent magnet

It is obvious from an examination of Fig. 199 that, in (*a*), the diaphragm undergoes two cycles of movement for a single cycle of current, whereas, in (*b*), it undergoes only a single cycle of movement. In (*a*), therefore, the associated earphone will emit sound at twice the frequency of the alternating current whilst, in (*b*), it will emit sound at the same frequency. The state of affairs in (*b*) is, of course, preferable to that in (*a*).

It is interesting to note that the effect given in Fig. 199 (*a*) is that which would be indicated by the result of our investigation into the first reason for having a permanent magnet. Without the magnet, the pull on the diaphragm is proportional to B_C^2. The square of both positive and negative quantities is always positive, and it follows that, without the permanent magnet, the pull on the diaphragm will always be in the same direction regardless of the direction of the current in the coils.

Another point which may now be raised is that we could, theoretically, dispense with the permanent magnet if we caused a direct current to flow through the coils in addition to the alternating current which corresponds to the sound signal. Provided that the direct current was always greater than the peak value of the alternating current, the earphone would then respond, correctly, in the same manner as is indicated in Fig. 199 (*b*). Put another way, it could be said that the direct current would itself magnetise the pole pieces, whereupon it would make the permanent magnet superfluous. In practice, however, this scheme is unattractive, as an inconveniently high direct current would be required to provide the same level of flux density as is given by a practical magnet. Apart from the difficulty of providing such a current, its high value would necessitate thicker wire in the coils than is required for signal currents and the earphone would become needlessly bulky and costly as a result.

It should be mentioned that, in some radio applications, circuit conditions are such that it is desirable to allow a small direct current to flow through the coils of an earphone in addition to the alternating signal current. The presence of such a direct current is, in general, permissible provided that it does not greatly exceed the peak value of the alternating current. The direct current should, preferably, flow in the direction which causes the resulting magnetic flux due to the coils to assist that due to the permanent magnet, but this is not entirely obligatory with modern earphones. In most instances, the magnetic flux due to a direct current of permissible level is much smaller than that given by the magnet, and the loss of sensitivity resulting from direct current flow in the incorrect direction is negligibly low. With earlier earphones it was considered that a direct current in the incorrect direction would, with time, cause partial demagnetisation of the permanent magnet and, hence, loss of sensitivity. There is little risk of this eventuality when modern magnet materials are employed. It should be added that, to ensure direct current flow in the correct direction, earlier earphones had one terminal marked with a "+" sign. This was the terminal which should then connect to the positive side of the source of direct current.

Practical Features

The earphone construction shown in Fig. 195 is typical of the larger, non-miniature, type of magnetic diaphragm earphone and it aptly demonstrates the basic method of operation. In some earphones of this type, usually of later design, the horseshoe magnet is replaced by a small bar magnet as illustrated in Fig. 200.

The pole pieces of the earphones shown in Figs. 195 and 200 are made of soft iron or of a magnetic material having similar properties. Occasionally, they may be laminated. The faces adjacent to the diaphragm are machined to provide an accurately dimensioned flat surface. The diaphragm is made from a high permeability material similar to that used for transformer laminations, and it has a japanned finish to prevent rust.

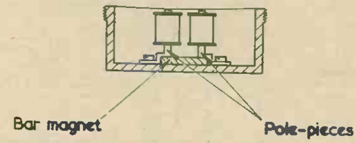


Fig. 200. An alternative construction to that of Fig. 195 employs a bar magnet instead of a horse-shoe magnet. The method of coupling the pole pieces to the bar magnet may differ, in some units, to that shown here, although the basic principle remains the same

Since the war, miniaturised earphones have become generally available, these being employed for hearing aids or as "personal" earphones for use with small portable radio receivers. They have the general appearance shown in Fig. 201, wherein the moulded projection is intended to fit directly into the auditory canal of the ear. The weight of such earphones may be considerably less than 1oz, as compared with the 2 to 5oz of an earphone using the construction of Fig. 195 or Fig. 200.

In order to achieve their small size, miniature earphones employ the typical construction shown in Fig. 202. In this diagram there is a single rod magnet mounted on a circular base of magnetic material and a single coil. A cylindrical pole piece ensures that both poles of the field from the magnet closely approach the diaphragm. The latter is made of springy magnetic material and is usually thinner than the diaphragms employed in the construction of Figs. 195 or 200. A thicker disc of magnetic material may be affixed to the centre of this diaphragm, as illustrated in Fig. 203, to provide bulk for the passage of magnetic flux. A small acoustic chamber appears in front of the diaphragm, a hole at its centre coupling to the projection which fits inside the auditory canal. Due to the small size of the assembly, the volume of air behind the diaphragm may be comparable with that in the chamber at the front, and the consequent compressions and rarefactions of this small volume of air could impede the movement of the diaphragm. To overcome this difficulty, it is usual to provide a small hole in the housing behind the diaphragm to ensure that the air behind it is not completely trapped.

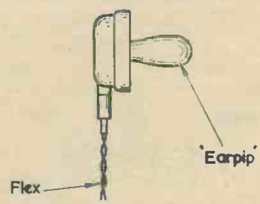


Fig. 201. The appearance of a typical miniature earphone

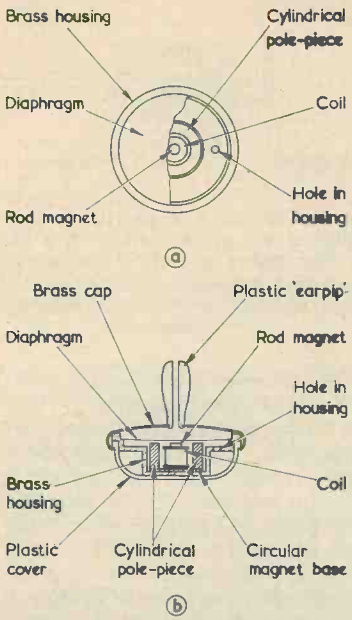


Fig. 202. A typical construction for a miniature earphone. In (a) we see the assembly behind the diaphragm, whilst (b) shows a cross-section through the complete earphone. The circular magnet base is made of magnetic material and completes the magnetic circuit between the lower ends of the rod magnet and the cylindrical pole piece

When we discussed impedance matching[3] we saw that it is desirable for a load connected to a generator to have a specific impedance for optimum transfer of power or to meet certain requirements in the circuit represented by the generator. An earphone may be considered as a load, with the consequence that it is necessary for it to have a specific impedance for operation with a particular circuit.

In the earlier days of radio, however, it was usual to refer to earphones in general terms of their coil resistance. The usual resistance figure for an earphone (i.e. the resistance of its two coils connected in series) was 2,000Ω, and such earphones were normally series-connected in pairs to form a headset having a total resistance of 4,000Ω. Headsets with a resistance of 4,000Ω have been in general use for radio work for many years and are still employed

[3] In "Understanding Radio" part 23, July 1963 issue.

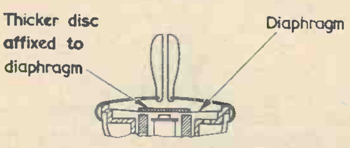


Fig. 203. A thicker disc of magnetic material may be affixed to the centre of the diaphragm in miniature earphones

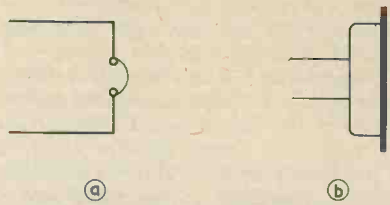


Fig. 204 (a). The circuit symbol for a headset comprising two earphones
(b). The symbol for a single earphone

very frequently at the present time.

During the war, the Services, including the R.A.F. in particular, commenced to employ equipment which required magnetic diaphragm headphones with much lower resistances, a typical figure being 50Ω per earphone. Since the lower resistance was given by employing coils with fewer turns of thicker wire, the impedance was lowered also.

Miniature earphones intended for connection to portable receivers or for use with hearing aids are normally specified both by their resistance and by their impedance at 1 kc/s. They are manufactured with a wide range of impedances, these varying from about 8Ω to 1kΩ or more. The reason for the wide range has been partly due to the introduction of transistorised equipment, which may require earphones having specific impedances (with relatively close tolerances) which are lower than is offered by the larger earphone with a resistance of 2,000Ω.

Advantages and Disadvantages of the Magnetic Diaphragm Earphone

The earphone of the type we have just discussed has a number of advantages and disadvantages which we should now consider.

The main advantages are its sensitivity, its simplicity and its robustness. So far as the first attribute is concerned, the inherent sensitivity of the earphone is enhanced by the fact that its small size and light weight enable it to be placed very close to the ear. In the case of the miniature earphone it may, indeed, be introduced into the auditory canal itself.

The greatest disadvantage of the magnetic diaphragm earphone is that it tends to have a limited frequency response and that it does not provide an audible signal which is a true equivalent of the electrical signal fed to it. It is also possible for resonant conditions to appear in the volume of air both behind and in front of the diaphragm, and in the diaphragm itself. These can cause some frequencies in the audible range to be reproduced at greater level than others.

Despite this shortcoming, the earphone is an extremely valuable device for radio work. It provides a quality of reproduction which is quite acceptable for speech and which may offer adequate entertainment value for music.

Circuit Symbols

In circuit diagrams, a pair of earphones, constituting a headset, is depicted in the manner shown in Fig. 204 (*a*). A single earphone may be depicted as illustrated in Fig. 204 (*b*).

Next Month

The writer had hoped to introduce the loudspeaker in this month's article, but it appears that the space available will not allow this. In consequence, we shall carry on to the loudspeaker next month.

ELECTRONIC "Watch Dog"

By R. M. QUAILE

Home-constructed devices which, during their development, arouse the interest of the B.B.C. and the national press do not always provide subjects for our articles! Nevertheless, this has been the fate of the electronic "watch dog" which is described here. The device requires no critical components, it gives audible warning of the approach of visitors or intruders, and it provides automatic front path lighting

In its initial stages the electronic "watch dog" unit which is described in this article was designed to close an electrical circuit for a fixed short period after the front garden gate had been opened. Under this condition it could then cause a bell or buzzer to sound, thereby offering audible warning of the approach of a visitor.

The device was originally built to let my wife know if my young son had wandered out on to the main road outside. For the amusement of my other children I later coupled the unit to a tape recorder fitted with an endless loop of tape. This recorder was set up so that it continuously announced "Bandits . . . Bandits . . . Bandits" whenever the gate was opened. To my amazement, the device was reported in no less than five newspapers, including the *Daily Express*, and was the subject of a B.B.C. broadcast recorded in my house!

Functions Offered

In its present state, the device does not offer facilities which are quite as sensational but it is, nevertheless, a very useful adjunct to the home. Furthermore, it requires no attention and its operation is simple and completely foolproof.

The functions offered by the device are:

(1) It gives audible warning by buzzer or bell of the approach of persons.

(2) It warns occupants of the house as to whether the garden gate is open or shut by lighting appropriate lamps.

(3) It automatically lights the garden path for visitors as soon as the gate is opened.

(4) It similarly lights the way for occupants leaving the house.

The lighting facility offered by items 3 and 4 is of particular value in my case, as street lamps outside my house are very few and far between.

The Circuit

The circuit of the electronic "watch dog" appears in Fig. 1.

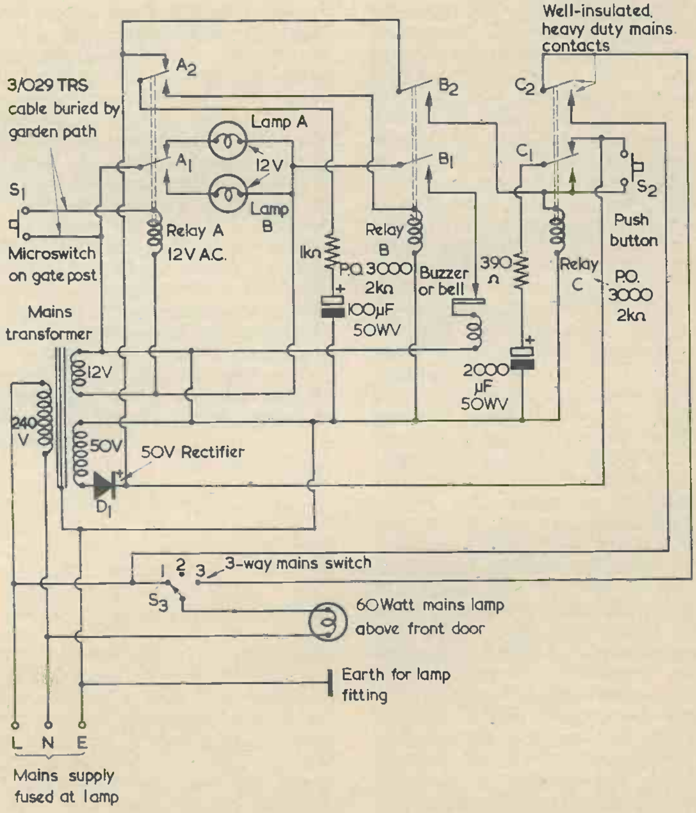


Fig. 1. The complete circuit of the electronic "watch dog".

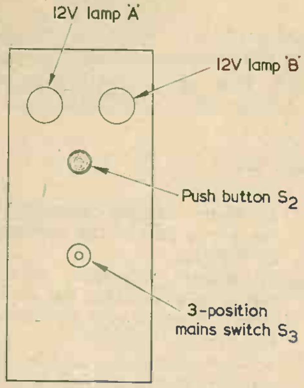


Fig. 2. The control panel. This may be fitted inside the house near the front door

When the gate is shut, microswitch S_1 is open and all relays are in the de-energised condition. The fact that the gate is closed is indicated by 12 volt lamp "A", which is illuminated by way of relay contact A1. At the same time, the 100µF electrolytic capacitor is allowed to charge up, via contact A2, to the potential on the 50 volt supply offered by the 50 volt mains transformer winding and rectifier D_1. Similarly, the 2,000µF electrolytic capacitor charges up to the potential on the 50 volt supply by way of contact C1.

When the gate is opened, microswitch S_1 closes, applying 12 volts a.c. to the coil of relay A, which then energises. Contact A1 transfers the 12 volt supply to lamp "B", and lamp "A" becomes extinguished. Lamp "B" now indicates that the gate is open. At the same time, contact A2 connects the charged 100µF capacitor across the coil of relay B, which then becomes energised for some 6 to 8 seconds until the 100µF capacitor discharges. Whilst relay B is energised its contact B1 connects the buzzer (or bell) across the 12 volt supply, causing it to give an audible warning. When relay B energises, its contact B2 applies the 50 volt supply to relay C which also energises, whereupon its contact C1 causes the already-charged 2,000µF capacitor to be connected across its coil. When contact B2 falls open after relay B de-energises, relay C remains held on by its own contact C1. It de-energises some 25 to 30 seconds later when the 2,000µF capacitor becomes discharged.

If the 3-way mains switch S_3 is in position 3, contact C2 causes a 60 watt mains lamp in a swan neck fitting outside the front door to be illuminated during the period when relay C is energised.

When, either during or after the operations just described, the front gate is closed again, relay A de-energises, causing lamp "B" to be extinguished and lamp "A" to light up. If the gate were closed during the 6 to 8 second period during which relay B is energised, this relay would de-energise also. However, such an eventuality is unlikely to occur in practice and the period during which the gate is open will, in any case, be sufficiently long for the audible warning to be effective. The 25 to 30 second switching cycle offered by relay C remains unaltered whether the gate is closed within the 6 to 8 second period or not.

The operations resulting from opening the gate may now be summarised in the following manner. Before the gate is opened lamp "A" is illuminated. On opening the gate, lamp "B" becomes illuminated, a buzzer is caused to sound for a 6 to 8 second period of time, and (when S_3 is in position 3) the external front door lamp becomes illuminated for 25 to 30 seconds. On closing the gate, lamp "B" becomes extinguished and lamp "A" lights up.

The 3-way switch S_3 provides two other functions in addition to that just described. In position 1 it causes the front door lamp to be illuminated continually. In position 2 it cuts the lamp out of circuit, with the result that the unit only causes the buzzer to sound when the gate is opened. As has already been noted, in position 3 it connects the lamp into the "watch dog" circuit.

A further facility is offered by push-button S_2. This button may be pressed when leaving the house, whereupon it causes relay C to become energised until the 2,000µF capacitor discharges. Sufficient time is then provided for the occupant to leave the house and garden before the external front door lamp switches off again.

Construction

As may be gathered from the circuit diagram of Fig. 1, the components required are not in any way critical. In the prototype, relays B and C were both P.O. 3000 types with 2kΩ coils. Relay A was a 12 volt a.c. component which had no identification marks. If any difficulty is experienced in obtaining a 12 volt a.c. relay, it could be replaced by a third P.O. 3000 type, the coil of the latter being energised (via the gate microswitch) from the rectified 50 volt supply.

The mains transformer was originally taken from an unidentified battery charger. Its secondary, rated at 17 volts 5 amps, was removed and new secondaries rewound with 23 s.w.g. enamelled copper wire to give 12 and 50 volt outputs.

The rectifier D_1 can be either a selenium or silicon type intended for 50 volt operation at some 50mA or so. The peak inverse voltage is 140, and this allows silicon rectifiers such as the XU612 to be used. The prototype employed a rectifier taken from ex-A.M. equipment, but the type required is not at all critical.

The 1kΩ and 390Ω resistors in series with the electrolytic capacitors are included to prevent current surges and possible sparking at the relay contacts. They may be 20% ½ watt components.

The controls and 12 volt lamps were mounted inside the house on a wall near the front door. The control box has the appearance

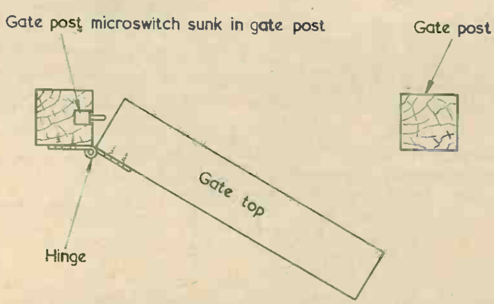


Fig. 3. A simple and satisfactory method of mounting the microswitch at the gate

shown in Fig. 2.

Constructors may have varying ideas on the mounting of the microswitch at the gate. The method employed in the prototype installation is shown in Fig. 3. This has proved to be perfectly reliable with time, and has the advantage of being inconspicuous.

This month, Smithy the Serviceman, aided as always by his able assistant Dick, embarks on a subject concerning which a number of readers have asked for information. This subject is the alignment of home-built superhets without a signal generator, and Smithy will conclude his discussion in next month's issue

"YOU CAN'T HAVE IT," SAID Smithy. "And that's final!"

To emphasise his point the Serviceman banged the thoroughly disreputable tin mug he was holding down on his bench. A little fountain of tea shot up into the air, to fall harmlessly back inside the confines of the mug.

"It's only," wheedled Dick, "for one night. One night only."

"I'm sorry," repeated Smithy, flatly. "But you just can't have it."

The Serviceman turned an aggrieved eye over the Workshop benches.

"Dash it all," he continued, "we'll have nothing left in the Workshop at all soon. On Monday night you borrowed both a large and a small soldering iron, and I have no doubt that you also secreted about your person a goodly quantity of our cored solder as well. On Tuesday night you borrowed three screwdrivers, a set of B.A. box spanners, two pliers, a pair of side-cutters and a hammer. And on Wednesday you borrowed the highest resistance testmeter we've got in the place. It's now Thursday, and I was hoping that you had at last satisfied your desire to set up a second Workshop in your back bedroom. But no. You now want to borrow our best signal generator as well!"

Smithy reached round, picked up his disgraceful mug and drank deeply of its contents. Refreshed, he returned to the attack.

"What are you building, anyway," he queried, "your own domestic digital computer?"

Superhet Alignment

"It's nothing like that at all," replied Dick hotly. "What I've just knocked up is a little medium and long wave superhet. All I need now is a signal generator to line it up with."

"Is *that* all?" queried Smithy incredulously. "Just a medium and long wave superhet?"

"That's right," replied Dick eagerly. "I could get it finalised tonight if I had the signal genny."

Smithy thought for a moment.

"Did you," he asked, "obtain your coils and i.f. transformers brand-new?"

Dick looked a little puzzled at Smithy's question.

"It so happens," he remarked, "that I did."

"And have you," continued Smithy, "played around with their iron dust cores in any way?"

Dick's perplexed expression deepened.

"As a matter of fact," he remarked, "I've left them severely alone. But what difference does that make?"

"It makes the important difference," replied Smithy triumphantly, "that I'm actually doing you a favour by not letting you have the signal genny! Provided they're put together properly, and the iron dust core settings in the coils haven't been altered, most home-made medium and long wave superhets can be lined up quite accurately without a signal generator at all. It will be good experience for you to attempt it with that set of yours!"

"I think that's pretty rotten of you," commented Dick disgustedly. "If I had that signal genny I could line the set up in no time at all. Without it, I wouldn't even know where to start."

"All you have to do," remarked Smithy, "is to remember your basic superhet theory."

"I *do* remember it," said Dick. "But I still wouldn't know where to start!"

"Then the practice you gain will be even more useful to you," replied Smithy heartlessly.

He glanced at the clock.

"I see," he added, "that we've got quite a bit of tea-break time left, so I might as well devote it to giving you a bit of introductory gen on this particular subject."

Smithy drew a pad of papers towards him and beckoned his assistant over. Obediently, Dick picked up his stool and sat at the Serviceman's side.

"The best way to start on this subject," said Smithy, "is to get down to first principles straightaway. We'll commence by considering a four valve superhet covering medium waves only. I'm choosing a valve set instead of a transistor set as an example because it's a little easier

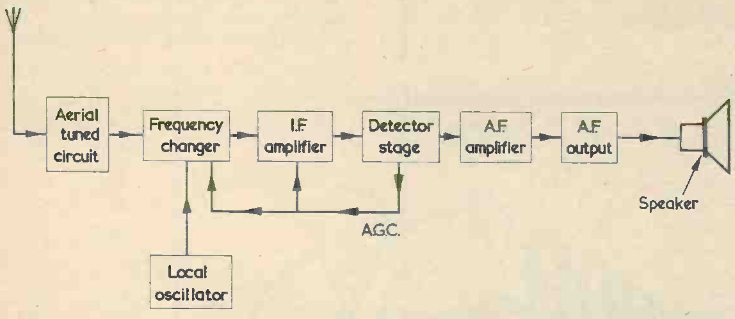


Fig. 1. Block diagram of a medium wave superhet. The aerial tuned circuit is shown as a separate block for purposes of explanation

to show the various stages."

Smithy scribbled out a diagram on his pad. (Fig. 1.)

"The first thing we need to look at," he continued, "is this block diagram of the receiver. Working back from the speaker we have the a.f. amplifier and output stages, these being preceded by the detector stage. The latter provides the a.f. modulation which is present on the signal, as well as an a.g.c. voltage. Sometimes a single diode does these two things, and sometimes two diodes are used. Before the detector stage, we have the i.f. amplifier."

Smithy paused.

"Now what," he asked, "is the function of the i.f. amplifier?"

"That's obvious," replied Dick scornfully. "It's to provide amplification at the intermediate frequency."

"Is that all?"

Dick thought for a moment.

"I can't think," he confessed eventually, "of anything else it's supposed to do."

