THE
RADIO CONSTRUCTOR

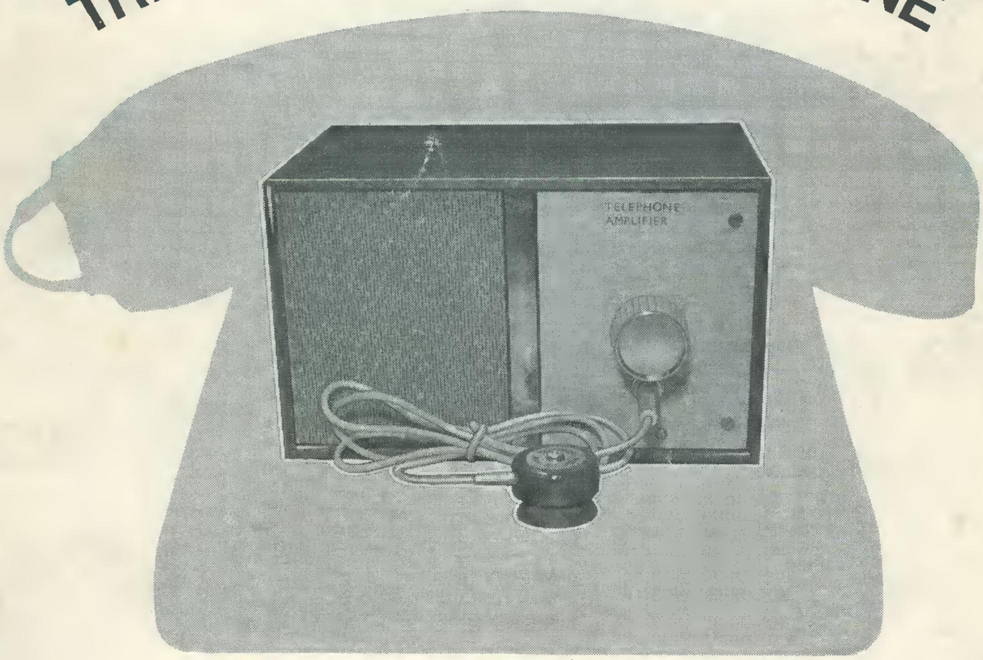
Vol 21 No 4

NOVEMBER 1967
2/6

A DATA PUBLICATION

RADIO . TELEVISION
ELECTRONICS . AUDIO

TRANSISTORISED TELEPHONE



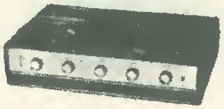
AMPLIFIER

Also featured

Simple product Computer ★ Automatic Radio Control Keying Unit ★ F.W. Pre-amplifier converter

AN EXCELLENT STEREO SYSTEM
A "Package Deal" saves you money

GARRARD PLAYER AT-60



20+20W STEREO AMP. AA-22U

20+20W TRANSISTOR STEREO AMPLIFIER. Model AA-22U. Outstanding performance and appearance. Kit **£39.10.0** (less cabinet).. Assembled **£57.10.0** Attractive walnut veneered cabinet £2.5.0 extra.

GARRARD AUTO/RECORD PLAYER. Model AT-60. less cartridge **£14.12.10** With Decca Deram pick-up **£19.7.4** incl. P.T. Many other Garrard models available, ask for Lists.

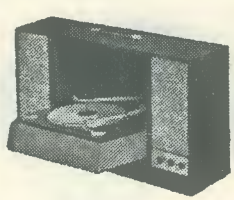
TRANSISTOR FM STEREO/MONO TUNER, TFM-1S Styled to match amplifier above. Comprises TFM-T1 Tuning Heart **£5.16.0** incl. P.T. TFM-IS I.F. Amp. P.S. etc. **£19.2.0** Total Price Kit **£24.18.0** (less cabinet). Cabinet **£2.5.0** extra.

COTSWOLD SPEAKER SYSTEMS. Standard or M.F.S. cover 30 c/s – 20,000 c/s. 3 loudspeakers. Kit **£25.12.0.** Assembled and Finished **£33.4.0.**

NEW! PORTABLE STEREO RECORD PLAYER, SRP-1

Kit £27.15.0

Assembled price on request



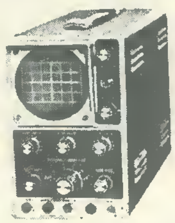
Automatic playing of 16, 33, 45 and 78 rpm records. All transistor—cool instant operation. Dual LP/78 stylus. Plays mono or stereo records. Suitcase portability. Detachable speaker enclosure for best stereo effect. Two 8in x 5in. special loudspeakers. For 220-250V a.c. mains operation. Overall cabinet size 15$\frac{7}{16}$ x 3$\frac{7}{8}$ x 10$\frac{1}{4}$in.

Compact, economical stereo and mono record playing for the whole Family—plays anything from the Beatles to Bartok. All solid-state circuitry gives room filling volume.

Heathkit DAYSTROM

ENJOY YOURSELF AND SAVE MONEY
Finished models provide years of superlative performances

INSTRUMENTS



OS-2

3" LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2. Compact size 5" × 7$\frac{3}{8}$" × 12" deep. Wt. only 9$\frac{3}{4}$lb. "Y" bandwidth 2 c/s-3 Mc/s ±3dB. Sensitivity 100mV/cm. T/B 20 c/s-200 kc/s in four ranges, fitted mu-metal CRT Shield. Modern functional styling.
Kit **£23.18.0** Assembled **£31.18.0**

5" GEN-PURPOSE OSCILLOSCOPE. Model 10-12U. An outstanding model with professional specification and styling. "Y" bandwidth 3 c/s-4.5 Mc/s ±3dB. T/B 10 c/s-500 kc/s.
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IM-13U

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

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V-7A

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

RF-1U

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

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100mV output.
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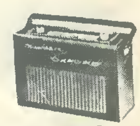
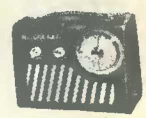
TRANSISTOR RADIOS



UXR-2

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



UXR-1

TRANSISTOR PORTABLE. Model UXR-1. Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7" × 4" loud-speaker. Real hide case.
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STEREO TRANSISTOR FM TUNER
(Mono version also available)
14 transistor, 5 diode circuit. Tuning range 88–108 Mcc/s. Designed to match the AA-22U Amplifier. Available in separate units, can be built for a total price.
TFM-IS Kit (Stereo) **£24.18.0** incl. P.T.
TFM-IM Kit (Mono) **£20.19.0** incl. P.T.
Cabinet extra £2.5.0.

FM Tuner

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Colour Television Explained. By W. A. Holm. **21s.** *Postage 1s.*

A Beginner's Guide to Television. A Newnes Pub. **8s. 6d.** *Postage 6d.*

Transistors for Technical Colleges. By L. Barnes. **25s.** *Postage 1s.*

101 Questions and Answers About Transistors. By L. G. Sands. **21s.** *Postage 1s.*

Transistor Pocket Book. By R. G. Hibberd. **25s.** *Postage 1s.*

Tape Recorder Servicing Manual. By H. W. Hellyer. **63s.** *Postage 2s.*

Inter: GEC Transistor Manual. 18s. *Postage 2s.*

Inter: S.C.R. Manual 4th ed. 25s. *Postage 2s.*

Questions and Answers Electronics. By C. Brown. **8s. 6d.** *Postage 6d.*

The Electronic Musical Instrument Manual. By A. Douglas. **37s. 6d.** *Postage 1s.*

Multi-Channel Radio Control A Map. Tech. Pub. **12s. 6d.** *Postage 9d.*

Transistor Electronic Organs for the Amateur. By A. Douglas and S. Astley. **18s.** *Postage 1s.*

TV Fault Finding 405 625 Lines. A Data Pub. **8s. 6d.** *Postage 6d.*

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6K7	U.10	MSP4	6G6G
Z21	Z22	KT41	

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SEALED RELAYS, 12v. 105Ω Coil Type A. 4 Pole, C.O. 15/-. Type B.2 Pole, C.O. + 2 Pole Norm. on, 12/6. P. & P. 1/6.

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SN7430	8 Input positive Nand Gate	21/6
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2N3822	'N' Channel 4-lead	15/-

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A1.	6—Silicon rectifiers BY100 type	20/-
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A3.	20—Mixed marked and tested trans.	20/-
A9.	1—2N 174 real power trans. 80V 150W	20/-
A15.	2—Power Comp. Pair. AD161/2	20/-
B1.	50—Unmarked untested, trans., new	10/-
B2.	4—Solar cells, inc. Book of Instructions	10/-
B3.	4—OA5 gold bonded, diodes Mullard	10/-
B5.	7—Matched set, OC44, 45/81D/81 + diode	10/-
B6.	15—Red spot AF. trans. or white spot RF	10/-
B8.	2—Power trans. OC26/35 type ...	10/-
B9.	1—Light sensitive cell, ORP12 type	9/-
B10.	10—50V trans. germ. PNP latest type	10/-
B44.	1—Tunnel diode, AEY11, 1050 Mc/s	10/-
B21.	2—Sil. recs. 10 amp., 50-100 PIV ...	10/-
B42.	5—Switching trans. TK22C STC ...	10/-
C2.	1—Uni junction, 2N2160 or 2N2646	15/-
C4.	2—RF power trans., OC22 and BUY11	15/-
C31.	4—Sil. recs. 800 PIV ¾ amp. top hat	15/-
C32.	2—Power trans. TK400A/NKT404 VCB64 IC 8 amp.	15/-
D18.	1—ORP60 type light sensitive cell	5/-

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10	Silicon 750 mA Top Hat	RECTIFIERS	10/-
40	NPN Silicon TO. 5. CAN	TRANSISTORS	10/-
5	3 amp. Silicon 50–800 PIV.	STUD RECS.	10/-

GENUINE TRANSISTORS NOT REMARKS

OC45	IF transistor	1/9
OC44	Osc. transistor	1/11
OA9	Equal to OA5	2/-
OC36	Power transistor (better than OC35)	7/6

TRANSISTORS	PRICE		
AC107	6/-	BSY25	10/-
AC126	2/6	BSY26	5/-
AC127	2/6	BSY27	5/-
AC128	3/-	BSY28	5/-
ACY17	5/-	BSY29	5/-
AF114	4/-	BSY95A	5/-
AF115	3/-	OC41	2/6
AF116	3/-	OC71	2/6
AF117	4/-	OC72	2/6
AF118	3/6	OC73	5/-
AF119	3/6	OC81	2/6
AF178	10/-	OC81D	2/6
ASY66	2/-	OC83	4/-
BCZ11...	7/6	OC139	2/6
BFY50	15/-	OC140	5/-

OC170...	2/6	2N1309	7/6
OC171...	4/-	2S303	2/6
OC200...	5/-	POWER TRANSISTORS	
OC201...	8/-	OC20	10/-
2G301	2/6	OC23	10/-
2G303	2/6	OC25	8/-
2N697	5/-	OC26	5/-
2N706	5/-	OC28	5/-
2N711	10/-	OC35	5/-
2N1302	4/-	DIODES	
2N1303	4/-	AAY42	2/-
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2N1307	6/-	OA81	1/9
2N1308	8/-	OA182	2/-
		IN914	1/6

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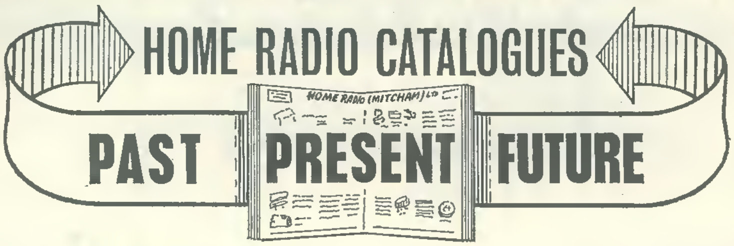

For the benefit of our customers who have catalogues dated earlier than February 1967 we set out below the new items that have been added.

Books

		Price
B135A	Fault Location Exercises in Radio and T.V. Servicing Vol. 2 ...	8/6
B31B	Radio Circuits by Miller/Spreadbury	25/–
B31C	"Reed Switches" F. R. Industrial Electronics	3/6
B78B	Radio and T.V. Servicing—Electronics Servicing. (Specimen Answers to Intermediate Papers 1961–64)	8/6

Capacitors. Metallized polyester 5% tolerance.

C77A	0.47μF	400V	31 x 15 mm	5/6
C77B	0.22μF	400V	26 x 12 mm	3/3
C77C	0.1μF	400V	19 x 11 mm	2/3
C77D	0.047μF	400V	16 x 10 mm	2/–
C77E	0.033μF	400V	16 x 8 mm	1/9
C77F	0.022μF	400V	14 x 7 mm	1/9
C77G	0.01μF	400V	14 x 5.5 mm	1/6

Capacitors. Increased range of Cyldon compression trimmers.

VC29LA	MT31A/3	3–40pF	1/–
VC29LB	MT31A/5	30–140pF	1/3
VC29LC	MT31A/12	7–60pF	1/5
VC29MA	MT25/1	2.5–40pF	1/6
VC29MB	MT25/2	3.5–70pF	1/6
VC29SA	TP10	400–1250pF	2/6
VC29SB	TP29	500–2000pF	2/10

Kits

KT206A	Printed Circuit Kit for photoelectric projects	39/6
KT206B	Optical parts for use with above kit	19/6

Rectifier

MR19A Contact-cooled rectifier 250V 100mA (bridge). 46 x 35 x 8 mm 15/–

Sockets. Metal sockets to take coil pins.

ZA38A	4-mm sockets	6d.
ZA38B	Standard ⅛in. sockets	6d.

Soldering Irons

ES25A	Weller "Marksman" soldering iron, 25 watt model SP25 ...	29/–
ES25B	Kit containing the above iron, solder, 2 spare bits and soldering aid	38/–
ES25C	Spare screw-in bits	3/–
ES25H	Spare element	11/–

Switches

WS152	Bulgin S319/D. SPST key switch with key removable in both positions	8/–
WS126	Bulgin SM357 SPCO "Push" switch	5/6

Tape. Synchrotape, Inexpensive British-made recording tape, complete with metallic stop-foils, coloured leaders and trailers (except for some 3in. sizes).

PAT33A	3in. 150ft.	4/9	PAT33J	5in. 900ft.	18/6
PAT33B	3in. 225ft.	6/3	PAT33K	5in. 1200ft.	28/6
PAT33C	3in. 300ft.	8/9	PAT33L	5¾in. 900ft.	18/6
PAT33D	3in. 450ft.	13/9	PAT33M	5¾in. 1200ft.	22/6
PAT33E	4in. 450ft.	12/–	PAT33N	5¾in. 1800ft.	36/–
PAT33F	4in. 600ft.	18/–	PAT33P	7in. 1200ft.	22/6
PAT33G	4in. 900ft.	27/6	PAT33Q	7in. 1800ft.	28/6
PAT33H	5in. 600ft.	15/–	PAT33R	7in. 2400ft.	48/–

Testgear

TG29	Signal tracer	26/3
TG30	Signal injector	26/3

Thermistor

VA1077 Mullard ... 2/6

Thyristors

SD33A	SCRO5	4 amp	400-volt PIV (240-volt RMS)	45/–
SD33B	SCRO6	10 amp	400-volt PIV (240-volt RMS)	70/–

Transformer. Midget for transistor power supplies.

TM25A Osmor MT9. 9–0–9 volts at 80mA. 30 x 40 x 30 mm 10/9

Transistor Mounting Kits.

TR47A Mullard 56239 insulating kit for AD161–AD162 etc. ... 8d.

Twist Drills. High-speed twist drills for BA sizes; tapping and clearing.

TL47A	No. 10	2 BA clear		2/2
TL47B	No. 24	4 BA clear	2 BA tap	1/6
TL47C	No. 31	6 BA clear	4 BA tap	1/3
TL47D	No. 42	8 BA clear	6 BA tap	1/–
TL47E	No. 50		8 BA tap	11d.

Volume Controls. Our moulded track range VR18B have proved to be so superior to the ordinary carbon track types we have now greatly extended this range.

VR18B	LOG. 5 K, 10 K, 25 K, 50 K, 100 K, 250 K, 500 K, 1 meg. 2 meg.	5/–
VR18C	LIN. 100 ohms, 500 ohms.	6/–
VR18D	LIN. 5 K, 10 K, 25 K, 50 K, 100 K, 250 K, 500 K, 1 meg.	5/–
VR18E	Ganged LOG. 1 K, 5 K, 10 K, 100 K, 500 K, 1 meg.	10/6
VR18F	Ganged/DP, LOG. 1 K, 5 K, 10 K, 100 K, 500 K, 1 meg.	13/–

Now what of the future? Set out below are new items, already in stock, that will be going into the next reprint of the catalogue. We would particularly like to draw your attention to the first item (large value 1% tolerance capacitors) which we believe are rare.

Cat. No.	*Capacity*	*D.C. Working Voltage*	*Tolerance*	*Price*
2FG 25	.001	100	1%	1/3
2FG 27	.005	100	1%	1/9
2FG 29	.01	100	1%	2/3
2FG 31	.05	100	1%	2/6
2FG 33	.1	100	1%	3/–
2FG 35	.5	100	1%	6/–
2FG 37	1.0	63	1%	11/6

Cat. No.	*Description*	*Price*
E966	Pyrex Glass strain insulators, ...	5/6
VC40 D	Dilemin 2 gang 192 + 78 + 15pF trimmers ⅞ x ⅜ x ½	12/6
DL 53 B	Spindle Lock for ¼in. spindle	1/6
PK 78	5 amp 3 pin non reverse flex connector	2/6
PL 36	Sub miniature filament lamp 6V. 70mA.	7/9

Reed Relays

Cat. No.	*Makers No.*	*Coil*	*Resistance*	*Switching*	*Contacts*	
WS153	CRI/A	18–30V	2.6K	S.P. normally open	200V .5A 10W	15/–
WS154	CRI/B	12–18V	560 ohms	" "	" " "	15/–
WS155	CRI/C	9–12V	400 ohms	" "	" " "	13/6
WS156	CRI/D	6–9 V	190 ohms	" "	" " "	12/6

Relays (Keyswitch)

Cat. No.	*Makers No.*	*Voltage*	*Switching*	*Price*
WS159	MH2	6	2PDT	12/9
WS160	1051	6	5PDT	12/–
WS161	MH4	6	4PDT	16/–
WS162	MH2	12	2PDT	12/9
WS163	1051	12	5PDT	12/–
WS164	MH4	12	4PDT	16/–
WS165	Mk2	24	2PDT	17/9
WS166	Mk3	24	3PDT	19/3

ES20N	240V Desoldering tool for printed circuit	84/–
WS133	Miniature toggle 25/64 x 5/16 x ½ SPDT	13/9
WS134	Miniature toggle 25/64 x 5/16 x ½ DPDT	27/3
WS174	Push Button switches Bank of 3 D.P. change over each button	11/–
WS175	Push Button switches Bank of 4 D.P. change over each button	13/6

TG39	V-T2 Meter Movement		50 microamps	2½ scale	75/–
TG40	V-T2	"	100 "	"	75/–
TG41	V-T2	"	500 "	"	75/–
TG42	V-T2	"	1 milliamp	"	60/–
TG43	V-T2	"	5 "	"	67/6

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Short Wave Converter

This simple unit operates both as a pre-amplifier from 1.6 to 5.3 Mc/s, and as a converter from 10.5 to 31.5 Mc/s. A neat circuit technique enables either function to be selected without complex switching. The output for the main receiver is at low impedance and is given by a cathode follower.

THE SIMPLER TYPES OF SHORT-WAVE RECEIVER—including many commercial broadcast sets—suffer from a variety of shortcomings. These include lack of sensitivity and selectivity on the lower ranges, and a proneness to image interference on the higher ranges. Tuning is often extremely critical and on the higher ranges almost impossible. The unit to be described has been designed to overcome these failings, and is both relatively simple to construct and low in cost.

The unit is in fact a dual purpose one. On the lower short waves (i.e. 1.6 Mc/s to 5.3 Mc/s) it functions as a pre-amplifier and gives a useful boost to signals received on these frequencies. On the higher range (10.5 to 31.5 Mc/s) it functions as a converter. Signals on this range are converted to 1.6 Mc/s, to which frequency the main receiver is then tuned. In this mode of operation the main receiver becomes an "i.f. strip" and the whole arrangement works as a double superhet with all the

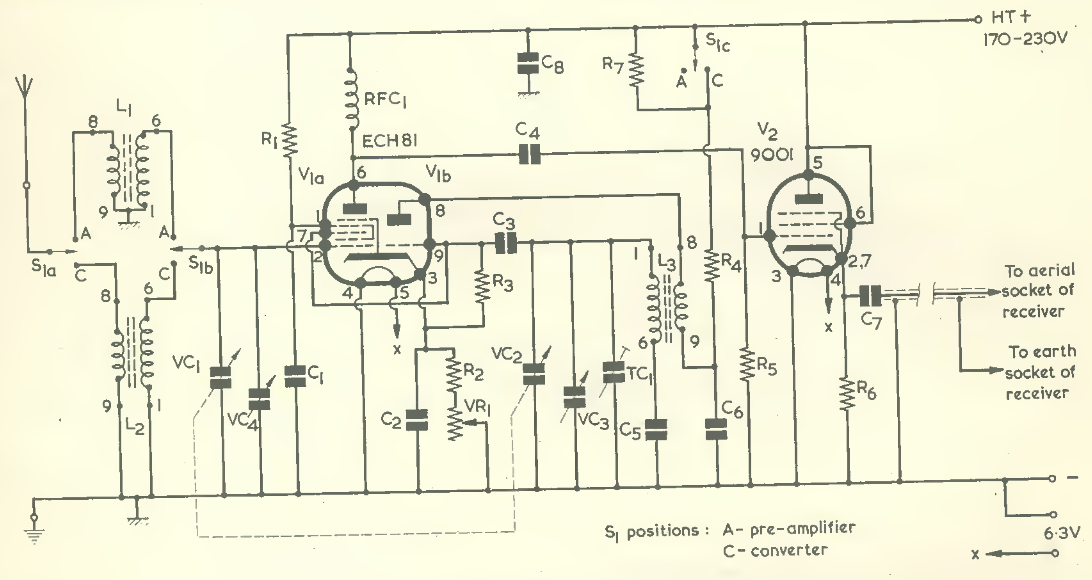

Fig. 1. The circuit of the Pre-Amplifier/Converter Unit. In some instances, this may obtain heater and h.t. power from the main receiver to which its output connects

Pre-amplifier Unit

by

G. A. Stanton G3SCV

advantages that this implies. On the higher band, tuning is entirely carried out on the converter, and as this includes band-spread facilities, becomes much more easy.

Circuit Operation

The circuit of the unit is given in Fig. 1. When functioning as a pre-amplifier, switch $S_{1(a)(b)(c)}$ is set to position A, whereupon signals are fed from the aerial to the grid of $V_{1(a)}$ via the coupling and tuned windings of coil L_1. This coil, in conjunction with VC_1 and VC_4, covers 1.6 to 5.3 Mc/s. V_1, it will be seen, is a triode heptode. On the range under consideration however, the heptode alone operates, the full h.t. supply being disconnected from the triode section by $S_{1(c)}$. The signals presented to the heptode grid are amplified and appear across the r.f. choke in its anode circuit. The signals could be taken direct from the anode to the main receiver, but this would present certain difficulties. For one thing the anode circuit is at a fairly high impedance, whereas most receivers will have a much lower input impedance at their aerial terminals. To connect directly from the one to the other will cause at least moderate, and probably severe, losses. Also, the output is best taken via a length of screened

COMPONENTS

Resistors
(All fixed values ½ watt 10%, unless otherwise stated)

R_1	15kΩ
R_2	150Ω
R_3	47kΩ
R_4	27kΩ
R_5	470kΩ
R_6	1kΩ
R_7	2.2MΩ 20%
VR_1	20kΩ potentiometer, linear

Capacitors

C_1	0.01μF ceramic, 250V wkg.
C_2	0.01μF ceramic
C_3	100pF silver-mica
C_4	220pF ceramic or silver-mica, 250V wkg.
C_5	2,000pF ceramic or polystyrene
C_6	0.01μF ceramic, 250V wkg.
C_7	1,000pF ceramic
C_8	0.01μF ceramic, 250V wkg.
$VC_{1,2}$	300 + 300pF (or 310 + 310pF) 2-gang air-spaced variable
VC_3	15pF air-spaced variable
VC_4	25pF air-spaced variable
TC_1	3-30pF trimmer, Mullard concentric

Inductors

L_1	Miniature Dual-Purpose Coil Range 3, Blue (Denco)
L_2	Miniature Dual-Purpose Coil Range 5, Blue (Denco)
L_3	Miniature Dual-Purpose Coil Range 5, White (Denco)
RFC_1	R.F. choke, 2.6mH, type RFC5 (Denco)

Valves

V_1	ECH81
V_2	9001 (see text)

Switch

$S_{1(a)(b)(c)}$ 3-pole 2-way rotary

Miscellaneous

2 epicyclic slow motion drives with flanges, Cat. No. 4511/F (Jackson Bros)
Spindle coupler
1 B7G valveholder
1 B9A valveholder
Knobs
Set No. 5 (Dials: control panels on clear background) or Set No. 6 (Dials: control panels on black background) Panel-Sign Transfers. (Data Publications, Ltd.)
Chassis materials, connecting wire, etc.

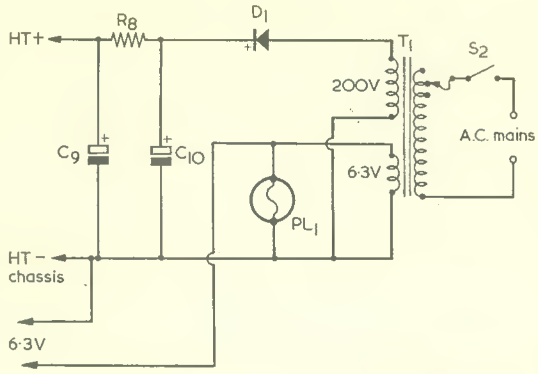

Fig. 2. If the unit is to be completely self-contained it may have its own power supply, as shown here

cable. If this were directly connected to the anode circuit of $V_{1(a)}$ the self-capacitance of the cable would add to the losses just mentioned. To overcome these difficulties the signal is fed from the anode of $V_{1(a)}$ to the grid of V_2, the latter functioning as a cathode follower. V_2 gives no voltage amplification. Instead, it serves as an impedance matching device and enables almost all the output of $V_{1(a)}$ to be fed to the main receiver.