"Your answer is perfectly right," admitted Smithy, "but I'm afraid it tends to put some of the emphasis in the wrong place. The i.f. amplifier *does* provide amplification at the intermediate frequency and, in so doing, imparts a considerable degree of sensitivity to the overall receiver. But it has a second attribute. Since it contains a relatively large number of tuned circuits, the i.f. amplifier also imparts a very high degree of *selectivity* to the receiver. The i.f. amplifier allows only those signals which fall within its pass-band to be fed to the detector, and it rejects all signals on either side. In other words it rejects all adjacent channel signals. Indeed, the i.f. amplifier offers practically all the adjacent channel rejection which the set is capable of giving."

The Frequency Changer Stage

"I get your point," said Dick. "Shall we carry on back to the frequency changer stage next?"

"If you like," agreed Smithy. "As you know, the frequency changer stage incorporates a local oscillator in addition to the frequency changer circuits themselves, the oscillator and frequency changer functions being usually carried out by a single triode-heptode or triode-hexode. You know also that the oscillator frequency in any conventional superhet is spaced above the frequency of the required aerial signal by the intermediate frequency. Thus, if the intermediate frequency is 470 kc/s and we want to receive an aerial signal of 1,000 kc/s, we set the oscillator to 1,470 kc/s. O.K.?"

"Sure," said Dick, a little impatiently. "The 1,470 kc/s from the oscillator beats in the frequency changer section with the 1,000 kc/s aerial signal to give the 470 kc/s intermediate frequency. Dash it all though, Smithy, isn't all this very elementary stuff?"

"It is," agreed the Serviceman, "but I'm trying to lead up to a very important point. What I want you to appreciate is that we are only receiving our 1,000 kc/s signal because the oscillator frequency is set to 1,470 kc/s. If we want to receive a signal on say 1,200 kc/s, then we do this by setting the oscillator to 1,670 kc/s. And, if we want to receive a 1,400 kc/s signal, we set the oscillator to 1,870 kc/s. In other words, the signal we receive is selected by the oscillator circuit only. When we adjust the frequency of the oscillator we are selecting the frequency which will be passed to the intermediate frequency amplifier. The intermediate frequency amplifier provides practically all the adjacent channel selectivity for the receiver, and the oscillator circuit selects the signal which will be passed on to that amplifier. The result is that adjusting the oscillator tuning capacitor has the same effect on station selection as would be given by adjusting, say, a whacking great 4-gang tuning capacitor in a straight receiver with all tuned circuits perfectly aligned!"

Dick looked impressed.

"I must confess," he remarked, "that I hadn't quite looked at the oscillator circuit in that manner."

"You should," replied Smithy. "The oscillator circuit is that which selects the signal which is received by the set. If you change the oscillator frequency, then you receive a different signal."

"What about the aerial tuned circuit?"

"The function of the aerial tuned circuit," said Smithy, "is twofold. Firstly, it has to bring the desired signal to as high a level as economic tuning circuit design will allow, whereupon it is then fed to the signal grid of the frequency changer for beating with the oscillator signal. Secondly, the aerial tuned circuit has to keep out unwanted signals."

"What unwanted signals?"

"The unwanted signals," replied Smithy, "which appear due to the superhet principle. These consist of the intermediate frequency itself, and of the second channel signal. Without an aerial tuned circuit, aerial signals at the intermediate frequency can pass straight through into the frequency changer and, thence, to the i.f. amplifier. Whilst there are no broadcasting stations in the 455 to 480 kc/s range in which the intermediate frequencies for domestic a.m. receivers appear, these frequencies still fall inside the 415 to 490 kc/s marine telegraphy band. Without the aerial tuned circuit, therefore, you could pick up quite a bit of ship's morse in some localities. So far as second channel interference is concerned, we need only return to our previous example to give a simple instance of this. We picked up an aerial signal at 1,000 kc/s by setting the oscillator to 1,470 kc/s. If, under these conditions, an aerial signal at 1,940 kc/s found its way to the frequency changer signal grid, this would similarly beat with the 1,470 kc/s oscillator frequency to give 470 kc/s, whereupon the 1,940 kc/s signal would also pass into the i.f. amplifier. The 1,940 kc/s is a second channel signal and, as you can see, is twice the intermediate frequency above the required signal. The function of the aerial tuned circuit is to prevent second channel signals of this sort arriving at the signal grid of the frequency changer."

Smithy paused for a minute, and carefully inspected the contents of his mug.

"I should add," he continued, "that, since the aerial tuned circuit is intended to prevent signals at the intermediate and second channel frequencies reaching the signal grid of the frequencer changer, it is capable of doing this most effectively when it causes the *required* signal to be passed on at optimum level. This increases the *ratio* between the wanted and unwanted signals, which is exactly what is required. In practice, when signals at i.f. and second channel frequency do get past the aerial tuned circuit, they cause whistles by beating with the required signal as the tuning capacitor is adjusted over the band. If ever you get this effect with an a.m. superhet you want to check the condition of the aerial tuned circuit. Very often, the whistles will drop in level or disappear if you make certain that the aerial tuned circuit is resonant at exactly the frequency of the required signal. Because the wanted signal is then passed to the frequency changer signal grid at an increased level, the effect of the unwanted signals is proportionately less and the whistles become weaker or disappear altogether."

"Since the wanted signal," interjected Dick, "is now at higher level, I presume that you could say that a.g.c. action makes the receiver less sensitive to the unwanted signals."

"That's true enough," agreed Smithy. "Anyway, to sum up all I have said up to now, you have to remember, firstly, that practically all of the adjacent channel selectivity in the receiver is provided by the i.f. amplifier. Secondly, signal selection is carried out by the oscillator, because it is the oscillator frequency that determines which aerial signal will be fed into the highly selective i.f. amplifier. And, thirdly, the functions of the aerial tuned circuit are to ensure that the required signal is passed to the frequency changer at optimum level, and that signals at the intermediate frequency and second channel frequency are kept out. I should perhaps add that, in some sets, the aerial tuned circuit will also add a little to the adjacent channel selectivity given by the i.f. amplifier, but this point is unimportant so far as alignment techniques are concerned."

Trimming and Padding

Smithy held his disgraceful tin mug to his lips and drained its contents. With a loud smack of the lips he passed it to his assistant, who accepted it with obvious revulsion.

"I can't understand," commented Dick, as he made his way to the heterogeneous array of utensils at the Workshop sink, "how you can even bring yourself to have this repulsive object in the place, leastways actually drink out of it!"

"What repulsive object?"

"This filthy old tin mug," called out Dick over his shoulder. "It must have fallen off the rag and bone man's cart."

An expression of incredulous affront spread over Smith's face.

"If you are referring to my drinking vessel," he snorted indignantly, "I must inform you I was issued with that at Aldershot in 1941."

"Blimey," commented Dick, holding the article under discussion at arm's length as he filled it from the battered teapot, "I didn't know the Pioneer Corps even got as far as Aldershot!"

"Furthermore," continued Smithy, ignoring his assistant's comment, "that mug has seen service in East Africa."

"East Acton would be more like it!"

"And, finally," said Smithy, with dignity, "I consider it my duty, as an ex-serviceman, to keep all the Army kit I have in a state of complete readiness."

"I can see the point of that," chuckled Dick as he walked back to the bench. "Throw a few mugs like this in amongst the enemy and they'd all be down with bubonic plague!"

"Nonsense," said Smithy. "Just because there are one or two bits of enamel missing here and there, it doesn't mean to say that this mug is in any way unhygienic. Anyway, let's get back to that superhet."

"As you like," said Dick, placing Smithy's refilled mug on the bench at as great a distance from himself as was possible.

"Right," said Smithy briskly. "We have already discussed the functions of the i.f. amplifier, the oscillator section and the aerial tuned circuit, so let's carry straight on to the actual business of alignment. We'll start off at the frequency changer, and we'll continue to talk in terms of a medium wave valve superhet."

The Serviceman sketched out a second diagram on his pad. (Fig. 2.)

"What I've drawn here," he announced, "is the sort of frequency changer circuit which used to be particularly common in the old days. It differs from the circuit you see in modern sets because both the aerial and oscillator coils are air-cored and because it has a variable padding capacitor. Since the coils do not have adjustable iron dust cores their inductances are fixed, and cannot be altered. Let us now assume that the 2-gang tuning capacitor in the circuit is fitted with a scale calibrated in wavelength or frequency and that it has a nominal capacitance of 500pF in each section. Also, that the i.f. is

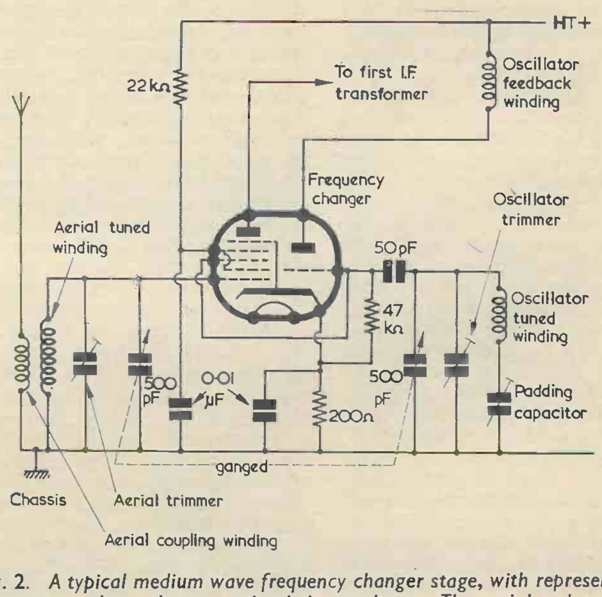


Fig. 2. A typical medium wave frequency changer stage, with representative component values. An a.g.c. circuit is not shown. The aerial and oscillator coils are air-cored

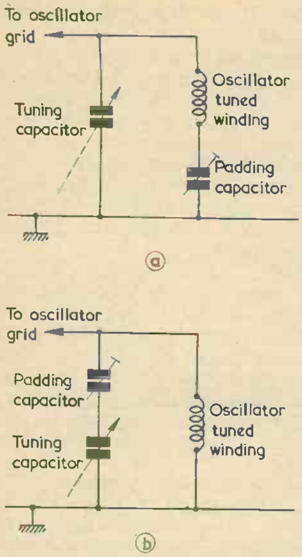


Fig. 3 (a). The padding capacitor of Fig. 2 is in series with the oscillator tuned circuit

(b). The padding capacitor would have the same effect on oscillator resonant frequency if it were more obviously connected in series, as shown here

470 kc/s and the i.f. amplifier has already been lined up. With this frequency changer stage we want to cover a band of some 200 to 500 metres which is, near enough, the conventional medium wave band."

"Those are nice easy figures," commented Dick approvingly. "200 metres is 1,500 kc/s and 500 metres is 600 kc/s."

"Exactly," confirmed Smithy. "And these figures mean that the oscillator has to cover 1,970 to 1,070 kc/s if it is to be 470 kc/s above aerial signal frequency. The ratio of top and bottom aerial signal frequencies is 1,500 to 600, or 5 to 2. At the same time, the ratio of top and bottom oscillator frequencies is 1,970 to 1,070, which is slightly less than 2 to 1. Since the oscillator tuned circuit has to offer a lower ratio between its top and bottom frequencies than does the aerial tuned circuit, it seems reasonable to expect that it requires a lower tuning capacitance. In the circuit I've just drawn, this lower tuning capacitance is provided by inserting a padding capacitor in series with the oscillator tuned circuit. (Fig. 3 (*a*).) The fact that the chassis connection appears at the junction of the tuning and padding capacitors is not of importance here, and the padding capacitor has the same effect on resonant frequency as it would have if it were more obviously in series with the tuning capacitor, say at the top end. (Fig. 3 (*b*).) The first circuit is more convenient in practice, however, especially when band-switching from medium to long waves is employed."

Smithy took a sip from his replenished supply of tea.

"We can now," he said, "start to align our circuit. As you can see, in addition to the variable padding capacitor we have two variable trimming capacitors in parallel with the two sections of the tuning capacitor. These trimmers are relatively low-value components, and will have a maximum capacitance of about 60pF or so. Since they are connected across the tuning capacitor sections, they have greatest effect on resonant frequency when the tuning capacitor is set to the minimum capacitance end of its travel. Which is, of course, the high frequency end of the tuning range. We start off, therefore, by adjusting the trimmers at the high frequency end of the range. However, it isn't usual practice to adjust the trimmers with the tuning capacitor vanes *fully* disengaged, and we normally engage the vanes by about 10 to 20 degrees before we commence the trimming operation. (Fig. 4 (*a*).) One reason for this is that any slight discrepancies in value between the two sections of the 2-gang capacitor do not, for obvious reasons, show up when the vanes are completely disengaged. If they are slightly enmeshed the trimming operation takes up tuning capacitor discrepancies at that setting as well as the stray capacitances in the two circuits. I should add that, if we were aligning a commercial receiver or a home-constructor kit set, there may well be alignment instructions which would tell us the exact point at which we should set the tuning capacitor for trimming purposes."

Smithy took yet another sip at his tea.

"Right!" he remarked, refreshed. "The first trimmer to attack is the oscillator trimmer. The tuning scale will indicate a wavelength or frequency corresponding to the tuning capacitor position and, if we have a signal generator, we set this to that frequency and apply its output to the aerial input circuit. We then adjust the oscillator trimmer so that the signal generator signal is applied to the i.f. amplifier. In other words, we set the oscillator trimmer so that oscillator frequency is 470 kc/s above signal generator frequency, with the result that the latter is passed into the highly selective 470 kc/s i.f. amplifier. Adjusting the oscillator trimmer gives the same effect as 'tuning in' the signal by means of the tuning knob on the front of the set."

"What happens if you haven't got a signal generator?"

"You work with a known broadcast signal," replied Smithy, "which appears at about the right place on the dial. You set the tuning dial to the wavelength or frequency of that signal and 'tune it in' with the oscillator trimmer. Incidentally, I'll be going into greater detail about alignment without a signal generator later on."

"Fair enough," commented Dick. "What happens after setting up the oscillator trimmer?"

"We then," replied Smithy, "adjust the aerial trimmer. In this case, though, we merely adjust the trimmer for maximum signal strength. You must remember that we've already 'tuned in' the signal with the oscillator trimmer. Now that we've got the signal going into the i.f. amplifier, all we need to do is to bring it up to maximum amplitude with the aerial trimmer. The latter doesn't 'tune in' the signal, it just increases its strength. O.K.?"

"Sure," responded Dick. "I'm with you all the way!"

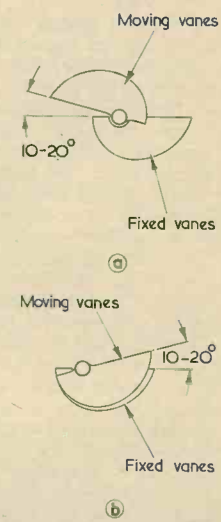


Fig. 4 (a). In the absence of specific alignment instructions, normal practice consists of carrying out trimming operations with the tuning capacitor vanes enmeshed for some 10 to 20 degrees

(b). Similarly, padding adjustments may be made with the vanes some 10 to 20 degrees short of being fully enmeshed

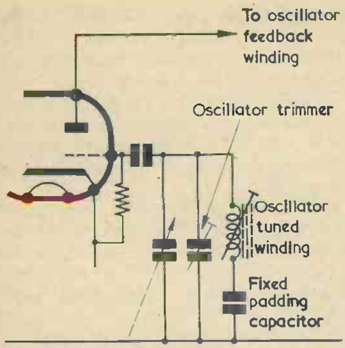


Fig. 5. The air-cored oscillator coil of Fig. 2, with its variable padding capacitor, may be replaced by an iron dust cored coil and a fixed padding capacitor

"Good," said Smithy. "The next job is to carry out a padding adjustment at the low frequency end of the range. We've already seen that the parallel trimmers have greatest effect when the tuning capacitor is at the low capacitance end of its range. It follows that the series padding capacitor will have greatest effect when the tuning capacitor is at the maximum capacitance end of its range. So we turn the tuning capacitor until its vanes are fully enmeshed except for about 10 to 20 degrees or so (Fig. 4 (*b*)) and start the padding operation. Note that we don't fully enmesh the vanes. If we did, we'd be adjusting for a tuning capacitor position which would only correspond to reception right at the bottom frequency point of the band. If there are alignment instructions for the receiver, these will, as at the high frequency end, tell us the exact position we should set the tuning capacitor to. Without such instructions it's satisfactory to have the tuning capacitor fully enmeshed except for about 10 to 20 degrees.

"Our tuning scale," continued Smithy, "will now indicate a new wavelength or frequency and, if we have a signal generator, we set it to that frequency and once more inject its output into the aerial circuit. We then adjust the padding capacitor. Since this alters oscillator frequency, we once more have the 'tuning in' effect. In consequence, we adjust the padding capacitor to 'tune in' the signal generator frequency. If we haven't got a signal generator, we 'tune in', at the appropriate position on the scale, a known broadcast signal whose frequency is close to the desired point on the dial. No further adjustment can then be carried out at this end of the range with our present circuit because there are no more variable components available. The next point is that our padding adjustment may have put things a little bit off alignment at the high frequency end of the band. In consequence, we return to the previous trimming frequency and repeat the trimming operation all over again. Since this could, in its turn, slightly alter the padding adjustment, we then return to the low frequency end and finally repeat the padding adjustment. Unless the adjustable components were miles off in the first place, the two trimming and padding adjustments I've just described should be enough to bring the whole circuit into full alignment. You can always repeat the trimming and padding processes a third time if you feel in a perfectionist mood."

Iron Dust Cores

"There's a snag here," frowned Dick. "But I can't quite put my finger on it."

"There *is* a snag," grinned Smithy. "And to save time I'll tell you exactly what it is. In the process I've just discussed it is assumed that the aerial circuit will be resonant at exactly the correct frequency when we adjust the padding capacitor. Unfortunately, we have no guarantee of this and there is, really, a further padding operation which should be carried out with circuits employing air-cored coils if we want to ensure that we are getting the best results possible. We set the tuning capacitor to the padding frequency as I've just described and carry out the padding operation. We then check the condition of the aerial tuned circuit by experimentally turning its trimmer, always bringing it back to its correct position after each check. If, to take an example, the aerial trimmer indicates that the aerial tuned circuit requires more capacitance to become exactly resonant at signal frequency, we then further enmesh the tuning capacitor vanes slightly to give that extra capacitance, and readjust the padding capacitor. After which we check with the aerial trimmer once again. When this process has been carried out several times we should have the aerial tuned circuit spot on frequency at the padding position."

"Blimey," remarked Dick, "that sounds a long-winded process!"

"It is, rather," admitted Smithy. "A simpler method consists of rocking the tuning capacitor back and forth over a small range on either side of the padding frequency, adjusting the padding capacitor at the same time. The point at which the required signal appears on the dial will shift around as we adjust the padding capacitor, and its strength will increase as we adjust in one direction. We adjust the padding capacitor for maximum signal strength as we pass through the signal whilst rocking the tuning capacitor. That is then the final padding capacitor setting, because it allows the aerial section of the tuning capacitor to present exactly the right capacitance to the aerial coil at the padding frequency."

"There's another snag here," said Dick. "If you adjust the padding capacitor in the manner you've just described, the tuning dial calibration will be incorrect at the low frequency end of the band."

"That's right," grinned Smithy. "And that was, indeed, one of the problems service engineers used to have in the old days with superhets which employed air-cored coils. The snag is that, with these coils, we have to rely on the aerial coil having exactly the right inductance to match up to the tuning capacitor and the tuning dial. Usually, they *did* match up, but if they didn't, we had to bodge things up a bit. What I used to do myself was to set up a receiver of this sort for maximum signal strength at the padding frequency, and blow the dial calibration! In most cases, however, the dial calibration was only slightly out and it could usually be put right by setting the pointer so that it was correct at the padding frequency. A little adjustment of the trimmers would then make the calibration correct at the high frequency end as well. But I'm digressing a little here, because difficulties of this nature don't crop up with modern coils!"

"Why's that?"

"Because," replied Smithy, "modern coils have adjustable inductances. With some of these, the adjustment is given by iron dust cores which can be screwed in or out of the winding."

Dick looked puzzled.

"I didn't know," he remarked, "that there were other types."

"Of course there are," snorted Smithy. "You get coils with varying inductances on ferrite frame aerials. You adjust their inductance by sliding the coils along the rod."

"Dear, oh dear," chuckled Dick. "I'd forgotten all about them!"

"Anyway," said Smithy, "the coils I'd like to deal with for the moment are those with iron dust cores. Nowadays, you will almost inevitably encounter these in the oscillator circuits, whereupon they replace the coils with fixed inductance we've considered up to now."

Smithy scribbled a further circuit on his pad. (Fig. 5.)

"In this circuit," he remarked, "an oscillator coil with an adjustable iron dust core replaces the previous air-cored type we considered. Also, the variable padding capacitor is replaced by a fixed capacitor having a value which is suitable for the range of frequencies to be covered. Despite these changes, the business of trimming and padding is pretty well the same as before, except that, in this instance, we do not adjust the padding capacitor at the padding frequency. Instead, we adjust the oscillator coil iron dust core. With a circuit of this nature we start off by setting the tuning capacitor to the trimming frequency at the high frequency end of the band, and we 'tune in' the required signal frequency with the oscillator trimmer, as before. We then, also as before, bring that signal up to a peak with the aerial trimmer. We next go to the padding frequency at the low frequency end of the band, whereupon we 'tune in' the required signal by adjusting the oscillator coil *core*. We repeat the trimming and padding processes again, after which we're fully lined up.

In Our Next

"You still have the same snag as before," objected Dick. "If the aerial coil hasn't exactly the right inductance, the optimum padding position doesn't correspond with dial calibration."

"True enough," agreed Smithy. "But that's something I'll have to return to later. In the meantime, we have achieved two advantages. We've replaced a bulky air-cored oscillator coil with a smaller iron dust cored type, and we've replaced a variable padding capacitor with a fixed capacitor. On medium waves, the padding capacitance required is usually of the order of 450pF, so the variable padding capacitor we've obviated is a relatively expensive and large compression component."

Smithy raised his mug to his lips and drained its contents. Fascinated, Dick watched a large piece of enamel flake off its surface and float to the floor.

"It looks," said Smithy, wiping his lips and glancing briskly at the Workshop clock, "as though we'll have to resume this discussion at our next little get-together. The clock says it's back to work now."

"Righty-ho," said Dick equably, taking his stool back to his own bench.

Smithy looked surprised.

"Aren't you going to ask for the loan of that signal genny after all?"

"I don't think so," replied Dick. "I'll restrain my impatience until we've had our next gen-session. After that I may not need it anyway!"

THREE TO ONE

Transistor Medium and Long Wave Tuner Unit

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

By taking advantage of the circuit up to and including the detector load on the popular Weyrad printed board type PCA1, it is possible to make a delightfully small and slim medium and long wave tuner unit. The unused section of the board provides a convenient mounting for the wavechange switch and the a.f. output components

If you require a sensitive tuner unit for use with your tape recorder or amplifier, and one that really works well with no aerial or earth connected, then this article is for you. The project is an extremely simple one and the construction can be completed in about four hours flat—even if you have to use the kitchen table! The outcome is a neat and slim unit that will being in numerous stations over the medium and long wavebands.

Very few leads have to be connected due to use of the Weyrad printed circuit board type PCA1, on which practically all the work has already been done for you. This board was originally designed to accommodate a complete transistor receiver, but only the r.f. and i.f. circuits are required for our present purposes. We still use the remainder, however, as will be seen later.

The finished unit uses three transistors and a diode, and a signal generator is necessary for alignment due to the superhet technique employed. The tuner *can* be aligned without a generator, but this tends to be a rather tedious and chancy procedure.

The physical dimensions of the assembly are 9¼ x 4¼ x 2in (including control knobs) the only additional items needed being a battery and a short piece of coaxial cable to enable an output connection to be made to the apparatus with which the unit is to be used.

The Circuit

Because this is a practical article a detailed discussion on the way the unit works will be omitted. The complete circuit is, nevertheless, shown in Fig. 1 and, here, everything to the left of the broken line is exactly as given in the printed board layout. The items added are to the right of the broken line and are only four in number since the battery is external. The battery may be either a 6 volt type such as the PP1, or a 7.5 volt type such as the AD43. As may be seen, T_1 (OC44) is a conventional mixer/oscillator whilst two OC45's function as intermediate frequency amplifiers. The diode acts both as signal and a.g.c. detector.

Mechanical Details

Before detailing actual construction it is convenient to consider the way in which the unit is held together and Fig. 3 gives the plan.

A panel (to which a dial is eventually pasted) is drilled with two holes through which the two control

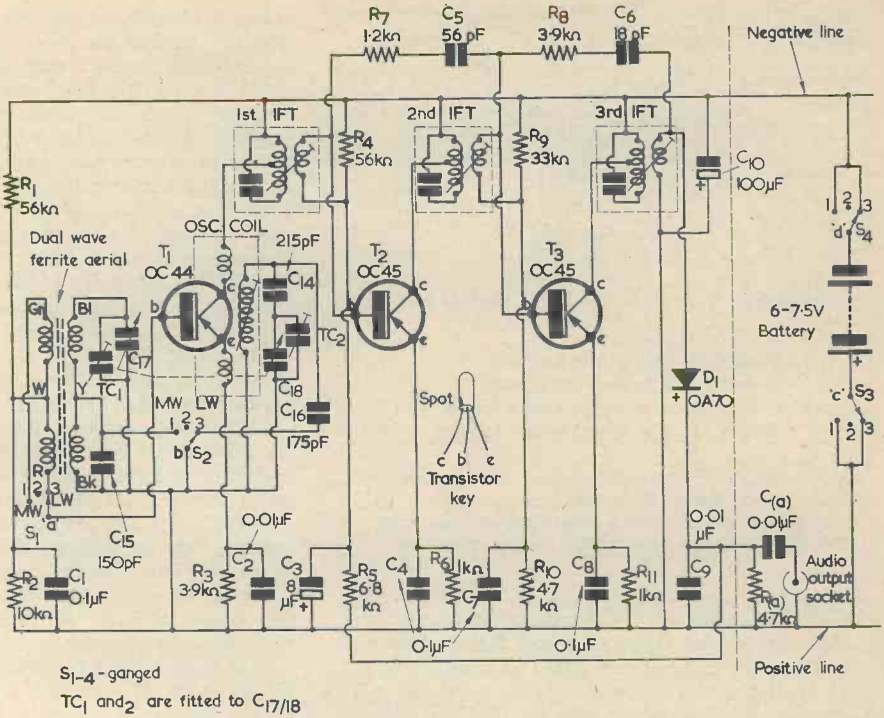


Fig. 1. The circuit of the tuner

Components List

Resistors (all resistors 10% ¼ watt)

R_1	56kΩ
R_2	10kΩ
R_3	3.9kΩ
R_4	56kΩ
R_5	6.8kΩ
R_6	1kΩ
R_7	1.2kΩ
R_8	3.9kΩ
R_9	33kΩ
R_{10}	4.7kΩ
R_{11}	1kΩ
$R_{(a)}$	4.7kΩ

Capacitors (all fixed capacitors should be miniature types, with electrolytic components at 9V wkg, and paper components at 150V wkg. Omissions in suffix numbers are due to capacitors agreeing with the printed board)

C_1	0.1μF
C_2	0.01μF
C_3	8μF electrolytic
C_4	0.1μF
C_5	56pF silver mica 5%
C_6	18pF silver mica 5%
C_7	0.1μF
C_8	0.1μF
C_9	0.01μF
C_{10}	100μF electrolytic
C_{14}	215pF silver mica
C_{15}	150pF silver mica
C_{16}	175pF silver mica (see text)
C_{17}, C_{18}	208+176pF, twin-gang type "00", with centre screen and trimmers (Jackson Bros.)
$C_{(a)}$	0.01μF

Coils, etc.

Oscillator coil P50/1AC
1st i.f.t. P50/2CC
2nd i.f.t. P50/2CC
3rd i.f.t. P50/3CC
Ferrite rod aerial RA2W
Printed board PCA1
} Weymouth "Weyrad"

Semiconductors

T_1	OC44
T_2, T_3	OC45
D_1	OA70

Switch

4-pole 3-way miniature rotary

Control Knobs

1 1in dia., gilt centred
1 2½in dia., transparent plastic with cursor line

Miscellaneous

Battery, PP1 or AD43 (see text)
Coaxial output socket, surface mounting
2 plastic clips for ferrite rod, ⅜in dia., Lektrokit LK-2851
Panel material, 9¼ x 4¼ x ⅛in

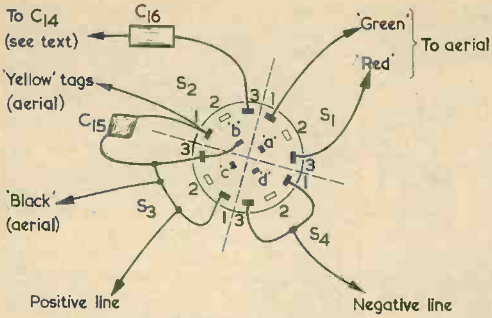


Fig. 2. Details of the switch wiring. The constructor should check the outer contacts corresponding to poles a, b, c and d before wiring, as orientation with some switches may be different to that shown here

spindles pass when the PCA1 board is placed over it. Two channelled strips of wood then engage the board at either end and are glued in position to the inside of the panel. When dry the assembly may be turned over whereupon, with the dial and control knobs fitted, it is ready for use. The reader may then either make up a slim casing or let the unit lie flat in a "well" cut out in an equipment cabinet.

Assembly

Note: When fitting resistors and capacitors to the board do not adopt a "spot soldering" technique. Bend the lead-out wires over by about $\frac{1}{16}$in and then solder to avoid bad joints.

(1) Commence by fitting C_{17}, C_{18} in the space marked for them, and checking that neither of the bolt heads fouls the negative line. Fit the i.f. transformers, noting that the third one differs in type from the other two. Also fit the oscillator coil but, before soldering in position, make certain the red spot painted on it agrees with the instruction printed on the board (see also Fig. 4).

(2) Fit the rotary switch in the hole provided originally for a volume control.

(3) Fit a coaxial output socket as shown in Fig. 4, using either 8BA nuts and bolts or enlarging the holes to take 6BA types.

(4) Solder a link wire between the two holes marked "R20". This will connect the output socket casing to the positive line. Check the printed wiring to ensure that this connection is correctly made.

(5) Solder in all resistors where indicated on the board up to and including R_{11}.

(6) Solder in all capacitors where marked on the board up to and including C_{10}, ignoring all + and − signs except for C_3 and C_{10}, which observe.

(7) Enlarge slightly the hole provided for D_1+ and insert in it the red lead of the diode together with one lead of $R_{(a)}$. Solder both to the board using a heat shunt for the diode. Also solder the negative lead of the diode as indicated.

(8) Solder the free end of $R_{(a)}$ to $C_{10}+$.

(9) Locate the hole originally provided for the volume control tag nearest the edge of the board (see Fig. 4) and solder in one lead-out wire of $C_{(a)}$.

(10) Locate the hole marked "A" near the output socket and solder in the free end of $C_{(a)}$. Also solder a short lead therefrom to the output socket centre tag. Ensure that the copper at hole "A" does not connect to any of the circuit as now used.

(11) Fit C_{14} where marked on board (see Fig. 4) close to the oscillator coil, checking that it does not foul the metal can.

(12) Wire the switch to agree with Fig. 2, connecting the tags marked "positive line" to the link wire in the "R_{20}" position.

(13) Locate the hole provided for "R_{13}" nearest the edge of the board and check that it is in contact with $C_{10}-$, already fitted. Solder a wire therefrom to S_4 where marked "negative line" (Fig. 2).

(14) Fit C_{16} and anchor one end by using the hole marked "B" on the board and in Fig. 4. It should be noted that it might be necessary to modify the value of this capacitor slightly later. Ensure that the copper at hole "B" does not connect to any of the circuit as now used.

(15) Run a lead from hole "B" to C_{14} (already fitted) on the copper side of the board.

(16) Solder in transistors T_1, T_2, T_3 exactly as marked on the board. Use heat shunts.

(17) Locate a small hole between "E" and "B", T_1 (see Fig. 4) and run a lead from this point to S_1, tag (a). Check the copper circuit to ensure that the connection at this hole is common to the base of T_1.

(18) Fit the aerial as shown and wire to agree with Figs. 2 and 4. Metal clips must *not* be used to retain the ferrite rod. Note the connection from the white tags on the aerial to a small hole adjoining R_1 (which should be common to the junction of R_1 and R_2). It is advisable to allow sufficient slackness in the inter-coil connecting leads to allow movement of the coils along the rod.

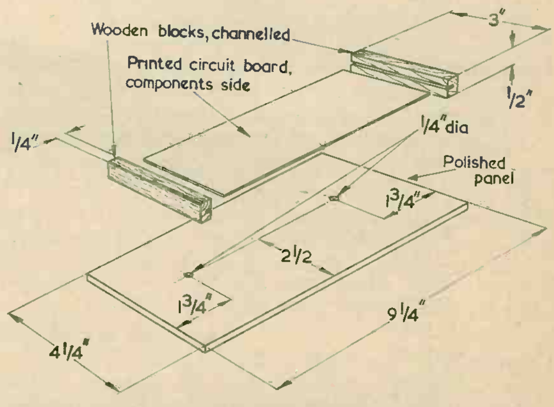


Fig. 3. How the printed board is assembled to the front panel

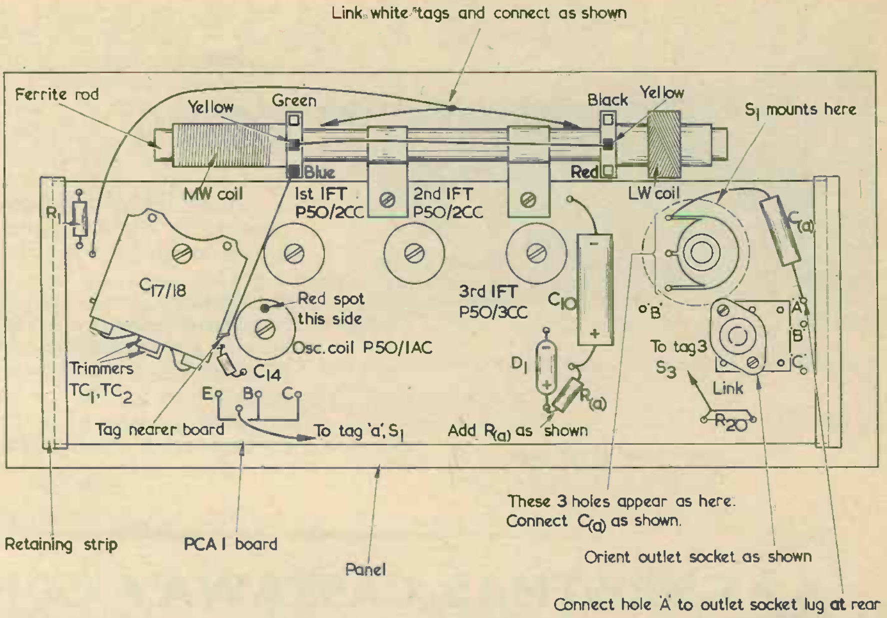


Fig. 4. The general layout, together with additional wiring and components

(19) Fit suitable stud or plug connectors to the appropriate battery leads coming from the switch, observing polarity.

This completes the wiring and, after checking for correct connections and performance, place the board in position and secure it to the panel as described earlier. When dry fix the dial and control knobs. It should be noted that, during assembly and checking, most of the printed circuit can be followed by holding the copper side of the board up to a strong light.

Alignment

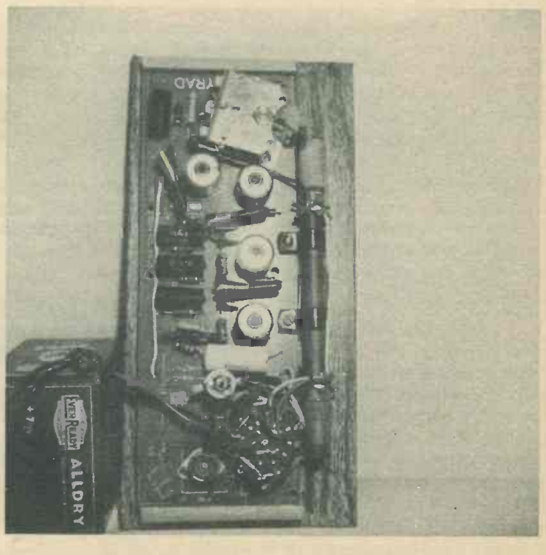
(1) With the unit connected to an amplifier, and with a battery fitted, switch on and set the switch to position "1". Rotate the tuning capacitor to fully enmesh the vanes. Bring a lead carrying modulated signals at 470 kc/s from a signal generator close to the aerial and carefully adjust the cores of the i.f. transformers (commencing with the third and working backwards) for maximum signal either aurally or with a suitable visual aid connected. Core settings tend to be critical, so always use the lowest detectable signal to prevent the a.g.c. system from masking results and to avoid overloading. If no signal is heard initially, inject the generator output, suitably attenuated and via a blocking capacitor of 0.01μF, between the positive line and the base feed potentiometers of T_2 and T_3 (i.e. at the junctions of R_9 and R_{10}, and of R_4 and T_5.

(2) Set the generator to 600 kc/s and with the tuning capacitor vanes very nearly closed carefully tune in the signal using the oscillator coil core. The core position is critical and will normally be almost at the top of the can. Roughly set the medium wave coil on the ferrite rod for maximum signal.

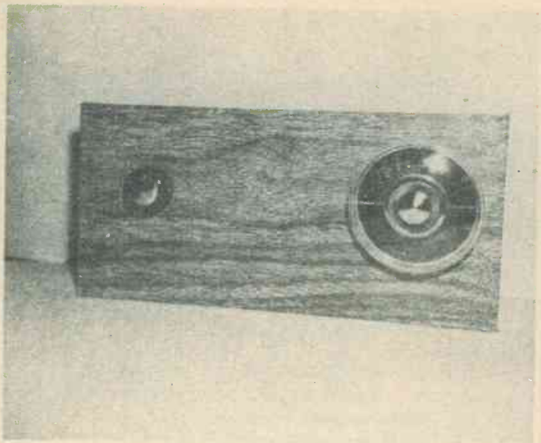
(3) Adjust the generator to 1,500 kc/s, almost fully disengage the tuning capacitor vanes and tune in the signal with TC_1 and TC_2. These trimmers peak sharply and require careful adjustment.

(4) Repeat (2) and (3) above several times, then seal the medium wave coil in position with Sellotape when no further improvements can be made.

(5) Rotate the switch to position "3" and set the generator to 200 kc/s. Rotating the tuning capacitor should resolve the signal when the vanes are 50 per



The completed tuner unit. Compare with Fig. 4 above



Front panel of the tuner

cent enmeshed. Small capacitor values—say 20pF —across C_{16} may help here, especially if the signal is received at the end of the scale.

If quick results are required use a trimmer in conjunction with C_{16} and replace it with a fixed component later after making a measurement of the correct value. Finally seal the long wave coil in position and remove the generator, whereupon broadcast signals should romp in. It is then permissible to slightly detune the second i.f. transformer to broaden the response.

Conclusion

After completion of this work, you will now possess a remarkably sensitive little tuner that will be most useful for tape recording purposes or for feeding into a valve or transistor amplifier. You can even use it as a low power headphone receiver by connecting a pair of high impedance phones to the output socket!

CHRISTMAS CASTAWAY CONTEST

Results and Prize-Winning Entry

In our Christmas Castaway Contest, details of which were given in the last December issue, we asked readers to send accounts of how they, themselves, would act if they were cast away upon the highly improbable desert island of Transistiana. This island, as readers will recall, possesses a fully equipped workshop with a power supply socket giving 240 volts a.c. at currents up to 50 amps. Castaways were allowed to have as many components as could be stored in a crate having internal dimensions of 4 x 3 x 2ft, and it was stated that there was no point in contacting ships or aircraft in an attempt at rescue, as the island was so situated that no ship or aircraft has yet been able to discover it. We pointed out also that humour would not be at all out of place.

We had anticipated that quite a number of entries would be in fairly serious vein with only an interlarding of humour, but it so happened that practically all contestants concentrated entirely on the humorous approach. Some of the humour was, indeed, very way-out! This reaction is probably because we made the conditions on the desert island a little *too* difficult, but it does not, of course, detract from the success of the competition.

The winner of the 10 guinea cheque and the 5 guinea book voucher is J. Leavis (London), and his prize-winning entry—which contains more atrocious puns per paragraph than we have seen for many a long year!—appears here.

Whilst we don't feel that they were quite good enough for publication, we would also like to mention the entries submitted by W. B. Glayzer (Swindon), J. R. Squires (California, U.S.A.) and A. E. Prowse (London). Mr. Glayzer concentrated on a science-fiction approach in which, by virtue of "controlled orbit generators", he first of all materialised on the island and, secondly, re-materialised in a friend's shack by way of the loudspeaker. Mr. Squires found that his crate was packed with tiny micro-electronic binary flip-flop solid state modules manufactured by Texas Instruments. Such modules are currently being made, incidentally, and his crate contained 21,233,664 of them. When last heard of, he was still attempting to solder these up into a vast computer! Mr. Prowse underwent quite a few weird adventures, including the setting up of a production line for transistor radios which were paid for by the local natives with back numbers of *The Radio Constructor*. Despite the fact that we are not publishing these entries, we are sending their authors cheques for 2 guineas plus 2 guinea book vouchers.

We would also like to thank all other competitors, both for their interest and for their keenness in submitting entries.

Letter found in a Bottle (6V6) *washed up at Westminster Pier*

By JOHN LEAVIS

I've been here now for nearly two years, and yet it seems like only yesterday when it all happened. One minute I was diving in at Westgate-on-Sea and finding a ship underneath, and the next, I was floating up the lagoon on that box. Imagine my surprise when I found it to be full of electronic components. When I found the hut, fitted out as a workshop, I had everything I needed for survival in style.

The first apparatus constructed from the contents of the box was the lagoon-water purification unit, Fig. 1, to provide drinking water.

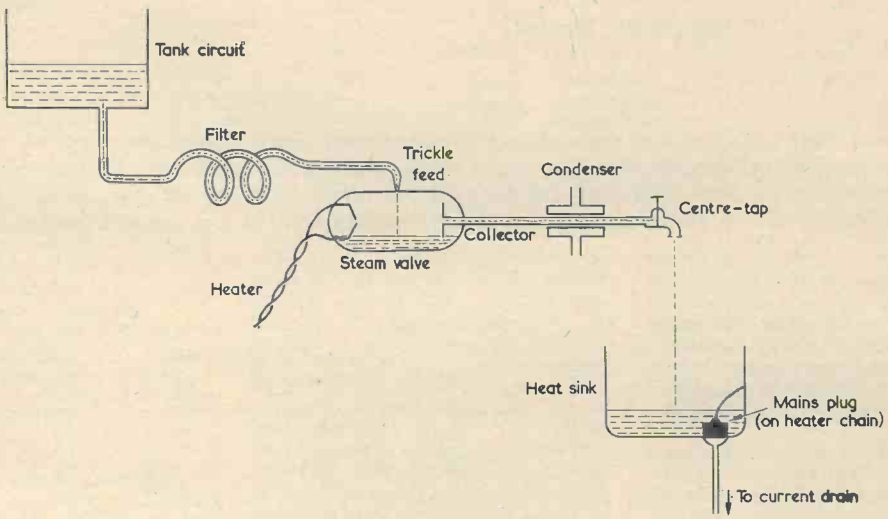


Fig. 1. Lagoon water distilling plant

Next I turned my attention to food. An old TV chassis provided me with yokes, cores and biscuits, which I cooked in a crystal oven, and served on dish reflectors. The island has an abundance of magnetic fields suitable for the cultivation of electric currents, although some have unsatisfactory gates. For liquid refreshment I use a bus-bar.

Transport is no problem, it being a matter of minutes to set up a complete tube system in a suitable cavity. The tube itself runs on lecher lines, with test points and a buffer at each junction. Coaches are Class A, Class B and Class C, although push-pull is necessary on peaks. Wheatstone bridges are used to cross ravines.

As for sea travel, the abundance of carrier waves makes surfing seem child's play, and work is now beginning on a clipper. In case of flood an arc has been struck, this being a major achievement due to the high resistance of gofer wood.

Of course, this life is not without its drawbacks; I always carry an electron gun, for fear of meeting one of the 625 lions, and I keep a battery ready charged at the hut. For musical relief I use a wave band, and I obtain hours of harmless fun from a short-wave receiver with 40 meters marked as "AMATEUR".

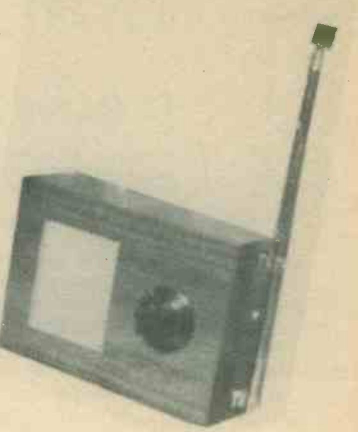
THE TELEVISION SOCIETY'S SILVER MEDAL AWARD

The Television Society announces that in future two Silver Medals will be presented annually for outstanding artistic achievement in television.

It is anticipated that one Medal will be awarded to an artist for outstanding artistic achievement in front of the camera and the second Medal will be presented for outstanding artistic achievement in television behind the camera.

The next presentation of these awards will be made at the Society's Annual Dinner and Dance on Friday, 8th May, 1964, at the Dorchester Hotel in London and the names of the recipients for this year will be announced for release on that date.

3-Transistor V.H.F. Receiver



by D. M. Bussell

This completely self-contained super-regenerative receiver, whose cabinet measures $4\frac{7}{8} \times 3\frac{1}{2} \times 1\frac{3}{8}$in only, offers loudspeaker reception on the v.h.f. bands. Although it was originally designed for the 2-metre amateur band (144–146 Mc/s) it can cover—with the aid of a simple optional modification—80 to 160 Mc/s, a range which includes Band II and aircraft frequencies

THE RECEIVER DESCRIBED IN THIS article was originally intended for the 2-metre amateur band but, on completion, it was found to give good reception between 80 and 160 Mc/s, which includes aircraft control bands as well as amateur transmissions. In areas of good signal strength, B.B.C. f.m. transmissions on Band II may also be received. The f.m. signals are discriminated on the skirts of the tuning response offered by the receiver.