When the unit is operated as a converter, signals are switched by $S_{1(a)}$ and $S_{1(b)}$ to the grid of $V_{1(a)}$ via L_2, this coil covering 10.5 to 31.5 Mc/s. At the same time the triode section of V_1 is brought into operation by $S_{1(c)}$. $V_{1(b)}$ functions as an oscillator, and the oscillations are mixed with the signal in the heptode section in the normal manner. The oscillator tuning is trimmed to produce an "i.f." of 1.6 Mc/s at the heptode anode. VC_2 (together with VC_1, to which it is ganged) provides the main bandset tuning. VC_3—a small variable capacitor in parallel with VC_2—enables the oscillator frequency to be varied slightly and provides bandspread. It will be noted that no switching appears in the oscillator tuned circuit itself. This not only greatly simplifies construction but also reduces losses and obviates r.f. switch wiring in a critical section of the unit.

The "i.f." signal appearing at the anode of $V_{1(a)}$ is passed to the grid of V_2 in the same manner as occurs when the unit is employed as a pre-amplifier. A low impedance output is then available at the cathode of V_2 for application to the main receiver.

When the unit is employed as a pre-amplifier for 1.6 to 5.3 Mc/s, signals are tuned in on the main receiver, being brought up to full strength by adjusting VC_1 in the unit. When the unit is used as a converter for 10.5 to 31.5 Mc/s, the main receiver is set to 1.6 Mc/s and remains tuned at that frequency. Tuning is then carried out by VC_1 and VC_2 in the unit, with VC_3 giving bandspread.

The screened cable coupling the unit to the receiver can conveniently be TV coaxial cable.

It will be noted that a 2.2MΩ resistor, R_7, is inserted in series with the h.t. supply to $V_{1(b)}$ when $S_{1(c)}$ is set to position A. This resistor prevents

COMPONENTS

Fig. 2 Power Supply

R_8 1kΩ 1 watt

Capacitors
$C_{9, 10}$ 16 + 16μF electrolytic, 300V wkg.

Transformer
T_1 Mains transformer. Secondaries, 200V at 20mA, 6.3V at 1A.

Rectifier
D_1 BY100

Switch
S_2 On-off toggle

Pilot Lamp
PL_1 6.3V 0.3A pilot lamp
Panel-mounting pilot lamp assembly

cathode poisoning in $V_{1(b)}$, which might otherwise occur if the unit were employed as a pre-amplifier for long periods of time. The value of R_7 is too high to allow $V_{1(b)}$ to oscillate when $S_{1(c)}$ is in position A.

VC_4, a small variable capacitor across the aerial tuned circuit, allows for different types of aerial and enables the input circuit to be correctly adjusted when the unit is used as a converter. VR_1, in the cathode circuit of V_1, controls the bias of the heptode section and acts as a gain control.

In the original, V_2 is a 9001 pentode connected as a triode (i.e. with the anode and screen-grid strapped). The only reason for using this particular valve was that it happened to be available in the spares box. A 6C4 will function just as effectively, as also will a triode connected EF91. The base connections shown in Fig. 1 are for a 9001.

Power Supply

Power requirements for the unit are very modest. For the h.t. supply a mere 15mA at 200 volts is ample, while a 6.3 volt 1 amp source will supply both valve heaters and a pilot light, with a fair margin to spare. Actual heater consumption for V_1 and V_2 is 0.45 amp when a 9001 or a 6C4 is used for V_2, and 0.6 amp when an EF91 is used for V_2. The prototype was self-contained and Fig. 2 gives the circuit of the power supply section. The mains transformer is a "converter" type.* The suggested rectifier is a BY100 silicon diode. The latter is capable of supplying current far in excess of that required here but, being available for a few shillings, it is an obvious choice. (*Continued on page 207*)

*A suitable transformer is available from G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2. This is listed as a "converter transformer" and has secondaries of 200 volts at 25mA, and 6.3 volts at 1 amp.—Editor.

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Short Wave Pre-amplifier Converter Unit

(*Continued from page 204*)

If the main receiver is an a.c. mains type incorporating an isolating mains transformer, it is quite likely capable of supplying the little extra power required for the unit, whereupon the components shown in Fig. 2 are not required. If this course is adopted it is suggested that a 2kΩ 1 watt resistor be included in the h.t. positive feed from the receiver. This will decouple the supply and will prevent the possibility of instability due to interaction between the unit and the receiver front end. *On no account should h.t. or heater supplies be obtained from a receiver whose chassis connects to one side of the mains.*

Construction

Construction is quite straightforward but the exact details will depend, of course, upon the components used. Standard types were used in the original and a chassis-plus-panel arrangement made for convenient assembly. The general layout is given in Figs. 3, 4 and 5.

The critical part of the circuit is that around V_1. Short direct connections are necessary here if best results are to be obtained, and most of the smaller components associated with this section should be mounted directly to the valveholder. In the interests of short leads, the valveholders should be oriented as shown in Fig. 4. (If a 6C4 is used for V_2, however, its valveholder should have pin 6 closest to V_1 valveholder). Especial care should be taken in wiring the oscillator section for, at the higher frequency end of the range covered, an extra half inch of wire or a "wobbly" component can make all the difference between success and failure. In order to keep the oscillator leads short the bandspread capacitor (VC_3) is mounted directly under the oscillator section of the main tuning capacitor (VC_2). In the layout VC_3 is shown as a chassis mounting type. Panel mounting types are cheaper to buy and one of these could be substituted, in which case it must be mounted on a small substantial metal bracket in the same position. A spindle coupler and a length of ¼in spindle couple VC_3 to its slow motion drive.

Outside dimensions for the prototype chassis and panel are given in Figs. 4 and 5, but these are intended merely as a guide. Constructors should first obtain the components they intend to use and then make up a chassis which can accommodate them comfortably. Chassis depth should be such as to give adequate clearance for the aerial and oscillator coils and VC_3. Solder connections to these coils should, incidentally, be made quickly, as excessive heat may cause the plastic mounting to distort. The coils are fitted to ¼in holes in the chassis and secured with the plastic nuts provided. Holes are also drilled for the connecting wires to the fixed vanes of VC_1, VC_2 and VC_4, the holes being positioned so that these wires follow the shortest possible route. Further holes will be required for other leads passing through the chassis, and all holes should be

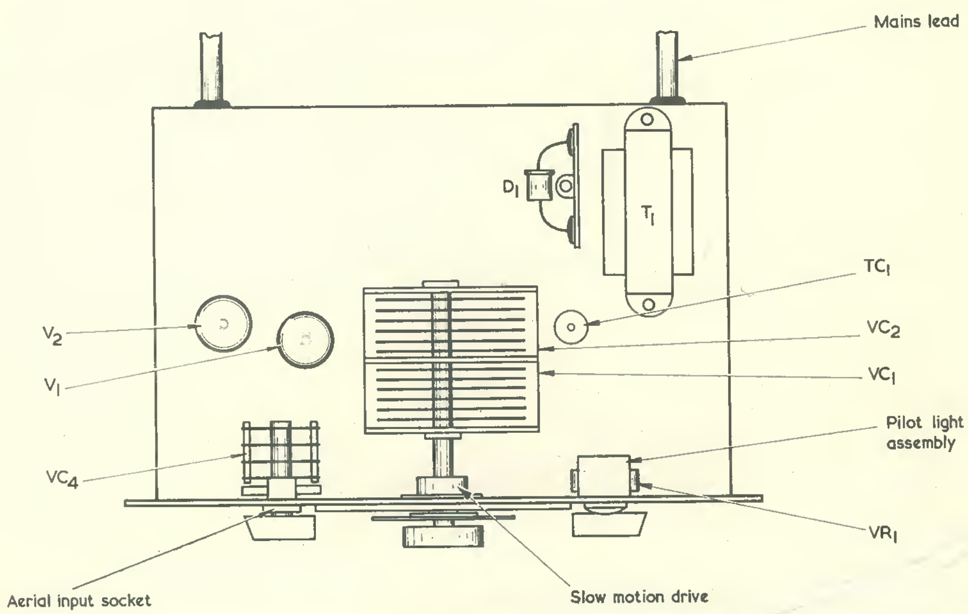


Fig. 3. Top view of the prototype unit, showing the positions taken up by the main components. TC_1 is soldered directly to the adjacent fixed vane tag of VC_2

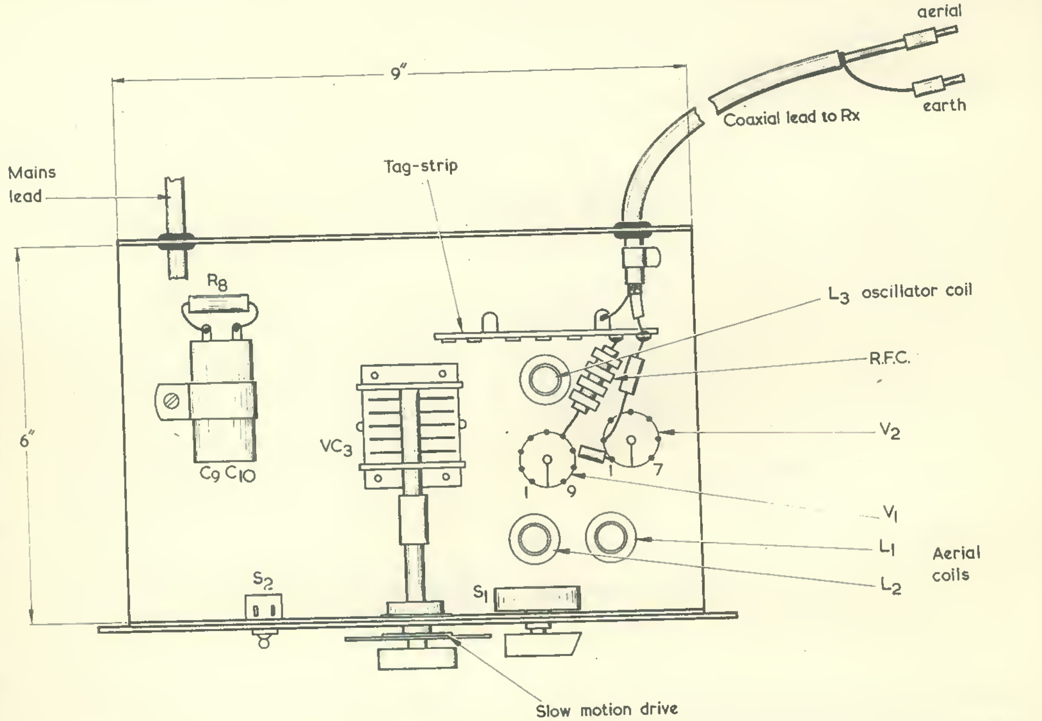


Fig. 4. Under-chassis view of the prototype, indicating the basic layout. Chassis dimensions are intended as a guide only

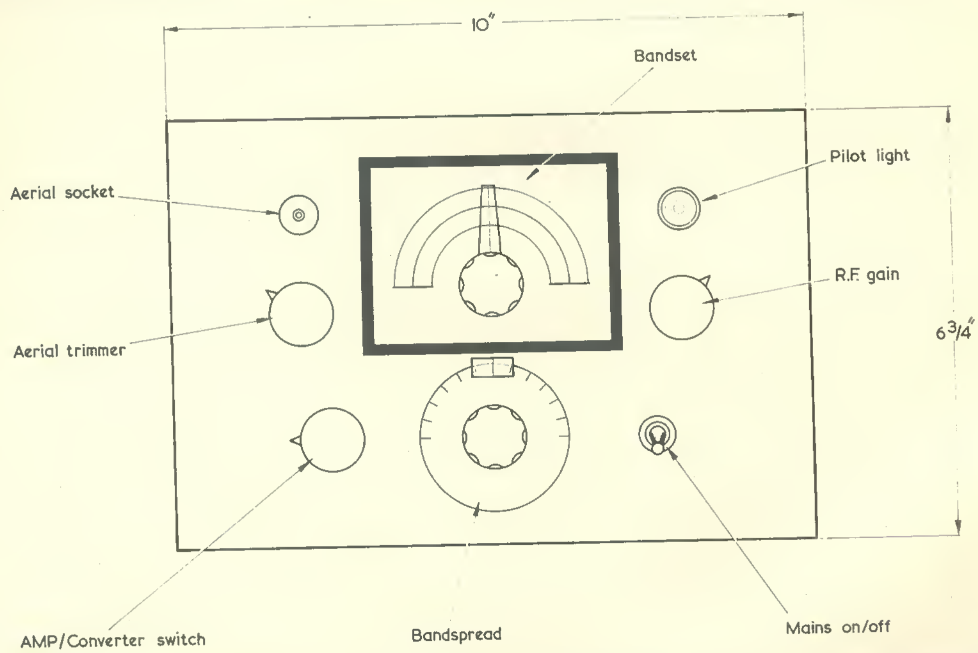


Fig. 5. The front panel layout of the unit. Panel material is aluminium sheet. The bandset cursor may be made from a small piece of Perspex, this being fixed to the flange of the slow motion drive

fitted with grommets. The moving vane connections to the variable capacitors may be taken via the chassis, one or more solder tags under the securing nuts for V_1 and V_2 valveholders providing the chassis connection for the coils.

Fig. 5 shows the panel layout, giving the positions of the various controls. Both the bandset and bandspread controls utilise flange-type epicyclic slow motion drives. A medium size dial taken from the Data "Panel-Signs" range is used for the bandset control. A small circular ivorine dial, or similar, mounted directly on the lower drive flange is used for the bandspread control.

Alignment and Calibration

Alignment and calibration of the unit is most easily carried out with the aid of a signal generator, standard practice being followed. The unit and its parent receiver are connected as for normal use, with the latter tuned to a point at or near 1.6 Mc/s. In practice the exact frequency is unimportant but should be carefully noted for future reference, for this is in effect the "first i.f.". The unit is switched to the converter position with the bandspread control and the aerial trimmer at their mid-points, and the r.f. gain control at maximum. With the bandset control at maximum capacitance a modulated signal of 10.5 Mc/s is injected into the aerial input of the unit and the core of L_3 is adjusted until the signal is heard. The core of L_2 is then adjusted for maximum response. With the bandset at minimum capacitance a signal of 31.5 Mc/s is injected and TC_1 is adjusted until this also, is heard. If two positions of the trimmer produce the signal, that with the lowest capacitance is the correct one. The aerial trimmer, VC_1, is next adjusted for maximum signal. The whole process is then repeated in order to take up any small final adjustments that may be necessary. The cores and TC_1 should then be fixed with a spot of wax and the converter range can be calibrated.

If a signal generator is not available alignment will be more tricky and will require rather more patience, for broadcast signals will have to be used. One of the difficulties in aligning without instruments is knowing where to expect the various bands to appear on the dial. As a rough guide the following were logged on the prototype using the "Panel-Signs" dial.

25 metre broadcast band — 80
19 metre broadcast band — 55
16 metre broadcast band — 40
13 metre broadcast band — 20

If the bandset dial is set at 80 the core of L_3 should be carefully adjusted until a broadcast signal in the 25 metre band is heard. This is then brought to maximum by adjusting the core of L_2. With the bandset dial at 20, TC_1 should be adjusted until a signal is heard in the 13 metre band. This is then brought to maximum by adjusting the aerial trimmer. This procedure will bring the circuits roughly into line and the dial can then be calibrated against known signals.

Alignment of the unit as a pre-amplifier is a simple matter with or without a signal generator. All that is necessary is the correct positioning of the core of L_1. The main receiver is set at 1.6 Mc/s and, with the bandset control at maximum capacitances, the core of L_1 is adjusted for maximum "noise". Signals on this range are tuned on the main receiver and "peaked" by the unit tuning control.

When used as a pre-amplifier it may be found that, with certain types of aerial, oscillation occurs. All that is necessary to prevent this is to adjust the r.f. gain until the oscillations cease. At this point the unit will be functioning in its most sensitive state. On many signals the r.f. gain will have to be reduced below this point to prevent overloading of the main receiver.

New Components for Colour TV

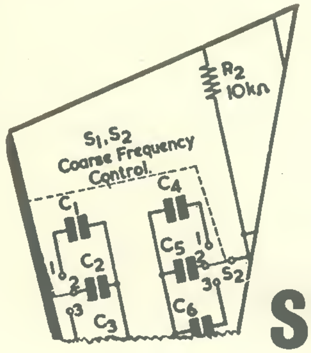
Plessey Voltage Multiplier for High Tension Supply

An alternative to the use of two valves in a colour television receiver is provided by a Voltage Multiplier Assembly developed by the Wound Components Division at the Titchfield, Hampshire, factory of the Plessey Components Group. Additionally, the assembly enables the line output transformer to be rendered far more simple and reliable.

By eliminating two rectifier valves an important source of unreliability is removed. This is of particular interest to rental companies whose financial success depends entirely upon keeping down maintenance costs.

The Voltage Multiplier has been designed around selenium rectifiers which, it is considered, provides the most economic method of extra high tension generation, and will do so for some time to come.

The more expensive silicon rectifiers, however, will be incorporated in an alternative version of the Voltage Multiplier which will shortly be available.



Simple Product Computer

SUGGESTED CIRCUIT No. 204

by G. A. FRENCH

In last month's "Suggested Circuit" article the author described a computer which, with the aid of a few electronic components, was capable of calculating the total resistance of two resistors in parallel or the total capacitance of two capacitors in series. Simple computers of this nature form interesting and instructive constructional projects and, provided that only a few components are required and that assembly can be carried out in a short time, are capable of offering quite useful facilities when they are completed.

The product computer described this month employs only a small number of standard components, and is capable of solving the equations $x \times y = z$, $x = \frac{z}{y}$ or $y = \frac{z}{x}$. A particularly useful feature is that it can be used to find square roots. The basic principles employed have been described in an earlier issue of this journal* but the previous article did not provide specific details for a suitable d.c. null indicating device, as are given here. The null indicating circuit described in the present article may prove to be of assistance also to readers carrying out general work on d.c. operated measuring bridges.

The Computer

The product computer employs the basic circuitry illustrated in Fig. 1, in which we see three linear track potentiometers, R_1, R_2, and R_3, a centre-zero current reading meter and a d.c. supply. It will be noted that R_1 and R_3 connect directly across the d.c. supply lines whilst the track of R_2 connects between the slider of R_1 and the lower supply line.

Let us now assume that R_2 has a high value compared with R_1, with the result that the current it draws through the upper section of R_1 is negligible compared with the current flowing through R_1 itself. Let us assume also that the d.c. supply offers E volts.

If the resistance between the slider of R_1 and the lower supply line is x times the total resistance of R_1, then the voltage appearing between R_1 slider and the lower supply line becomes xE volts. This voltage is applied to the track of R_2. If, in its turn, the resistance between the slider of R_2 and the lower supply line is y times the total resistance of R_2, then the voltage between R_2 slider and the lower supply line is y times the voltage given by R_1. In other words, the voltage at R_2 slider is y.xE. At the same time, if the resistance between the slider of R_3 and the lower supply line is z times the total resistance of R_3, then the voltage between the slider of R_3 and the lower supply line is zE volts.

When the potentiometers are adjusted such that the centre-zero meter suffers no deflection, the voltage at the slider of R_2 relative to the lower supply line is equal to the voltage at the slider of R_3. Under these conditions, $y.xE = zE$, which simplifies to $y.x = z$, or $xy = z$. If the three potentiometers were fitted with scales calibrated in terms of x, y and z, we could then find from the scale of R_3 the product of x and y on the scales of R_1 and R_2.

A numerical example may help to illustrate this relationship. Let us assume that each potentiometer has a scale calibrated in fractions from 0 to 1, with 0 corresponding to the lower end of the track. If we adjust R_1 so that its slider is $\frac{1}{3}$ of the way up its track then the voltage at the slider (relative to the lower supply line) is $\frac{1}{3}$E, and the R_1 scale will indicate $\frac{1}{3}$. If we similarly adjust R_2 so that its slider is $\frac{1}{3}$ of the way up its track, the voltage on R_2 slider is $\frac{1}{3}$ of that applied to R_2. This is $\frac{1}{3} \times \frac{1}{3}$ of E, or $\frac{1}{9}$ E. We next adjust R_3 so that the meter indicates zero, whereupon the slider of R_3 must offer a voltage of $\frac{1}{9}$E, corresponding to the slider of R_3 being $\frac{1}{9}$ of the way up its track. The scales fitted to the potentiometers will then indicate that $\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$, which is of course correct.

Practical Scales

To introduce the operation of the computer we have employed the terms x, y and z, these representing fractions of the total resistance of each potentiometer. It is, however, difficult to read scales calibrated in fractions and a practical version of the circuit requires potentiometer scales which are calibrated in terms of numbers above unity. A very useful set of scales is shown in Fig. 2, this diagram also including the centre-zero null indicating meter and an on-off switch in series with the d.c. supply. R_1 and R_2 are calibrated from 0 to 10, the calibration being equal to 10 times x or y, as applicable. The scale for R_3 is calibrated from 0 to 100, the calibration being equal to 100 times z (or 10x multiplied by 10y, which equals 100xy). The three potentiometers have linear tracks and are connected into the basic

*"In Your Workshop", *The Radio Constructor*, March 1963.

circuit of Fig. 1. Also, the zero point on each potentiometer scale corresponds to the slider being at the end of the track which connects to the lower supply line.

Several further examples will illustrate how the scales of Fig. 2 may be used. Let us set R_1 to 5, and R_2 to 7, then adjust R_3 so that the meter reads zero. R_3 will indicate 35. This is, of course, obvious from our previous discussion, because R_1 is giving five-tenths of E, and so on.

If we have an Ohms Law problem, in which we want to find the resistance when, say, a potential of 6 volts causes 3 amps to flow, we may use the $x = \frac{z}{y}$ relationship offered by the computer, substituting for $R = \frac{E}{I}$. We set R_3 to 6 and R_2 to 3, after which we adjust R_1 for zero indication in the meter. R_1 will indicate 2, which tells us that the resistance is 2Ω.

To find square roots we set R_3 to the square and adjust R_1 and R_2 in step for zero deflection in the meter. If, for instance, we set R_3 to 81, then the meter will indicate zero when both R_1 and R_2 are adjusted to 9.

We have used whole numbers in these numerical examples for simplicity of illustration but, with careful calibration, it will be possible to obtain readings which include fractions of whole numbers as well. With good calibration we should be able to find, for instance, that the square root of 72 is 8.5 to two significant figures.

To obtain increased utility from the computer it is desirable to add a second scale to each potentiometer, as in Fig. 3. In these second scales, R_3 is calibrated from 0 to 10 and R_1 and R_2 from 0 to 3.16, which is the square root of 10. (Details of carrying out the calibration are given later in this article). This second set of scales will be particularly useful for square root calculations. The first set of scales may be used where the squares are 10 to 100, 1,000 to 10,000 and so on, whilst the second set of scales is used for squares from 1 to 10, and 100 to 1,000, etc. The second set of scales also "expands" the R_3 scale over the 0—10 range for normal multiplication.

Working Circuit

To convert the basic circuit of Fig. 1 into a usable form, it is necessary to add a few extra components. A full practical circuit is illustrated in Fig. 4, and it may be noted that the added components all appear around the null indicating meter. Their function is to maintain the sensitivity of the meter as the null is approached whilst ensuring that excessive current does not pass through the meter when the sliders of R_2 and R_3 are a long way from the balance positions. Inspection of the circuit will show that it is possible to set up the potentiometers so that the full supply voltage appears between the sliders of R_2 and R_3.

The normal approach to a problem of this nature is to connect two diodes across the meter in the manner shown in Fig. 5. If these were silicon diodes they would conduct when the forward voltage applied to them was of the order of 0.6 volts, and the series resistor shown in the diagram would be given a value which ensured that the meter read full-scale deflection under this condition. The limiting resistor shown in Fig. 5 ensures that excessive current does not flow through the diodes when the applied voltage across the two end terminals increases further.

The writer initially checked results with two silicon diodes, using a centre-zero 1—0—1mA meter having a coil resistance of 100Ω, and a limiting resistor of 200Ω. He found in practice that the meter series resistance had to be well in excess of 1kΩ if excessive current was not to pass through the meter. Making the assumption that the meter reads voltage changes only as the sliders of R_2 and R_3 in Fig. 4 approach the null point, this meant that the meter would be worse than 10 times less sensitive than it need be for settings of R_2 and R_3 near the null. Germanium diodes, which pass forward current at a lower voltage than silicon diodes, were next tried, and these enabled the series resistance to be significantly reduced. But by far the best results were given with two germanium transistors type ACY19 connected as shown in Fig. 4 with the base-emitter and base-collector junctions of each transistor in parallel. These enabled the series resistance to be reduced to 300Ω in the author's experimental circuit, and had the advantage of becoming

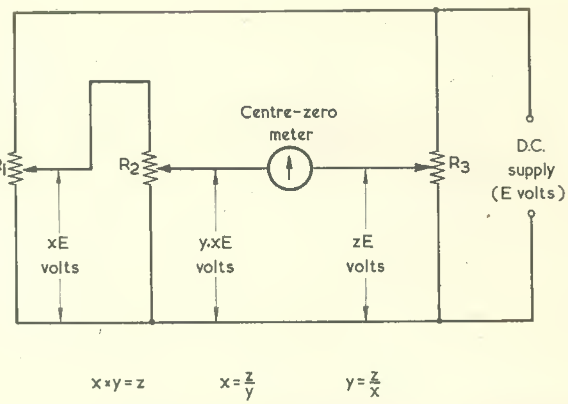


Fig. 1. The basic circuit of the product computer. The three potentiometers have linear tracks

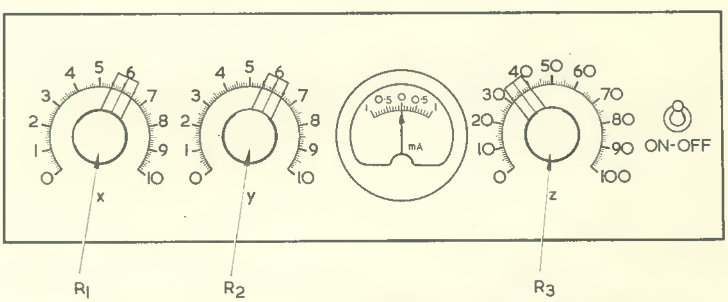


Fig. 2. How scales may be fitted to the three potentiometers to enable them to be used in a practical computer. The panel layout shown here is suitable for the working circuit of Fig. 4

conductive much more abruptly as forward voltage increased than did the germanium diodes. The two transistors were, in consequence, employed in the prototype circuit. The 200Ω limiting resistor, R_5, limits the current in the transistors to 45mA and the power to 18mW, both these figures being well within the ratings for the types used. It is very probable that other transistors in the ACY17 to ACY22 (inclusive) range will offer similar results in the present application, but these were not checked by the writer.

In Fig. 4 the series meter resistance is given by the preset variable resistor R_4. After construction of the computer, this resistor is set to insert full resistance into circuit, after which R_1 and R_2 sliders are set to the top ends of their tracks and R_3 to the bottom end. R_4 is then adjusted to give full-scale deflection in the meter. R_2 slider is then set to the bottom end of its track and R_3 slider to the top end. If the meter reading is now in excess of f.s.d. R_4 is readjusted to bring it to f.s.d. The writer found that, with the transistors employed by himself, the setting for R_4 was about the same for either transistor in the conducting state. If desired, R_4 can be replaced by a fixed resistor of the same value after this setting-up procedure.

The three potentiometers in Fig. 4 are given values which reflect a compromise between resolution of readings and battery current consumption. At normal potentiometer settings battery consumption will be of the order of 22mA. If desired, increased resolution would be given if the three potentiometers were reduced to about half of the values shown in Fig. 3, this being at the cost of a doubled battery current consumption. The three potentiometers should, preferably, be large wirewound types. When the potentiometers are set close to the positions which cause maximum current to flow via the limiting resistor R_5, the current drawn by the meter circuit will approach 45mA. This factor also argues the desirability of using wirewound potentiometers. In practice, care should be taken to ensure that the potentiometers are not left in the positions which cause this high current to flow for very long periods as, apart from battery drain, overheating of the end sections of the potentiometer tracks could result.

Again with economy in mind, it was decided to employ a 1—0—1mA centre-zero meter for the unit, and the protection circuit given by the two transistors is intended for a meter of this sensitivity only.

The battery may be any 9-volt type capable of providing the required current. Since the circuit functions in the manner of a bridge, accuracy is maintained despite reductions in voltage as the battery ages.

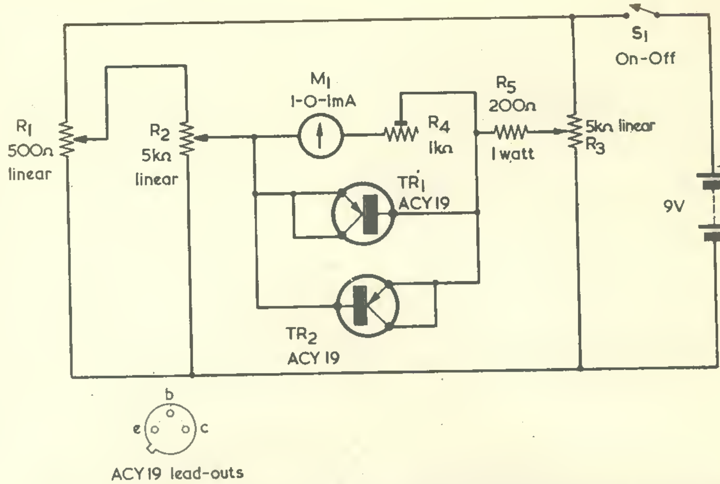


Fig. 4. A practical product computer circuit. R_1, R_2 and R_3 are the similarly numbered potentiometers of Fig. 1, and the circuit functions in the same basic manner

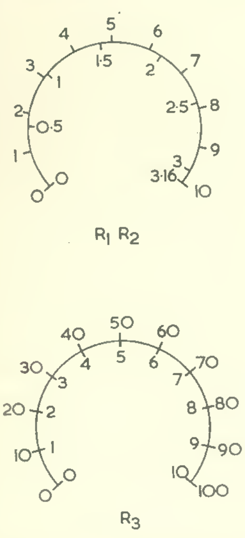


Fig. 3. For increased utility, a 0 to 3.16 range is added to the scales of R_1 and R_2, and a 0 to 10 range to the scale of R_3. For simplicity, inter-number graduations are not shown here, although they should appear in the actual scales made up

Calibration

After construction has been completed and R_4 set to its final resistance, calibration may be carried out. The first potentiometer to be calibrated is R_3. Since some potentiometers have small sections at the ends of the track which offer zero resistance over a small angle of rotation, it is first of all necessary to find the angular settings of the slider which correspond to the start of the track proper. Switch on S_1, connect a

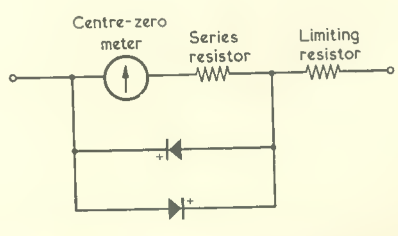


Fig. 5. The usual approach to giving a centre-zero meter a high sensitivity when low voltages are applied to the terminal points, whilst preventing excess meter current when high voltages are applied

voltmeter between the slider of R_3 and the lower supply line and, with its aid, mark off the points where the actual track commences. Calibrate these as 0 (lower end of track) and 100 (upper end of track) respectively. The voltmeter is now no longer required, and the intervening points for the R_3 scale may all be calibrated as a linear scale.

Next, set the slider of R_1 to the top of its track and, using the null indicator, calibrate R_2 from the corresponding calibration points for R_3 (i.e. 90 corresponds to 9, 80 to 8, and so on). Then, set R_2 slider to the top of its track and similarly calibrate R_1 from 0 to 10, also working from the R_3 calibration. It will be recalled that an initial assumption was made that R_2 draws negligible current through R_1. In fact, of course, R_2 draws a significant current, and this point is taken up in the manner in which R_1 (which has a slightly non-linear scale) is calibrated.

Next, add the 0–10 scale to R_3 and the 0–3.16 scales to R_1 and R_2. The latter two scales may be made up by following Fig. 6, which shows the figures of each scale alongside each other.

The computer is then ready for use.

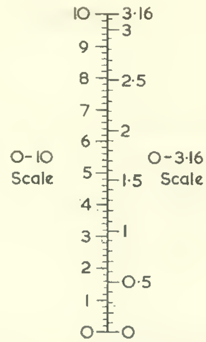


Fig. 6. As stated in the text, R_1 and R_2 require a 0–3.16 scale in addition to a 0–10 scale. After the 0–10 scale has been calibrated, the 0–3.16 scale may be added by following this diagram, which shows the corresponding figures of the two scales alongside each other.

SWINGEING PRICE REDUCTIONS IN INTEGRATED CIRCUITS

For the second time in nine months, S.T.C. Semiconductors Limited has made substantial cuts in its UK prices of diode-transistor logic (DLT) integrated circuits.

Some sixty flatpack and dual-in-line devices have been reduced: all are ceramic-packaged units in the company's internationally known MIC 930 series.

The cuts, described by a company official as "swingeing" have been particularly dramatic in the case of dual-in-line circuits, many of which have been reduced by over 50%.

For example, the price of the industrial MIC 946 Quad 2-input gate, which was 37s. each for 100-up quantities, is now 15s. 9d. each: equivalent to a gate function of less than 4s.

These considerable reductions in price have been made possible by continuous improvement in manufacturing techniques and the rapid expansion of manufacturing volume. The additional reductions on the dual-in-line circuits following the recent commencement of quantity production at the company's Footscray, Sidcup, Kent, plant.

The manufacturing unit has the advantage of being equipped with the latest production equipment available, including automated test equipment for both production and quality assurance testing.

Commenting on the reductions, Mr. P. A. L. Harris, Marketing Manager of S.T.C. Semiconductors said "In the majority of applications, where higher speeds of operation are not required, our DTL provides technical advantages for the user, including absence of current-spiking problems, availability of the direct wired-OR function, plus a fully proven hermetic package at a cost only marginally above that of plastic encapsulated circuits."

"Despite the claims now being made for TTL integrated circuits, it remains a fact that the 930 DTL series is in use in far greater numbers throughout the world, is available from more suppliers and above all is cheaper than any TTL family."

New Approach to D.I.Y.

'MIDIEX '68' AT BIRMINGHAM NEXT MAY

A new twist to "do-it-yourself" exhibitions is announced by Gordon Saville Exhibitions (1967) Ltd. Believing that there is an increasing public interest in leisure and sporting pastimes, Mr. Gordon Saville is to stage a "make-it and do-it" exhibition at Bingley Hall, Birmingham.

"Despite the television age which makes vast numbers of the public stick to the TV sets like limpets", claims Mr. Saville, "there is a definite trend towards spare time occupations that develop the creative instincts in a person. There is a great thirst for knowledge on all manner of hobbies amongst all ages."

Mr. Saville adds, "More and more people are carrying out their own home repairs, making everything from furniture to boats, collecting all manner of items from stamps to national costumed dolls, assembling kits ranging from model railways to single seater aircraft, and a host of other pastimes which test both the mental and physical capabilities of the individual".

The exhibition, "MIDIEX '68", will take place from the 8th – 18th May, 1968. A plan drawing giving the stand areas and rents is available on request from Gordon Saville Exhibitions (1967) Ltd., 21 Victoria Road, Surbiton, Surrey (Tel: 01-399 3232) or from Sales Publicity Management (Midlands) Ltd., Northampton House, Poplar Road, Solihull, Warwickshire (Tel: 021-705 8302).

NEWS . . . AND .

That Term 'Ham' Again

We were very intrigued to see a letter in a recent issue of the R.S.G.B. *Bulletin* pointing out, once again, the undesirability of using the term "ham" with reference to those participating in amateur radio.

This term has always been one of this magazine's pet aversions, and in any reference to amateur radio we have always taken care to avoid its use.

There seems to be some doubt as to how the word originated and why it became particularly associated with amateur radio. The phrase "ham actor" seems fairly well authenticated, and was a derogatory term for an actor who was not particularly outstanding in his profession. We are not aware that it was ever used to identify a person who engaged in amateur dramatics or acting "just for the fun of the thing". However, whatever its origin, it conveys a sense of derogation to the man in the street.

Every group these days is concerned with keeping its "image" in the public eye as favourable as possible, and this is particularly important for amateur radio as its facilities are much coveted by commercial interests.

We would like to see "ham" dropped entirely where amateur radio is concerned.

Ultra Sensitive TV Camera

In his "Industrial Newsletter" in the BBC World Service programme "Science and Industry", Denis Desoutter reported on a television camera that is extremely sensitive to ordinary wavelengths of light. In fact it is sensitive to light so dim that it would be difficult or impossible for a human eye to notice. The heart of the device is a new camera tube, developed by the English Electric Valve Company and called the Isocon.

The Isocon, said Desoutter, could be used to take cine film or still pictures in the dark, and after amplification give a high quality television picture of either 625 lines or 1,025 lines. He anticipated that it would have many industrial and military uses but one special application would be in astronomy, where the light of distant stars is very faint. In the past huge telescopes like the 200in one at Mount Palomar had to be built to collect enough of this dim light to make a good picture. The Isocon camera is about 100 times more sensitive which means that it can do the same job as an ordinary 200in telescope with only a 24in aperture.

Out For the Count

When reading comments by sports writers it sometimes seems almost unnecessary to play off the event as, according to the journalists, it is only bad luck, or injury, or something of that nature which can prevent the favoured one from winning, defeat from such a cause being unfair and not proving the winner to be the better man. It all seems pointless and one wonders whether the relevant information could be fed into a computer, which could then work out the winner with all chance and bad luck being eliminated.

We have recently learned, with some surprise, that something like the foregoing has actually happened in the States.

Someone had the idea of finding out who was the greatest boxer ever. Boxing experts fed information such as punching power, stamina, intelligence, etc. into a computer in respect of several boxers past and present. "Fixtures" were arranged, the first being between Jack Dempsey and "Gentleman Jim" Corbett.

The computer produced a round by round commentary and Jack Dempsey was computed to have won by a knock-out in the seventh round.

Perhaps a computer will one day work out which came first, the chicken or the egg, and why it really did cross the road!

Free Sample Offer — New Instrument Cleaner

This new instrument cleaner consists of two blocks which are soft, rather like plasticine to the touch, and which do not injure the skin or corrode metal.

"Rodico" is not intended to usurp the use of normal cleaners, but is especially provided to remove dirt and contamination from specific surface areas such as those found in watches, precision instruments, etc.

Send to Southern Watch & Clock Supplies Ltd., 48–56 High Street, Orpington, Kent, mentioning this magazine, for a free sample.

This is "Rodico", a revolution in the cleaning of specific areas on small parts. A touch with "Rodico" removes the loose dirt; if the dirt is fixed then rub until removed — miniature tools too, may be cleaned with "Rodico" before they are used.

Electronics for Everyone

Do-it-yourself kits which enable anyone, regardless of their technical knowledge, to assemble radio/electronic apparatus for use in the home, have been announced by Electroniques, STC's retail distribution organisation.

An agreement has been concluded between STC and Allied Radio Corporation, America's largest retail electronic distributor, whereby Electroniques (proprietors STC Ltd.) will exclusively manufacture and market, in the UK and Europe, the complete range of Knight-Kit construction kits for electronic apparatus.

Knight-Kits are designed to provide everyone of average intelligence with hours of enjoyment which is both instructional and materially beneficial. They enable anyone to assemble useful radio tuners and hi-fi amplifiers, which have a professional finish, will work first-time, and have a high performance.

All the preparational chores normally associated with this work have been eliminated: all parts are ready for assembly and are accompanied by very clear and easy-to-follow instructions.

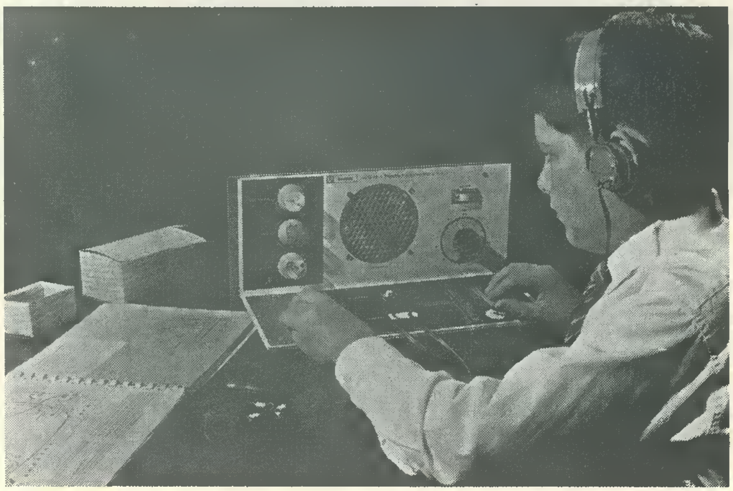
The areas of interest covered by Knight-Kits are quite wide. In addition to stereo radios and amplifiers, the range includes car engine testers—believed to be the first of their kind available in the UK—electronic test equipment, a photographic exposure meter and electronic instructional apparatus for children.

All these kits will be manufactured at Harlow, but initially, kits are being imported and are available completely adapted to British power supplies and standards.

A full technical advisory service, staffed by STC engineers, trained by Knight-Kit, has been set-up at Harlow to provide full technical support.

Announcing the new move, Mr. Jack Evans, Manager of STC Electronic Services Division, the parent organisation of Electroniques, said—"The availability of Knight-Kits in the UK and Europe is further proof of Electroniques policy in providing a comprehensive service in electronics to the Public."

Measuring engine speed with the Knight KG-375A Auto Analyser. The KG-375A is one of the many "Knight-Kit" construction kits now being marketed exclusively in the UK and Europe by Electroniques (prop STC Ltd.). "Knight-Kits" are easy to assemble kits which enable anyone regardless of their technical knowledge to assemble professional standard apparatus. Believed to be the only instrument of its kind available in kit form in the UK, the KG-375A checks engine speed, contact dwell-angle, charge rate, and the operation of generator automatic voltage control systems



Using the Knight "100 in 1" Electronic Laboratory, one of the many instructional devices which can be easily assembled from the "Knight-Kit" range of construction kits now being marketed in the UK and Europe exclusively by Electroniques (prop STC Ltd.). Capable of being assembled by anyone, regardless of their technical knowledge, the "100 in 1" Electronic Laboratory enables children in the 8 to 16 age group to carry out over 100 interesting and instructive experiments in radio and electronics

Automatic Radio Control Keying Unit

M. W. SHORES N.Z.I.S.T.

Intended for the more experienced radio control enthusiast, this article describes a transmitter attachment which provides automatic control of two escapements.

THE SIMPLE SYSTEM TO BE DESCRIBED IS DESIGNED for use with an already established single channel transmitter-receiver combination. This radio link may either be tone modulated, or straight carrier wave. The important requirement is that the receiver switches a relay in its final stage; the relay in turn controlling a separate rubber driven escapement circuit.

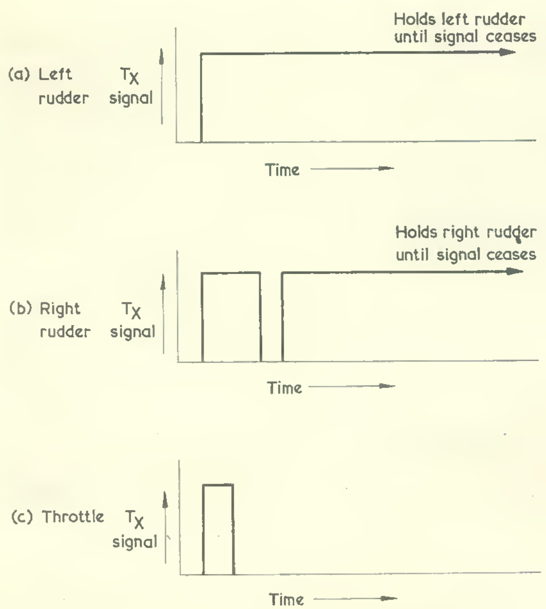


Fig. 1. The transmitted control signals employed in the author's system

Escapements are of two basic types, known as "simple" and "compound" respectively, and they find use mainly in model aircraft to move the control flying surfaces, or actuate an engine throttle control. In the writer's model a Japanese O.S. K1 compound escapement is used for rudder control, with a simple two-pawl escapement linked to it electrically to provide throttle control on "quick blip" (a very short transmitted pulse).* This latter function is made possible through a circuit which includes the "back contact" of the relay. A full description of escapements may be found in model control literature.

Keying Sequences

The transmitter keying sequences required for the respective control positions are shown in Fig. 1. Escapement wiring and connections to the receiver relay appear in Fig. 2. Usually the transmitted signals represented in Fig. 1 are keyed manually, using a micro-switch or similar, but this presupposes a certain amount of concentration on the part of the controller which is often better applied to the behaviour of the model itself. The truth in this statement becomes obvious when we consider that the average radio control model aircraft covers a distance of perhaps 50ft. each second.

The keying unit of Fig. 3 is able to "think" for the controller, and provides selective left/right rudder plus engine control at will in the shortest possible time; and all from single channel! In the absence of a signal, the K1 escapement automatically returns to neutral rudder.

In Fig. 3, a P.O. self-centring key switch with two sets of changeover contacts each side is used for rudder operation. For left rudder the key is pushed to the left and held there. The normally open contacts of $S_{1(a)}$ close, completing the transmitter output circuit via the keying leads. A continuous signal is transmitted, and left rudder holds on until the key is released, breaking the transmitter circuits.

*The O.S. K1 compound escapement is available from E. Keil & Co. Ltd., Russell Gardens, Wick Lane, Wickford, Essex. E. Keil & Co. are the sole agents in the U.K. for O.S. products.—Editor.

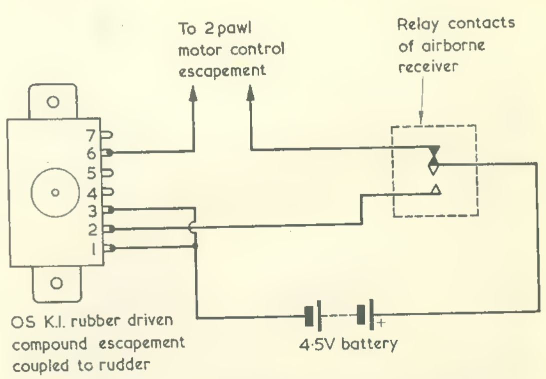


Fig. 2. The escapement wiring in the airborne equipment

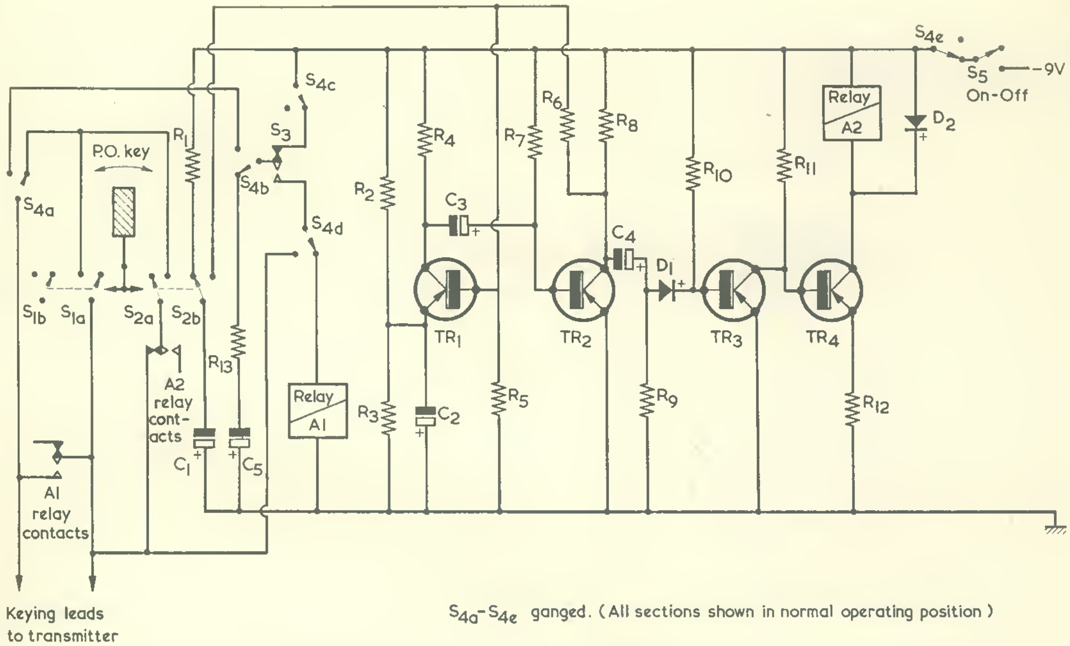


Fig. 3. Full circuit of the automatic keying unit

COMPONENTS

Resistors
(All resistors ¼ watt 10% unless otherwise stated)

- R_1 50Ω 1 watt
- R_2 1kΩ
- R_3 330Ω
- R_4 10kΩ
- R_5 20kΩ
- R_6 180kΩ
- R_7 220kΩ
- R_8 10kΩ
- R_9 33kΩ
- R_{10} 47kΩ
- R_{11} 2.2kΩ
- R_{12} 100Ω
- R_{13} 68Ω ½ watt

Capacitors
(All capacitors electrolytic)

- C_1 30μF, 12V wkg.
- C_2 100μF, 6V wkg.
- C_3 5μF, 12V wkg.
- C_4 8μF, 12V wkg.
- C_5 100μF, 12V wkg.

Semiconductors

- TR_1 OC71
- TR_2 OC71
- TR_3 OC71
- TR_4 OC72 (with heat sink)
- D_1 OA81 or similar
- D_2 OA81 or similar

Switches

- S_1, S_2 P.O. self-centring key switch; 2 sets changeover contacts each side
- S_3 Microswitch, s.p.d.t.
- S_4 5-pole, 2-way, miniature wafer switch (optional)
- S_5 s.p.s.t., toggle

Relays

A1, A2 Relays with single set of changeover contacts; or make contacts (A1) and break contacts (A2). Coil resistance 100Ω or greater

Batteries

Two 4.5V batteries type 1289 (Ever Ready)

If the key is pushed to the right and held, $S_{2(a)}$ and $S_{2(b)}$ change over their contacts. Now, before this change, C_1 was fully charged to −9V through R_1; this resistor merely limits the charging current to a safe value. Because of the change-over of $S_{2(b)}$, the charged capacitor is immediately connected to the base of TR_1 where it discharges rapidly, delivering a sharp negative pulse. TR_1 and TR_2 form a monostable multivibrator where, in the stable state, TR_1 is off and TR_2 conducting.

The negative spike from C_1 now turns TR_1 on and TR_2 off. This switching action is regenerative and very sharp. A negative square-edged voltage results at the collector of TR_2 which is differentiated by C_4 and R_9 to a sharp negative-going pulse at the anode of D_1. The polarity of this diode is such that it will not conduct this pulse, and any vestige that did get through would only try to switch TR_3 on harder, for this transistor is already conducting. This condition exists because R_{10} provides a path for base current to TR_3. Since TR_3 is on, TR_4 is biased off by the potential developed across R_{11}, which very nearly equals the supply voltage.