The Circuit

The circuit of the receiver appears in Fig. 1, and it will be seen that the first stage functions as a superregenerative detector, thereby enabling a very high sensitivity to be achieved with relatively few components. The feedback capacitor, C_5, is that provided by a pair of twisted insulated wires and is adjusted for best reception conditions. The capacitance offered here is of the order of 1 to 2pF. Transistor TR_1 is brought to its optimum operating point by means of VR_1, which also functions as a volume control.

The prototype employed a Texas Instruments 2G403 in the TR_1 position. Also tried were an AF115 and an OC171. These were satisfactory, but not quite as "hot" as the 2G403.

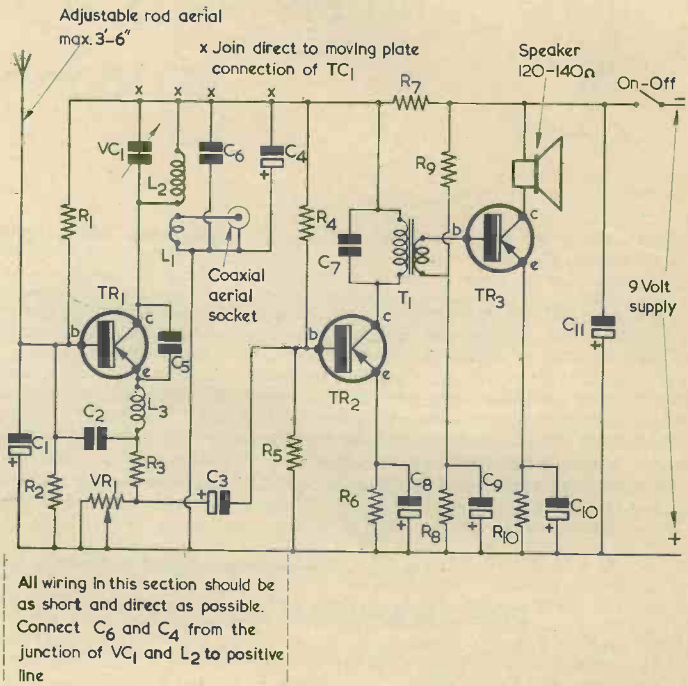


Fig. 1. The circuit of the 3-transistor receiver. The on-off switch is ganged with VR_1

A rod aerial is fitted for use in areas of good signal strength.* Alternatively, an external dipole may be employed, this being connected to the receiver by way of 75Ω coaxial cable. Of the three coils, L_1 is the dipole coupling coil and L_2 the signal tuned coil, whilst L_3 is an r.f. choke.

Components List

Resistors

(All fixed resistors ½ watt 10%)

R_1	22kΩ
R_2	4.7kΩ
R_3	1.2kΩ
R_4	33kΩ
R_5	10kΩ
R_6	1kΩ
R_7	100Ω
R_8	1.5kΩ
R_9	8.2kΩ
R_{10}	100Ω
VR_1	5kΩ linear potentiometer with switch. Edge adjustment (optional).

Capacitors

C_1	8μF electrolytic 6V wkg.
C_2	0.005μF disc ceramic
C_3	8μF electrolytic 6V wkg.
C_4	25μF electrolytic 12V wkg.
C_5	Twisted pair (see text)
C_6	100pF ceramic
C_7	0.002μF disc ceramic
C_8	50μF electrolytic 6V wkg.
C_9	50μF electrolytic 6V wkg.
C_{10}	50μF electrolytic 6V wkg.
C_{11}	200μF electrolytic 12V wkg.
VC_1	5pF variable

Inductors

$L_{1, 2, 3}$	For details see text
T_1	4.5:1 interstage or driver transformer, centre-tapped secondary. Only half of secondary is used

Transistors

TR_1	2G403, OC171, AF115 (see text)
TR_2	GET114, OC71
TR_3	OC72

Speaker

3in speaker, 120–140Ω impedance. (Alternatively, use 3Ω speaker with 9:1 output transformer, such as Radiospares type T/T4)

Battery

9 volt battery. Every Ready type PP3, and connectors

Miscellaneous

Telescopic aerial, max. length 3ft 6in
2 Terry clips for aerial
Ferrite rod, optional (see text)
Flush-mounting coaxial socket
Tagstrips, cabinet, knob, speaker fabric, etc.

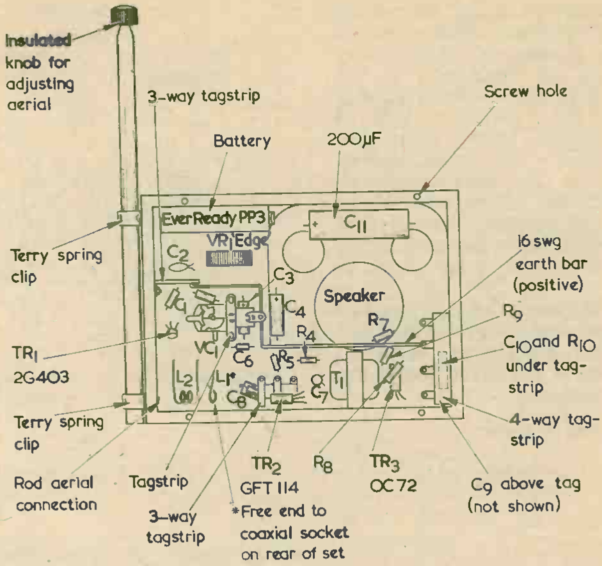


Fig. 2. The general layout inside the cabinet. Inside dimensions are 4½ x 3⅛ x 1⅞in

VC_1 has the relatively low capacitance of 5pF, and this enables tuning to be carried out without the necessity of a slow motion drive. It should be noted that the moving vanes of VC_1 are at the negative supply potential, thereby providing a tuned circuit with very short interconnecting leads. To extend the frequency range, a ferrite rod may be inserted into L_2, and details of this are given later. The use of the ferrite rod is optional.

In the prototype, VR_1 is a miniature potentiometer intended for edge adjustment, the edge protruding through a slot in the rear of the cabinet. A miniature potentiometer with spindle adjustment may be employed in its place, if desired.

The output from TR_1 is fed, via C_3, to a fairly conventional transformer-coupled a.f. amplifier. TR_2 is a GET114 or OC71, and it drives the output transistor TR_3 by way of T_1. This last component is a 4.5:1 interstage or driver transformer using half of the secondary winding only.

TR_3 is an OC72 and it feeds directly into a 3in loudspeaker having in impedance of 120–140Ω. If it is desired to employ a 3Ω speaker, this may be used in conjunction with a 9:1 output transformer.

Coils

The coils are home-wound. The r.f. choke, L_3, consists of approximately 22in of 35 s.w.g. enamelled wire wound in a single layer on a former having a diameter of ¼in. The turns should be as close together as possible. L_2 consists of 6½in of 16 s.,w.g. tinned copper wire wound three times around a $\frac{7}{16}$in diameter former, which is then removed. The turns are spaced by the diameter of the wire. About 1in of wire should be free at each end for subsequent connection across the tuning capacitor VC_1. L_1 consists of one turn of the same wire and on the same diameter former as L_2, the former being removed afterwards. Details of the positioning of L_2 are given later.

Construction

The complete receiver is housed in a wooden cabinet having internal dimensions of 4½ x 3⅛ x 1⅞in. The positioning of the components is illustrated in Fig. 2, and it will be noted that the assembly is extremely compact. Most of the parts are mounted on a 4-way tagstrip at the speaker end of the cabinet, a 3-way tagstrip on the base, and a 3-way tagstrip at the aerial end. An earth busbar, common to the positive

* It will be noted that the rod aerial is connected to the base of TR_1, which is bypassed to the positive supply line by the electrolytic capacitor, C_1. Signal pick-up is still feasible, however, as C_1 may have a significant impedance at v.h.f. It is also possible that the rod aerial functions partly as a counterpoise to the r.f. wiring in the receiver itself.—Editor

supply, connects to the second tag down on the 4-way tagstrip, to the tag at the speaker end of the 3-way tagstrip on the base, and to the rearmost tag on the remaining 3-way tagstrip. The busbar consists of 16 s.w.g. tinned copper wire. The variable resistor VR_1 is mounted by soldering the tags connecting to its slider and the earthy end of its track to the busbar. Also soldered to the busbar is a further tagstrip which is shown in more detail in Fig. 5.

Fig. 3 illustrates the rear panel of the cabinet and illustrates the slot needed for adjustment of VR_1. Also shown is the coxial socket for connection to L_1.

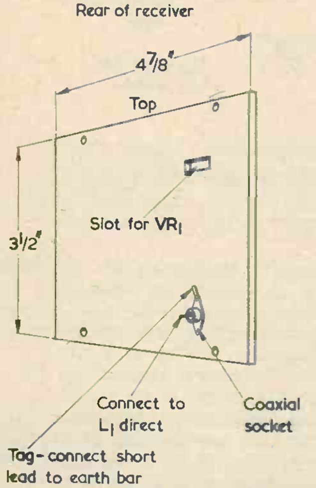


Fig. 3. The rear panel, showing the slot for VR_1 and the coaxial socket

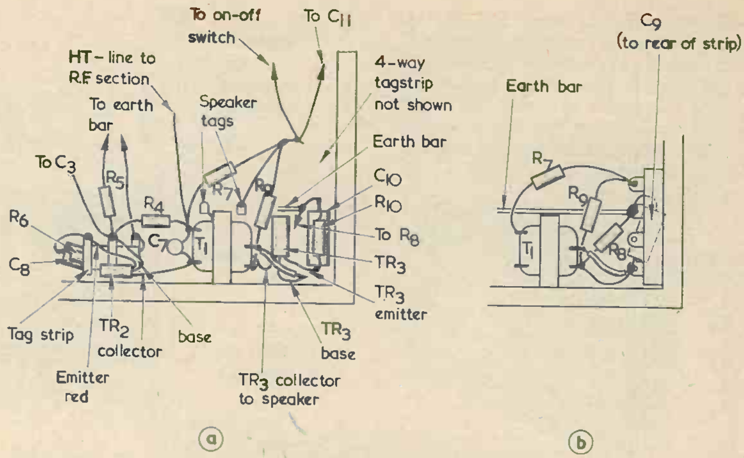


Fig. 4 (a). Wiring up the a.f. stages.
(b). The components around the 4-way tagstrip

Construction should commence with the a.f. stages, the components from R_4 and R_5 up to the speaker being wired as shown in Figs. 4 (*a*) and (*b*). For clarity, the 4-way tagstrip is omitted in Fig. 4 (*a*), thereby enabling the position of components below this tagstrip to be shown. The tagstrip and its associated components then appear in Fig. 4 (*b*). Capacitor C_9, shown in dotted line, is, actually, to the rear of the tagstrip.

The a.f. stages should be wired following the layout of Figs. 4 (*a*) and (*b*) and carefully observing the circuit diagram of Fig. 1. Electrolytic capacitors must be wired with correct polarity, and a heat shunt used when connecting up the transistors.

The a.f. stages may be tested when completed. After checking the wiring against the circuit diagram, temporarily connect the negative lead-out of C_3 to the junction of R_4 and R_5. If a low impedance earpiece or headphone is available, this should be connected between the positive lead-out of C_3 and the positive supply line. The earpiece will now function as a microphone and, if tapped, should cause a resultant signal to be heard from the speaker. If a low impedance earpiece is not available, a faint hum will be heard (assuming the usual mains wiring in the vicinity) if the positive lead-out of C_3 is touched with the finger.

The detector stage is next wired up, following the layout given in Fig. 5 and carefully checking, all the time, against the circuit diagram of Fig. 1. The twisted pair, C_5, consists of about 2in of narrow gauge insulated wire twisted together as shown, one wire connecting to the emitter of TR_1 and one to the collector. The rod aerial connects into circuit by way of the lower Terry clip. The connection between this clip and the base of TR_1 must be as direct as possible.

The shield lead-out of TR_1 should be connected to the earth busbar.

The coupling coil, L_1, has one lead-out wire connected to the earth busbar and the other to the central tag of the coaxial socket on the rear panel of the receiver. When all connections are made and the rear panel is fitted, L_1 should be spaced from L_2 by ⅛in. Also, the

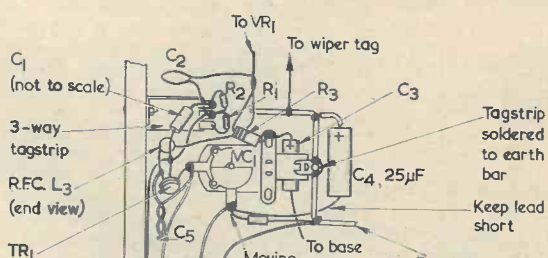


Fig. 5. The layout around TR_1. All wiring here must be as short and direct as possible

two coils should be so positioned that a ferrite rod can be slid into them through the side of the cabinet, as in Fig. 6.

A 1-way tagstrip is soldered to the earth busbar as illustrated in Fig. 5. The tag on this strip carries the connections at the positive end of C_3.

When wiring up the r.f. stage, care should be taken to ensure that electrolytic capacitors are connected with correct polarity. All wiring must be short and direct, and a heat shunt should be used when connecting the transistor.

The completed cabinet should have the appearance shown in Fig. 6. The dimensions given here agree with the internal dimensions quoted for Fig. 3 when $\frac{3}{16}$in wood is used for the sides and top and $\frac{1}{8}$in wood for the front panel. The manner in which the edge control of VR_1 protrudes through the rear panel is clearly visible here. Also shown is the hole in the side of the cabinet through which the ferrite rod is passed.

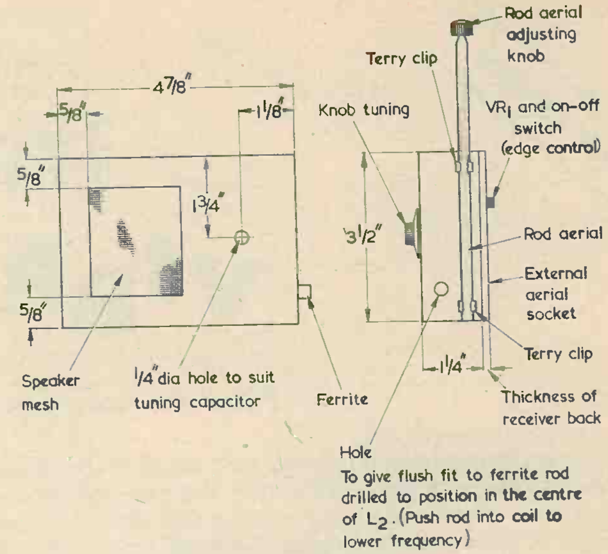


Fig. 6. External details of the cabinet

Operating the Receiver

On completion of wiring and final checking, the receiver may be tested. A battery should be connected and the receiver switched on. If VR_1 is adjusted a hissing noise should become audible, this indicating that the detector is operating correctly. VR_1 should be adjusted for maximum noise. When a station is received the hiss level will drop, and modulation should be heard. The telescopic aerial is then adjusted for maximum output, bearing in mind that it should not be held with the bare hand as this will reduce sensitivity. Finally, the twisted wire capacitor, C_5, should be adjusted for best results at all positions of VC_1, adjusting VR_1 for maximum output. When the correct capacitance has been found, C_2 should be sealed with insulating tape.

For reception of lower frequency signals, a ferrite rod is inserted through the hole in the side of the cabinet. The rod should have a diameter of $\frac{3}{8}$in and sufficient length to enable it to pass fully into L_2 and L_1 whilst still being capable of being gripped outside the cabinet. With the rod fully inserted, signals at frequencies in the range of 80 to 100 Mc/s should be obtained, frequency increasing as the rod is progressively removed. For 140 to 160 Mc/s, the rod is not required. The permeability and type of rod is experimental, "yellow grade" being employed in the prototype.

When the receiver is functioning correctly, consumption from a new 9-volt battery will be slightly in excess of 10mA.

Radio Aids in New Universal Bulk Ship

A comprehensive range of Marconi Marine communications equipment and radio aids to navigation has been installed in the new universal bulk ship *Carlton*, 20,386 tons deadweight.

Built at Sunderland by Short Brothers Ltd., for Chapman and Willan Ltd., Newcastle, the *Carlton* employs an "Oceanspan VI" transmitter with an "Atalanta" receiver for worldwide communication by radiotelegraphy on medium and high frequencies.

The emergency equipment comprises a "Salvor" medium frequency transmitter, an "Alert" guard receiver, an "Autokey" automatic keying device and the new "Lifeguard" auto-alarm, all mounted in an auxiliaries rack. An "Argonaut" v.h.f. transmitter/receiver will provide short range radiotelephone communication, while a "Lifeline" portable survival craft radiotelegraph transmitter/receiver is supplied for use in the vessel's lifeboats.

The radar chosen for this new vessel is a "Radiolocator IV"; and other aids to navigation include a "Seagraph III" high-power recording echometer and a "Lodestone IV" direction finder.

Carlton is the first universal bulk ship to be built in Britain.

Cover Feature

Transistorised VIBRATO Unit

By Peter A. Roe, Grad.I.E.E.

This article describes a vibrato unit which is completely transistorised, provides virtually distortion-free sine wave modulation, and has continuously variable depth and speed controls. Apart from its immediate applications with electrical and electronic musical instruments, the design employs a diode modulator circuit which offers many potential uses in wider fields

THE WRITER HAS FOR SOME TIME REQUIRED A self-contained vibrato unit for use with an electric guitar which could be introduced between the guitar and any amplifier (in the writer's case a 5 watt battery powered amplifier) without the need for external power supplies. There are many vibrato units and circuits available but almost invariably they use valves and require an external h.t. and heater supply. The unit developed by the writer is, however, transistorised and consumes a relatively small current (about the same as a pocket radio) so that the unit can be made quite small and be powered by a couple of small batteries. The depth of vibrato is continuously variable from 0 to 100% and the speed is variable over about 2 c/s to 10 c/s.

Principle of Operation

The vibrato effect is produced by amplitude modulating the audio frequency signal from the guitar pick-up with a low frequency signal obtained from a sine wave oscillator. The modulator section of the unit is built around a simple diode modulating element and the low frequency sine wave is obtained from a phase shift oscillator.

Transistor modulators operating at radio frequency usually use transformers or tuned circuits to couple the carrier and modulating signals to the modulator, but in the case of the vibrato unit the carrier is the audio frequency signal from the pick-up, and the modulating signal is only a few cycles per second. Clearly a tuned circuit is impossible in the carrier circuits and a tuned circuit in the modulating signal circuits would require impractically large value components (typical values would be, roughly, 100H and 1μF at 10 c/s). The writer has overcome this difficulty by developing a simple junction diode design which completely eliminates the use of transformers and tuned circuits.

By suitable choice of components the modulator section is capable of satisfactory operation over a very wide range of applications, of which the vibrato unit described here represents just one typical example.

The Basic Modulator Element

The basic modulator arrangement is shown in Fig. 1, and it consists of an a.c. voltage divider

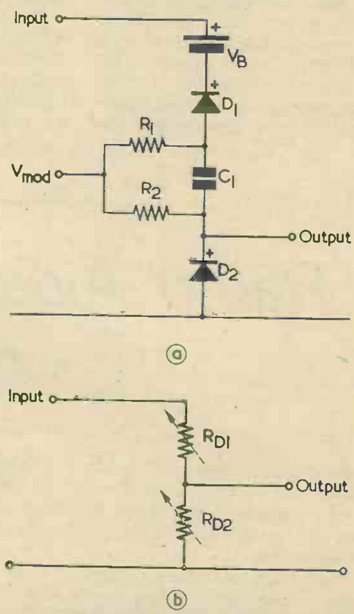


Fig. 1 (a). The basic modulator circuit
(b). The a.c. equivalent of the modulator circuit. R_{D1} and R_{D2} are the dynamic resistances of D_1 and D_2

formed by D_1, C_1 and D_2. Both diodes are biased in the forward direction by the bias voltage V_B, which is about −12 volts. The forward current through D_2 depends upon V_{MOD} and the value of R_2, and the forward current through D_1 depends on the difference between V_B and V_{MOD} and the value of R_1. A diode biased in the forward direction behaves as a non-linear resistor and the resistance at any particular forward current (called the slope resistance or dynamic resistance) depends upon the forward current. A typical diode characteristic is shown in Fig. 2 and, as can be seen, the slope of the characteristic and hence the dynamic resistance varies over quite a wide range. The dynamic resistance can, in fact, be shown to be inversely proportional to the forward current over a range of about 5μA to a few milliamps. Using this fact and some simple algebra it can be shown that the voltage divider action of D_1, C_1 and D_2 is directly proportional to $(V_B - V_{MOD})$ and this is a condition for linear amplitude modulation of the input signal.

In order that the modulation shall be linear and free from distortion there are several conditions which must be fulfilled in order to justify its use. They may be summarised as follows.

(1) The modulating current through the diodes must be proportional to the modulating voltage, which means that R_1, R_2 must be much larger than the d.c. resistance of the diodes. A typical value for R_1, R_2 is 47kΩ.

(2) The current driven through the diodes by the carrier signal must be much smaller than the modulating current. This imposes a limit of about 50mV (r.m.s.) on the carrier signal that can be used.

(3) The impedance of the capacitor C_1 must be small at the carrier frequency so that the modulation depth is independent of frequency, but the impedance of C_1 must be large at the modulating frequency so that the modulating current is not shunted away from the diodes. Obviously C_1 can only have one value at a time and so the carrier frequency must be much higher than the modulating frequency to satisfy this condition. A satisfactory figure would be a carrier frequency of at least 10 times the modulating frequency. There is also an optimum value of C_1 since a compromise must be reached, and the criterion for this is that the impedance of C_1 at the minimum carrier frequency is between 350 and 450Ω. Fig. 3 is a graph showing the optimum value of C_1 for various carrier frequencies.

(4) The carrier signal must have a low source impedance below about 180Ω in order to ensure that the variable loading produced by the change in diode resistance does not affect the carrier voltage.

(5) The output impedance of the modulator is fairly high, and the minimum output load that can be used is about 47kΩ.

(6) A large modulating signal is required for high modulation depth. For 100% modulation the peak to peak modulating voltage must equal V_B, which is about −12 volts.

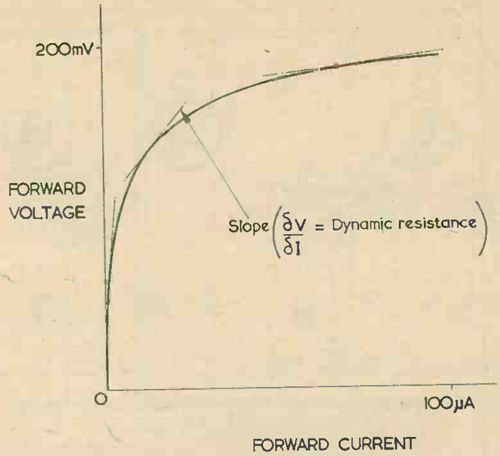


Fig. 2. A representative diode characteristic

Provided that all these conditions are observed good quality modulation up to about 90% can be obtained with any carrier from 50 c/s to over 1 Mc/s using any modulating signal from d.c. upwards. The distortion of the carrier is very low, less than 1%, and the modulating signal less than 5%. All of these limitations can be exceeded if an increase in distortion and non-linearity can be tolerated.