Meanwhile, $S_{2(a)}$ has also been changed over by the key switch, and the transmitter circuit is completed through its contacts and the normally closed contacts of relay A2. The transmitter therefore radiates a signal until this circuit is broken.

The monostable is now in its unstable state, and will remain so until C_3 has discharged through R_7 and the bottomed transistor, TR_1. C_3 begins to discharge immediately after the unstable state has been reached. After a finite time (approximately 0.7 times the time constant of C_3 and R_7) the stable state is resumed, whereupon TR_1 cuts off, and TR_2 conducts and bottoms. The consequent *positive* voltage step occurring at the collector of TR_2 is differentiated, and this time D_1 conducts. The resultant positive spike is passed to the base of TR_3 which is driven beyond cutoff, producing a square topped negative pulse at its collector. The width of this pulse is proportional to the time constant of C_4 and R_9. TR_4 amplifies the pulse current and briefly energises relay A2, whose contacts interrupt the circuit to the final of the transmitter. Having quickly passed through the left rudder position, the escapement will now have reached right rudder and will remain there until the P.O. key is allowed to return to neutral. At this neutral position C_1 is reconnected to the negative rail and rapidly recharged, ready for the next command. By altering the values of C_3 and C_4, the time delay and duration of signal interruption are easily adjusted.

The values shown in Fig. 3 are those found to be satisfactory in the original unit. Diode D_2 protects TR_4 from the high back e.m.f. in the relay coil when this transistor ceases to conduct. The relays used in the prototype were fairly small 100Ω types salvaged from defunct weather balloon transmitters, but any small relays of the same or greater d.c. resistance should suffice.

Quick Blip

Now we come to quick blip. This is given very simply by the charging of C_5 through R_{13}, and its subsequent discharge through R_{13} and relay A1 when S_3 is pressed; no originality is claimed. The normally open contacts of relay A1 are wired across the keying leads and briefly complete the transmitter circuit until the charge in C_5 is exhausted.

S_3 requires a little explanation. In the writer's original a microswitch was used for reliability, but ordinary push button or key types may be preferred. A toggle switch is not suitable, as one has to remember to switch back to the 'charge' position each time. Also, hand keying with a toggle switch becomes almost impossible when S_4 is switched to the fail-safe position. Relay A1 will always pull in for the same length of time, regardless of how long S_3 is pressed.

Fail-Safe

A fail-safe circuit is incorporated in the original, but is not absolutely necessary. It is provided by S_4, which cancels all the circuitry and returns all keying functions to manual, using S_3 only.

The unit as described has been fully flight tested and has been in use for over a year. S_4 has only ever been used during ground tests, in order to conserve battery power. Two flat 4.5V torch batteries have proved a most satisfactory and lasting power source, these being wired in series.

The prototype is housed in an aluminium case measuring 8 x 5 x 2½in, which is held quite comfortably at waist level, connected via twin flex to a ground based transmitter. The quiescent current from the 9V supply is in the order of 12mA rising to 50mA when either relay pulls in, which is for comparatively short periods.

It might appear possible to use the rudder circuitry for control of a model equipped with the most simple system, where a two-pawl escapement is connected directly to the rudder proper. In such a case, however, there are two neutral rudder positions, unlike the single neutral of a compound escapement. This means that a pulse of interference moves the escapement from one neutral to the other. A left rudder signal then gives right rudder, and vice versa. The resultant confusion could quickly write off many hours of painstaking work. The present system is therefore recommended only for use with the types of escapement referred to at the beginning of this article.

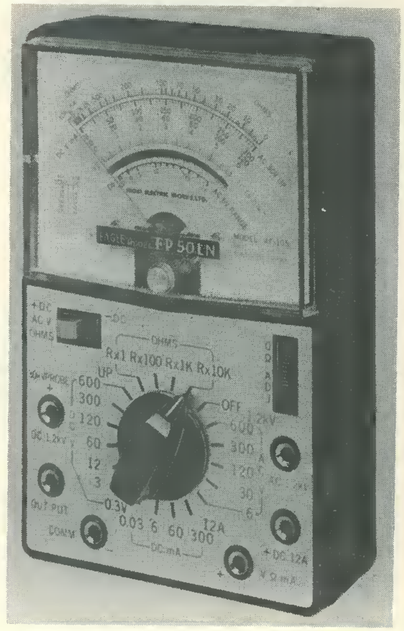
Finally, it can be stated that the construction of the original proved very worthwhile and that the resultant saving in mental strain has been considerable.

Micro-Power Amplifier

Quite a few readers have reported good results with the Micro-Power Amplifier described in our last September issue. Some who have used the modification shown in Fig. 4 of the article concerned have found the control of gain to be somewhat cramped at the low resistance end of the potentiometer travel. A smoother control of gain is given if the potentiometer is reduced in value, a suitable alternative value being 50kΩ.

TRADE NEWS

Eagle Products' New Multimeter



Special features designed to achieve greater accuracy are incorporated in the new Multimeter EP.50LN illustrated here—the most advanced model in the new range of Eagle Products' precision test instruments.

The features include 50,000Ω/V d.c. for greater accuracy on high resistance circuits and a specially mirrored and expanded two-colour scale eliminating parallax in reading. Additionally the facility of an "Off" position locks the movement thus protecting against shock and possible damage whilst in transit, etc.

The EP.50LN incorporates an overload protection circuit, a special 0 to 3V d.c. range for transistor circuit tests and a polarity reversing switch.

Front panel markings are in two colours for simplified operation, and the new Multimeter is supplied complete with fitted leather case, test leads, batteries and instruction manual.

Specification is as follows: Volts d.c. 0 to 0.3; 0 to 3; 0 to 12; 0 to 60; 0 to 120; 0 to 300, 0 to 600 and 0 to 1,200V. Volts a.c. 0 to 6; 0 to 30; 0 to 120; 0 to 300; 0 to 600 and 0 to 1,200V. Current d.c. 0 to 30μA, 0 to 6mA; 0 to 300mA and 0 to 12A. Resistance 0 to 10kΩ; 0 to 1MΩ, 0 to 10MΩ and 0 to 100MΩ. Decibels −20 to +17dB (0dB 1 milliwatt in 600Ω). Output—capacitor in series with a.c. voltage ranges. Size $6\frac{1}{2}$ x $4\frac{1}{4}$ x $\frac{4}{5}$in. Retail price (approx.) £11.11.0d.

Knight-Kit Star Roamer Receiver

The Knight "Star Roamer" communications receiver, one of the many useful devices which can be easily constructed from the range of "Knight-Kits" now being marketed in the UK and Europe by Electroniques (prop STC Ltd.). Capable of being assembled in an evening by anyone, regardless of their technical knowledge, the "Star Roamer" is an ideal "starter" receiver for short-wave listening. It covers the frequency range 300 kc/s 30 Mc/s in 5 bands.

STC Logic Modules

STC's low-cost logic modules, the Series 40, now includes a Schmitt Trigger module (Type 43E) which facilitates system operation from transducers.

The Series 40 are discrete-component germanium modules of a robust fully encapsulated construction which enable solid state logic systems to be devised at a cost comparable to relay logic.

The Type 43E converts transducer analogue outputs into a two-state form. Its basic upper and lower trigger levels are 0.4V and 0.35V respectively, and can be increased by an external resistive divider.

Input signals can be from photo-electric, magnetic, ultrasonic, capacitive and semiconductor transducers.

Its fan-out capability is three; the outputs are suitable for driving a Series 40 system.

The new module is expected to have wide application in logic systems involving the measurement or control of temperature, quantity, flow, and speed of materials, liquids and gases throughout industry and science.

Electronic Oscilloscope Switch

by L. J. Aston

Using readily available transistors and components, this electronic switch enables an oscilloscope to display two traces at the same time. The unit may be built in a small case or, even, fitted inside the oscilloscope case.

QUITE A NUMBER OF ELECTRONIC "trace doublers" have been described in various technical magazines. These have been very useful in their way, but all have employed valves. The oscilloscope switch presented here employs eight inexpensive transistors together with standard miniature parts, these giving an instrument which is small and light and which requires only 6 volts at some 3 to 5mA for power.

Circuit Description

Consider TR_1 and TR_2 in the circuit, which appears in Fig. 1. These two transistors conduct alternately at a rate determined by the frequency control switch $S_{1(b)}$. First TR_1 conducts, the signal applied to its base being amplified and fed to the oscilloscope input, whilst TR_2 is cut off. Then, after a period, selected by $S_{1(b)}$, TR_2 conducts and TR_1 is cut off. It is the signal fed to TR_2 base which is then applied to the oscilloscope. The switching speed is too fast to be seen and the result is that two traces are displayed on the screen.

TR_7 and TR_8 form a multivibrator which generates the switching frequency. $S_{1(b)}$ changes the timing capacitor, giving switch frequencies of about 1, 2.5, 4 and 15 kc/s. It is found that TR_7 and TR_8 give a reasonably 50:50 output at all the frequencies selected by $S_{1(b)}$. The

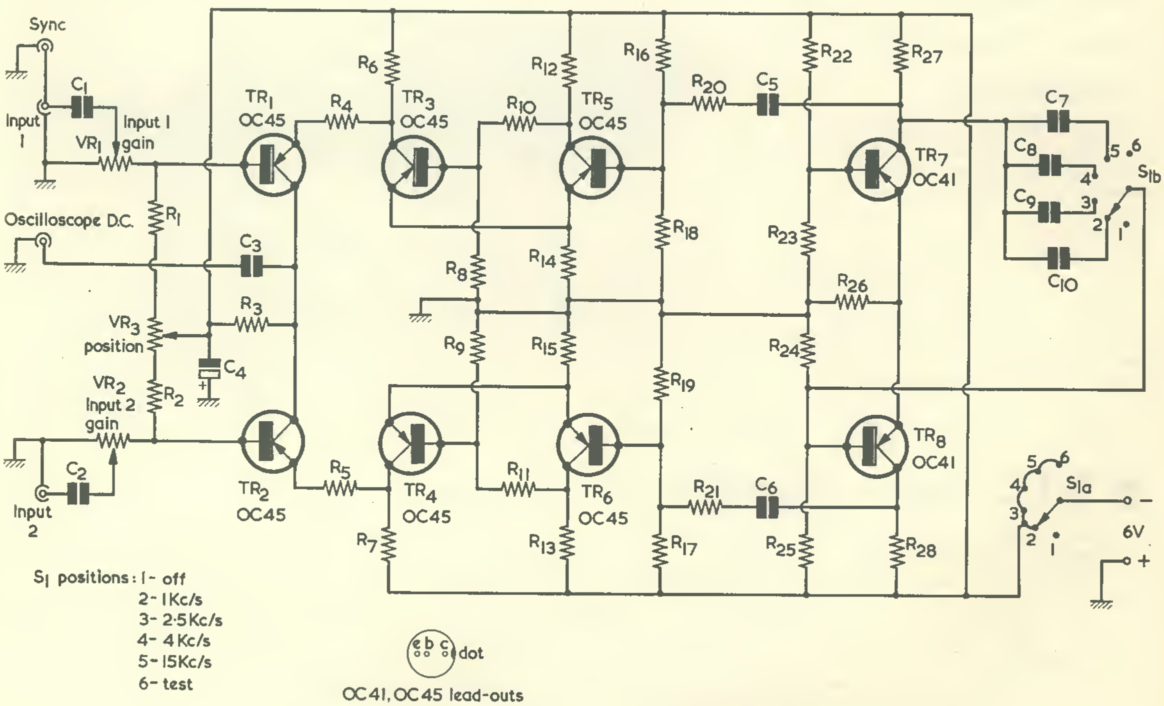


Fig. 1. The circuit diagram of the electronic oscilloscope switch

COMPONENTS

Resistors
(All fixed valued ¼ watt 5%)

R_1	10kΩ
R_2	10kΩ
R_3	3.3kΩ
R_4	3.3kΩ
R_5	3.3kΩ
R_6	10kΩ
R_7	10kΩ
R_8	3.3kΩ
R_9	3.3kΩ
R_{10}	10kΩ
R_{11}	10kΩ
R_{12}	3.3kΩ
R_{13}	3.3kΩ
R_{14}	470Ω
R_{15}	470Ω
R_{16}	100kΩ
R_{17}	100kΩ
R_{18}	10kΩ
R_{19}	10kΩ
R_{20}	1kΩ
R_{21}	1kΩ
R_{22}	5.6kΩ
R_{23}	4.7kΩ
R_{24}	560kΩ
R_{25}	470kΩ
R_{26}	10kΩ
R_{27}	10kΩ
R_{28}	10kΩ
VR_1	10kΩ potentiometer, carbon, linear
VR_2	10kΩ potentiometer, carbon, linear
VR_3	25kΩ potentiometer, carbon, linear

Capacitors

C_1	0.1μF
C_2	0.1μF
C_3	0.1μF
C_4	10μF electrolytic, 9V wkg.
C_5	0.1μF
C_6	0.1μF
C_7	200pF silver-mica or ceramic
C_8	400pF silvei-mica or ceramic
C_9	680pF silver-mica or ceramic
C_{10}	800 pF silver-mica ceramic

Transistors

TR_1	OC45
TR_2	OC45
TR_3	OC45
TR_4	OC45
TR_5	OC45
TR_6	OC45
TR_7	OC41
TR_8	OC41

Switch

S_1 2-pole 6-way rotary switch

Miscellaneous

6-volt battery
4 coaxial sockets
4 knobs
Connecting wire, case, panel, etc.

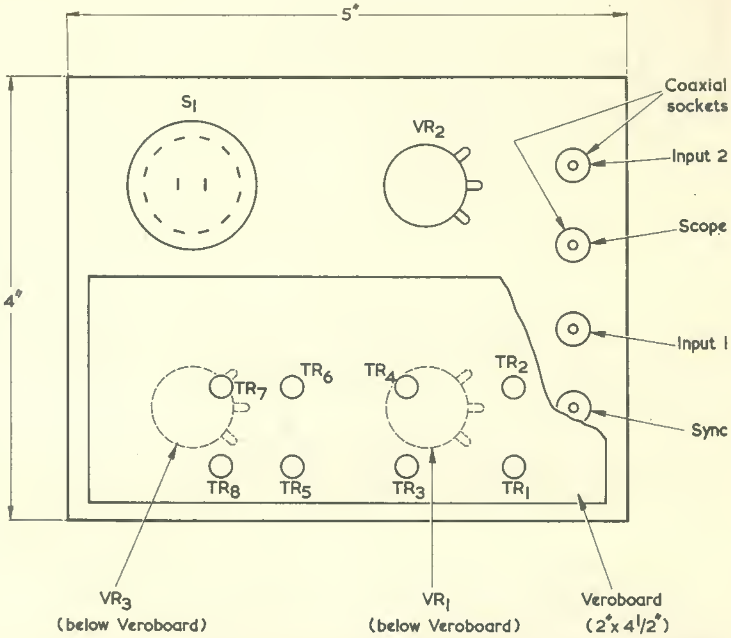


Fig. 2. The layout is not critical, and that used for the prototype is shown here to provide an idea of what is required. All components are mounted on a 4 x 5in panel which fits to a box having a depth of 2¼in. There is room behind VR_2 for a small 6 volt battery

output pulse at TR_7 collector is 180° out of phase with that at TR_8 collector. During one half-cycle TR_5 base receives a positive pulse from TR_7 and TR_6 base receives a negative pulse from TR_8. In the next half-cycle the pulse polarities reverse.

TR_4, TR_5, and TR_3, TR_6 are squaring circuits which convert the multivibrator pulses to fast-rising square waves to drive the emitters of TR_1 and TR_2. A positive pulse fed to the base of TR_5 produces a positive square wave at TR_3 collector which drives TR_1 into conduction; at the same time a negative pulse fed to the base of TR_6 produces a negative square wave at TR_4 collector, driving TR_2 into cut-off. Any signals fed into the base circuits of TR_1 and TR_2 are thereby passed on to the oscilloscope on alternate half-cycles, and appear as two separate waveforms.

The test position on $S_{1(b)}$ disables the multivibrator by removing the timing capacitor and only one trace is displayed. This is an amplified version of whatever is being fed into the input sockets, and its existence proves that the battery supply for the switch is usable. The writer employs a battery of five 225mA/H DEAC cells which lasts a long time between charges, but it is still useful to know that all is well before settling down to test, for example, the frequency response of an amplifier.

It will be noted that $S_{1(a)}$, which is ganged with $S_{1(b)}$, functions as the on-off switch.

The position control moves the two traces relative to one another. When the slider of this control is at one end of the track, one trace is displayed at the top of the screen with the other below it. Turning the control causes the two traces to approach each other until they become superimposed, after which they separate again with the trace previously at the top being below. The inputs to the two channels are controlled by the two 10kΩ gain potentiometers. The input impedances are relatively low, but this fact has given no difficulties with the writer's activities which have consisted of testing radios and amplifiers. If a high impedance source is used, it may be connected via a suitable pad to avoid loading it excessively, but this has not been found necessary in the writer's case.

The prototype unit was assembled in a box measuring 5 x 4 x 2½in, which is about the minimum useful size for easy operation. The circuit

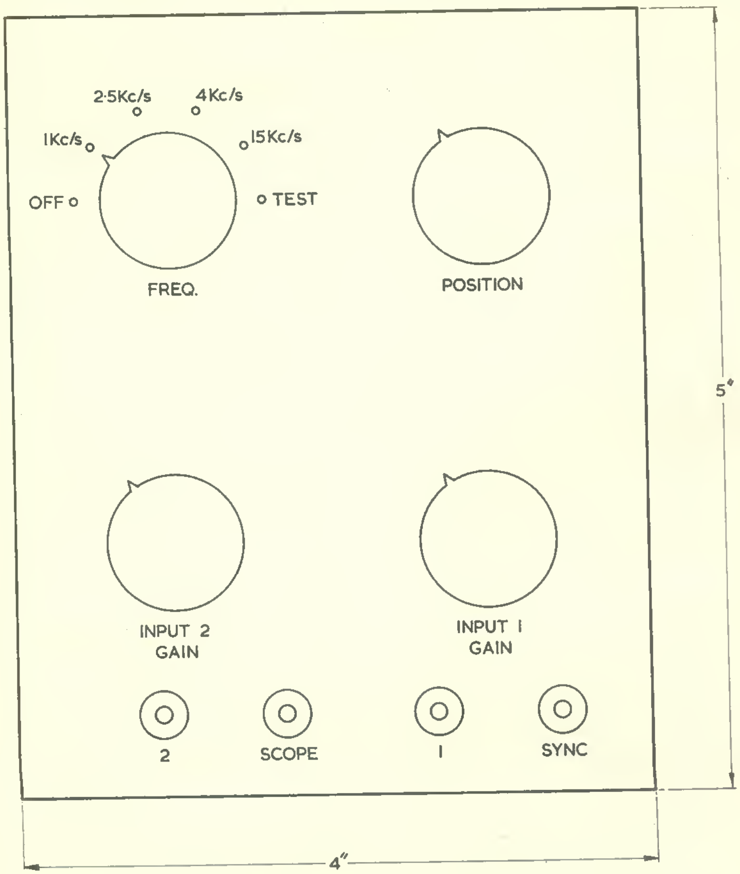


Fig. 3. Front view of the panel

was made up on Veroboard with flying leads to the potentiometers, switches and sockets, these being mounted on a front panel to which the Veroboard was secured with spacing pillars. The general layout is given in Fig. 2. Component positioning is not critical, however, and constructors building the unit may employ any reasonable layout they wish. Miniature coaxial sockets should be used for the inputs, the sync socket and the output socket. There is no reason why the whole unit could not be built inside an oscilloscope, providing there is sufficient space on the front panel to accommodate the extra controls and sockets.

Setting Up

Insert a milliammeter in series with one of the battery leads, switch on and check that the current is between 3 and 5mA. If all is well, remove the milliammeter and connect a lead from the "Oscilloscope" socket to the d.c. input of the oscilloscope. With the internal sync of the oscilloscope on, a square wave will appear on the screen. Next, connect a lead from the "Sync" socket of the unit to the oscilloscope external sync, and switch the latter to external sync. Connect an audio frequency generator to the "Input 1" socket and adjust Input 1 gain to display a sine wave. Run another lead from the generator to the "Input 2" socket and set the Input 2 gain control to give a sine wave on the other trace. Adjusting the position potentiometer will move the traces as previously described.

Next, adjust the position control until the two traces are superimposed. Perfect meshing of the waveforms indicates that the phase shifts in the switch amplifiers are identical. This condition, it may be added, is easily obtained without matching transistors although, if a transistor tester should be available, it is worthwhile matching TR_3 to TR_4 and TR_5 to TR_6.

Useful sync should be given even when the Input 1 gain control is close to, or at, zero level.

The best switching frequency depends on the ranges in the oscilloscope being used and the frequencies being examined. It is, of course, a simple matter to adjust S_1 whilst a particular waveform is being checked to find the best frequency.

Practical Uses

Having become familiar with the controls, let us test a valve or transistor a.f. amplifier. Connect an audio frequency generator to the "Input 1" socket of the switch unit, and to the input of the amplifier. Connect the output of the amplifier to the "Input 2" socket of the unit. With the unit coupled to the oscilloscope as already described, adjust the gain controls for equal amplitude on both traces. The signals can now be compared for distortion, and the result of any alterations made to the amplifier under test can be directly observed on the screen. Varying the frequency of the audio generator will indicate the high and low frequency cut-off points in the amplifier.

In company with all other electronic oscilloscope switches, this unit cannot give results equal to those obtainable with a double beam oscilloscope. Nevertheless, it will be possible in many cases to build it from the "spares box", and it is a very useful accessory.

Anglia Prepares for Colour

Anglia Television's preparations for the start of their colour television service in 1970 has begun with an order for seven of EMI's highly successful Type 2001 colour camera channels. Vertical aperture correctors and encoders are also being supplied by EMI Electronics.

The latest contract, part of an extensive colour television expansion programme, brings the total value of orders received by EMI Electronics from Anglia to £190,000. Earlier contracts have covered sound and vision switching for a new Master Control, a vision mixer and remotely-controlled cameras for Presentation, a telecine chain and an eight-channel studio sound control desk.

Scintillation Detectors and Photomultiplier Tubes

by M. J. Darby

Electronics covers a wide range, a not unimportant section of which is devoted to radiation detection. This short article offers a simple description of the operation of scintillation radiation detectors, these being devices which have important advantages when compared with Geiger-Müller tubes.

A scintillation detector or scintillation counter is one of the most important types of apparatus used for the detection of nuclear radiation.

History

In the early years of this century a great deal of fundamental work on radioactivity and atomic structure was carried out by Rutherford and others using a very simple form of scintillation detector. Alpha particles from a radioactive source were allowed to strike a screen coated with phosphorescent zinc sulphide so that the energy of each alpha particle was converted into a minute flash of light (or scintillation). These flashes of light were counted visually in a dark room. Anyone who has attempted to count scintillations will appreciate how tedious and time consuming this experimental work is. It is necessary for a person to wait about ten minutes in a dark room for his eyes to become fully adapted to the dark before he can even see the scintillations. It was mainly for these reasons that interest in scintillation detectors declined when gas filled detectors (especially Geiger-Müller tubes) became available and were used with electronic counting equipment.

However, interest in scintillation detectors greatly increased when S. C. Curran and W. Baker used a phosphorescent material (or phosphor) in combination with a photomultiplier tube for the automatic counting of the scintillations (about 1944). The method was developed by H. Kallmann of Germany in 1947. Only alpha particles can be counted visually, because the flashes of light emitted when beta particles or gamma photons strike a phosphor are too weak to be detected by the eye. However, any type of nuclear radiation can be detected by the use of a suitable phosphor with a photomultiplier tube.

Photomultiplier tubes

All conventional types of photomultiplier tube consist of a photocathode deposited on one end of the tube and a system of electrodes known as "dynodes". Two common types of tube are shown in Fig. 1.

When a very small amount of light strikes the specially prepared photocathode surface, electrons are emitted from the latter and are attracted to the first dynode by the applied potential. The dynode surfaces are also specially prepared so that each electron which strikes the surface will cause an average of about four electrons to be emitted ("secondary emission") . These secondary electrons are attracted to the next dynode and further multiplication takes place at this dynode surface. A typical photomultiplier tube contains about 10 to 12 dynodes and provides an overall amplification of perhaps one million. This amplification by secondary emission is, however, very dependent on the overall potential applied to the tube.

The photomultiplier tubes are constructed so that each electron emitted by any one dynode must strike the next dynode. This may be effected by the venetian blind or the box and grid structures shown in Fig. 1, but other types of photomultiplier tube employing focussing devices are also available. Special types of electron multipliers have recently recently been manufactured [1,2,3], but so far as is known these have not yet been used for scintillation counting.

Photomultiplier tubes must always be used in a light-proof enclosure. They have a sensitivity which may exceed 10,000 amps per lumen and the photocathode will be damaged if any appreciable amount of light falls on it whilst potentials are applied to the tube. The tubes should be used only to detect light of extremely low intensity.

(*Continued on page 230*)

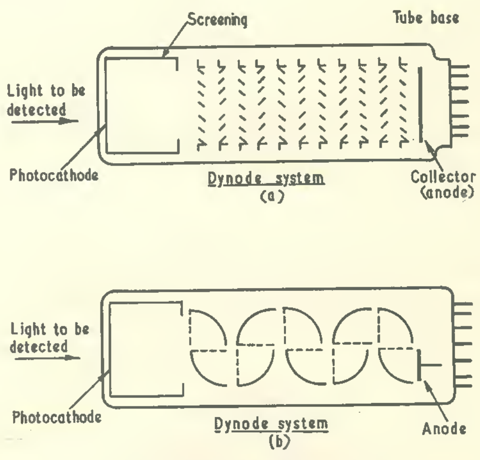
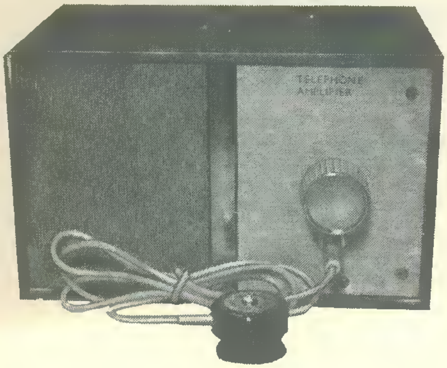


Fig. 1 (a). Scintillation photomultiplier using the venetian blind system
(b). The alternative box and grid system



Transistorised Tele

by B. T. H

A simple high-gain telephone amplifier wh all telephone co

THIS SIMPLE DEVICE ENABLES THE RECEIVED SIGNAL from a telephone to be reproduced at good volume from a loudspeaker. The amplifier pick-up signal is derived from an induction coil that is simply attached to the side of the telephone with a rubber sucker. The Telephone Amplifier can be of particular value in the following typical situations.

(1). Taking notes dictated over the telephone, in which case the Telephone Amplifier eliminates the need to hold the hand-set, and both hands are left free.

(2). Waiting while a secretary at the other end of the line spends half an hour trying to locate the party to whom one wishes to speak. In this case the Telephone Amplifier allows one to carry on working or relaxing some distance from the instrument, without fear of missing the connection when it is finally made.

(3). Receiving a call from a long-lost friend or relative in the presence of the whole family. In this instance the Telephone Amplifier allows the conversation to be shared by the entire family, thereby eliminating the constant shouts of "What's he saying? What's he saying?" that usually occur in such situations.

The unit described on these pages employs a five transistor circuit, has a built-in speaker, incorporates provision for volume adjustment, and costs about £3.10.0 to build.

System Operation

The basic principle of operation of the Telephone Amplifier is illustrated in block diagram form in Fig. 1. Here, the communication signals flowing in the telephone lines pass through a coil in the body of the telephone instrument, and in so doing create a magnetic field that fluctuates in sympathy with the speech signals; this coil is usually situated in the right-hand rear of a standard telephone instrument.

If a second coil is now placed in the fluctuating field of the telephone coil, electrical signals corresponding to the original speech signals are induced into this second coil, which thus functions as an inductive pick-up unit. The pick-up signals can then be amplified and fed to a loudspeaker or some other device, as required.

In practice, the pick-up signals from the inductive unit are very weak, and must be subjected to considerable amplification before they can be fed to a loudspeaker. In the Telephone Amplifier described here, the pick-up signals are first fed to a high-gain pre-amplifier and then on to a power-amplifier stage before finally reaching the loudspeaker.

The actual inductive pick-up coils used in a system of this type are available, ready-built, at moderate cost from most component suppliers. In consequence so far as the amateur electronics enthusiast is concerned, the construction of the Telephone Amplifier system is mainly concerned with electronic amplifier assembly, and a practical circuit is shown in Fig. 2.

Here, the pick-up coil is connected, via a jack plug and socket, across VR_1 which functions as a volume control. A portion of the pick-up signal is then taken from VR_1 slider and fed, via C_1, to the pre-amplifier stage given by TR_1 and TR_2.

In the pre-amplifier stage TR_1 is wired as a common emitter amplifier, with bias network R_1, R_2, R_5 and C_2, and having a split collector load comprising R_3 and R_4. TR_1 collector is direct coupled to the

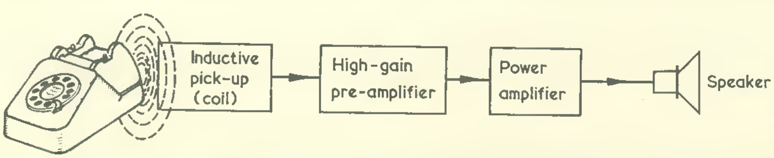


Fig. 1. Block diagram illustrating the functioning of the Telephone Amplifier

Cover Feature

ephone Amplifier

Hathaway

which gives loudspeaker reproduction of conversations.

base of TR_2, which is wired as an emitter follower. TR_2 has a high input impedance and a low output impedance, and gives near-unity voltage gain with zero phase shift between input and output. Thus, the signal appearing at TR_2 emitter is virtually identical with that at TR_1 collector and is at a low impedance level. This output signal is fed, via C_3, to the junction of R_3 and R_4 in the collector load of TR_1; consequently, almost identical a.c. signals appear at both ends of R_4 when the circuit is operating, and very little alternating current flows in this resistor, which therefore behaves as if its a.c. resistance were far greater than its d.c. resistance. In other words, the feedback signal to the junction of R_3 and R_4 causes TR_1 to behave as if it had an exceedingly large value of collector load; the voltage gain of the circuit is consequently very high.

This technique of increasing the effective a.c. resistance of a component by the use of signal feedback is known as bootstrapping, and is widely used in modern transistor circuitry.

The greatly amplified pre-amplifier signal is taken, at low impedance, from the emitter of TR_2 and is fed, via C_5, to the power amplifier stage incorporating TR_3, TR_4 and TR_5.

TR_3 is wired as a common emitter amplifier, with collector load R_8 and VR_2. Also, the collector of TR_3 is d.c. coupled to the bases of TR_4 and TR_5 which are wired as complementary emitter followers, giving a very low impedance output signal at the

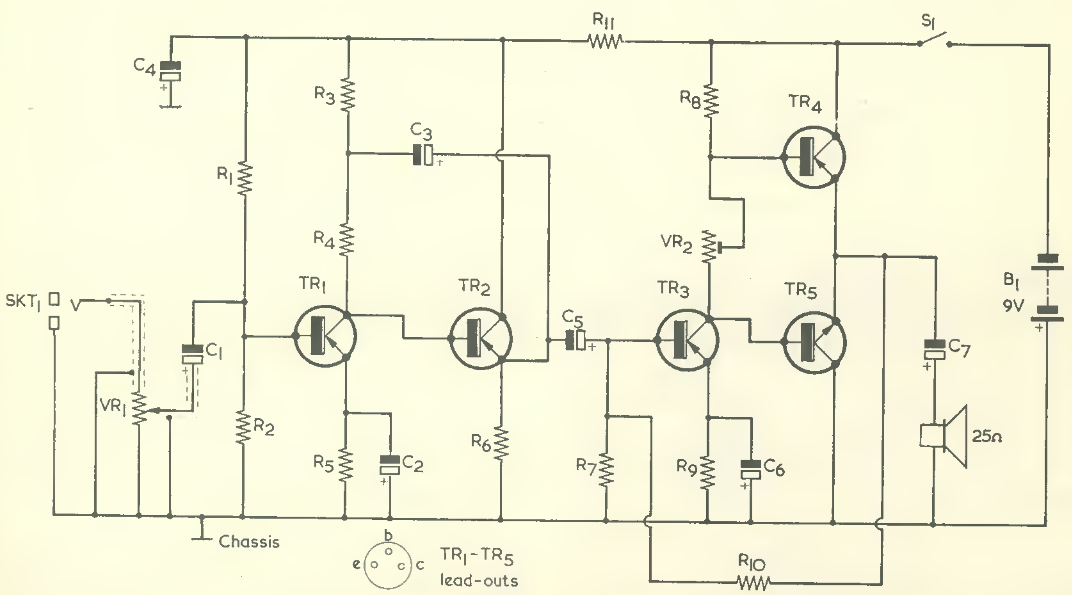


Fig. 2. Circuit diagram of the Telephone Amplifier. The pick-up coil (not shown here) couples into SKT_1 via a suitable plug. and lead. S_1 is ganged with VR_1

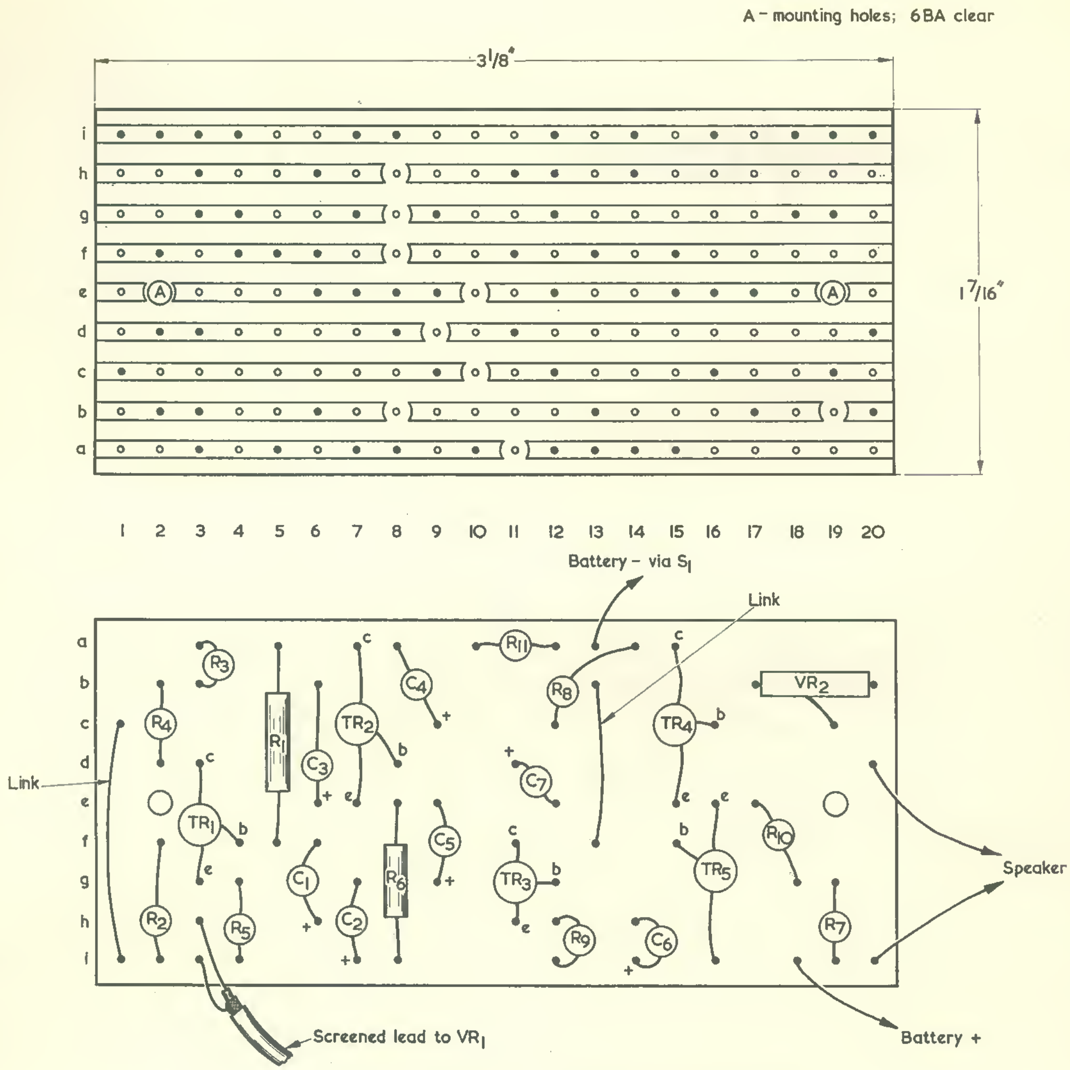


Fig. 3. The copper and component sides of the Veroboard panel

junction of TR_4 emitter and TR_5 emitter which is virtually identical in form to that at TR_3 collector. This low impedance output signal is coupled to the 25Ω speaker via C_7. VR_2 enables the quiescent bias currents of TR_4 and TR_5 to be set to the correct operating levels. Base-bias for TR_3 is provided by R_7 and R_{10}. These resistors also form a direct coupled negative feedback loop which helps to stabilise the bias levels and improve the fidelity of the power amplifier stages.

The power amplifier is decoupled from the pre-amplifier by C_4 and R_{11}, the latter component being inserted in the negative supply line. The unit is powered by a 9 volt battery, and consumes a total current of approximately 6.5mA under quiescent conditions.

Construction

The major part of the electronic circuitry is wired up on a small piece of Veroboard panel with 0.15in hole spacing, and construction should be started by cutting this panel to size and drilling the two small mounting holes, to clear 6BA screws, as shown in Fig. 3. Cut back the copper from the two mounting holes to prevent possible short-circuits, later, to the mounting screws. Next, break the copper strips, with the aid of a small drill or the special cutting tool that is available, as indicated.

Component assembly details, on the non-copper side of the panel, are also shown in Fig. 3. Note that all components other than R_1 and R_6 are mounted vertically on the panel, and that insulated sleeving should be used where there is any danger of com-

COMPONENTS

Resistors
(All fixed values $\frac{1}{2}$ watt 10%)

R_1 82kΩ
R_2 10kΩ
R_3 1.8kΩ
R_4 4.7kΩ
R_5 1kΩ
R_6 4.7kΩ
R_7 1.8kΩ
R_8 680Ω
R_9 100Ω
R_{10} 12kΩ
R_{11} 560Ω
VR_1 5kΩ potentiometer, log track, with on-off switch S_1
VR_2 100Ω potentiometer, skeleton preset, vertical

Capacitors
(All capacitors miniature electrolytic)

C_1 16μF 12V wkg.
C_2 30μF 6V wkg.
C_3 16μF 12V wkg.
C_4 50μF 12V wkg.
C_5 16μF 12V wkg.
C_6 50μF 6V wkg.
C_7 160μF 10V wkg.

Transistors

TR_1 2G374 (Texas)
TR_2 2G374 (Texas)
TR_3 2G374 (Texas)
TR_4 2N1307 (Texas)
TR_5 2N1306 (Texas)
(N.B. In case of difficulty, the transistors may be obtained from L.S.T. Components, 23 New Road, Brentwood, Essex.)

Switch
S_1 s.p.s.t., part of VR_1

Battery
B_1 9-volt battery type DT7 (Exide)

Pick-up Coil
Telephone pick-up coil (recording adaptor) with lead and jack plug. (Henry's Radio)

Socket
SKT_1 Jack socket, to suit pick-up coil plug

Speaker
25Ω speaker, 3in

Miscellaneous
Veroboard with 0.15in hole spacing, $3\frac{1}{8}$ x $1\frac{7}{16}$in (see Fig. 3)
Sheet aluminium, grommets, connecting wire, insulated sleeving, screened lead, etc.

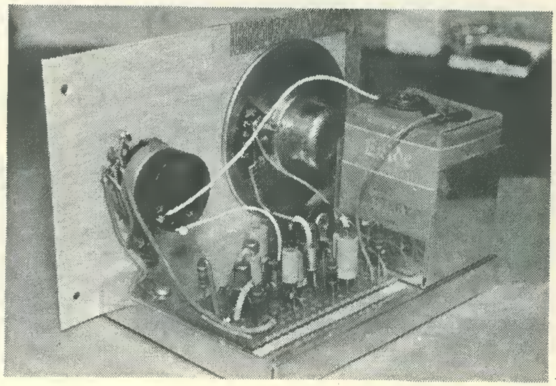
ponents short-circuiting against one another. The mounting legs of VR_2 should be reduced in diameter with the aid of a small file, so that they fit easily in the holes in the Veroboard, before attempting to solder this component in place. Particular care should be taken to ensure that all transistors and electrolytic capacitors are correctly orientated when they are soldered in place.

Once component assembly on the Veroboard panel is complete the unit can be given a simple functional check in the following manner. Set VR_2 for zero resistance (slider at TR_4 end of the track), short-circuit the screened input leads together and connect up the speaker. Also, connect up the battery with a meter in series and check that the total current of the unit is less than 7mA. Then check that TR_1 collector, TR_2 emitter, TR_3 collector, and the emitters of TR_4 and TR_5 are all at a potential of 4.5V $\pm$ 1V with respect to either supply line.

If satisfactory, the rest of the unit can now be made up. Bend, cut, and drill the chassis, battery holder, and front panel, as shown in Fig. 4.

Fig. 4(*a*) gives a front view of the front panel, which is made from aluminium sheet. Holes A are 6BA clear and are used for securing the main chassis to the panel. Holes B are for fixing the front panel to the cabinet and are drilled as required. Hole C is $\frac{3}{8}$in diameter and takes VR_1, whilst hole D has a diameter to suit the input jack socket SKT_1. In the prototype the speaker was fixed to the back of the front panel by impact adhesive, this being found quite satisfactory in practice, but if the constructor prefers to bolt or clamp the speaker to the panel, suitable holes may also be drilled at this stage.

A top view of the chassis, also made from aluminium sheet, is given in Fig. 4(*b*). The four aprons are bent down, away from the reader. The battery holder is shown in Fig. 4(*c*) and is made from light aluminium. In the prototype the holder was secured to the main chassis with impact adhesive at the position indicated in Fig. 4(*b*)



Rear view of the amplifier outside its cabinet

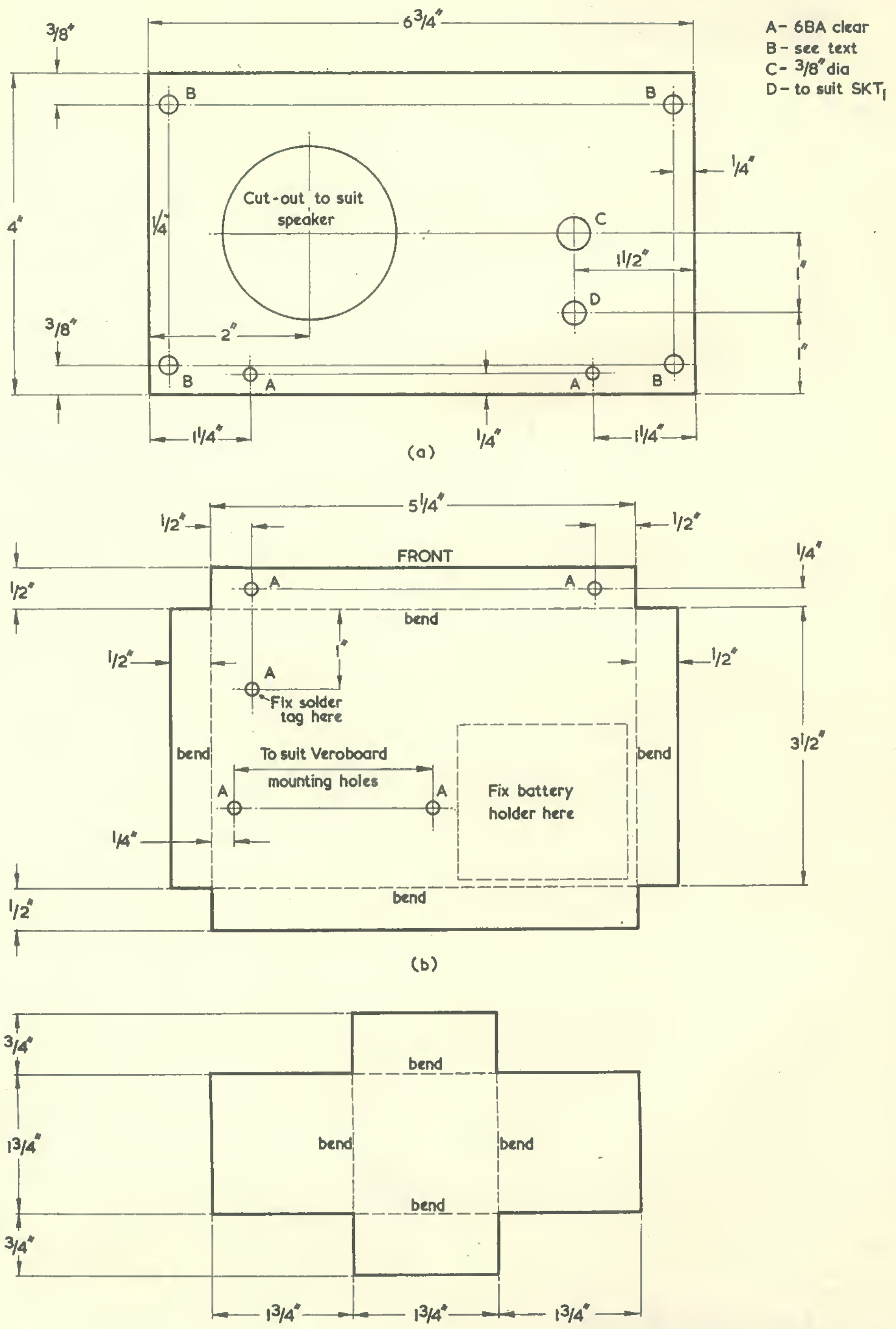


Fig. 4 (a). Drilling details for the front panel
(b). The main chassis before bending
(c). The battery holder

but it can alternatively be bolted in position, whereupon suitable holes may now be drilled in both parts.

The three parts of Fig. 4 should be made up as illustrated. Next, cover the front panel with a self-adhesive decorative plastic and speaker fabric, if required, and fix the speaker to the front panel with an impact adhesive (or by any other mounting method preferred). Fit VR_1 and socket SKT_1 to the front panel.

Now bolt the main chassis to the front panel, and mount the battery holder in position, using impact adhesive or bolts, as desired. Next secure the Veroboard panel to the main chassis, taking care to interpose two small rubber or p.v.c. grommets between the underside of the Veroboard and the chassis to act as spacer-insulators. A spare piece of self-adhesive plastic can be secured to the chassis below the Veroboard to act as an additional insulator if required.

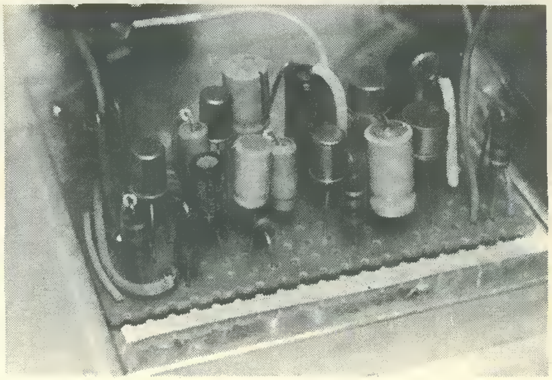
Fix a solder tag to the main chassis as shown in Fig. 4(*b*), and wire up the final circuit in the following manner. Connect the negative Veroboard lead to the negative battery terminal via S_1, connect the positive Veroboard lead to the positive battery terminal, and wire up the speaker. Connect the screened lead from the Veroboard panel to VR_1 and a second screened lead from VR_1 to socket SKT_1. Connect the earthy tag of VR_1 to the solder tag fitted to the main chassis. The braiding of both screened leads connects to the earthy tag of VR_1.

The unit is now complete and ready for use, and can be fitted in a suitable cabinet.

Using The Unit

Before putting the amplifier to permanent use, it must be set up in the following manner.

Plug the inductive pick-up coil into SKT_1, connect a current meter in series with the battery, move the telephone hand-set well away from the amplifier, and switch on. Now, after dialing "TIM" or a similar service, move the pick-up head around the telephone instrument until a position of



A closer view of the assembled Veroboard panel. Transistor TR_1 is to the left

maximum signal strength is found, and then fix the pick-up head in place with the rubber sucker. Adjust the volume control as necessary.

Once a good signal has been obtained in the above manner, adjust VR_1 for low volume and then adjust VR_2 for minimum current reading in the meter consistent with low cross-over distortion. This will normally be obtained with a quiescent current of about 6.5mA. Once set as above, the unit is ready for permanent use.

It should be noted that if the volume of the amplifier is set too high or the telephone hand-set is placed too close to the speaker, acoustic feedback will result and the system will "howl". This occurrence should be guarded against when fixing the equipment in position. If the inductive pick-up is to be semi-permanently fixed to the telephone body, it is recommended that the rubber sucker be lubricated with brake fluid or a similar oil rather than water, since the oil has a low rate of evaporation and will therefore retain the necessary vacuum for very long periods of time.

EMI U.H.F. Aerials

Contracts totalling £400,000 have been awarded to EMI Electronics by the BBC and ITA for the supply and erection of UHF transmitting aerials. These will extend the range of current BBC-2 colour programmes and provide the facilities for the UHF duplication of existing VHF transmissions.

The new aerials, consisting of Emislot panels and varying in aperture from 20 feet to 72 feet, will be cantilever-mounted on existing masts and towers and enclosed in 5ft. diameter fibreglass cylinders. The cylinders reduce the wind-loading effect by one-third and provide protection against the weather for both aerials and maintenance staff.

The sites involved are the BBC structures at Crystal Palace, Cottingtons Hill in Hampshire and Waltham-on-the-Wolds, Leicestershire, and the ITA installations at Caradon Hill, Cornwall, Sandy Heath, Bedfordshire, Moel-y-Parc, Flintshire, and Angus near Dundee. Under the co-siting agreement UHF aerials are used by both broadcasting organisations. The 650ft. Crystal Palace tower will carry two co-linear aerials, each of 27ft. aperture, which replace the original aerial supplied by EMI for experimental purposes.

The sub-contractors for the erection work are the B.I.C.C. Company Ltd. and J. L. Eve Company Ltd.

Scintillation Detectors and Photomultiplier Tubes

(*Continued from page 223*)

The photocathode material must, as in a photocell, be chosen according to the wavelength of the light which is to be detected. Antimony-caesium are often employed. Even in the absence of light a few electrons will be emitted from the cathode, since they will gain enough heat energy to leave the cathode. They give rise to spurious or background counts. The background counting rate can be reduced by cooling the photomultiplier tube in a refrigerator, since this will reduce the number of electrons leaving the cathode when the latter is in complete darkness.

Typical Circuit

A typical circuit for a photomultiplier tube is shown in Fig. 2. A potential divider chain is required to enable appropriate potentials to be applied to each of the dynodes, so that the electrons are suitably accelerated. When photons of light fall on the photocathode, the emitted electrons are multiplied in the dynode chain and a pulse of current flows in the anode circuit. This pulse is coupled to the first amplifier valve via the capacitor C_2. After suitable amplification the pulses are counted electronically.

The e.h.t. potential is normally in the range 700 to 1,800 volts, depending on the amplification required. Pulse output voltages of somewhat over 1 volt can be obtained when high potentials are applied to the tube, but optimum noise performance is obtained at smaller applied voltages.