The Vibrato Unit

The vibrato unit utilises an audio frequency version of the basic modulator element together with appropriate buffer stages and a phase shift oscillator to supply the modulating signal.

The complete circuit is shown in Fig. 4. The

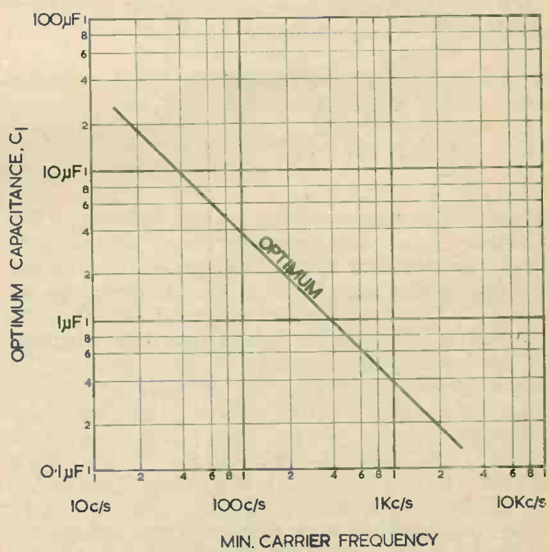


Fig. 3. Graph showing optimum values of capacitance against minimum carrier frequency

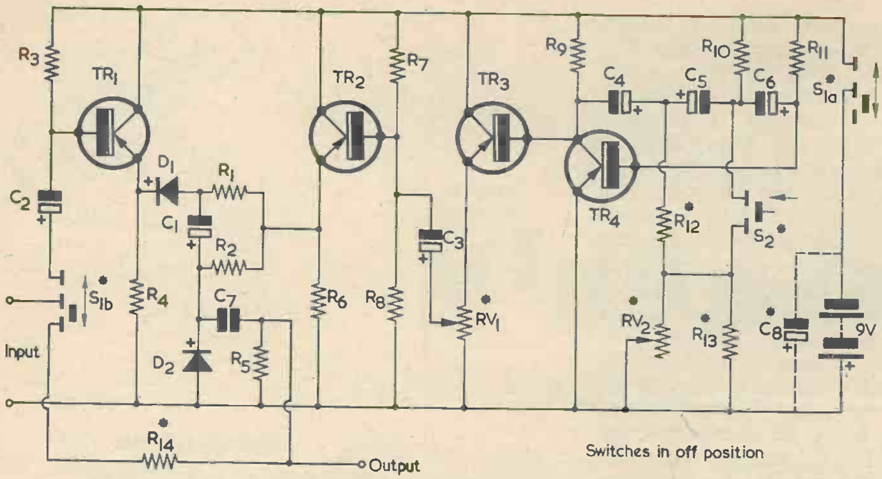


Fig. 4. Circuit of the complete vibrato unit. The components marked with an asterisk are not mounted on the circuit board

Components List

Resistors (all fixed resistors 10% ½ watt)

R_1	47kΩ
R_2	47kΩ
$^*R_3$	180kΩ
R_4	4.7kΩ
R_5	47kΩ
R_6	4.7kΩ
$^*R_7$	12kΩ
R_8	10kΩ
R_9	2.7kΩ
R_{10}	5.6kΩ
$^*R_{11}$	680kΩ
$^*R_{12}$	2.7kΩ
$^*R_{13}$	100kΩ
R_{14}	10kΩ
RV_1	2.5kΩ potentiometer, lin track
RV_2	25kΩ potentiometer, lin track

Capacitors (all capacitors except C_7 are electrolytic)

C_1	4μF 15V wkg
C_2	8μF 15V wkg
C_3	100μF 25V wkg
C_4	1μF 15V wkg
C_5	1μF 15V wkg
C_6	1μF 15V wkg
C_7	0.047μF
$^*C_8$	250μF 25V wkg

Semiconductors

$TR_{1, 2, 3}$	OC71 or similar
TR_4	OC75, GET102, OC202*
$D_{1, 2}$	OA5, OA81, OA90

Switches

S_1	d.p.d.t. slide switch
S_2	s.p.s.t. press switch

Batteries

2 PP4 batteries

Miscellaneous

Printed circuit board, case, plug, socket, knobs, etc.

* See text for further details.

carrier buffer consists of an emitter follower, TR_1, biased by R_3 so that its emitter is at −12 volts to supply the forward biasing voltage for the diodes. The modulating signal buffer, TR_2, is biased by R_7 and R_8 to give an emitter potential of −6 volts (i.e. half of TR_1 emitter voltage) so that, when an a.c. modulating signal is applied, the voltage to the diode modulator varies symmetrically about this centre value and, for 100% modulation, varies by ±6 volts.

The lowest frequency likely to be obtained from a guitar is 80 c/s (Bottom E is 82 c/s) and by reference to Fig. 3 the capacitor C_1 has been chosen as 4μF. If the vibrato is to be used with any other instrument the lowest fundamental produced by the instrument must be determined and a suitable value of C_1 selected from Fig. 3. The leakage current of this capacitor flows, in the main, through the diodes D_1 and D_2 and so must be very small, less than 10μA in fact. The leakage current in electrolytic capacitors, especially miniature types, varies quite considerably with type and age, etc., and so old or suspicious components must not be used in this position. A new component with a voltage rating of at least 15 volts is recommended for C_1.

The diodes used were actually Mullard OA5's but almost any germanium diode with a low reverse current can be used. The "driving" resistors R_1 and R_2 are 47kΩ, 10% tolerance components.

The output is taken from D_2 via C_7 and R_5, which are chosen to start cutting off at about 100 c/s and so help filter out the unwanted modulating signal, a small part of which (about 150mV) appears across D_2 together with the required modulated output.

The modulating oscillator is of the phase shift type built around a single high gain transistor TR_4. The phase shifting network consists of three RC sections, of which one, RV_2, is variable in order that the frequency of oscillation may be controlled. (R_{12} and R_{13} are chosen so that the maximum frequency range consistent with reliable oscillation is obtained.) The values in the Components List were the optimum values used by the writer, and were found by trial and error. The values of C have been chosen to give a vibrato speed to suit the writer's preferences and the range may be changed, if desired, by selecting different values for C_4, C_5 and C_6. Care must be taken to see that these capacitors are correctly connected or they will be wrongly polarised, and difficulty may be experienced in making the oscillator function properly. The attenuation of the phase shifting network is high and so a transistor with a current gain of at least 60 is required for TR_4—the higher the better. Recommended transistors for this position are OC75 or GET102. The collector potential is set to roughly −9 volts by suitable selection of the bias resistor R_{11}. The value of this resistor depends upon the gain of the transistor and should be between 330kΩ and 1.5MΩ. If a value lower than this is required, the transistor is of low gain and unsuitable; and if a higher value is required either the transistor is of very high gain or, more likely, the leakage current of C_6 is upsetting the bias. If a meter is not available R_{11} may be selected for most satisfactory operation of the oscillator.

In order to ensure complete reliability of the oscillator and to prevent it from being too heavily loaded it is buffered by another emitter follower TR_3. The Depth control, RV_1, is conveniently incorporated in the emitter load and is a 2.5kΩ potentiometer, preferably wirewound. If economy is required, the buffer may be omitted and the Depth control incorporated in the oscillator load as shown in Fig. 5 (note the reversal of polarity of

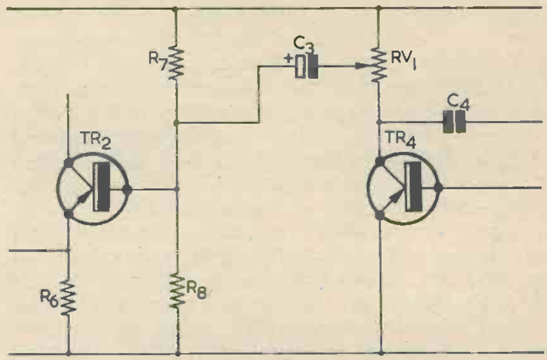


Fig. 5. The buffer transistor TR_3 could be deleted if this circuit is employed

C_3). However, the Fig. 5 circuit may cause unreliable operation of the oscillator and, for the price of one transistor and a resistor, is hardly worth-while.

The oscillator is temporarily stopped by operation of S_2, which places resistor R_{12} across C_5 and prevents the phase shifting network from functioning effectively. This method was found to be the best as it enables the oscillator to start again quickly

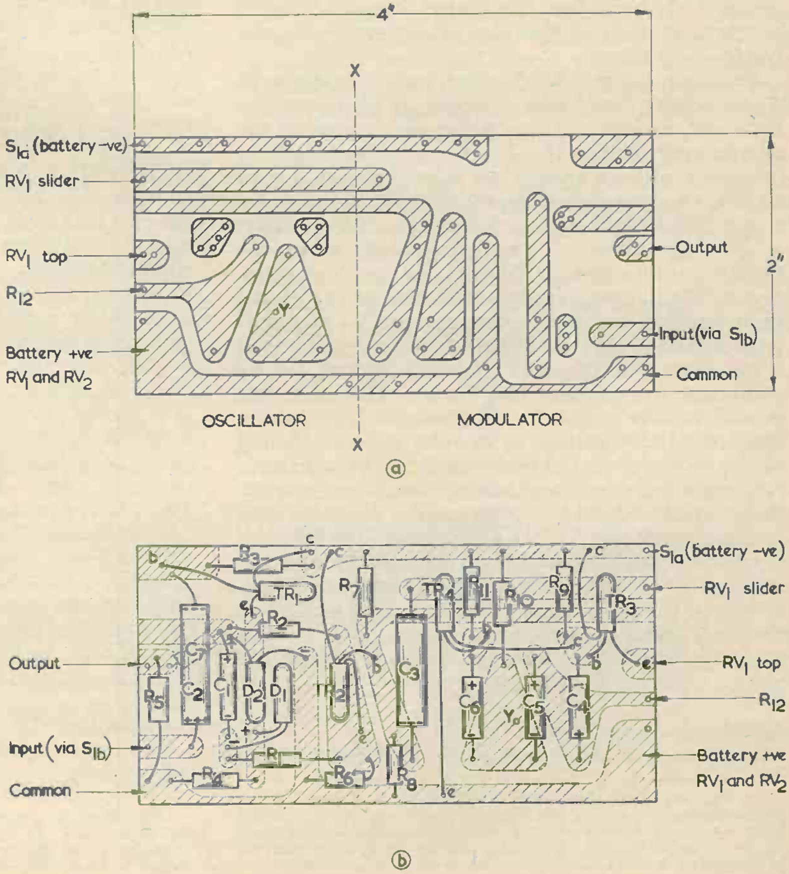


Fig. 6 (a). The copper side of the printed circuit board (b). The components mounted on the board. In this view the copper is on the underside. C_7 is mounted below the board

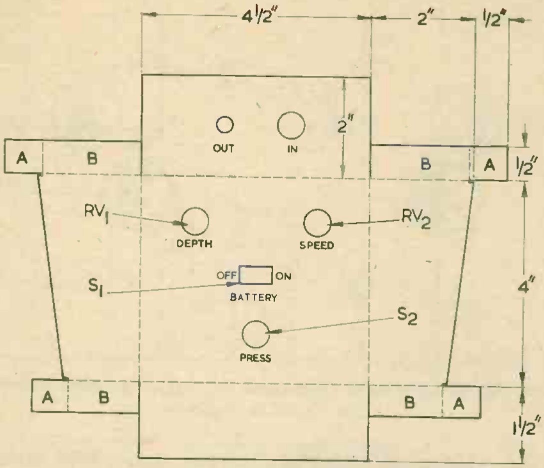


Fig. 7. Details of the case before bending. Bends should be made along the dotted lines, the size and position of holes depending on the components used. A base should be cut to fit the box (4⅝ x 3⅞in approx.)

when S_2 is re-opened. Also, it produces the minimum amount of "click" on the output when the switch is operated, since it does not affect any of the d.c. levels in the circuit.

Switch S_1 is the On-Off switch and, in addition to disconnecting the battery supply, it also connects the input directly to the output via R_{14} when the unit is not switched on. This enables the battery to be saved without having to take the unit out of circuit. A large capacitor, C_8, 250μF, is connected across the battery to smooth out any ripple voltage which may appear across the supply when the oscillator is running.[1] This ripple can cause unpleasant "thumping" noises as the batteries age and their internal resistance rises but, as C_8 is rather large in size it may be dispensed with if space is at a premium, the "thumping" being filtered out by additional RC sections like C_7 R_5. However, this second course is not so satisfactory. The recommended battery voltage is 18 volts and this should not be exceeded or the transistors may be damaged. Although the modulator section functions satisfactorily down to quite low voltages, the oscillator may become temperamental at low voltages (although if a good transistor is used for TR_4, operation is still satisfactory at 9 volts supply). Failure or irregularities in the oscillator are usually a good indication that the batteries need replacement. The current drain is only about 12mA and so quite a good life can be expected from them.

Additional Circuit Notes

The voltages at various parts of the circuit are given in the table. This shows the approximate voltages which should occur with normal components and, if a voltmeter is handy, these may be checked and adjusted if necessary. The emitter voltage at TR_1 should be 5 or 6 volts less than the supply voltage and TR_2 emitter voltage should be half of TR_1 emitter voltage ±1 volt. As mentioned earlier, TR_4 collector and TR_3 emitter should be at about half the supply voltage.

TABLE

Position	*Voltage*	*Adjust*
TR_1 emitter	12V ±1.5V	R_3; 100–270kΩ
TR_2 emitter	6V ±1V	R_7; 10–15kΩ
TR_4 collector and TR_3 emitter	9V ±2V	R_{11}; 330kΩ–1.5MΩ

Battery 18 volts
(RV_1 set to minimum and S_2 closed)

CAUTION: *Do NOT connect any low resistance (milliammeter, short circuit or even high value capacitor) across any of the emitter resistors, or the initial surge of current will almost certainly destroy the transistor. This happens in a few micro-seconds and so even the shortest fault can be disastrous. This also applies to the short-circuiting of C_1 but, in this case, D_1, D_2 or TR_1 or all three, may be damaged.*

The emitter followers are inherently temperature stable and so no difficulty should be encountered if the unit is used at elevated temperatures, which may occur in cabinets or other enclosures containing valve amplifiers. The oscillator, however, is biased in a very simple manner and is very susceptible to temperature variations and so, if the unit is to be used in a position where it is likely to get warm, a high gain silicon transistor such as the OC202 could be used.[2]

If a deeper vibrato effect is required the modulator buffer transistor, TR_2, may be biased so that the diode modulator section is cut off over part of the oscillator cycle. This may be achieved by setting TR_2 emitter voltage to about three-quarters of TR_1 emitter voltage (i.e. about 9V) by selecting a lower value for R_7, suitable figures being 6.8 to 8.2kΩ.

A 15kΩ resistor should be added directly across D_1 to reduce the reverse bias when the diode cuts off, and this also helps to reduce the additional "thumping" which may be produced by unsymmetrical modulation.

Construction

The unit can be constructed in many forms and the reader will probably have his own ideas of the

[1] In Fig. 4 and the subsequent layout diagram of Fig. 8, C_8 is shown as being connected permanently across the battery. When wired up in this manner, a small polarising current flows through this capacitor continually. A saving in battery life could be achieved by connecting C_8 into circuit after the on-off switch.—EDITOR.

[2] The absolute maximum V_{CE} rating ($+V_{BE} > 500$mV) for the OC202 is —15V. In consequence, an OC202 in this circuit will be operating at, or slightly exceeding, maximum rating when an 18V battery is employed.—EDITOR.

best method for his use. One suggested form which the writer has found very useful is to construct the unit as a box that can be used as a foot switch. The complete unit is shown on the front cover and, as can be seen from Fig. 7, it is built in a strong aluminium box measuring about 4 x 4½ x 2in, complete with Depth and Speed controls, On-Off switch and also a press switch (of the type fitted to table lamps) capable of being operated by the foot.

If the unit is to be foot-operated it must obviously be of fairly robust construction and the best way of achieving this is to mount the components on a printed board. A suitable printed board and component layout designed and constructed by the writer is shown in Fig. 6, and this holds all the components except those directly associated with potentiometers and switches. The layout has been designed in two halves so that, if the board is cut down the line XX, one half contains the modulator unit and buffers and the other half contains the oscillator with its buffers. The board was constructed using one of the printed circuits kits that are available. Standard size resistors are used throughout. Miniature capacitors are used in all positions to reduce the size, although C_2 and C_3 may be standard components, if desired. It is not proposed to describe the actual construction of the printed board but one or two points on the assembly of the components to the board are worth mentioning.

(1) Check carefully that the printed circuit is correct and that the components holes are in the correct place before mounting any parts.

(2) Mount the resistors and solder them in first of all, so that the minimum heat is applied to the rest of the more delicate components. Do not solder R_{11} permanently into circuit until the unit has been tested.

(3) The capacitors should be mounted next, but take care that excessive heat is not applied, particularly to the miniature electrolytics, or damage may occur. Use a heat shunt if necessary. Make sure that the capacitors are connected with the correct polarity.

(4) The diodes and transistors are soldered in last of all. Cut the leads to the appropriate length for their position on the board, but no less than ¼in from the can, and fit plastic sleeving on the leads before soldering to prevent accidental short circuits to the other components. Use a heat shunt if necessary.

(5) Check the completed board against both component layout and circuit diagram. This is most important since expensive damage could result from a wrong connection.

A suitable box for the unit is shown in Fig. 7 before bending. The shape is cut from a piece of 18 s.w.g. aluminium, and is bent along the dotted lines. The box is not very big and neat bends can be obtained by using a small vice. The lugs marked "A" in the diagram are for securing the base and, when bent under, should be about ⅛in below the level of the sides. The sides then extend slightly below the base when fitted and this makes a neater job.

The writer uses a rather interesting technique in chassis construction by employing Araldite epoxy resin to fix the corners of chassis. This technique can be used here. The flanges marked "B" are coated with Araldite and then firmly clamped to the sides to form a neat corner. The whole arrangement of clamps and box is then heated to about 300°F. in an oven for about an hour, bu which time the Araldite has completely hardened. Any surplus Araldite squeezed from the joint when the clamps are applied is left on and, when heated, runs into the gaps and forms very smooth corners. When the Araldite is hard it can be filed and finished like the aluminium itself and nicely rounded corners are produced. The resultant join is very strong, being much neater than joining with rivets, and it imparts a good finish to the box.

The potentiometers, which may be standard size components, should be fastened in the box before wiring, as also should the two switches. The on-off switch is a simple two-pole two-way sliding type, as fitted to many portable radios. The press switch may, of course, be replaced by a heavier duty metal type such as is used in guitar foot switches if this is thought desirable, although the normal plastic

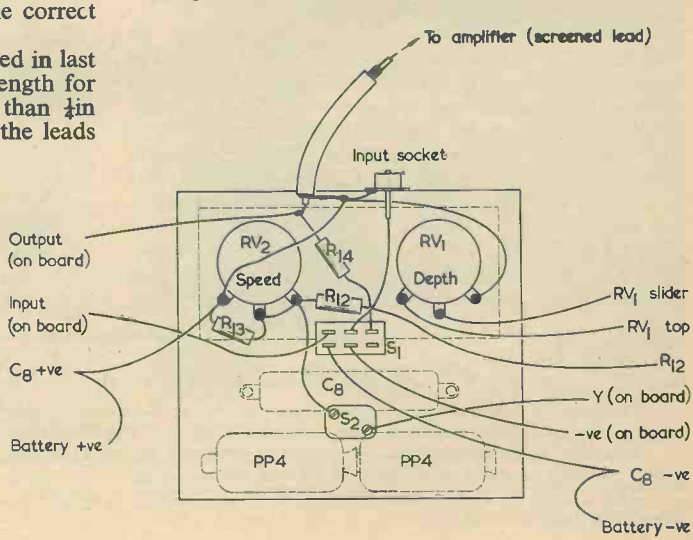


Fig. 8. Layout of components in the case. The batteries, C_8, and the printed board when completely assembled are shown in dotted line

switch will stand up to quite a lot of heavy treatment. The printed board is mounted above the potentiometers on single stand-off insulating bushes which may be improvised from odds and ends in the spares box.

The components associated with the potentiometers and switches (R_{12}, R_{13} and R_{14}) are connected directly to their respective tags, and flexible plastic covered wire is used to link the controls with the printed circuit. See Fig. 8. The input socket may be of any suitable type, and a length of screened lead suitably terminated with a plug provides the output connection. Two PP4 batteries clipped end to end provide the supply, the ripple removing capacitor C_8 being connected across the battery supply leads. The arrangement of components in the box is clearly shown in Fig. 8 and the positions of the printed board, batteries and C_8 (if fitted) are indicated by dotted lines. The batteries and C_8 are held in position by the base and a piece of plastic sponge between the battery and C_8 and the switches.

This arrangement prevents any of the components moving around and hence causing trouble. Suitable plastic sponge may be obtained from any of the chain stores or occasionally with some of the detergents. A coat of crackle paint, four rubber feet secured to the base with Araldite, and a couple of control knobs finish the job off.

Testing the Unit

The unit should normally operate quite satisfactorily immediately it is switched on but in order to ensure optimum operation and reliability there are several checks that can be made.

(1) *D.C. Voltages.*—Typical d.c. voltages in various parts of the circuit with the Depth control at minimum and the oscillator stopped (by S_2) are shown in the table with the corresponding component to adjust if necessary. The meter used should be at least $1k\Omega$ per volt and great care must be taken not to short circuit any of the components when taking the measurements. R_{11} is the component most likely to require adjustment.

(2) *Oscillator Checks.*—The oscillator can be checked by observing TR_3 emitter, which will swing round from about -2 volts to -15 volts, depending on the meter damping, in sympathy with the oscillator. If the meter needle "kicks" when S_2 is operated but does not oscillate, check the phase shifting components C_4, C_5, C_6 and R_{10}, R_{12}, R_{13} and RV_2, paying particular attention to the polarity of the capacitors. Adjust the values of R_{12} and/or R_{13} so that the oscillator operates over the whole range of RV_2. If the oscillator still does not function despite these checks, the gain of TR_4 may be low, although this should be apparent from the value of R_{11}, as mentioned previously.

(3) *Modulator Checks.*—If the oscillator appears to function correctly but the input is not being modulated check that, with the Depth control set to maximum, TR_2 emitter voltage swings by about the same amount as TR_3 emitter. If it does, but the input is still not being modulated, then there is a fault in the diode modulator circuit. Check that the diodes are connected with correct polarity and that C_1 is correctly connected. The voltage across the diodes should not exceed 0.5 volt when correctly connected, but if they are wrongly connected almost the full oscillator voltage will appear across them.

Conclusion

The vibrato unit has been in use for some time, by the writer and some guitar playing friends, during which time it has proved very convenient and very reliable. The battery drain is fairly small and the batteries should last several months depending upon the amount of use. A small mains unit using a 12 volt heater transformer and 4 diodes in a bridge rectifier circuit could be used instead of the batteries if desired, although the writer's unit was initially built to be self-contained. The unit is fairly small as it is, but by using a slightly simplified circuit and miniature components it could be made small enough to actually fit inside the guitar itself. The writer is at present working on a design using $\frac{1}{10}$ watt resistors, micro-alloy transistors, and sub-miniature capacitors, potentiometers and diodes. The unit will be encapsulated in Araldite and be powered by miniature mercury cells, so that it can be fitted in the control panel in the guitar.

The modulator section of the vibrato unit has many applications in the control of audio frequency signals. By deriving the modulating voltage from a suitable trigger circuit operated by the input signal, the rise and decay times of the output from the modulator can be controlled. This effect is often used with electronic instruments and is particularly useful with electronic organs to remove the keying effects. By operating the modulator from a d.c. modulating voltage proportional to the average amplitude of the input signal the modulator section will behave as an automatic volume control. This is very useful in controlling tape recording levels when the sound source is moving around relative to the microphone.

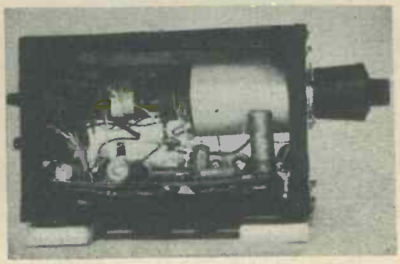
The modulator section of the vibrato unit is obviously a very useful device, but readers interested in other applications are recommended to re-read the section on its principle of operation before setting out to design any other unit.

MALAYSIA PLACES ANOTHER TV CONTRACT WITH EMI

Ministry of Information and Broadcasting, Malaysia, has now awarded EMI Electronics Ltd. a further contract to supply equipment for the First Phase of the Malaysian Television Service.

Included in the contract are two image orthicon cameras and associated equipment, picture monitors, vision and sound mixing consoles, for use in a second studio at Kuala Lumpur.

This order follows within three months the previous contract awarded to EMI to provide equipment for the Malaysian Television Service.



TRANSISTORISED HOME BUILT CLOSED CIRCUIT TV

Part 4—R. Murray-Shelley and T. Ian Mitchell

The last in a series of four articles describing the construction and operation of an amateur-built closed circuit television camera. The camera, which is fully transistorised, provides an r.f. output at any channel in Band I and it may, in consequence be used in conjunction with a conventional domestic television receiver

In this concluding article of the series we shall give details of the setting up procedure for the camera together with some notes on its use.

Setting Up Procedure

The first and most essential part of this operation is to thoroughly check all the wiring. Special attention should be paid to the transistor connections. The connections to the Vidicon should also be checked.

It is suggested that the first tests be made with the Vidicon out of the camera.

Connect the camera output to the input of the television receiver which is to be used as a monitor via a length of coaxial cable. The receiver should be tuned to a channel in Band I. (Band I covers Channels 1–5 inclusive.) The channel selected should be other than that on which the local B.B.C. transmission is radiated.

Next connect in the 12 volt supply and tune the camera r.f. oscillator to the receiver frequency. The screen of the receiver will brighten considerably when this is done—tune for maximum brightness of the screen. C_{13} should, of course, be adjusted using an insulated trimming tool. Should the unit not oscillate, reverse the connections to L_2. The trimmer C_{12} should be set to a low capacitance for this part of the operation.

The video amplifier can be empirically checked at this stage by applying some sort of signal to the input. Just touching it with the finger should result in an intense pattern forming on the monitor screen.

The line frequency can now be adjusted by varying the inductance of L_4. Correct adjustment is characterised by the receiver horizontal hold control being at about the centre of its travel when the picture is stable in a horizontal direction.[1] The line frequency was found to be a little critical with some receivers, notably those using electrostatic focusing.[2] Notice that at this stage no vertical sync is being applied to the receiver.

The Vidicon tube can now be fitted into the camera and the lens system fixed in place. Be careful not to damage the side pip on the Vidicon—careless handling could easily break it off and ruin the tube. The rest of the camera power supplies are now connected in. Make sure before doing this that the target and beam controls are set to minimum.

Allow the Vidicon to warm up for at least one minute. Fix the camera on a suitable scene—an outside view with plenty of light is best—and set the target to a low voltage (about 20 volts). Now slowly increase the beam until a picture is obtained.

Another picture reproduced by way of the camera and a domestic television receiver

[1] Or when the control takes up a central position within the limits needed for reception of B.B.C. signals.—Editor.

[2] The main difficulty given with electrostatic focus receivers was found to be impairment of focus at incorrect line frequencies.

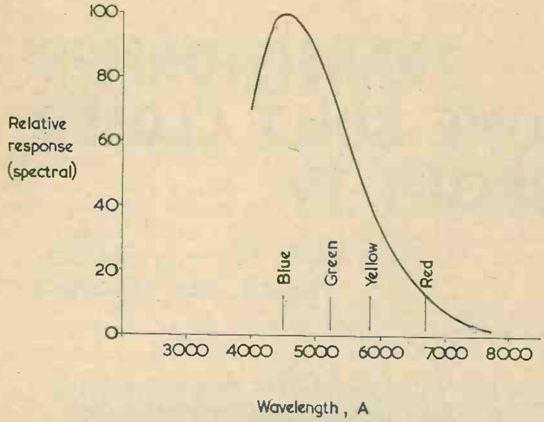


Fig. 19. The spectral response curve for the Vidicon "Amateur" grade 10667M (E.M.I. Electronics Ltd.)

Adjust the coarse (electromagnetic) focus control initially for best focus. Later adjustments can be made with the fine (electrostatic) focus control.

The optical focus control must naturally be correctly set if a well focused picture is to be obtained. The use of three focus controls, two electronic and one optical, takes a little getting used to. In practice the coarse focus control is rarely used and experience tells whether the optical or electrical focus is in need of adjustment.

Having obtained a picture—of sorts—slide L_3 towards L_1 (see Fig. 10 in Part 2 of this series) until a point is reached where there is no crushing of the white parts of the picture and the line and vertical hold on the monitor are solid. As was mentioned earlier, too much coupling may result in vertical juddering. Once L_3 has been correctly adjusted, it can be held in position with polystyrene cement.

The trimmer C_{12} should be adjusted in conjunction with L_3, until optimum conditions of field and line stability are reached. The exact adjustment of this trimmer will depend to some extent on the type of monitor used. Notice that increasing C_{12} too much will prevent the oscillator operating.

The value of C_7 may need adjustment depending on the monitor used.

The width and height controls should be adjusted until the edges of the target just disappear. The vertical linearity control should be adjusted until there is no change in the height of an object as it is moved from one part of the field of view to another. The aspect ratio of the picture should be the standard 4:3. The correct relation between height and width can be obtained by focusing the camera on a circular object—it should appear circular in the monitor.

It may be found instructive to check the waveforms present in the circuit with an oscilloscope if this is available. Care should be taken not to operate, or attempt to operate the camera in the event of failure of the line and/or vertical timebases. The lack of drive could result in serious damage to the Vidicon.

Light

The Vidicon is very sensitive—far more sensitive than, for example, ordinary photographic film. One disadvantage which is inherent in the Vidicon, however, is that if the incident illumination is low, the tube takes rather a long time—relatively—to respond to changes in illumination. The result of this is that when the light level is low a sharp well focused picture can be obtained, but smearing on moving objects will be observed. The contrast obtained in a picture of a dimly lit scene will also suffer. Further, if the light input to the tube is low, it will be necessary to raise the target voltage rather a lot in order to resolve a picture. This will cause any blemishes on the target to show up.

The lesson to be learnt from these remarks is that the scene to be televised should be well illuminated. Front lighting is best and for indoor scenes can be provided by one or two 150 watt lamps in reflectors. As can be seen from the relative spectral response curve shown in Fig. 19, the standard 10667 Vidicon is rather more sensitive to light in the blue region than in any other.

Too high a target voltage will result in the picture going partially or completely negative. The beam control on the CCTV camera is in some ways analogous to the brightness control on a normal receiver. The target voltage control has a similar effect to the contrast. These two controls are, however, interdependent, and in general the beam control should be set so as to just discharge the highlights in the picture.

Beam Alignment

No provision has been made in this circuit for any electrical alignment of the electron beam in the camera tube. The guns of Vidicon tubes are normally very accurately aligned and, provided the tube is located accurately in the focus coil, no further alignment is normally required. The test for accurate alignment is to defocus the picture with the fine focus control. If the alignment is good the picture should rotate out of focus with little lateral shift.

Camera Mounting

The method which is adopted for mounting the

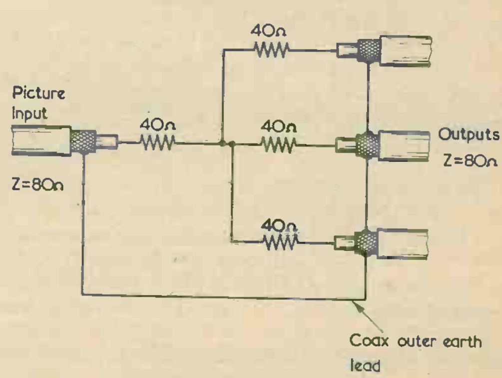
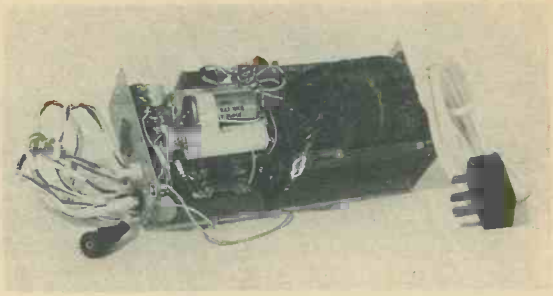


Fig. 20. A 3-way outlet box for splitting the modulated r.f. signal

camera will depend rather on what the individual constructor has at his disposal. The camera is not particularly heavy and therefore quite a small tripod could be used. A ball and socket head of the type used for film cameras might be pressed into service.

More than one monitor could be used with the camera. Some sort of distribution network is then required—a suitable circuit is shown in Fig. 20, which allows 3 monitors to operate. Up to 6 receivers can be run from the camera by an extension of this method. It might be advisable in this case to raise C_8 considerably—say to between 330pF and 1,000pF. If this is done, some adjustment of the coupling winding L_3 may prove to be necessary.



The power supply unit employed by the writers

Television Production

It is not the claim of the writers that they are well versed in the field of television production. Quite ambitious programmes can be produced with the type of equipment described here, provided that its limitations are realised. The primary drawback is that usually only one camera is available, and it will have only one lens. There is perhaps what might be described as a "fundamental principle" for this type of production—that is, to keep the camera still and let the subjects move. Very rapid camera movements can only be achieved after much practice, since they invariably call for refocusing and adjustment of the tube controls. In any case, panning of the camera should always be done slowly as it will be found that this gives a better overall effect.

If some sort of commentary is required as is usually the case, it is normally simpler in the long run to use a separate p.a. system rather than to try to incorporate a sound channel with the video signal from the camera.

Talkback facilities should be provided between the camera operator and the producer. Background music can be provided usually by some combination of tape recorder and record player.

For setting up and introductory purposes, some form of test card is required. The exact design of this card is left to the imagination of the individual, but it should contain test bars and circles as well as a graduated tone scale. A photograph can also be incorporated as a very useful focusing aid. The test card can be made using indian ink on a white background.

There is no limit to the complexity and the facilities which can be introduced into a closed circuit television system. The cost is one limiting factor which has for a long time plagued work in this field. We have tried to show in these articles that it is possible to produce equipment capable of giving very good results for a reasonable outlay. More complicated systems might well be built up by groups of amateurs and clubs as a joint project.

AEI to design and build £250,000 Radio Telescope

A new 82ft steerable aerial, to be used by DSIR for studying radiation and radio signals pick-up, is to be built at Chilbolton, Hampshire. The Ministry of Public Building and Works has placed a £250,000 contract for the detailed design and installation of the aerial with AEI's Electronics Group.

The moving structure will weigh approximately 300 tons and be controlled in winds of up to 45 m.p.h. to a pointing accuracy of two minutes of arc.

The dish and backing structure, control system and mounting have been designed by the Electronic Apparatus Division of AEI's Electronics Group, which also specified the design parameters of the supporting towers.

The aerial will be mounted on altazimuth axes but will be controllable in equatorial co-ordinates for astronomical work.

Drive motors will be supplied by AEI's Motor and Control Gear Division.

The AEI Electronics Group already has a wide experience in this type of work including provision of the control system for the 210ft diameter radio telescope at Parkes, Australia—the most accurate steerable radio telescope in the world.

USE OF TOOL-CLIPS IN CONSTRUCTIONAL RADIO WORK

by E. Lawrence

DESPITE THE VERY WIDE RANGE OF RADIO components which have been designed to fulfil specific functions, the experimenter often solves a constructional problem by pressing into service something originally intended for a non-radio purpose. Many of the items developed as a result of the "do-it-yourself" vogue fall into this category. The spring tool-clip is a long-established adjunct of the workshop and forms a very good example of the type of article which can be put to many uses other than that for which it was designed, and it is readily available from most tool and general ironmongery suppliers in a range of sizes from about $\frac{3}{8}$ to 3in, with plated or coloured plastic finish.

Wiring

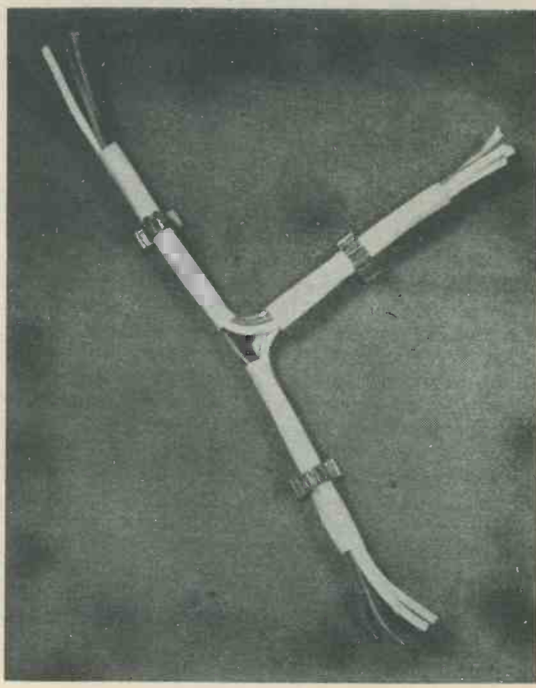
Maintaining a neat layout as lengthy power supply leads accumulate is a frustrating aspect of constructional radio. A neat below-chassis appearance quickly degenerates into an untidy mess as work progresses, and any method which renders a bunch of wires less intractable is worthy of trial. The first illustration shows a complex wiring scheme built up progressively from various diameter single insulated conductors, and then finally tidied up with short lengths of wide gauge plastic tube and secured to a flat surface with tool clips. A feature of this technique is that the spring action of the clips not only exerts a firm safe hold but, at the same time, allows the removal of the article held any number of times without the use of tools or fear of damage. The smallest size clips are ideal for a single thick conductor and serve admirably when installing television coaxial cable. Should a wire be expected to carry voltage in excess of the rating of its insulation a large diameter plastic tube can be added to afford extra electrical and mechanical protection.

Mounting Relays

When drilling the requisite holes for relays in an aluminium chassis with a hand tool, it is often difficult to ensure correct alignment. If a number of relays are to be fitted, not only is the task a tedious one but the result is often unsatisfactory due to the untidy appearance of those which are not quite square with the others. Much of this tedium can be avoided by employing a pair of tool-clips to grip the relay coil. Only two holes per relay are now needed and the problem of correct alignment is greatly simplified. Also, with the introduction of a suitable plug and socket into the associated wiring, the relay can be removed for spring adjustment and contact cleaning, or be changed to one of different coil resistance, with little difficulty. A typical Post Office type 3000 relay is shown with its associated clips in the second photograph.

Transistors and Other Components

The miniaturisation of components as a result of the development of transistors has removed the need to secure them in the manner common to their larger counterparts. However, where, for the sake



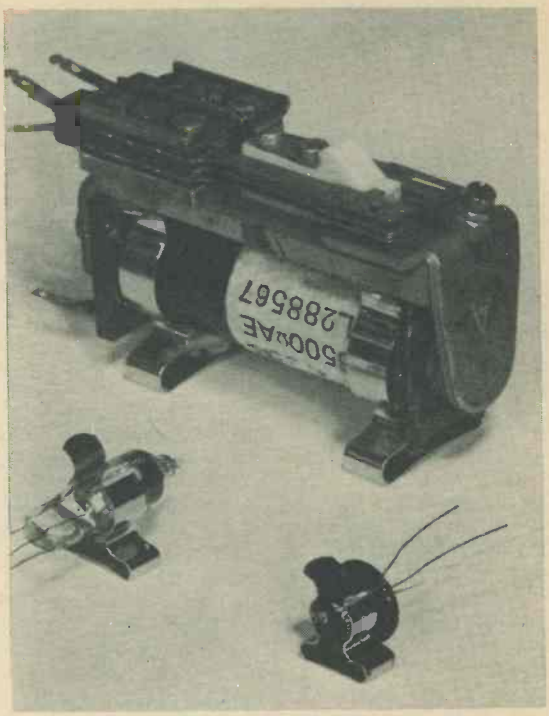
A complex wiring layout presents a very tidy appearance with the aid of tool-clips of appearance, it is desired to anchor transistors to a surface, they may be gripped in a clip of appropriate size. This will also afford a degree of coupling to the chassis mass and may contribute favourably to the transfer of heat from the transistor, but care is necessary in the application of this feature and manufacturers' recommendations should not be disregarded.

Any component of cylindrical form, such as an electrolytic capacitor, can be fixed directly to a chassis by means of a tool-clip. Where a difference of potential exists between the outer case of the component and the surface to which it is to be attached, either a plastic covered clip should be used or it will be necessary to interpose a layer of insulating material. The type of insulation employed must take into account the question of heat dissipation, if applicable.

It is not unusual nowadays to encounter valves which have flying leads in place of the conventional plug-in base and the attendant mounting problems can be overcome, with little risk of damage to the relatively fragile glass envelope, by selecting a suitable size tool-clip. Examples of such a mounting, together with that for a transistor, can be seen adjacent to the relay in the second illustration.

Valve Top-Cap Connectors

Tool-clips can be used to advantage in lieu of the conventional pattern of valve top-cap connectors. It is not an uncommon experience, when removing an ordinary type of connector which has been in position for a long time, to find that it is so firmly attached to the top-cap that any attempt to remove it by force results in the cap parting company with the valve. This problem is especially acute when the valve is inaccessibly placed, whereupon the task of removing the connector and then replacing it may require considerable dismantling of the equipment. Such difficulties are largely eliminated by the spring action of the tool-clip. In the third illustration a grid-stopper resistor has been attached by means of a short tagstrip.



The clips are especially useful for mounting relays, small wire-ended valves, transistors, and other components with cylindrical bodies

A neat solution to the problem of the top-cap connector

General Applications

Radio is an expensive business and it is satisfying to find a component of high quality and versatility at a price which enables even the most impecunious experimenter to keep a selection close to hand for the many small mounting problems which arise in the course of his work. The writer has used these clips for many purposes; as door clips, instrument cabinet lid catches, for supporting mechanical loads, for temporary electrical connections in the same manner as crocodile clips. Plug-in units as used for receiver band-changing coil packs, require positive electrical connectors which can be easily disconnected by a light pulling action. Such connections can be established with the aid of these clips in association with suitable contact bars.

The clips are also very useful, of course, for holding tools!

An Interchangeable Oscilloscope

PART 3

by J. Hillman

Testing the Timebase and X Amplifier

Having checked over the wiring carefully, the timebase and X amplifier unit can now be coupled up to the power supply by means of the octal plug. Switch on and see if the valves light up then check that there is h.t. voltage at pins 7, 8 and 9 of V_1, pins 1 and 6 of V_2 and pin 6 of V_3. Next couple up the sockets on the back of the chassis to the sockets on the c.r.t. unit, "Grid" connecting to "Grid", "Int. Sync" to "Int. Sync", and "X" to "X". The connections should be made with short pieces of unscreened flex having wander plugs at both ends. With the Beam switch of the c.r.t. unit at the on position, a straight line should appear on the screen, and this line should be capable of being varied in length by operating VR_{10}. (Fig. 28.)[1] The maximum expansion of the line should occur when S_4 is in Position 1, i.e. Non-Linear. The setting of the linearity controls can be left until the Y amplifier is coupled up, although if it is desired to set those up the following procedure may be adopted. Connect a mains a.c. voltage in series with a 0.1µF capacitor to the Y socket of the c.r.t. unit, a convenient source of a.c. being the heater voltage. With the coarse frequency switch S_3 in Position 1, and the sync switch S_2 in the "Int Sync" position, advance the sync gain control VR_6 slightly and adjust the fine frequency control VR_8 until a stationary trace of about 4 c/s appears on the screen. If the trace does not remain stationary VR_6 may need to be further advanced. Having got a satisfactory trace, put the linearity switch S_4 to Position 2 (Linear) and adjust the X amplitude control VR_{10} so that the trace is spread across the screen. The trace will probably be cramped at one end or in the middle, so next adjust VR_7 and VR_9

[1] Circuit references to components in the timebase and X amplifier unit apply to Fig. 28, which was published in last month's issue.