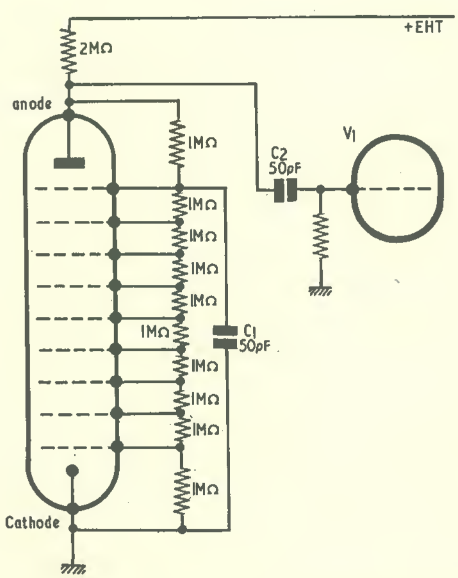


Fig. 2. A typical circuit for a photomultiplier tube

The output pulses produced by a Geiger counter are all of the same amplitude if the potential applied to the tube is kept constant. In the case of a scintillation counter, however, the number of photons produced in the phosphor is (under certain conditions) proportional to the energy of the particle of radiation being detected. After photoemission and amplification has taken place, the anode current (and hence the output pulse voltage) will also be proportional to the energy of the incident particle which gave rise to the pulse. Thus if the pulses are sorted into various channels according to the amplitude of each individual pulse, it is possible to count the pulses due to particles of each energy separately.

Phosphers

The phosphor used to convert the energy of the nuclear radiation into light must be chosen according to the type of radiation which is to be detected. A screen coated with impure zinc sulphide can be used to detect alpha radiation. The alpha particles reach the phosphor via a very thin aluminium window. Phosphors of naphthalene may be used for beta detection, whilst a large crystal of sodium iodide containing a trace of thallium iodide can be used as a gamma detector. The efficiency of the latter is much greater than the efficiency of a Geiger tube for gamma detection. Potassium iodide is not suitable for use as a phosphor, since potassium is weakly radioactive and would give rise to a steady background count.

Very low energy particles (such as those from tritium) are often counted by a liquid scintillation technique, since they do not have enough energy to penetrate even a thin window. In liquid scintillation counting the specimen of the radioisotope is mixed with an organic phosphor disolved in a solvent. The resulting liquid is placed inside the dark enclosure in front of the photmultiplier tube cathode.

Cerenkov Detectors

Photomultiplier tubes are also used in Cerenkov detectors. P.A. Cerenkov discovered in 1934 that a weak bluish-white light is emitted from transparent materials when high energy radiation passes through them. This phenomenon was explained in 1937 as being due to a kind of electromagnetic shock wave which arises when a charged particle at nearly the velocity of light enters an optically denser medium. The velocity of light itself is lower in the second medium and the particle velocity therefore quickly falls, so that the particle is not travelling at a velocity exceeding that of light in the second medium. Light is emitted in this process. The phenomenon is somewhat analogous to the sound shock wave produced when an aircraft breaks the "sound barrier".

A Cerenkov counter is very similar to a scintillation counter, but a transparent medium such as glass or water is used instead of a phosphor. The light emitted by a single particle of radiation is much weaker in intensity than that emitted in normal scintillation counting. (However, those who have seen a really large source of radiation of about one million curies shielded beneath water cannot fail to be impressed by the beautiful bluish-white Cerenkov light which is emitted.)

Other Uses

Photomultiplier tubes are used in various types of optical equipment. For example, they often find application in flying spot scanners, in equipment for counting and sizing microscopic particles, in photometry, and in spectroscopy, etc.

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1. G. W. Goodrich and W. C. Wiley. "Resistance Strip Magnetic Multiplier", *Rev. Sci. Insts.*, Vol. 32, p. 846 (1961).
2. J. Adams and B. W. Manley. "The Channel Electron Multiplier", *Electronic Engineering*, Vol. 37, p. 180 (1965).
3. J. B. Dance. "Resistive Film Electron Multipliers", *The Radio Constructor* July 1966.

Suggestions for Further Reading

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J. Sharpe. "Dark Current in Photomultiplier Tubes", E.M.I. Document No. CP5475 (1964).
"Mullard Photomultiplier Tubes", Mullard Publication 23/007/D/E-4-'63.
S. C. Curran. "Luminescence and the Scintillation Counter" Butterworth, 1953.
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Lightweight Whip Aerial for 160-metres Mobile

by W. E. Thompson G3MQT

Details of a simple base-loaded whip which, using a 64in telescopic aerial, resonates satisfactorily from 1,920 to 2,000 kc/s. An advantage of the design is that the parts may be readily obtained through normal home-constructor channels.

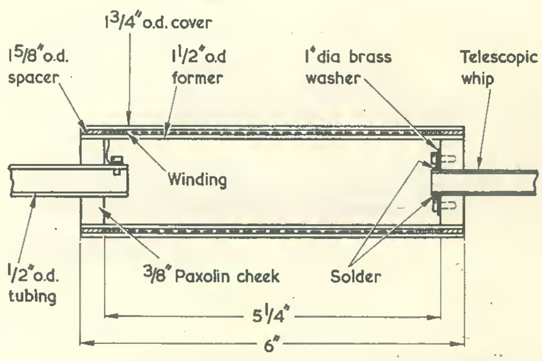
THIS SIMPLE BASE-LOADED WHIP WAS DESIGNED to be cheap and easy to make from readily procurable parts, to be weatherproof, and to be capable of being quickly erected or removed when necessary. It weighs no more than 9 ounces, and the cost to the author was only 30s. Performance is quite satisfactory so far as can be expected with aerials of this type on Top Band.

Once the design was formulated the aerial was made in a few hours, using only the usual tools to be found in most amateur workshops. Access to a lathe would have been of help, but not possessing one the writer managed with a file and a hand drill clamped in the bench vice for the small amount of turning necessary.

Construction

The accompanying diagram, which shows a sectional view of the assembly, will reveal the method of construction readily enough. The coil assembly is made up from three 6in lengths of Paxolin tubing obtained from Home Radio (Mitcham) Ltd. One piece is 1½in outside diameter, on which the coil is wound. Another piece is 1⅝in outside diameter, from which two pieces ⅜in long are cut from each end. This ensures getting two square ends! The rest of the 1⅝in tubing is not required. The two short pieces are fitted to the ends of the 1½in tube to serve as spacers for locating the outer cover, and to contain the coil ends. Two small holes in the coil former alongside the inside edges of the spacer are needed to secure the ends of the winding. The coil is close-wound with 24 s.w.g. enamelled wire to occupy the 5¼in length between the two spacers. This will take about 216 turns, using just over 2oz of wire, and will produce a coil of about 440μH. The third length of tubing is 1¾in outside diameter, and this fits over the two end spacers so that it totally encloses the coil to keep it weatherproof, and to protect the winding from damage. As these Paxolin tubes have 1/16in walls, they will be found to interfit closely.[1]

[1]The three Paxolin tubes are available in 6in lengths from Home Radio (Mitcham) Ltd. under Cat. Nos. ZA25 (1½in O.D.), ZA25A (1⅝in O.D.) and ZA25B (1¾in O.D.). Wall thickness in these sizes is 1/16in.—Editor.



Sectional detail showing the construction of the base-loading coil assembly. In the author's installation the ½in tubing at the left is passed over an existing car radio aerial in the partially retracted position, thus enabling the 160 metre aerial to be quickly fitted and removed

The whip aerial mounted on the existing car aerial

Two end cheeks are required. These can be made from $\frac{3}{8}$in thick Paxolin, turned so that they fit reasonably tightly into the inside ends of the coil former. Those who possess a lathe might well use thicker material so that a lip can be formed to cover the edges of the Paxolin tubes.

A $\frac{3}{8}$in hole is made centrally in one cheek to take the bottom end of the telescopic whip. This whip is 8in closed, and 64in fully extended. It is obtained from Henry's Radio, Ltd.[2] The whip should be a tight fit in the cheek, but for additional strength it can be soldered to a 1in diameter washer made from thin sheet brass which is fixed to the inside of the cheek by two short 6BA screws. The tapped holes for these screws should be "blind" so that they do not pierce the surface of the cheek. One end of the coil can be connected to the whip by clamping the wire under one of the 6BA screws.

The other cheek has a hole drilled centrally to take the end of a 9in length of stout (17 s.w.g. wall) aluminium tubing, $\frac{1}{2}$in outside diameter. A slightly undersize hole, and some careful dressing of the tubing with fine abrasive paper, will ensure a force fit which should be quite secure. If necessary, the tube could be clamped to the cheek by some means (by pinning, or a grub screw, for example). It should protrude above the inside surface of the cheek sufficiently to take a small 6BA screw in its wall, to which the other end of the coil is connected.

At this stage of construction the coil ends may be finally connected to the telescopic whip and to the 9in aluminium tubing, keeping the wire lengths as short as possible. The end cheeks are then secured to the coil former. The faces of the cheeks should be level with the ends of the Paxolin tubes. Three holes are needed at each end, spaced 120 degrees circumferentially, drilled and tapped 6BA to a depth of about $\frac{1}{2}$in. Countersunk screws should be used. If the whole coil assembly is now sprayed with three or four coats of Holt's "Dampstart", which can be obtained in aerosol cans from a garage or a motor accessory shop, the aerial will be rendered quite weatherproof. Several thin coats are better than fewer thick ones, but each coat should be allowed to dry off before applying another.

Fitting To The Car

Readers will probably have their own ideas of where and how to fix the whip to a car, but the method adopted by the writer may be of interest. His car already had a car radio aerial mounted on the off-side front wing. This aerial retracts into the wing and locks in the closed position when not in use. When it is unlocked it springs up, revealing some 4 to 5in of the bottom section with the other sections still retracted in it. This seemed the obvious place to mount the 160 metre whip, since the coaxial feeder would serve for both aerials.

The inside of the aluminium tube at the base of the 160 metre whip was carefully enlarged with fine abrasive paper wrapped around a rat-tail file until a smooth sliding fit was obtained on the car radio aerial. It is now only a moment's task to erect or to dismount the mobile whip and, when mounted, it is quite secure and safe. Being very light and thin it offers little wind resistance, and the telescopic top bends only slightly at speeds up to the legal maximum of 70 m.p.h. The writer has no idea what it would do at higher speeds because he has no desire to get pinched for speeding.

The neat appearance of the 160 metre whip when mounted in position

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[2]The 8in x 64in telescopic aerial used by the author was listed as Type D in pre-1967 Henry's Radio catalogues. The current 8in x 64in aerial available from Henry's Radio is listed as Type TA13. To ensure a tight fit, check the diameter at the base of the TA13 aerial before drilling the hole in the Paxolin cheek.—Editor.

Tuning

The aerial is tuned in the usual way be adjusting the length of the telescopic top section and noting the effect on a field-strength meter. When resonated at a particular frequency, the setting holds good for about 10kc/s each side of resonance. It has been found that the aerial performs best from about 1,920 to 2,000kc/s. At lower frequencies it is admittedly somewhat temperamental. This suggests that a coil slightly higher in inductance would cover the lower frequency range better, but this has not been investigated in practice as the writer rarely uses Top Band frequencies below 1,900kc/s when mobile.

Some Results

The best contact made when mobile with this aerial was on the A.13 travelling from the exit of the Dartford Tunnel towards Dagenham, when a satisfactory two-way contact was established near West Thurrock with G3SZC/A in Whitstable, Kent, and held until signing out near Dagenham, about 36 miles from Whitstable along the Thames Estuary. The topography and propagation conditions at the time were favourable factors, but mobile contacts made at other times show that ranges of 15 to 20 miles are often achieved.

When the aerial was in its infancy on G3MQT/M a contact was made one evening at Pembury, Kent, with G6TQ at Tonbridge some 4 miles away when driving in pouring rain. This contact was held while travelling down the A.21 towards Hastings until near Whatlington, some 18 miles from G6TQ. Even though the rain was bucketing down the aerial held its tune.

Conclusion

This aerial has been in use for over a year, has been out in all weathers, and has stood the test of time and many miles of motoring. It has attracted favourable comment at mobile rallies, such as Pegwell Bay, Longleat, South Shields, and others. Taking all things into consideration the design fills the writer's needs quite adequately, and it is thought to be of sufficient interest for the information to be passed on to others.

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

Pye V.H.F. Transmitter & Receiver Units, Type PTC113.—N. T. Shepheard, 10 Worth Park Avenue, Pound Hill, Crawley, Sussex,—borrow or purchase any information.

ARC-5 Command Receiver.—H. A. Kemp, Lower Cliff Farm, Strines, Stockport, Cheshire,—designated R-27/ARC-5, any information.

Minimitter MR44 Receiver.—S. Smith, 19 Hyde Road, Kenilworth, Warks,—loan of circuit or handbook.

Reflectograph Tape Recorder.—A. Nichols, 1 South Avenue, Swanton Morley, East Dereham, Norfolk, —model and type unknown, valve line-up is 2 x 6V6, 2 x 6SL7, with variable tape speed. Circuit diagram, manual or any information.

V.H.F. Receiver Unit 62A.—F. Shacklock, 3 Sycamore Road, Nottingham,—serial No. AP67590 (1957), circuit, manual or any information.

Equipment Required.—I. M. Juggins, 12 Field End, Cheltenham Road East, Gloucester,—has undertaken to rebuild a Halifax Bomber for the Skyfame Museum at Staverton Airport. The project is greatly in need of the outer cases of the following equipment—ARI 5085 receiver, ARI 5153 indicator, ARI 5085 indicator and Mk XIV computer. Also required is a set of valves for the R1155 receiver.

Philips BG290U/15 Receiver.—D. Jones, 70 Gloucester Avenue, London, N.W.1.—purchase or borrow circuit diagram.

UNDERSTANDING RADIO

Phase-splitter Circuits

by W. G. Morley

In last month's contribution to this series we commenced an examination of valve phase-splitter circuits suitable for providing out-of-phase a.f. voltages for application to the control grids of two output valves in push-pull. We then examined the split-load phase-splitter, this consisting of a single triode having equal values of resistance in its anode and cathode circuits. The out-of-phase voltages then appear at the anode and cathode of the triode.

We now carry on to further types of phase-splitter.

The "Paraphase Amplifier"

A very simple phase-splitter circuit is illustrated in Fig. 1. In this diagram the input a.f. signal is applied, by way of C_1 and grid resistor R_1, to V_1, which functions as a normal voltage amplifier. An amplified version of the input signal appears at the anode of V_1, R_2 being the anode load.

The anode signal from V_1 is fed, via C_3, to the potentiometer given by R_4 and R_5, the signal voltage at the junction of these two resistors being passed to the grid of V_2. V_2 is similar to V_1, and the two triodes could consist, in practice, of a double-triode valve. V_1 anode load, R_2, is equal in value to R_6. Similarly, cathode resistor R_3 is equal in value to R_7. C_2 and C_4 are electrolytic cathode bypass capacitors, and C_1, C_3 and C_5 are a.f. coupling capacitors.

The signals for the control grids of the following push-pull stage are taken from the anodes of V_1 and V_2 via C_3 and C_5 respectively. The output via C_3 is merely the input signal amplified by V_1 whilst the output via C_5 is the same signal after further amplification by V_2. V_2 provides 180° phase reversal, with the result that the two signals are 180° out of phase, as is required of the circuit.

The input signal to V_2 grid is attenuated by R_4 and R_5, the attenuation being such that the output via C_5 is equal in amplitude to the output via C_3, as is also required of the circuit. To see how the desired amount of attenuation is achieved, let us assume that V_2 offers a voltage gain of 40. R_4

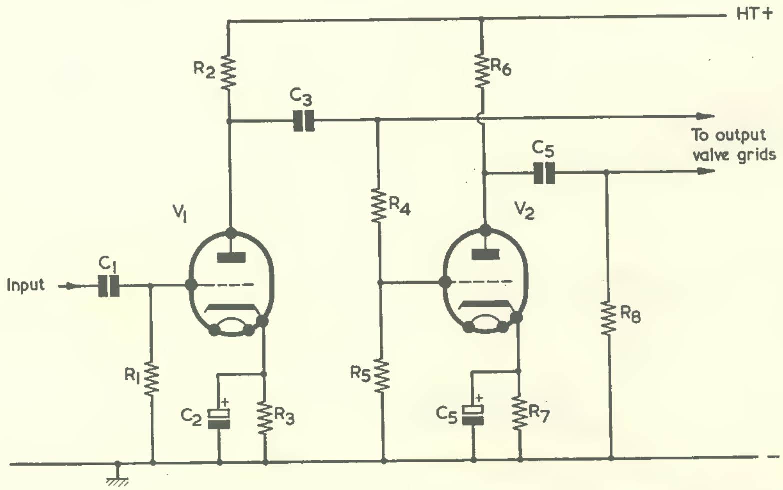


Fig. 1. The "paraphase amplifier" phase-splitter. V_2 provides the requisite phase reversal

and R_5 are then given values which ensure that $\frac{1}{40}$ of the signal voltage from C_3 is passed to V_2 grid. In general, $\frac{R_4+R_5}{R_5}$ should be equal to the voltage gain of V_2.

R_4 plus R_5 are equal to R_8, and it will be noted that R_4 plus R_5 can be used as the grid resistor for one of the push-pull output valves whilst R_8 can be used as the grid resistor for the other push-pull output valve. Each output voltage is an amplified version of the input voltage, the amplification being that provided by V_1.

The cathodes of V_1 and V_2 may share a common cathode resistor and bypass capacitor, as in Fig. 2 (*a*). The single resistor should have half the value of either R_3 or R_7 in Fig. 1, since it is required to drop the same cathode bias voltage at twice the current. Since the a.f. currents passed by the cathodes of V_1 and V_2 are assumed to be equal and opposite, the bypass capacitor may be dispensed with, as in Fig. 2 (*b*). In practice, however, omitting the common cathode bypass capacitor may result in some unbalance at extreme high and low frequencies.

An advantage of the phase-splitter circuit under discussion is that both the triode cathodes couple to chassis via a low value resistor, with the result that there is less likelihood of hum pick-up from the heater supply than with the split-load phase-splitter we discussed last month. On the other hand the circuit suffers from the disadvantage that, for good balance, R_4 and R_5 have to be adjusted to cater for the actual voltage gain provided by V_2. Thus, R_4 and R_5 may need to be altered if a new valve is fitted in the V_2 position or if the voltage gain offered by the existing valve varies as it ages. The changes in value could be conveniently made, incidentally, by replacing R_4 and R_5 by a preset potentiometer, as in Fig. 2 (*c*). A further disadvantage is that the output signal obtained from V_2 has undergone an extra stage of amplification, and may in consequence be a slightly distorted version of that obtained from V_1. Also, the signal obtained from V_2 passes through an extra capacitor, C_5, whereupon some unbalance at the lower audio frequencies, where the reactance of C_5 becomes appreciable, may occur. This last point can be of importance in high quality or high fidelity applications.

The phase-splitter of Fig. 1 is sometimes described as a "pharaphase amplifier". However, the world "paraphase" tends to be applied to other amplifying circuits which offer two push-pull outputs for a single input, and this fact should be borne in mind when references to the term are encountered.

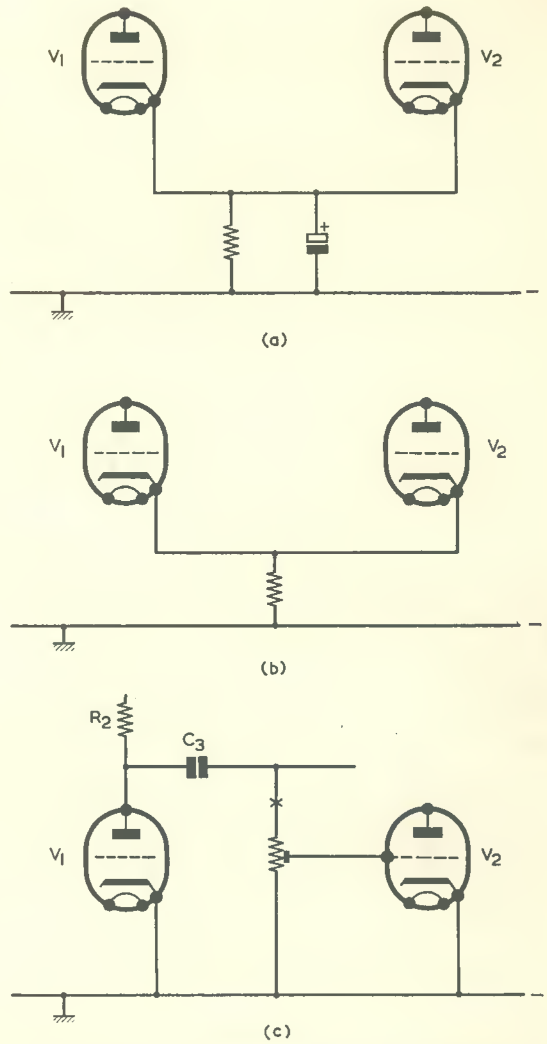


Fig. 2 (a). The separate cathode resistors and bypass capacitors in Fig. 1 may be replaced by a single cathode resistor and bypass capacitor, as shown here
(b). The bypass capacitor may also be omitted, and a single cathode resistor employed on its own
(c). For convenience of adjustment, R_4 and R_5 of Fig. 1 can be replaced by a preset potentiometer. A fixed resistor inserted at the point marked with a cross could be added to limit the range offered by the potentiometer and make its setting-up easier to carry out

See-Saw Phase Inverter

Fig. 3 shows a phase-splitter circuit which is known as a "see-saw phase inverter". For the circuit to function correctly, R_4, R_5 and R_6 are closely matched in value, which can be typically 1MΩ. Also, capacitor C_2 should have negligible reactance at the audio frequencies it is intended to handle. R_2 and R_7 are merely anode load resistors. Both have the same value, which is that normally employed by either triode when used as a voltage amplifier. The two cathodes of the double-triode are connected together and couple to chassis via cathode bias resistor R_3. As we shall see shortly, there is no necessity for a cathode bypass capacitor. Capacitors C_1, C_3 and C_4 are a.f. coupling capacitors, and R_1 is the grid resistor for V_1. The two outputs provide out-of-phase signals for the grids of a following push-pull output stage.

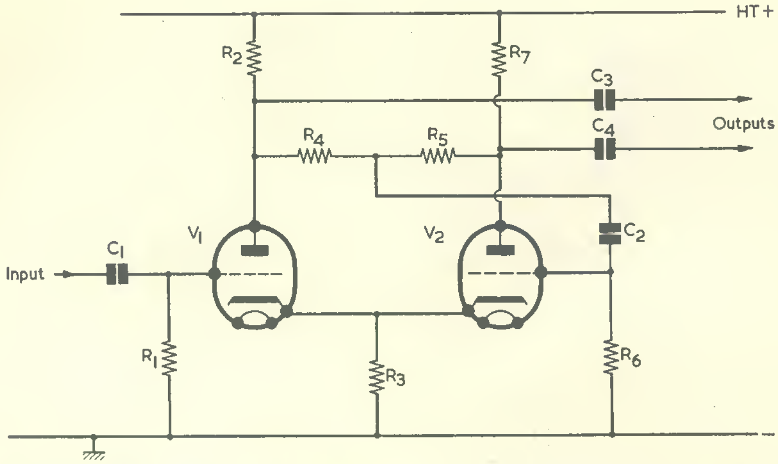


Fig. 3. The "see saw phase inverter". In this circuit R_4, R_5 and R_6 are closely matched in value.

When an a.f. input is applied to the grid of V_1 an amplified signal appears at its anode. Ignoring the action of V_2 for the moment, this signal is applied to the potentiometer given by R_4 and R_6 (C_2 has negligible reactance) and a portion is applied to the grid of V_2. Thus, the grid of V_2 has applied to it a signal of the same phase as that at the anode of V_1. V_2, whose action we have ignored up to now, amplifies this signal and an amplified version, 180° out of phase with that at V_1 anode, appears at the right-hand end of R_5. In consequence, when the operation of V_2 is considered we find that amplified signals of opposite phase appear at the outside ends of R_4 and R_5, the signal at their junction being fed to the grid of V_2.