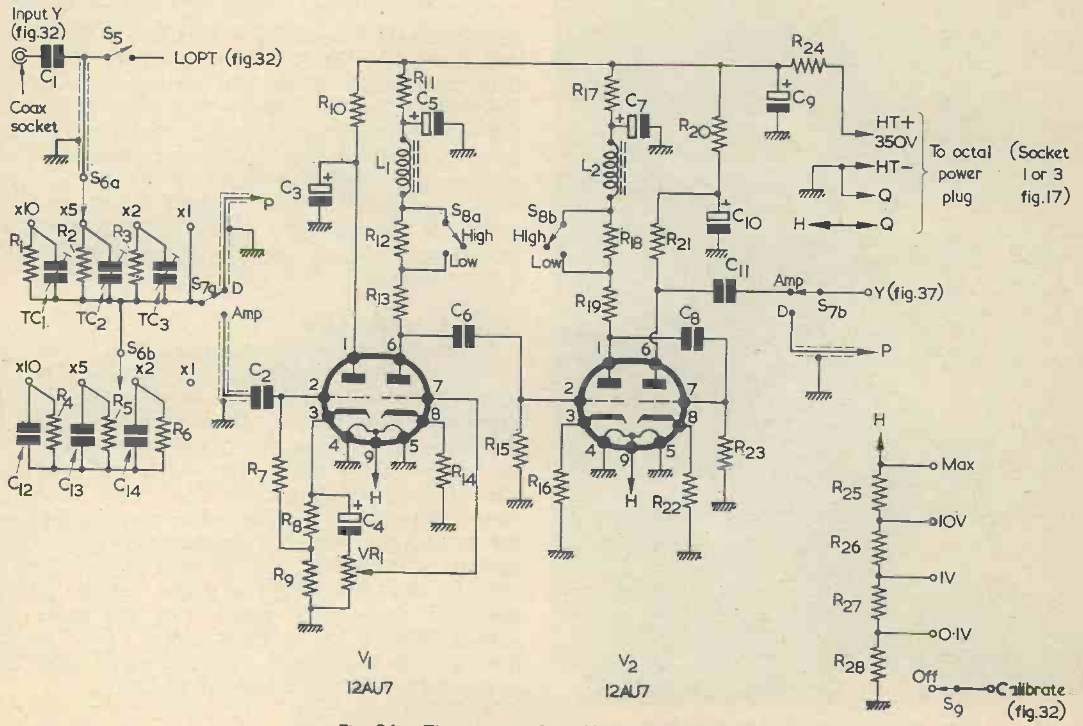


Fig. 31. The circuit of the Y amplifier unit

Components List

(Fig. 31)

Resistors (½ watt 10% unless otherwise stated)

R_1	1MΩ	R_{15}	1MΩ
R_2	1MΩ	R_{16}	470Ω
R_3	1MΩ	R_{17}	10kΩ
R_4	100kΩ	R_{18}	22kΩ
R_5	220kΩ	R_{19}	4.7kΩ
R_6	470kΩ	R_{20}	10kΩ
R_7	1MΩ	R_{21}	22kΩ
R_8	220Ω	R_{22}	470Ω
R_9	4.7kΩ	R_{23}	1MΩ
R_{10}	56kΩ	R_{24}	2.7kΩ 1 watt
R_{11}	10kΩ	R_{25}	39Ω 5%
R_{12}	22kΩ	R_{26}	470Ω 5%
R_{13}	4.7kΩ	R_{27}	47Ω 5%
R_{14}	470Ω	R_{28}	5Ω 5%

Potentiometer

VR_1 5kΩ carbon (Y amp)

Capacitors (all 350V wkg unless otherwise stated)

C_1	0.5μF
C_2	0.25μF
C_3	8μF electrolytic
C_4	100μF electrolytic, 25V wkg
C_5	2μF electrolytic
C_6	0.25μF
C_7	2μF electrolytic
C_8	0.25μF
C_9	16μF electrolytic
C_{10}	8μF electrolytic
C_{11}	0.25μF
C_{12}	50pF
C_{13}	25pF
C_{14}	10pF
TC_1	3–15pF trimmer
TC_2	3–15pF trimmer
TC_3	3–15pF trimmer

Valves

V_1, V_2 12AU7

Switches

S_5	1-pole, 1-way (L.O.P.T.)
S_6	2-pole, 4-way (attenuator)
S_7	2-pole, 2-way (direct amplifier)
S_8	2-pole, 2-way (amplifier gain)
S_9	1-pole, 5-way (calibrate)

Inductors

L_1, L_2 Long wave coils, dust cored

Miscellaneous

2 B9G valveholders
1 18-way miniature tagstrip
4 Pointer knobs
3 Wander plug sockets
1 Coaxial socket
1 Octal plug
1yd 4-core flex

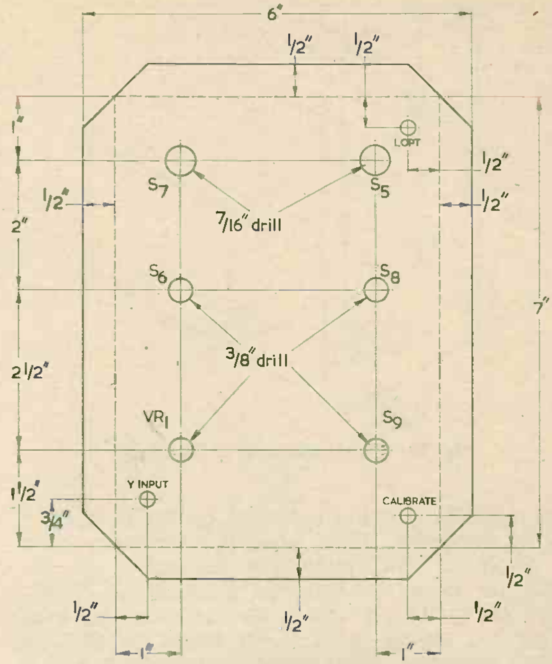


Fig. 32. The Y amplifier front panel

to give the most linear trace, this being indicated by the fact that each cycle is the same shape.[2] By adjusting the frequency control a number of different traces will be obtained and the frequency setting of

[2] If difficulty is experienced in obtaining a linear trace, it may be helpful to experimentally adjust the value of R_{11}.—EDITOR.

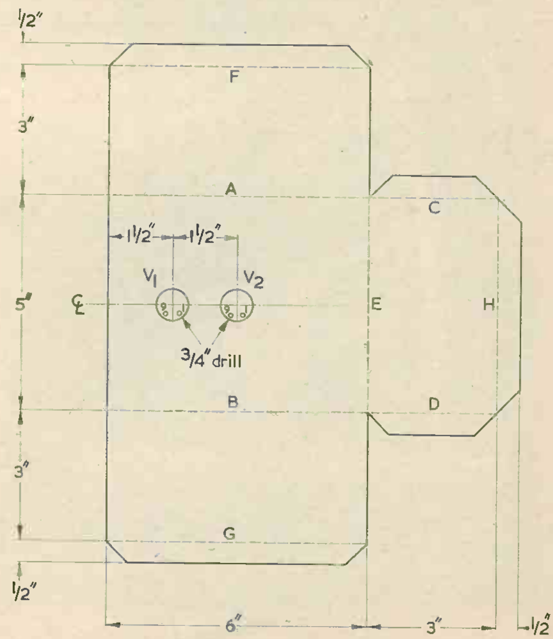


Fig. 33. The Y amplifier chassis

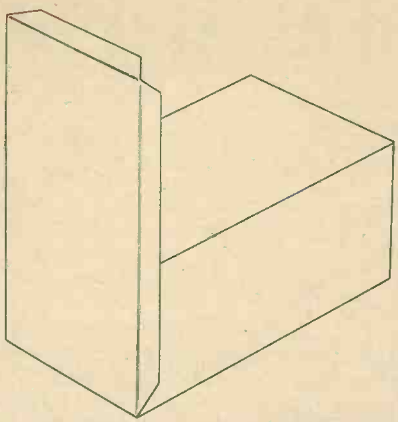


Fig. 34. Fitting the panel to the chassis

the timebase is easily indicated by the number of cycles displayed. Thus, when one stationary cycle is displayed, the timebase is running at 50 c/s; with two cycles the timebase frequency is 25 c/s; with four cycles it is 12.5 c/s; and so on. By applying other a.c. sources such as the audio output of a signal generator, other speeds can be calibrated if desired. If the frequency of the signal generator audio output is not known it may be determined first setting the timebase to 50 c/s and then applying the audio signal from the generator to the Y socket of the c.r.t. unit and counting the number of the complete cycles shown on the trace. By multiplying this number by 50 the approximate frequency of the audio signal can be found. Thus, if the number of cycles is six, the audio frequency is approximately 300 c/s.

The ranges of the coarse frequency switch are as follows: Range 1, 5 to 150 c/s; Range 2, 50 to 2,500 c/s; Range 3, 2 to 50 kc/s; Range 4, 6 to 350 kc/s; Range 5, 140 to 600 kc/s; Range 6 is the off position.

The beam blanking control, VR_5, is adjusted as follows, with a trace on the screen turn up the brightness until the flyback line joining the two ends of the trace is visible. Then adjust VR_5 so that this line disappears, leaving the forward trace only.

Construction of the Y Amplifier

First mark out and drill the front panel, as in Fig. 32, then bend the ½in edges at right angles as shown. Next mark out the chassis (Fig. 33) and bend the edges in the following order: A, B, C, D, E, F, G and H. Bolt up edges C and D with 6BA nuts and bolts, fit the front panel to the chassis as in Fig. 34, and secure with 6BA nuts and bolts. Valveholders V_1 and V_2 are fitted next, with pins 1 and 9 having the orientation as shown in Fig. 33. Fit components to the front panels as in Fig. 32. Fix a miniature 18-way double-bank tagstrip on insulated bushes about ½in off the chassis surface and with about ½in clearance from the adjacent chassis sides, see Fig. 35. Drill the back panel as shown in Fig. 37 and fit the grommet and wander plug socket. Finally make the baseplate and top cover, as shown in Figs. 38 and 39.

Wire up to the circuit diagram of Fig. 31 and the layout diagrams of Figs. 35 and 36. Coaxial leads are used for the three screened wires shown in the circuit diagram, and these come up through the chassis by way of the three large grommets shown

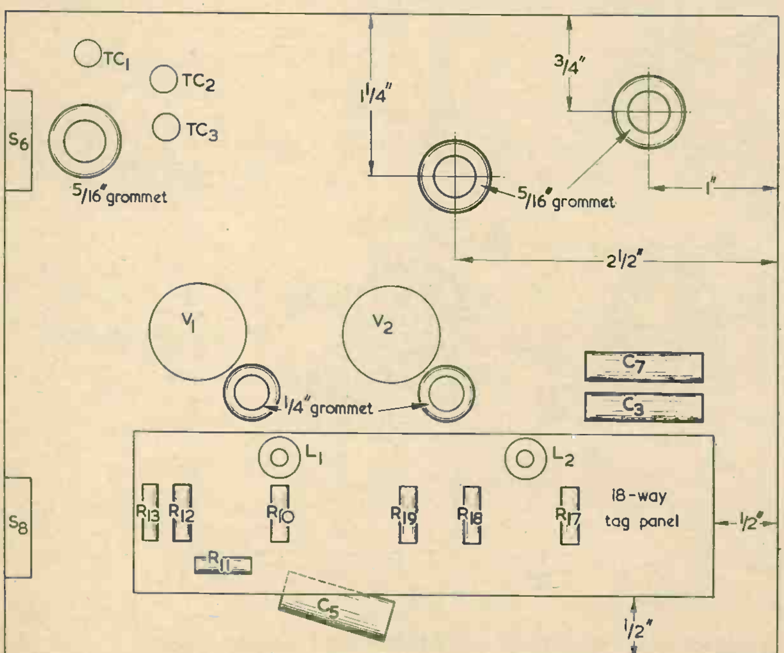


Fig. 35. The above-chassis layout

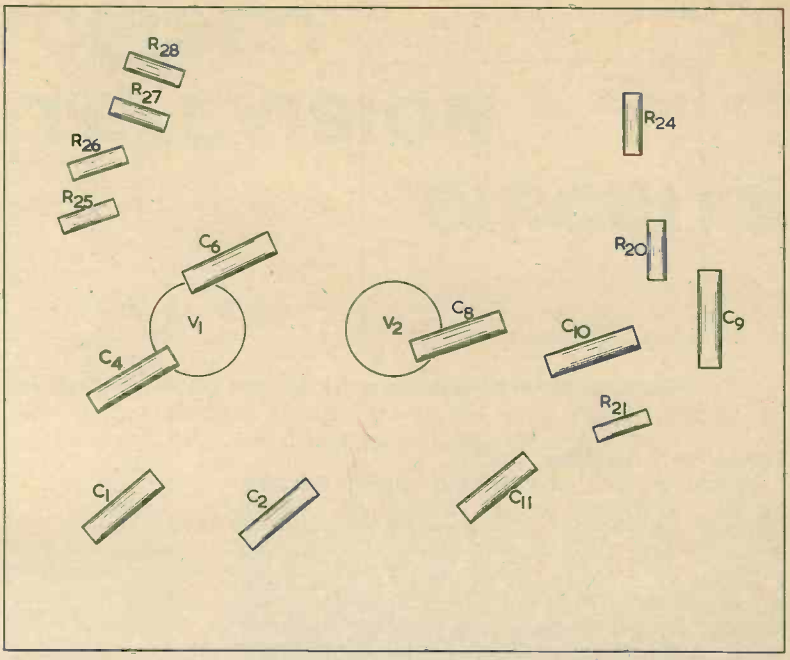
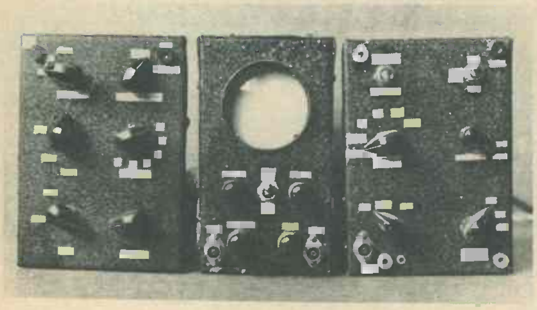


Fig. 36. The layout below the chassis

in Fig. 35. A screening can is used for V_1. Approximately 1 yard of 4-core cable is used for power supply connection, the lead terminating at one end in an octal plug wired to fit Socket 1 or 3 of Fig. 17 (published last month) and the other in a 5-way tagstrip bolted to the side of the chassis. It is very important to ensure that the heater lead earthed at the Y amplifier chassis corresponds to that similarly earthed at the X amplifier chassis. All wiring must be as short as possible.



Front panels of the units

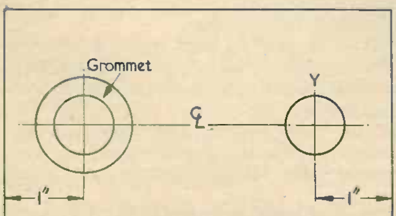
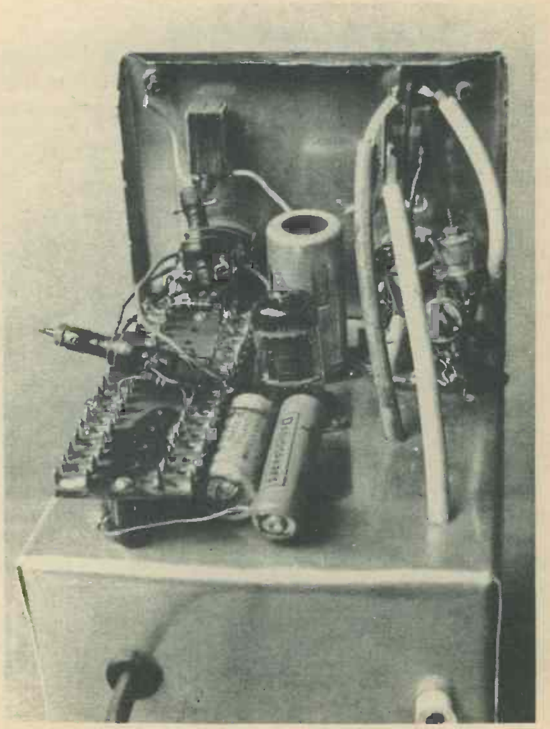


Fig. 37. The rear of the Y amplifier chassis



Above-chassis view of the Y amplifier

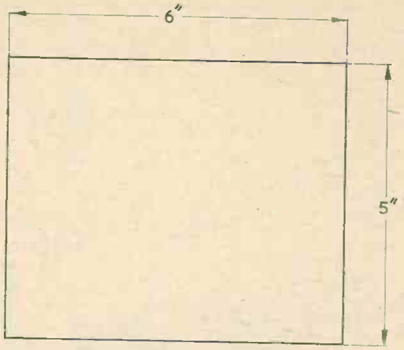


Fig. 38. The baseplate

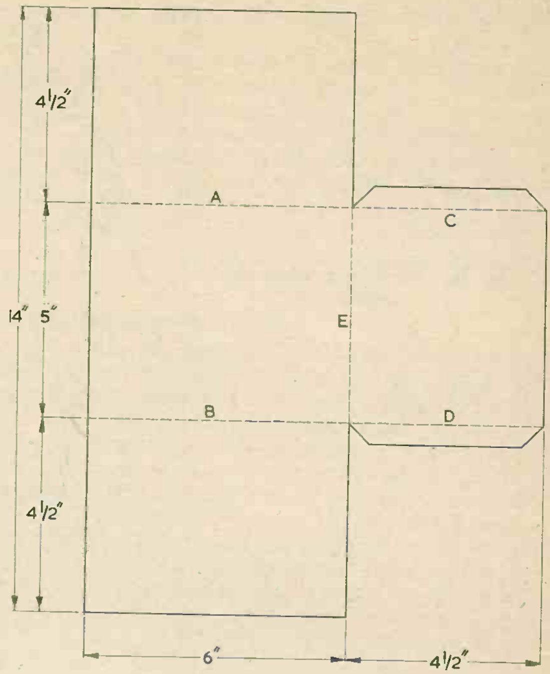


Fig. 39. The top cover

Testing the Y Amplifier

Having checked over all the wiring, the unit can now be coupled up and switched on. Ensure that the valves light up and that h.t. voltage is present at pins 1 and 6 of V_1 and V_2. Couple the Y socket to the Y socket of the c.r.t. unit, using unscreened flex. First put switch S_7 to the direct position, D, and couple a lead from the Calibrate socket to the Y Input socket on the front panel. Set the attenuator switch, S_6, to the X1 position. A sine wave trace should now appear and this should vary in height when S_9 is switched to different positions. Now switch S_7 to the A (amplifier) position, set S_8 to the Low position and ensure that the Y amplitude control, VR_1, increases the height of the trace as it is turned. Leave this control at a high setting, and check that the attenuator switch S_6 decreases the height of the trace as it is switched from X1 to X2 and through to the X10 position. Now check that there is a large increase in height of trace when amplifier switch S_8 is placed in the High position, To adjust trimmers $TC_{1,2}$ and TC_3 a square wave input is required, the trimmer being adjusted to give a similar waveform to that obtained in the X1 position. The calibration switch is used to decide the height of any trace and is marked in peak-to-peak voltages.

(*Conclusion*)

Switzerland's New Mountain Top "Car Calling Network"

Ten VHF radio-telephone transmitters which will form a new permanent network for the public car-calling service in Switzerland have been ordered from Standard Telephones and Cables Limited, London.

Placed at strategic high points above the valleys, these transmitters will be used by telephone operators for calling subscribers—private motorists or commercial vehicles—to tell them that a message awaits them. On receipt of such a call on his radio receiver the driver stops at the nearest telephone box and dials the operator or the person who wishes to contact him. The call is thus completed over the normal telephone system.

In this way a low-cost service can be provided for subscribers "on the road" without the expense of fitting radio transmitters in subscribers' vehicles. Main reason for the service, however, is that normal low-powered mobile radio transmitters are swamped by the mountains which make two-way mobile radio telephone service very difficult and unreliable.

The car calling service, at present in limited operation on an experimental basis, is provided by the Swiss Post and Telegraph administration.

The transmitters to be supplied are STC type DU-6A, with an output of one kilowatt in the frequency range 100 to 156 Mc/s.

TRANSISTORISED TELEVISION CIRCUITS

PART 6 By Gordon J. King,
Assoc.Brit.I.R.E., M.T.S., M.I.P.R.E.

In this, the last in the series covering the circuits employed in transistorised television receivers, our contributor describes a new vertical timebase circuit, then carries on to discuss power supplies. The series then concludes with information on servicing these receivers

New Vertical Timebase Circuit

BEFORE WE GO ON TO CONSIDER TRANSISTORISED television power supplies a new and interesting vertical timebase using no inductors or transformers is worth looking into, and will tie up with what was said last month.

The circuit has recently been developed by the Radio Corporation of America and is the subject of a patent. It is not possible at the time of writing to show circuits, but the arrangement is basically as follows.

The vertical scanning coils are directly coupled to a pair of complementary transistors in Class B push-pull.[1] A "discharge transistor", along with a "charging capacitor" (see Part 5) produces the drive signal and is responsive to the vertical sync pulses. The capacitor charge is reversed in one direction by the discharge transistor and in the other direction by the output circuit.

Two feedback paths are used, one to supply a forward bias to the discharge capacitor from one transistor of the output pair, which conducts during the latter portion of the sawtooth current waveform in the scanning coils, and the second to provide a pulse for the discharge transistor when the transistor of the output pair (as above) "bottoms" near the finish of the sawtooth cycle.

A driver transistor is used between the discharge transistor and the output stage and positive feedback is applied to the driver. A constant current charging source is given by virtue of the path from the output stage to the charging capacitor, and the same path constitutes a negative feedback loop which linearises the sawtooth current waveform.

The circuit has good noise performance, being immune to noise pulses between the sync pulses, and has excellent thermal stability.

Power Supply Arrangements

Turning now from the vertical timebase to the power supply circuits, we find that the majority of transistorised television sets are designed to work from (*a*) internal battery or cell, (*b*) external battery, and (*c*) mains power supply. Mains-derived power may be either from the "trickle-charging" of the internal battery or from a specially designed regulated power supply unit.

The Pye TT1 set, for example, works either from its own internal battery, which is a 10-volt, nickel-cadmium accumulator, from an external 12-volt car battery, or from an a.c. mains supply of 200–250 volts, 50 c/s.

The basic power supply, however, is the nickel-cadmium accumulator. This type of battery differs from the ordinary lead-acid accumulator in that it

Transistorised portable television with three-band radio by Global Electronics

[1] See "Complementary Circuits using PNP and NPN Transistors", by Mullard Limited, leaflet No. TP517.

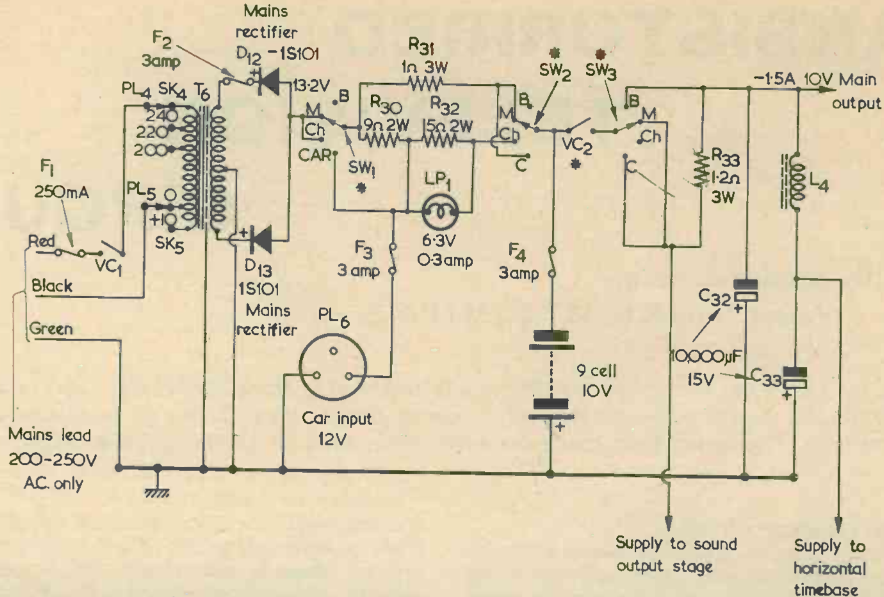


Fig. 19. Power supply arrangements of the Pye TT1. The switches marked with an asterisk are ganged, e.g. SW_1, SW_2 and SW_3 and VC_1 and VC_2. The former is the function switch and the latter the on/off switch, ganged to the volume control. The prime source of power is the 9-cell nickel-cadmium battery. For mains and car battery operation, this battery is "float charged"

produces no harmful or corrosive fumes, it can be left in a discharged condition for any length of time without ill effect, and it is of rugged, sealed-cell construction which requires no topping up. It is thus ideally suited for use inside a piece of electronic equipment.

The Perdio "Portarama" transistorised television set

In the "battery" position, the set is wholly powered from the nickel-cadmium accumulator which, when fully charged, will operate the set for at least two hours.

The circuit of the Pye power supply is shown in Fig. 19. The 9-cell battery is protected by a 3A fuse. VC_2 (ganged to VC_1 in the mains input circuit) is the on/off switch, while switches SW_1, $_2$ and $_3$ are also ganged to provide the "function".

With the function switch in the "mains" position, power is drawn from the a.c. mains supply via a full-wave rectifier comprising D_{12} and D_{13}, and sufficient voltage is available to "float-charge" the battery while operating the set. The set will operate indefinitely under this condition.