Because the values of R_4, R_5 and R_6 are equal, the circuit has an automatic tendency to give output signals of nearly equal voltage amplitude. If, for some reason, the amplitude of the signal at the anode of V_2 were to decrease, the signal at the junction of R_4 and R_5 would contain a higher proportion of the V_1 anode signal. This higher proportion would be applied to the grid of V_2, resulting in an increase in signal amplitude at V_2 anode which would counteract the previous decrease. Put another way, the circuit stabilises because the amplitudes of the signals at V_2 anode and grid are interdependent; the anode signal amplitude must always be that which causes the corresponding signal amplitude to appear at the grid. The equilibrium taken up by the circuit is such that the signal at the junction of R_4 and R_5 always contains

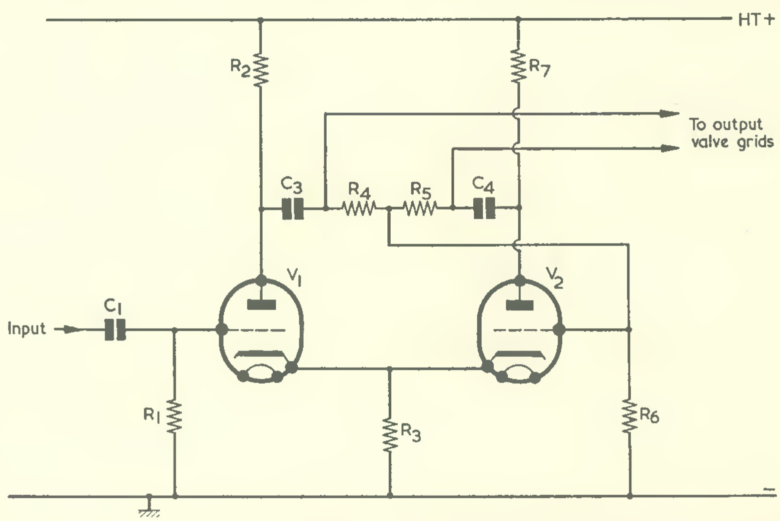


Fig. 4. A slight rearrangement of the circuit of Fig. 3 gives this "floating paraphase" phase-splitter, in which C_2 is not required. Some "floating paraphase" phase-splitters have separate cathode bias resistors, with parallel bypass capacitors, for the two triodes

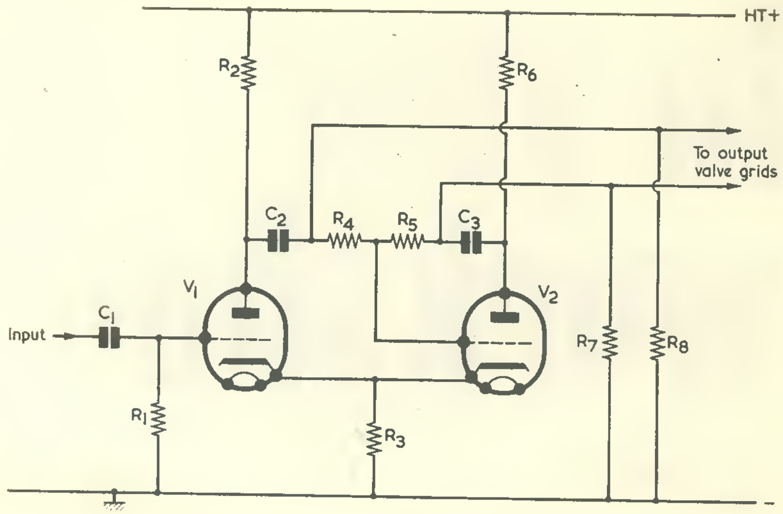


Fig. 5. A development from the circuits of Figs. 3 and 4. Only two closely matched resistors, R_4 and R_5, are required here

a small proportion of the signal at the anode of V_1. To obtain output voltages in practice which are closely equal in amplitude, R_4, R_5 and R_6 should be components having a tolerance of $\pm$ 5% or better, selecting R_5 to have a slightly higher value that R_4. Also V_2 should be a type offering a high degree of voltage amplification.

The "see-saw phase inverter" provides amplification, this being given by V_1. Each output has very nearly the same amplitude as would appear at the anode of V_1 if this triode operated on its own as a normal voltage amplifier. Both output impedances are the same, and the two outputs in Fig. 4 may connect direct to the push-pull output grids. Also, the valve cathodes connect to chassis via a low-value resistor, with the result that hum pick-up from the heater supply is liable to be low. R_3 has a value equal to half that of a normal cathode bias resistor for either triode on its own. There is no necessity to connect a bypass capacitor across R_3 because it carries both anode currents, these being opposite in phase and (very nearly) equal. The phase splitter derives its name from the fact that the outer ends of R_4 and R_5 swing in the manner of the ends of a see-saw about a fulcrum, the latter being slightly to the right of their junction. V_1 and V_2 may, in practice, consist of a double-triode valve.

There are a number of phase splitter circuits which operate in a similar manner to that of Fig. 3. These can all be identified by the fact that they have two valves whose anodes feed into the distinctive pattern of three closely matched resistors (with the junction coupling to the grid of the second valve) given in Fig. 3 by R_4, R_5 and R_6. In some versions R_4 and R_5 may be grid resistors for the push-pull output valves, the anodes being coupled to them via coupling capacitors (see Fig. 4). Such circuits are generally described as "floating paraphase" phase splitters, the term "floating" deriving from the fact that the grid of the second valve is connected to a "floating" point in the circuit. As was mentioned earlier, the term "paraphase" applies to an amplifier which converts a single input into two push-pull outputs.

If, with the circuit of Fig. 3, C_2 presents appreciable reactance at the lower audio frequencies, some unbalance at such frequencies is possible. Unbalance of this nature is less liable to occur with the somewhat more symmetrical circuit of Fig. 4, where both anodes couple into R_4 and R_5 by way of coupling capacitors C_3 and C_4, these having equal values.

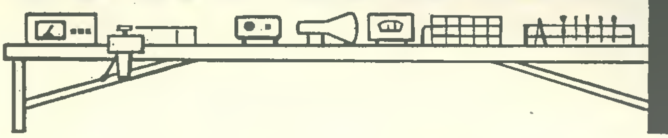
A development of the circuits of Figs. 3 and 4 is given in Fig. 5, in which there are only two closely matched resistors, R_4 and R_5. These resistors may similarly be of the order of 1MΩ in value. R_2 and R_6 are normal anode load resistors having equal values, whilst C_2 and C_3 are equal value a.f. coupling capacitors. The same self-balancing action occurs as with the previous circuits, the signal at the anode of V_2 having an amplitude which causes the corresponding signal amplitude to be applied to its grid. This circuit provides slightly better balance than do those of Figs. 3 and 4. It will be seen that the grid of V_2 is maintained at chassis potential so far as bias is concerned by way of R_4, R_5, R_7 and R_8. R_7 and R_8 are the grid resistors for the output valves.

In the three circuits just discussed balance improves, in all cases, as the voltage gain offered by V_2 increases. In consequence it is desirable to use a high gain valve here, and a suitable choice would be one section of an ECC83 double-triode. The other section of this valve can then be employed as V_1.

Next Month

In next month's issue we shall complete our examination of phase-splitters by discussing the Schmitt phase inverter, after which we shall introduce the subject of negative feedback.

In your workshop



Microphony is not a common trouble in transistor radios, but it still crops up every now and again. In this month's episode Dick has his first encounter with the fault, but he is soon shown how to clear it by Smithy.

With a grunt of satisfaction, Dick fitted into place the last screw which secured the little printed circuit board of the medium and long wave transistor portable.

It had had an interesting fault: the 0.01μF i.f. bypass capacitor immediately following the detector had decided to change its function in life from that of merely holding a charge to the more exciting exercise of passing current, and it had passed a wide variety of currents modulated by a.f. ranging from the Beatles to Tchaikowsky ever since it had arrived at this decision. Eventually, it passed the current from Dick's testmeter switched to an ohms range, whereupon its guilty secret was laid bare. As so frequently happens to those of us who have lost the capacity to meet our obligations, the capacitor was then forcibly removed from its fellows and thrown into the wretched company of the broken-down (i.e. Dick's waste bin), its place in the receiver being taken by a more disciplined brother of equal potential value.

After fitting the new capacitor, Dick had ensured that the receiver was working correctly in its disassembled state, including a full volume check on what was now his favourite test transmission—Radio 1 on 247 metres. He had then applied his signal generator and carefully aligned the i.f. transformers. And, now, he was cheerfully turning home the last screw which held the printed circuit board in place in the cabinet.

Microphony

Dick next fitted and connected the battery, closed the cabinet and switched on the receiver for its final check-out. An exploratory turn of the controls showed that the set had excellent sensitivity and selectivity on both medium and long waves. Dick finally switched to medium waves and once more selected Radio 1 on 247 metres. He turned the volume to its full setting and slightly adjusted the tuning. At once the receiver broke into a loud discordant howl. Startled, Dick reduced the volume level, whereupon the howl disappeared.

Dick cautiously advanced the volume control again, with the result that the howl became audible once more. He readjusted the tuning control and the howl disappeared. After further investigation Dick discovered that the howl only occurred at a tuning point very close to the central position for the Radio 1 transmission and that it did not appear at any other setting of the tuning capacitor on either the medium wave band or the long wave band. He scratched his head and gazed despondently at the receiver which had developed this unexpected last-minute fault.

"Hey, Smithy!"

There was silence for a moment. Smithy the Serviceman, at his bench on the other side of the Workshop, was obviously fully preoccupied.

"Yes?" he replied eventually, and with manifest reluctance.

"I've got a real weirdie here," called out Dick to Smithy's back. "I'm getting a howl on just one station only."

"I know," said Smithy laconically. "I heard it over here."

"But what would cause a fault like that?"

"Is it a transistor set?" queried Smithy in return.

"Yes," replied Dick, puzzled at this reaction on Smithy's part, "as a matter of fact, it is."

"Then," stated Smithy firmly, "you've very probably got a microphonic tuning capacitor."

After which pronouncement Smithy, presumably satisfied that he had completely cleared up Dick's problem, once more proceeded to lose himself in the receiver he was repairing.

Dick glared furiously at the Serviceman's back, and returned to the attack.

"How," he persisted, "can you say it's the tuning capacitor if you haven't even *seen* the set?"

Wearily, Smithy laid his test prods on his bench. He switched off the set on which he had been working, stood up and walked over to Dick's bench.

"I can see," he remarked resignedly, "that the quickest way of getting your troubles sorted out is to come over here and tackle them directly. What have you done with that set up to now?"

"To start off with," said Dick in reply, "I found the fault, which was a shorted i.f. bypass capacitor after the detector. I put in a new capacitor and, since there was just a slight possibility that changing it might have had an effect on the alignment of the last i.f., I gave the i.f. transformers a touch-up and put the printed board back into the case. After which, blow me if the set doesn't start to howl like a banshee every time I tune slightly to one side of Radio 1!"

"I think," said Smithy thought-fully, "I can see what's happened here. Incidentally, there wasn't any real necessity to align the i.f.'s although it was a reasonable thing to do, I suppose. Did you line them up as recommended in the service sheet?"

"Oh, definitely," replied Dick promptly, picking up a service manual and passing it over to Smithy. "As you can see, the manual says the i.f. is 470 kc/s. I tuned the set to the high frequency end of the medium wave band, applied the signal generator via a 0.01μF capacitor to the fixed vanes of the signal frequency section of the 2-gang and set the genny up to 470 kc/s." (Fig. 1).

I.F. Alignment

"Well," commented Smithy, "that's a pretty good start at any rate. When you're lining up the i.f.'s of a medium and long wave transistor radio you have to apply the i.f. signal to the base of the mixer-oscillator, and the method of coupling you've just described is as good as any. Also, it has the advantage that the fixed vane tag of the aerial tuning capacitor is easy to get at. By the way, some manufacturers state that the set should be tuned to the low frequency end of the medium wave band instead of the high frequency end before you line up the i.f.'s. So, for the very best results, you should really check the service literature before commencing the alignment. Still, your approach is good enough for general work."

Smithy looked briefly at the manual Dick had given him.

"After connecting up the signal generator," he continued, "what did you do next?"

"I lined up the i.f. transformers." said Dick simply.

"To 470 kc/s?"

"To 470 kc/s."

"All of them?"

"Of course."

"In," asked Smithy gently, "a set with *staggered* i.f.'s?"

"Who says this set has staggered i.f.'s?"

"I do, you steaming great nit," snorted Smithy wrathfully, returning the service sheet to Dick. "And so does this service manual! If you'd taken the trouble to read it more fully instead of merely glancing at the figure for the intermediate frequency, you'd have seen that the third i.f. transformer should be aligned to 470 kc/s, the second to 468 kc/s and the first to 472 kc/s!"

The Serviceman pointed an accusing finger at the section of the manual devoted to i.f. alignment.

"Well, stap me," said Dick, crestfallen, "I must have missed that bit!"

"I'll say you did," growled Smithy. "Anyway, you might as well line the i.f.'s up properly, now I'm over here. If we're fortunate, that's all that will be needed to get rid of that howl of yours. You can get at the i.f. cores quite easily whilst the set is in its case. You can also get at the injection point for the signal generator and the speaker tags as well."

"Why should I want to get at the speaker tags?"

"Because," replied Smithy, "I want to see the i.f.'s aligned correctly this time, and the best way of doing this is to either replace the speaker with an output meter switched to the speaker impedance or to connect a high resistance a.c. voltmeter across the speaker terminals. (Fig.2). You'll get much more accurate results using a meter to indicate the output level than by relying on your ears. I see that this set has got a 15Ω speaker so you want to keep your signal generator at a level which causes the a.c. voltmeter to read about 0.9 volts."

Dick looked puzzled.

"Why 0.9 volts?" he asked.

"That voltage," explained Smithy, "corresponds to approximately 50-mW in 15Ω, and 50mW is the generally accepted standard output to be used when lining up loudspeaker radios, unless the makers state otherwise. With a 10Ω speaker 50mW corresponds to 0.7 volts, by the way, and with a 20Ω speaker it corresponds to 1 volt. I should add that 50mW is a fairly low output power and the corresponding i.f. input is usually too small to allow the results of alignment to be heavily masked by a.g.c. The receiver volume control is, of course, turned to full whilst you do the alignment, and the a.c. voltmeter you connect across the speaker must present a resistance considerably higher than the speaker impedance."

"Fair enough," said Dick, as he reached for his testmeter, and switched it to a low a.c. volts range.

It did not take Dick long to make the requisite connections to the receiver.

"Here we are," he called out cheerfully, as he switched on the set. "All systems go! I'll start off with the third i.f. transformer at 470 kc/s."

Carefully, Dick adjusted the signal generator to this frequency and set its output level to give approximately 0.9 volts in his meter. He aligned the core of the third i.f. transformer.

"What did you say the frequency for the middle one was?"

"468 kc/s," replied Smithy.

Dick readjusted the signal generator frequency and aligned the second i.f. transformer, also adjusting the signal generator output for the required reading in his testmeter.

"The first one," he asked, "is 472 kc/s, isn't it?"

"That's right," confirmed Smithy.

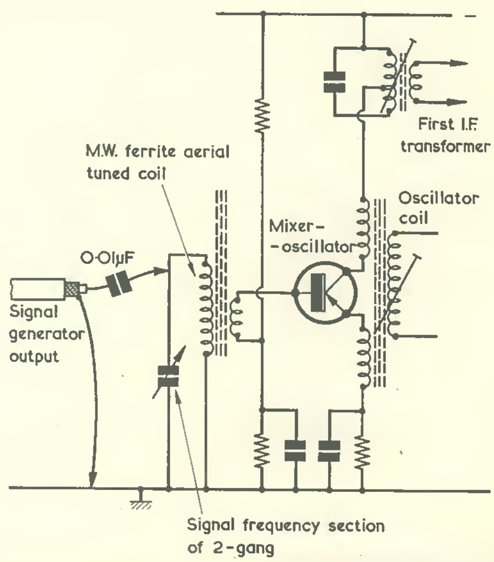


Fig. 1. The basic signal frequency circuit of a typical mixer-oscillator stage switched to medium waves. A convenient method of injecting an i.f. signal for alignment consists of applying the signal generator output, via a 0.01μF capacitor, to the signal frequency section of the 2-gang tuning capacitor

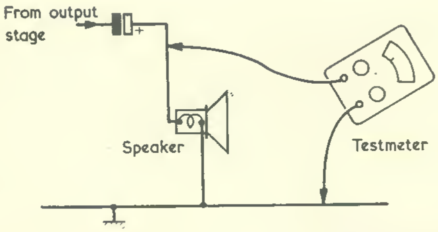


Fig. 2. Most transistor receiver manufacturers specify that the i.f. stages should be aligned with the receiver providing an a.f. output of 50mW. When the coupling from the output stages to the speaker is via an electrolytic capacitor, instead of via a transformer, the speaker impedance will be high enough to enable 50mW to correspond to a useful deflection in a testmeter connected across the speaker and switched to a low a.c. volts range

The alignment of the first i.f. transformer was soon completed, whereupon Dick switched off the receiver and disconnected the test equipment leads.

"I must admit," he remarked, "that it's a jolly sight easier to line up these i.f. transformers with a meter than it is by ear, because you get such a *definite* indication that you're at the peak."

"True enough," agreed Smithy. "I know there are a lot of service engineers who line up the i.f.'s of a radio by ear, thinking that it's a waste of time to connect up an output meter or, even, to clip a test-meter switched to an a.c. volts range across the speaker. In general, though, it's best to use the meter and it can often cause the actual alignment to be carried out more quickly, too. A further point is that the alignment will almost certainly be more accurate. Anyway, let's see if we've cleared that howl out of your receiver."

Dick switched on the receiver and tuned in the 247 metre Radio 1 signal.

"I get the impression," he remarked, "that the a.f. quality is a bit better. There seems to be more top."

"There should be," stated Smithy. "You've now got the i.f. response that the manufacturers intended, instead of the much narrower response which *you* introduced."

Dick turned the volume to full and tuned carefully through the Radio 1 signal. There was no trace whatsoever of any howl.

Acoustic Feedback

"Smithy," said Dick admiringly, "you're a genius."

The Serviceman breathed on the fingernails of his right hand and polished them nonchantly on his lapel.

"I suppose," he remarked modestly, "that I do have my occasional little successes."

"This is certainly one of them," said Dick jubilantly. "First of all, you make a correct diagnosis without even seeing the set, after which you get me to do the exact thing which is needed to cure the fault."

"I was a bit lucky there," confessed Smithy. "I was banking on the fact that your original i.f. alignment had made the skirts of the i.f. response a lot steeper than they should have been."

Dick's mood of elation at having successfully cured the fault changed to one of gloom as he considered the nature of the fault itself.

"So far as I'm concerned," he stated morosely, "this whole business is a complete mystery. You said at the beginning that the howl was very probably due to a microphonic tuning capacitor and I then cleared the fault just by realigning the i.f.'s. I'm baffled!"

"Don't let it worry you," said Smithy soothingly. "Everything is really quite simple, as I'll show you. The best way to explain what happens will be to start right at the beginning with this microphony business. Have you ever bumped into a microphonic howl with an a.f. amplifier?"

Dick scratched his head for a moment, then his face brightened.

"Yes I have," he said. "Some years ago I had a valve tape recorder in for repair which howled like billy-oh on playback if you turned the volume up above a certain level. That was a dead easy snag. too. All I had to do was to replace the valve immediately following the playback head, which had gone microphonic. You could tell the valve was microphonic because, if you tapped it at a volume setting which was too low to bring on the howl, it sounded from the speaker as if you were bashing a Chinese gong!"

"Right," said Smithy. "Well, that situation represents about the simplest sort of acoustic feedback you can have. (Fig. 3). In this case you have a microphonic valve in an early stage of an a.f. amplifier, and it develops a signal voltage corresponding to any noise or vibration that impinges on it. If the sound from the speaker reaches the valve, either via the air or the hardware of the cabinet and chassis, or via a combination of the two, you have a positive feedback loop set up and the whole thing is capable of breaking into oscillation, resulting in what we often call an 'acoustic howl'. The usual reason for a valve going microphonic is that a mechanical fault has caused the control grid to lose its rigidity and to flap around. The valve offers the greatest microphonic effect at the mechanical resonant frequency or frequencies exhibited by the grid. In the howl which is then set up these frequencies tend to predominate and this factor gives the acoustic howl a distinctive quality that I can best describe as being 'mechanical' in nature."

"That effect," remarked Dick, "is similar to what you get when a

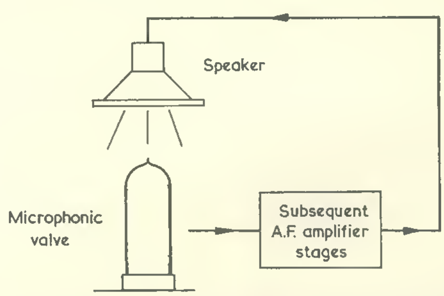


Fig. 3. If a microphonic valve in an early stage of an a.f. amplifier is subjected to sound from the speaker, a positive feedback loop is set up. If there is sufficient overall gain in the loop the system breaks into oscillation, causing an acoustic howl to be given by the speaker

public address microphone picks up too much signal from the speaker."

"True enough," confirmed Smithy. "In the public address case, though, the coupling back from the speaker to the microphone is via sound waves in the air only. When the loudspeaker is in the same cabinet as a microphonic valve, as occurred in your tape recorder, you get coupling by way of the hardware as well, as I mentioned just now. Anyway, let's press on! Now, a valve is a component which is well-known for becoming microphonic. Another component which is also well-known for microphony is an air-spaced tuning capacitor. As you can readily imagine, if the vanes of an air-spaced tuning capacitor are subjected to sufficient vibration, the capacitance it offers will vary at the frequency of the vibration. This is especially true if the capacitor vanes are thin and are very closely enmeshed, as occurs in the types which are used in medium and long wave radio receivers. In receivers of this type, the capacitor is also in the same cabinet as the speaker, whereupon an acoustic feedback path can exist between the two."

Feedback Path

"I can understand all that," said Dick, "but what puzzles me is how varying capacitance in a tuning capacitor can cause an a.f. signal to be fed to the speaker and allow an acoustic howl to be given. The effect *can't* be as direct as with a wobbly control grid in an a.f. amplifier valve."

"It isn't," agreed Smithy. "Nevertheless, the varying capacitance *can* be changed to a.f. if the capacitor in question tunes the oscillator of a superhet. Let's assume that we have an a.m. superhet, and we tune it to a signal. An i.f. signal equal to the difference between the signal carrier frequency and the oscillator frequency is then fed to the i.f. amplifier. If we cause the vanes of the oscillator section of the tuning capacitor to vibrate at an audio frequency and thereby change in capacitance, we are varying the oscillator frequency at the same rate. This means that the intermediate frequency fed into the i.f. amplifier is also varying at the same rate."

"But that," interrupted Dick excitedly, "is a *frequency* variation! If the set's an a.m. superhet, its detector won't respond to a frequency variation."

"It won't," confirmed Smithy, "but if the frequency variation is applied to the sloping skirt of the i.f. response due, perhaps, to slight detuning of the receiver, it becomes converted to an *amplitude* variation, and the detector *can* respond to that. The overall feedback loop then includes the following processes. (Fig. 4). Mechanical vibration of the oscillator tuning capacitor vanes due to sound from the speaker produces an oscillator frequency varying at a.f., and the mixer then changes this to a varying intermediate frequency. If this varying i.f. is applied to a sloping part of the i.f. response, it becomes converted to an amplitude variation. The amplitude variation is then detected by the detector and passed on to the a.f. stages of the set. These amplify it and feed it to the speaker. So, provided there is sufficient gain in the loop, everything is set up for oscillation to occur and an acoustic howl to be given. This loop is more complicated than the microphonic valve one, because one of the processes in the loop is the conversion of frequency variation in the i.f. amplifier to amplitude variation. Also, feedback cannot take place unless a carrier is tuned in on the receiver and applied to the mixer in order that an i.f. can be formed. But the tendency to oscillate is still there, and if there is sufficient gain and the sound from the speaker can cause sufficiently high vibration in the tuning capacitor, the whole thing breaks into oscillation at the mechanical resonant frequency, or frequencies, of the vibrating parts of the capacitor. The resultant howl has the same distinctive 'metallic' character as with a microphonic valve, which is why I recognised that howl from your set as microphony when I first heard it."

A sudden gleam of enlightenment appeared in Dick's eyes.

"I'm just beginning to realise," he remarked, "what you meant when you said that my i.f. alignment may have brought on the howl because it could have made the i.f. response have a steeper skirt. I suppose that, if the skirt is steeper, the amplitude variation becomes bigger."

"Exactly," confirmed Smithy. "It would appear that the tuning capacitor in your particular receiver is fairly close to the acoustic howl condition, but that actual oscillation doesn't occur when the i.f. response curve has a nice symmetrical shape with fairly evenly sloping skirts, because the amplitude variation resulting from frequency variation is too small. (Fig. 5 (*a*)). I would guess that your first alignment caused the skirts to be much steeper than they should have been with, probably, one side steeper than the other. (Fig. 5 (*b*)). The steeper the slope the greater the i.f. amplitude variation resulting from frequency variation and, hence, the greater the overall gain in the oscillation feedback loop. The fact that the howl occurred only when you tuned to one side of the signal would also argue that the i.f. response was asymmetric, there being just sufficient change from frequency to amplitude variation on the steeper slope to allow the howl to appear."

"Why," asked Dick, "did the howl only occur on one station?"

"That," replied Smithy, "is just the luck of the draw, as there are a lot of fortuitous factors involved. In medium and long wave transistor

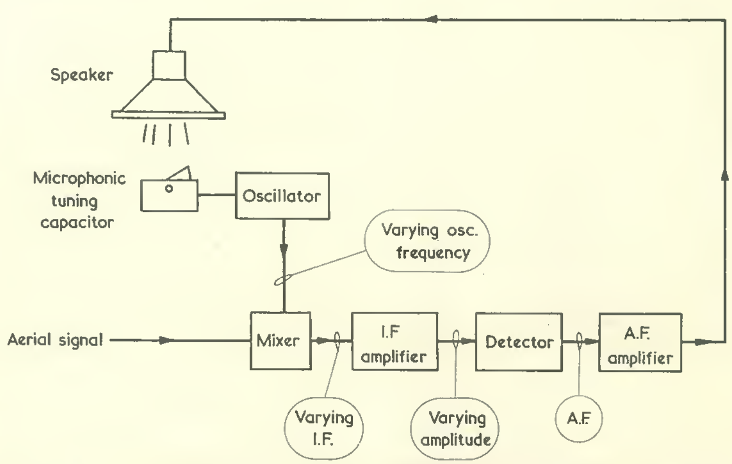


Fig. 4. When a microphonic oscillator tuning capacitor in an a.m. receiver causes the appearance of an acoustic howl, the feedback loop takes up the form shown here. The manner in which a varying i.f. is converted to a varying signal amplitude is illustrated in Fig. 5

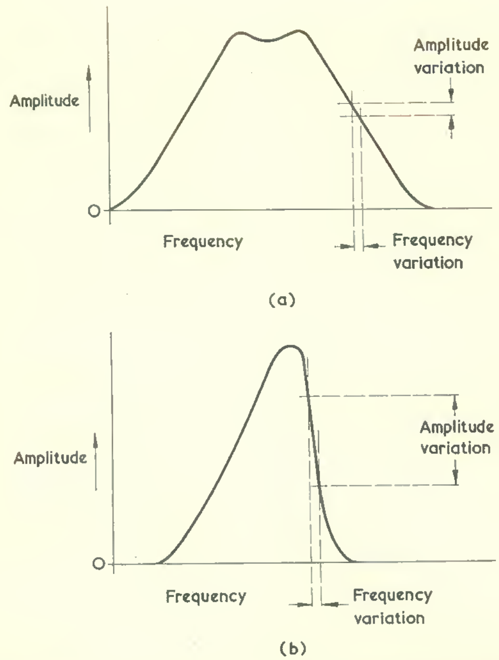


Fig. 5 (a). If the i.f. corresponding to the carrier of a received signal is applied to the skirt of an i.f. response and is then varied slightly, an amplitude variation results

(b). Due to Dick's careless alignment, the i.f. amplifier in his receiver was given an asymmetric response curve similar to that shown here. A frequency variation applied to the steep side of the response results in a much greater amplitude variation

sets acoustic howls usually turn up near the high frequency end of the medium wave band where the tuning capacitor vanes are slightly meshed, as occurred, in your case, on 247 metres. This will be the condition which corresponds to maximum oscillator frequency variation for a given level of mechanical vibration in the capacitor. In your set, the maximum oscillator frequency variation just happened to occur around 247 metres. You don't normally get acoustic howls on long waves because the lower oscillator frequency means that the frequency variation will also be lower."