The battery charging continues with the charge current falling eventually to zero when the e.m.f. of the battery becomes equal to that across the receiver-loaded power supply. Thus, with normal mains operation, the battery remains in the fully-charged condition. In addition to supplying power "on battery", the battery serves to stabilise the power supply in the "mains" position owing to its very low shunt impedance. In this way it also greatly assists in deleting the ripple from the rectified d.c.

Resistor R_{33} (1.2Ω, 3 watts) is included in series with two of the supply feeds in the "mains" position because the e.m.f. of the battery is somewhat higher than the required 10 volts; the resistor corrects the voltage under this condition.

When the set is operated from a car battery, in the "car" position, the 12 volt car battery acts rather like the rectified mains-derived power supply, in that the battery "float-charges" the set's internal battery while also working the set. A car battery of average capacity and charge will work the set for a period of some 25 hours.

The Pye also has a fourth position on the function switch, marked "charge". In this position the mains power supply is connected to the battery and the receiver load disconnected. The power unit then acts as an ordinary charger for the battery and is intended to supply a fast overnight charge for the battery when the set is required for portable use the following day.

The red warning lamp, LP_1, indicates that the battery is on charge, and a fully discharged battery takes about fourteen hours to fully charge in this way.

In addition to the smoothing provided by the battery itself, extra smoothing and decoupling is given by the 10,000μF electrolytic capacitor on the main output circuit and by the 10,000μF electrolytic capacitor and the smoothing choke L_4 on the supply to the horizontal timebase circuits, the latter smoothing also helping to decouple the large timebase currents from the remainder of the circuits.

Regulated Power Supply

As the power consumption of the receiver is continuously changing during normal operation as the result of, for example, changing picture brightness and sound volume, it is essential that the power supply used must be regulated. An ordinary rechargeable battery has a very low impedance across its terminals which means that its output voltage remains substantially constant under varying conditions of load.

Although the impedance of a rectified type of power supply unit operated from the mains supply also has a low impedance, the voltage regulation is nowhere near as good as that given by an accumulator, and the terminal voltage will change as the load represented by the receiver changes. This would detract considerably from the performance of the receiver, causing both the picture size to vary in sympathy with the sound and the sound to be affected by variations of the vision signal. To avoid this highly undesirable state of affairs, a mains power supply which does not use the accumulator as a stabilising device must feature some electronic form of voltage control or regulation.

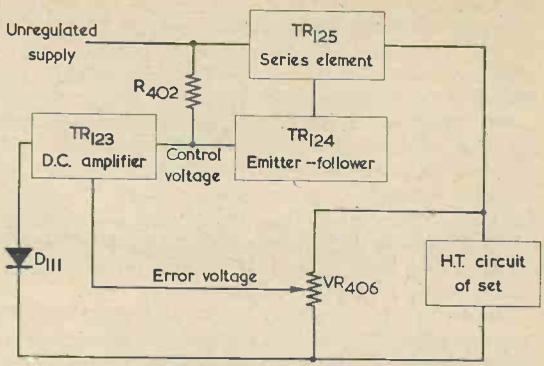


Fig. 20. Block diagram of the regulated power supply used in the Perdio "Portarama" receiver

A circuit which provides a useful degree of voltage control, as used in the Perdio "Portarama", is shown in block form in Fig. 20. This is called a "series voltage regulator", and in the state when the voltage supplied to the set is constant (at 11.6 volts in the Perdio set) the circuit works as follows.

A small portion of the voltage applied to the receiver is extracted by way of the potentiometer VR_{406} and fed to the base of a d.c. amplifier transistor TR_{123} (see also the circuit in Fig. 21). This

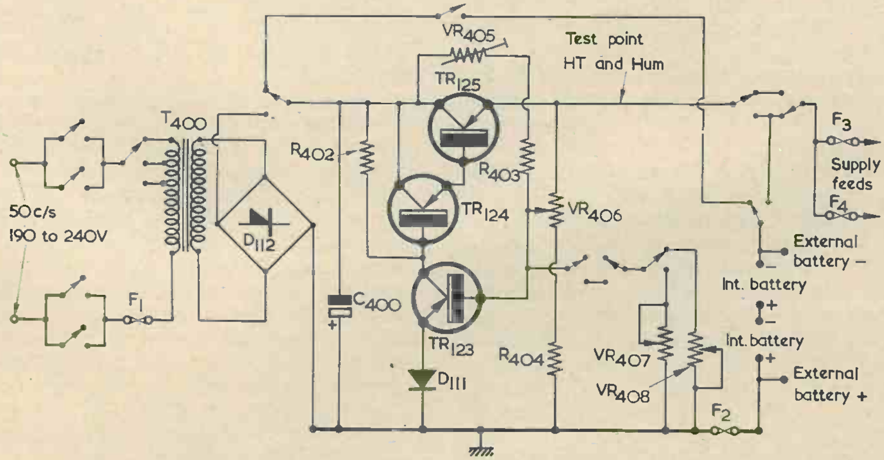


Fig. 21. Circuit details of the Perdio power supply system. This is explained in the text in association with the block diagram in Fig. 20

voltage is compared with a reference voltage at the emitter of TR_{123} due to a zener diode, D_{111}.

The resultant voltage, which is produced across the collector load (R_{402}) of TR_{123}, is applied to the base of an emitter-follower stage, TR_{124}. This in turn "drives" a series regulating element, comprising transistor TR_{125}. In effect, TR_{125} is an emitter-follower as well, the input to which is the control voltage produced across R_{402}.

The emitter of TR_{125} is loaded by the receiver power circuits as a whole, and the output voltage across this load (e.g., across the receiver supply rails) is the regulated supply voltage.

Now, if the receiver load (and hence current consumption) varies and endeavours to change the supply voltage from the pre-set level, a small portion of this voltage change is "sensed" by VR_{406} and fed to the base of the d.c. amplifier TR_{123}. This causes a corresponding change of the control voltage across the load R_{402}. The change in control voltage (either up or down depending upon the load variation) is transferred to the base of the series element (TR_{125}), via the emitter-follower TR_{124}, and this causes the current transference between the collector and emitter of Tr_{125} to alter in such a manner as to restore the original level of voltage.

In other words, the voltage from the series element transistor is automatically adjusted by the control voltage at its base, and since the control voltage is an amplified sample of the change of voltage due to a changing load condition, the adjustment is such that the voltage output remains very nearly constant despite increasing or decreasing load conditions.

The power proper is derived from a bridge rectifier circuit (D_{112}), in which C_{400} (Fig. 21) is the reservoir capacitor. VR_{405} is a kind of feedback control which can be adjusted as a "humdinger" to minimise the hum level. It works by providing a small balancing amount of anti-phase hum feedback to the collector of TR_{125}. VR_{406} controls the supply voltage by virtue of adjusting the conditions of the d.c. amplifier TR_{123}. In the Perdio set the adjustment is for 11.6 volts.

The power supply circuit also provides facilities for recharging the internal accumulator, with VR_{407} and VR_{408} as the charging rate controls, and for operation from an external 12 volt accumulator.

The Complete Receiver

We have now arrived at the last section in the transistorised television receiver, and the foregoing articles in this series have discussed all the various stages, with illustrations from commercial models. Variations of the circuits described will undoubtedly occur as the transistorised television set becomes more popular; and more popular it is definitely going to become. The days are surely numbered when beach-goers and holiday makers are going to demand no more from their "transistors" than mere sound. Already in the U.S.A. have appeared the "cordless TV" and the "rear-seat auto TV" and, indeed, there are more transistor television receivers operating in Great Britain than may be realised. A number of firms are already producing models, and at least one set is endowed with ordinary radio facilities over the long, medium and short wavebands.

For portable use, the sets feature a telescopic aerial section loaded to the tuner r.f. amplifier, while an ordinary coaxial input socket is also available for reception of the more distant stations. At v.h.f. transistors have a better noise performance than valves, which really means that the "maximum usable sensitivity" of a transistor set is a few decibels better than that of a valve set.

Based on this principle is a comparatively new transistorised set-top aerial. A dual-band transistor amplifier steps up the signal induced into a special aerial system without adding too much noise. In fact, used with a valve set, the overall noise performance is usually improved. This device allows indoor aerials to be used at distances at least 20% in advance of those normally considered suitable for set-top aerial operation.

U.H.F. transistors are now becoming available, and already a u.h.f. tuner is available. This breakthrough will tend to popularise transistorised television receivers even more, since there would be a limited market if transistors failed to work above v.h.f. now that television in the u.h.f. bands is with us.

Servicing Aspects

It is, of course, impossible to include very much on servicing matters in this article, but transistor receiver servicing may be dealt with later in these pages. One or two points are, nevertheless, worth consideration. Whether we like it or not, all transistor models feature printed circuit boards, and so far the transistors are soldered direct into the circuit, making their removal extremely difficult when it becomes necessary to perform a substitution check. There is a very strong case, especially so far as transistorised television sets are concerned, for transistors to be designed for plugging into sockets on the printed board, like valves. While this technique would probably put a few more shillings on the price of the set, the saving would be many-fold in terms of time during servicing. It is understood that this possibility is under active consideration—so we may yet be able to change transistors like valves!

As sections of a transistorised television set are somewhat miniaturised, the use of small, specially selected tools is essential for efficient and speedy servicing. When removing transistors in particular, a heat-shunt clamped between the component and the printed board on the lead-out wire is a must to avoid damage to a component which has not yet been proved defective. Such tools are now readily available, as also are sub-miniature soldering irons which really get hot at their tips! Concentrated tip-heat for the shortest possible time is the maxim for printed circuit board servicing. Good thermal contact between the soldering iron tip and the soldered joint makes this possible, and this applies in particular when *removing* a component from the board as well as when replacing one.

A useful "tool" is a large illuminated bench magnifier for locating hairline breaks in the printed wiring. A good substitute is a fair-sized magnifying glass or reading lens.

To avoid having to rely on the set's battery, a variable regulated power supply unit is a convenient adjunct to the transistor "test bench". These can be made up or purchased commercially. For basic testing a 20,000 ohms/volt multimeter, having a full-scale range of around 12 volts, and sub-multiples and multiples thereof, is useful. The instrument should feature a couple of resistance ranges, from about 50Ω to several megohms, but its internal battery should not be greater than 3 volts. Otherwise, the forward current in a transistor resulting from a resistance test of the associated circuit may cause damage.

A transistor tester may be of help, and will definitely be of greater help when transistors become plug-in components. There are one or two transistor testers on the market which are designed for testing certain parameters without removing the transistor from the circuit.

Acknowledgements: The author wishes to thank Pye of Cambridge, Perdio Electronics and Global Electronic for their kind help in supplying data and information which has made this series of articles possible.

RADIO TOPICS . . .

One of the difficulties in designing equipment for home-constructor use, or indeed for mass-production, lies in finding suitable capacitor types for each particular circuit. At the end of the war, believe it or not, there were only three basic types of fixed capacitor in large-scale general use in this country, these being the electrolytic, the paper capacitor and the mica capacitor. Ceramic capacitors were also available at that time but they were, comparatively speaking, something of a rarity, and usually appeared as temperature compensating components in oscillator circuits and in Services equipment operating at v.h.f. and higher frequencies.

Since that time, ceramic capacitors have become available in very large quantities and represent what is almost an inevitable choice for decoupling circuits in the front-ends and i.f. strips of television and f.m. receivers. The lower values also appear in v.h.f. tuning and coupling circuits and, in competition with other types, in circuits operating at lower frequencies. Also appearing since the war have been the polystyrene capacitor (introduced in quantity by Suflex Ltd.) and the polyester capacitor.

When confronted with all these varieties, the problem which faces the equipment designer and the home constructor is: which type should be used for each circuit application?

Choosing a Capacitor

Probably the best way of discussing this question is to deal in turn with the various types of capacitor, starting off with the paper capacitor.

As we all know, one type of paper capacitor consists, essentially, of a roll comprising two strips of metal foil with paper dielectric sandwiched in between. The two strips of foil then form the plates of the capacitor. The alternative type of paper capacitor employs metallising deposited on the paper instead of metal foil, the whole being rolled up as with the foil version. Because of their rolled construction, paper capacitors offer a large capacitance in a small space, this representing one of their main attractions.

Paper capacitors are low tolerance components, the versions generally available for commercial applications having tolerances of ±20 or ±25% on nominal value. They also have a wide range of temperature coefficients (change in capacitance in parts per million for a rise in temperature of 1°C) according to the grade of dielectric and other factors. Despite these apparent shortcomings, paper capacitors represent an excellent choice for a.f. circuits, where close tolerances on capacitor value are not usually required. They are, also, excellent for a.f. and r.f. decoupling up to some 20 Mc/s or so. In the past, paper capacitors had something of a reputation for developing leakiness with the passage of the years, but this trouble is largely absent with modern versions of the component. Even so, leaky paper capacitors do appear now and again in modern chassis, as most service engineers will confirm.

The mica capacitor is the next component to consider. Some beginners get a little puzzled at the difference between "mica" and "silvered mica" or "silver-mica" capacitors. The mica capacitor employs metal foil for the plates, whilst the silvered mica, or silver-mica, capacitor has a deposit of silvering on the mica itself. Silvered mica capacitors have a higher stability than mica capacitors and are, in general, to be preferred. In practice, almost all modern wire-ended "mica" capacitors are of the silvered mica type so that, if you order a small "mica capacitor", you are pretty certain to get a silvered mica component in any case. Which is, of course, all to the good.

For home-constructor work, mica capacitors are an excellent choice for circuits operating up to 50 Mc/s or even higher. This fact may surprise those constructors who look upon the region above 20 Mc/s or so as being almost exclusively the domain of the ceramic capacitor. However, if you want to check up on this point, take a look inside the transformer cans on a few 34.65–38.15 Mc/s TV i.f. strips, and see how many silvered mica capacitors you find tuning the i.f. coils!

Silvered mica capacitors are not, nowadays, generally used in values above 1,500pF or so because it is cheaper to employ other types. Apart from their excellent performance over the frequency range I've just mentioned, silvered mica capacitors exhibit the further advantage of having a low and stable temperature coefficient, this being of the order of zero to PO60. (The "P" indicates a positive temperature coefficient, given by an *increase* in capacitance with rise in temperature.)

Ceramic Capacitors

Ceramic capacitors come next, and it is necessary here for the constructor to realise that these differ from other components in that they have a very wide range of temperature coefficients and tolerances. Low value types, up to about 500pF or so, normally fall into what is known as the low-K category, and they have fixed temperature coefficients varying from P100 to N750, the temperature coefficient depending upon the grade of ceramic employed for the dielectric. (The "N" signifies a *decrease* in capacitance with rise in temperature.) High value ceramic capacitors, from about 800pF up, are usually of the high-K type which have very large and non-linear temperature coefficients. Because of the type of ceramic employed as dielectric, high-K capacitors tend to have maximum capacitance at temperatures of the order of 20°C. At temperatures around −40°C they may drop in value by about 25%, and at temperatures around 85°C they may drop in value by as much as 40%. These capacitors employ either the disc or tubular construction and it is safe to assume that, if a ceramic capacitor packs a very large capacitance into a very small space, it will be of the high-K variety and will give large changes in capacitance for variations in temperature. Another point with high-K ceramic capacitors is that they are made with very wide tolerance on value, a figure of −20% +80% being quite common.

The wide range of capacitance (due to tolerance on value and change with temperature variations) which is given by individual high-K ceramic capacitors does not prevent their being used in what is their most useful application: that of r.f. bypass capacitor. Provided an r.f. bypass capacitor has a value which is always greater than a certain minimum figure, that capacitor will always exhibit a reactance equal to or less than that which corresponds to the minimum value. In consequence, the high-K ceramic capacitor provides an excellent choice for all r.f. decoupling circuits up to 250 Mc/s and above, a typical nominal value being 1,000pF. Such capacitors are usually encountered by home-constructors in the disc form but, as I mentioned just now, they are also made in the tubular form as well. Both types function equally well for practically all r.f. decoupling functions, the disc type being usually more convenient since it takes up a little less space.

Because of their high value and small size, high-K ceramic capacitors become very attractive also for anode-to-grid coupling and similar functions in a.f. amplifiers. These capacitors have a high quoted insulation resistance, and there seems no real reason why they shouldn't be used for such applications provided that their wide tolerances and changes in value with temperature are realised. It would probably be best to avoid using them as coupling capacitors to the grids of a push-pull output pair, and for similar circuits where relatively closely matched components are required.

Low-K Capacitors

The low value, low-K ceramic capacitors (having temperature coefficients between P100 and N750) are close tolerance components which are excellent for r.f. circuits up to 250 Mc/s and above, but their temperature coefficient must always be borne in mind. Despite this it is usually safe, in home-constructor designs, to ignore the temperature coefficient when the capacitor tunes a coil at aerial signal frequency, because the amount of detuning given by change of capacitance as the receiver warms up after switching on is liable to be very low. On the other hand, the use of an incorrect temperature coefficient can cause a lot of trouble if the capacitor has control over receiver oscillator frequency. Most valve oscillator circuits drift on warming up, and the drift is usually in the direction which can be counteracted by a capacitor with a negative temperature coefficient. Because of this, some constructors are tempted to employ, say, an N750 capacitor in the oscillator tuned circuit in order to counteract the drift. The trouble is that such a capacitor can sometimes apply far too much correction whereupon the subsequent drift, in the opposite direction, becomes far worse than that which occurred originally! Unless the constructor can obtain a range of ceramic capacitors with known temperature coefficients and is prepared to carry out the long-winded process of determining which one he requires in his particular circuit, I often feel it is preferable to avoid ceramic capacitors in oscillator tuned circuits altogether unless one is certain that they are P030, NPO or NO30 types. One can then play safe by using silvered mica capacitors instead, designing the receiver so that the oscillator and its components stay as cool as possible after switching on. This applies only, of course, to capacitors which affect the actual oscillator frequency itself.

Incidentally, for those who wish to delve further into this subject, the colour coding employed to indicate temperature coefficient in low value ceramic capacitors was discussed in the "Understanding Radio" article in our June 1962 issue.

The remaining capacitors to deal with are the polystyrene and polyester types. Here, the problem of selection becomes much easier. It is safe, in general, to look upon polystyrene capacitors in rather the same light as silvered mica capacitors. They may be used at frequencies up to about 50 Mc/s and they have a temperature coefficient between about N050 and N200, according to type, plus the attractive feature of an exceptionally high insulation resistance. Polyester capacitors can be employed at any circuit point where paper capacitors are acceptable and they have a lower dielectric loss than paper types. Also, they are manufactured with a closer tolerance on value, this being, typically, ±10%. Both polystyrene and polyester capacitors employ a rolled-up construction which is basically similar to that of the paper capacitor.

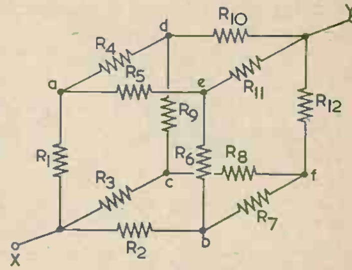


Fig. 1. The cube of resistors. If each resistor has a value of 1Ω, what is the resistance between X and Y?

That Cube of Resistors

Turning from capacitors to resistors, you may recall that, in the December issue, I referred to the cube of resistors which is shown in Fig. 1. Each resistor has the same value (say 1Ω) and the problem is to find the resistance between points X and Y or the total current which flows when a specified voltage is applied to these points.

To demonstrate how the problem may be solved I showed how the cube could be rearranged in symmetrical form, whereupon points of equal potential could be identified and, for the sake of calculation, connected together. My symmetrical network had the disadvantage that three resistors appeared at a slant, and the symmetry was not entirely obvious at first sight without a few words of explanation.

Mr. D. Graves (Rothwell, Leeds) has since sent me an alternative and

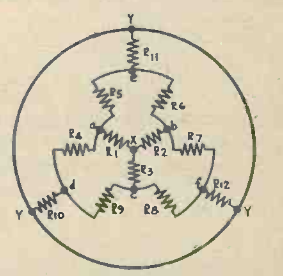


Fig. 2. As demonstrated by Mr. Graves, the cube may be rearranged in the manner shown here.

better version of the rearranged cube, and this exhibits a symmetrical layout which is completely obvious at first sight. I reproduce Mr. Graves's network in Fig. 2. It is at once obvious from this diagram that, if a voltage is applied to X and Y, points (*a*), (*b*) and (*c*) take up the same potential, as also do points (*d*), (*e*) and (*f*). These similar-potential points may, therefore, be joined together for purposes of calculation, whereupon we end up with the network of Fig. 3.

The final resistance of the cube, working from Fig. 3 and assuming that each resistor has a value of 1Ω, is $\frac{1}{3}+\frac{1}{6}+\frac{1}{3}=\frac{5}{6}\Omega$.

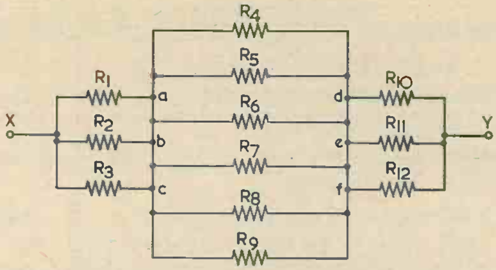


Fig. 3. Connecting points of equal potential together allows the cube to be presented in this simple form

Reaction Circuit

Finally, a short note concerning Sir Douglas Hall's article "Simplicity and Sensitivity with Two Transistors", which appears elsewhere in this issue.

Since this article went to press, Sir Douglas has found that a slight but worthwhile improvement can be obtained by adding a 1,000pF capacitor between the "free" end of the potentiometer and the emitter of TR_1. This enables oscillation to start near the maximum end of the potentiometer throughout the range and makes the circuit even more efficient.

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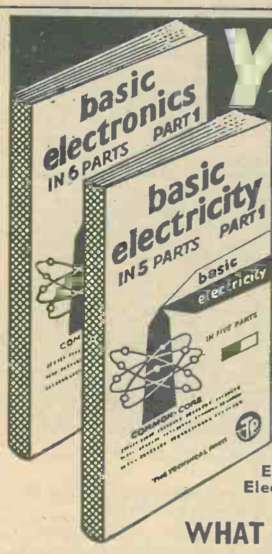

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Continued from page 645

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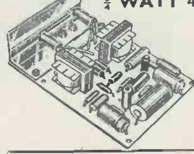

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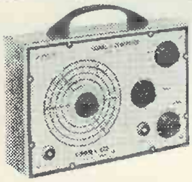

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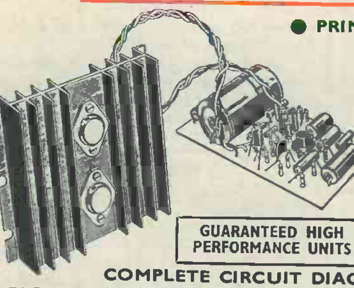

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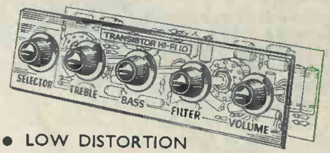

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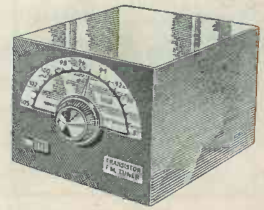

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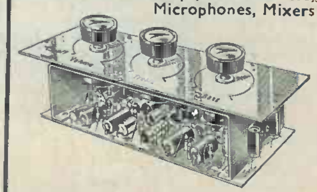

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