Howl On Short Waves

Dick absorbed this information. "If that's the case," he remarked after a moment's thought, "the situation must become worse with sets which cover short waves."

"That's very true," agreed Smithy. "Because the oscillator frequency is higher again. In practice, though, acoustic howls don't seem to be too troublesome in the fairly small proportion of transistor radios made in this country which cover short waves. This will be, of course, because the manufacturers have taken the appropriate precautions against it. In earlier years, by the way, acoustic howl on the short wave bands of three-band mains valve radios used to be a great problem both to manufacturers and to service engineers. This was due to the fact that these sets had output valves giving a good 3 or 4 watts and the oscillator tuning capacitor used to have the relatively high value of 500pF instead of the lower capacitance that appears in more modern tuned circuit designs. To prevent acoustic coupling from the speaker, the tuning capacitors in those older radios were frequently mounted on very soft rubber grommets, or on a sub-chassis which was similarly mounted on very soft grommets. You could bring on an acoustic howl with some of these sets by merely fitting a replacement dial cord too tightly! If the replacement cord pulled the tuning capacitor out of position and made it exert too much pressure on its rubber grommets, the acoustic isolation provided by the latter would be reduced and the set would then start howling as you tuned in stations on the short wave band. Some of those old sets were real shockers in that respect. Alternatively, the howl could be caused by a microphonic oscillator section in the frequency-changer and all that was then required was the fitting of a new valve. Transistors don't go microphonic, which was why I asked you at the beginning whether your set was a transistor type. If it was, your acoustic howl would have almost certainly been due to tuning capacitor microphony, as that was about the only possible culprit left."

"Well, I'm darned," said Dick admiringly. "You really *did* use a crafty bit of reasoning there!"

"Oh, I'm like that," grinned Smithy. "Anyway, so far as medium and long wave transistor radios are concerned, the precautions against acoustic feedback to the variable capacitor don't have to be so stringent as for the short wave bands of those earlier valve radios. In some transistor sets the tuning capacitor is mounted on small rubber grommets, whilst in others it's just bolted straight down. Incidentally, if you ever get another set with the same sort of acoustic howl, you want to check that the i.f. alignment is as the manufacturer intended and that the effect of any resilient mounting provided for the tuning capacitor hasn't been upset in any way. If the worst comes to the worst and both these points prove to be satisfactory, then you just have to fit a new tuning capacitor. Cheerio!"

F.M. Receivers

With which unexpected parting shot, Smithy turned abruptly and made his way back to his own bench.

"Hey, hang on a minute!" called out Dick. "What about f.m. radios? Won't acoustic howl be more liable to occur in these than in a.m. receivers? The oscillator frequency in f.m. sets is higher than on short waves and the frequency variation caused by a vibrating tuning capacitor will be detected directly by the discriminator."

"Good point," commended Smithy, who was now back at his own bench. "But don't forget that the frequency variation will have to be pretty wide to give an appreciable audio frequency after the discriminator. The range of the discriminator in an f.m. sound radio is plus or minus 75 kc/s, whereas quite efficient frequency discrimination via the skirts of a 470 kc/s i.f. amplifier can take place over plus or minus 1 kc/s only. Again, a variable capacitor which has to tune the oscillator frequencies for Band II requires only a few vanes and these can be quite widely spaced. Such a capacitor will give less microphony than one of about the same dimensions with a greater number of vanes that are more closely spaced. With f.m. sets the possibility of acoustic feedback is *there*, but the risk of its occurring is not so great as might at first sight appear. A simple resilient mounting for the tuning capacitor using rubber or p.v.c. grommets is normally all that is necessary to avoid it. Toodle-pip!"

After this final farewell, Smithy turned his back very firmly on his protesting assistant and proceeded to devote his full attention to the receiver he had been investigating before Dick's acoustic howl had made itself evident.

In point of fact, that howl from Dick's bench had raised in Smithy's mind many nostalgic memories of his earlier struggles to clear acoustic feedback on the short wave bands of those old valve radios he had referred to. So vivid were his recollections, indeed, that his fingers had been itching to get to grips once more with one of the oldest of his electronic adversaries, and he had secretly been highly relieved when Dick called for his assistance.

Perhaps it was for the better, then, that the Serviceman was not capable of reading the thoughts which were passing through Dick's mind at that moment. As that percipient young man put it to himself: old Smithy always makes a fuss when you ask him for a bit of help, but he loves doing it nevertheless!

EMI Colour TV

EMI announced in April of this year that they had passed the million pounds mark for colour television equipment orders. Since then they have received further substantial orders bringing the present total value to £2,000,000 in less than five months. These orders have been received mainly from Europe and the United Kingdom and customers include A.B.C. TV, Anglia TV, B.B.C. and Yorkshire TV.

EMI's colour experience over the last 20 years has been incorporated in a very comprehensive range of colour television equipment. Designed for both the American and European television standards, using solid-state techniques throughout, the range includes the colour camera channel, slide scanner, vision mixing and switching equipment, encoders, decoders, vertical aperture correctors, and other ancillary equipment.

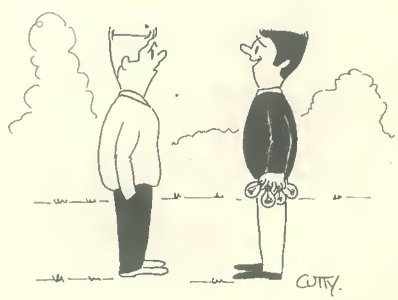
The four lead-oxide vidicon colour camera Type 2001 has continued to impress customers particularly in respect of stability and ease of operation. The camera's remarkable stability, both electrical and mechanical, results from the use of a direct imaging optical system together with the "capstan" arrangement of pick-up tubes and the unique lens mounting. The camera takes a range of zoom lenses each of which can quickly and simply be replaced.

New Sample Changer

A new automatic gamma sample changer has been developed by EMI Electronics specifically for use with a wide variety of different nucleonic counting systems. The user is thus able to adapt the unit to his particular application using existing ancillary equipment. The sample changer (Type ASC 1) accommodates up to 50 samples, has an integral solid state programme unit and employs a highly stable, low noise EMI photomultiplier.

The unique design of the heavily shielded crystal/photomultiplier assembly ensures high efficiency independent of sample volume and a low background level, unaffected by local highly active sources.

CARTOON
HUCKLE



"I'm gonna plant these old light bulbs and grow some electric currants"

Stabilised Variable Mains Supply Unit

by F. Neville Hart

A simple low-cost unit offering output voltages from 0 to 17 at currents up to 500mA.

Now that it is possible to obtain or build really high quality transistor amplifiers, many giving outputs of well over 5 watts, it is essential to provide a fully stabilised power supply offering anything from 9 to 17 volts or so.

In the case of amplifiers with push-pull output stages, a voltmeter will show considerable supply voltage variations, even across a battery, on loud passages, and to a musical ear distortion is quite obvious in such instances.

The writer uses the unit described in this article to supply a 5 watt amplifier and radio at a voltage of 12 to 15. Only on a particularly high input does the voltmeter needle budge, and then only for a quarter of a volt or so. It is also useful to be able to vary the output voltage so that small radios, etc., can be supplied. The present unit provides a variable output from 0 to 17 volts.

Power Unit Circuit

In the circuit, shown in Fig. 1, it will be seen that the ACY18 controls the voltage by regulating the current to the base of the large OC35. The base current required by the ACY18 is only of low value, and the potentiometer does not have to handle a heavy current. It can, in consequence, be an ordinary carbon type. It was found in practice that the value chosen for this component, 20kΩ, gave good calibration spacing for a dial mounted behind its control knob.

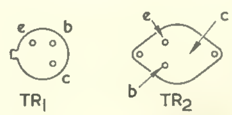
The two zener diodes can be type OAZ207, whereupon slightly greater than 18 volts (assuming diodes in the centre of tolerance) appears across them, this voltage then being applied to the track of the potentiometer. The zener diodes are clamped to a small aluminium heat sink measuring $1\frac{3}{4}$ x $1\frac{1}{4}$in, plus a flange for mounting, which also enables them to be supported mechanically. The heat sink is not entirely necessary, but the writer considered it worthwhile as there appeared to be some warming up of the diodes with the prototype.

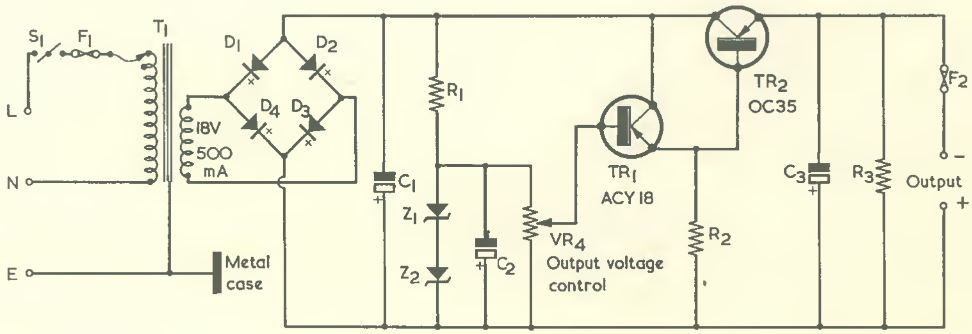
Other combinations of zener diodes, with a total zener voltage adding up to about 18, could also be used. If desired, the diodes could be chosen to offer a total zener voltage up to about 21 volts (corresponding to a maximum output voltage from the unit of approximately 20 volts) but regulation may be poorer at output voltages above about 17. With the original, it was found that capacitor C_2, across the diodes, eliminated a ripple which was otherwise present on the output.

As will be seen from Fig. 2 (*a*), the OC35 is directly secured to a heat sink, this being made of aluminium sheet and measuring $2\frac{1}{2}$ x $1\frac{3}{4}$in excluding the mounting flange. This sheet is at the full rectified negative potential, so care must be taken to see that it is well insulated from other components and wiring.

The function of resistor R_3 is to ensure that C_3 discharges rapidly when switching off without a load, this being a useful facility for some applications.

Fig. 1. Circuit diagram of the power supply unit





The power unit is built into an aluminium case to assist in the elimination of mains hum, a 2-way output lead passing out of this to the radio or amplifier being supplied. In any event, however, negligible hum is present, since large value smoothing capacitors are used.

Fuses

Fuses are advisable. One-hole-fixing fuse holders are available, and both fuses should be rated at 1 amp.

With 3-way mains sockets the earth connection may be taken to the power supply case, as shown in the circuit diagram. If desired, the positive output of the power supply may be made common to the metal case.

For safety reasons, a piece of Paxolin is attached over the mains terminals of the transformer. In addition, the inside of the metal case is covered with Fablon as insulation against any accidental contact with a "live" wire or connection. It must be remembered that the inside of the case cannot be seen when the top half is fitted and all precautions *must* be taken to ensure that there is no risk of any connection touching the internal surface of the case. Do *not* rely on the Fablon for this, as it is merely intended as an additional safeguard.

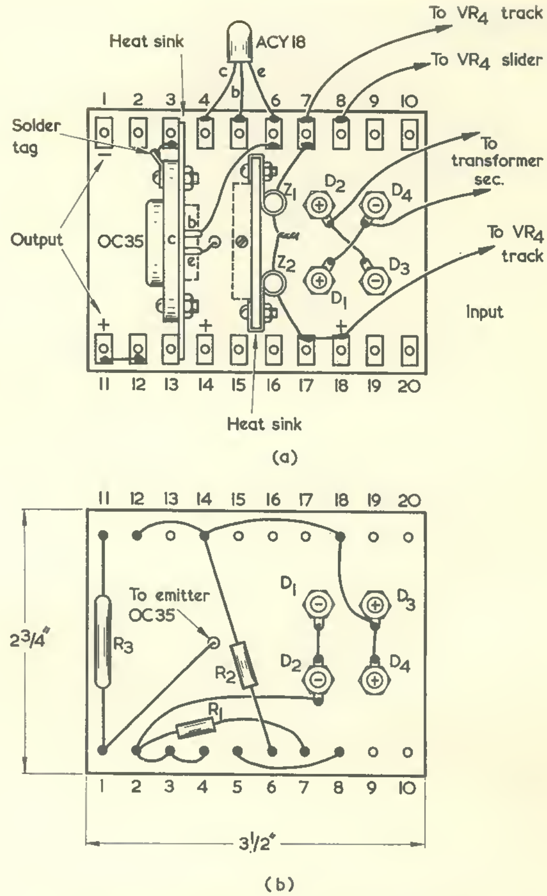


Fig. 2 (a). The upper side of the tagboard (b). The wiring on the underside of the tagboard

The potentiometer can be calibrated with a good voltmeter and the reading will be little affected by variations of the current taken. For evenly spaced readings around the dial, the potentiometer must have a linear track.

The usual care in soldering the leads of the transistors should be observed and this point also applies to the zener diodes and the germanium rectifiers, as the transference of excess heat to any of these would affect performance.

The metal case is made of two pieces of aluminium bent to fit into one another, one piece forming the ends and bottom, and the other the sides and top. They should be held together with self-tapping screws. See Fig. 3.

The transformer is secured to the bottom half direct, but the main part of the unit is built on to a Paxolin double tagboard obtainable generally and cut to approximately $3\frac{1}{2}$ x $2\frac{3}{4}$in, with 10 tags on each side. The wiring layout before the capacitors

COMPONENTS

Resistors
(All fixed resistors 10%)
R_1 1kΩ ½ watt
R_2 1kΩ 1 watt
R_3 2kΩ ½ watt
VR_4 20kΩ variable, linear

Capacitors
$C_{1,2,3}$ 500μF electrolytic, 30V wkg.

Transformer
T_1 Mains transformer, secondary 18V 500mA, type PS245 (Henry's Radio Ltd.)

Semiconductors
TR_1 ACY18
TR_2 OC35
$D_{1,2,3,4}$ Germanium rectifier type GJ3M (Henry's Radio Ltd.)
$Z_{1,2}$ Zener diode type OAZ207 (see text)

Fuses
$F_{1,2}$ 1A fuse, with fuse holder

Switch
S_1 on-off toggle

Miscellaneous
Heat sink clips
Pointer knob
Tagboard
Aluminium sheet, spacing washers, grommets. etc.

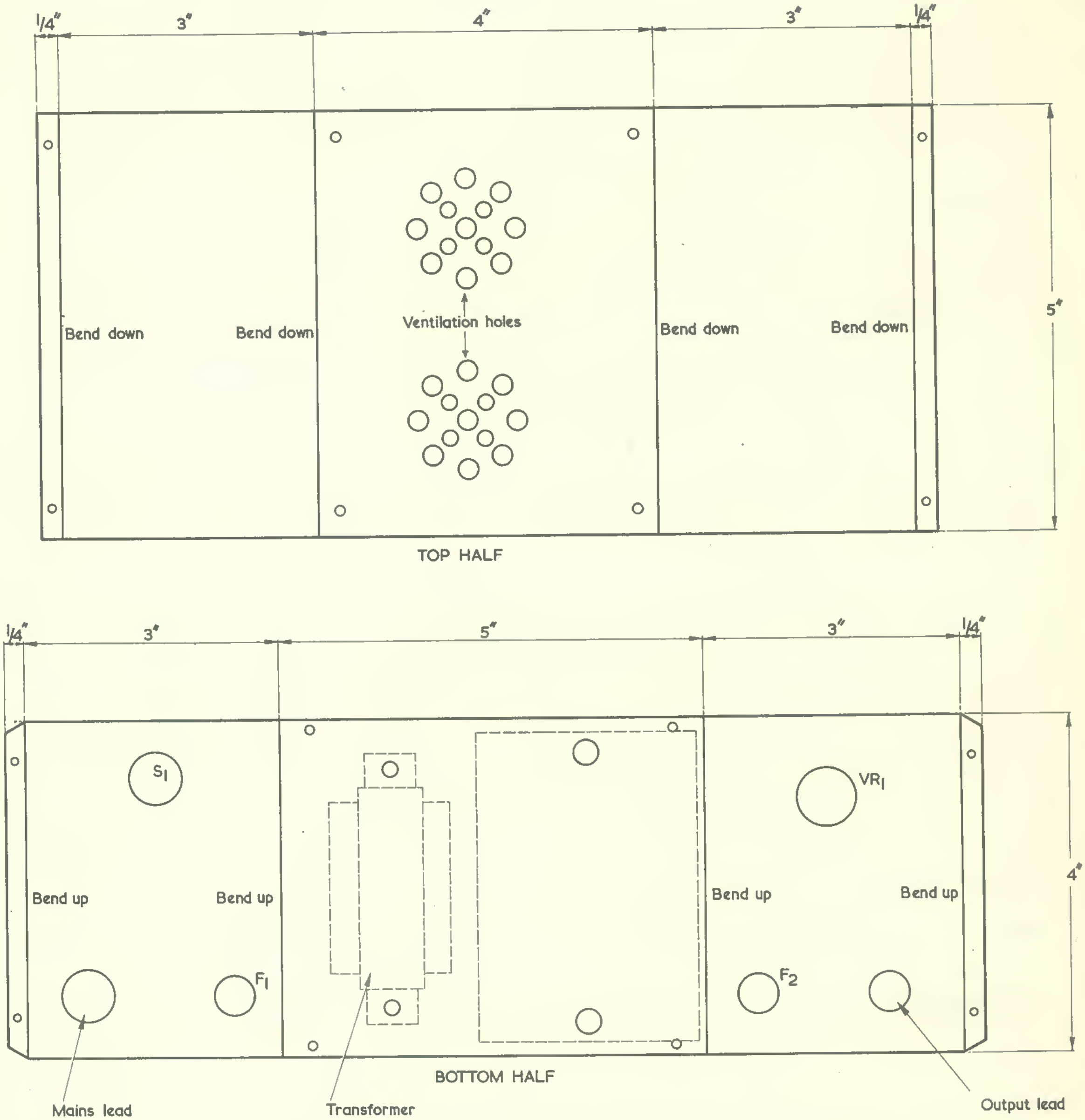


Fig. 3. Details of the two halves of the metal case before bending. The material is aluminium sheet

are fitted is shown in Figs. 2 (*a*) and (*b*). After the wiring steps shown are completed the capacitors are added in the following manner, carefully observing polarity. C_1 between tag 18 (positive) and tag 4; C_2 between tag 17 (positive) and tag 7; C_3 between tag 12 (positive) and tag 1. Fit sleeving over all wires where any risk of short-circuit exists. When soldered up, the tagboard is secured to the bottom half of the metal case by means of long screws with spacing washers.

The rectifiers are mounted on to the Paxolin of the tagboard at suitably drilled holes. Connections are made by way of solder tags, as this type does not have wire ends, only fixing nuts. The larger end of each rectifier is positive (+) and the transparent end is negative (—).

The power unit should not, of course, be used at a higher voltage for any radio or amplifier than that specified by their manufacturers. ✱

Radio Topics

By Recorder

ONE OF THE MAIN DIFFICULTIES with building small computers for industrial, educational and experimental applications is the large number of connections which have to be made. For instance even the humble bistable which is needed to divide by 2 has some 14 two-terminal components (resistors, capacitors and diodes) and 2 transistors, whereupon the total number of connections it needs is of the order of 20. Thus, to set up a counter capable of dividing only by 8, you have to sit down and make no less than 60 connections. The problem involved is not so much the cost of components required for the computer—it is the amount of time which has to be spent in wiring it up.

Logic Modules

A neat answer to this problem is provided by West Hyde Developments Ltd., who manufacture a wide range of plug-in logic modules under the name "Pidam", each module consisting of a complete logic element capable of performing a basic function in logic circuitry. The modules may be plugged into B9A valveholders, and are designed so that the wiring between valveholders is kept to a minimum. In consequence, the Pidam system considerably eases the problems of initial design and assembly of small computers because it reduces wiring time and offers the further advantages of versatility and flexibility.

The supply voltages required are +7.5, 0 and −7.5 and the modules are standardised so that pin 7 is always OV, pin 8 is always −7.5V and pin 9 is always +7.5V. A layout intended for experimental work may, therefore, have pins 7, 8 and 9 of the B9A valveholders permanently wired up to the supply source. If relay operation is required, a −24V supply is also needed. Suitable power packs capable of offering the required voltages can be obtained from West Hyde Developments, as may other ancillary equipment including reed switch relays, an electromagnetic counter and an oscilloscope. Apart from their use for experimental and educational purposes, Pidam modules can, of course, appear in finalised equipment intended for industrial control functions.

There are 16 logic modules in the Pidam range, these including AND and OR gates, a linear amplifier, a Schmitt trigger, a bistable and a shift register. The accompanying photograph illustrates the Pidam bistable with its cover removed. As may be seen, standard components are used inside the module.

An illustrated booklet describing the Pidam system and its applications has now been published. Readers of *The Radio Constructor* may obtain copies free of charge by writing to West Hyde Developments Ltd., 30 High Street, Northwood, Middx. I should add that many of the Pidam assemblies may be obtained in kit form, as is made clear in the booklet.

Printed Circuit Hotel

One of our contributors, Mr. C. P. Finn (his last article, "S.W.G. Measurement", appeared in the December 1966 issue), reports an unconventional use for printed circuit boards at Atherstone, Warwickshire. In the White Hart Hotel at Atherstone printed circuit boards measuring 6 x 4in are screwed to some of the doors to act as rather intriguing finger-plates. These were originally intended for industrial use, possibly computing, since they have tab areas on the edge for plug-in connections. Other points of interest are that they are "imperforate" (that is, the holes have not been pierced for the components) and they have never seen solder in their lives. As a result, the copper parts have acquired quite a lustre from the polishing action of many fingers, although they are not deliberately polished.

Mr. R. Packer, the present landlord of the White Hart Hotel, says the printed circuit boards were there when he took over, and has no idea of their past history or who made them.

A well-designed printed circuit board immediately after etching is, of course, quite a decorative thing, and is certainly attractive enough in appearance to be used as an unconventional finger-plate on a door. Some of the bright plastic housings used for present-day capacitors and other components are similarly pleasant to look at. Perhaps we are approaching the time when our wives, instead of fussing because electronic bits and pieces find their way into the house, will actually start raiding our spares boxes for components with which to embellish the place!

A Theremin For Christmas

It won't be long before the party season commences and the more electronically minded amongst us are called upon to produce gadgets for the amusement of guests.

One of the simplest gadgets to make for a party is based on the principle of the theremin, and can be easily knocked up by the more experienced short-wave enthusiast. For those who haven't heard of it before, I should mention that the theremin is a pre-war electronic musical instrument which is still mentioned in the radio press every now and again. Basically, it consists of two r.f. oscillators beating with each other, the resultant a.f. note being fed to an amplifier and loudspeaker. A vertical metal rod several feet long is connected to the hot end of the tuned circuit in one oscillator, with the consequence that the resonant frequency of that tuned circuit varies as the theremin player's hand approaches the rod.

If the oscillators are set up so that a zero beat note is given when the player's hand is well away from the rod, a continually rising note is given as the player's hand comes closer to it. Quite interesting and amusing effects can be obtained with practice. It is desirable to give some tremolo to the tone by waggling the hand or fingers, as otherwise the sine wave beat note tends to become monotonous. It is, of course, the body capacitance of the theremin player which causes the change in oscillator frequency, and it is necessary to ensure that the earthy end of the tuned circuit coupled to the rod is connected to a reasonably good earth.

The party variation on the theremin consists of replacing the metal rod with a piece of thin wire some four or five feet long fixed to one side of a doorway. The hot end of the tuned circuit of an r.f. oscillator is coupled to this, and the oscillator output is fed to any short-wave receiver fitted with a b.f.o. and capable of feeding a speaker at good volume. Best results will normally be given at a frequency in the order of 5 to 10 Mc/s. The oscillator and receiver are set up to zero beat before the party starts, and guests are invited to try and pass through the doorway without causing the "radar sentry" (or whatever fanciful name you care to give the gadget) to sound a warning. Non-technical people find it quite fascinating to observe that a siren-like tone which gradually increases in pitch is heard as they approach the door, and to find that the "sentry" cannot be "beaten" however carefully they try to sidle through.

The oscillator coupled to the pick-up wire at the door may be mounted unobtrusively on the skirting board near the bottom of the wire, and it could employ a single transistor and its own small battery. It should have a pre-set variable capacitor across the tuned coil to which the pick-up wire connects, the capacitor being adjusted to a value which gives the pick-up wire just sufficient sensitivity. As can be readily imagined, the pick-up wire will have greater sensitivity as the value of the pre-set capacitor decreases, since it will then be capable of altering a greater proportion of the total tuning capacitance. The short-wave receiver is tuned to whatever oscillator frequency is given at the desired frequency. Sufficient sensitivity is given when the beat note approaches the upper audible limit in frequency when someone is very close to the wire.

Car Radio Supply

To finish this month, I pass on

A Pidam bistable module, manufactured by West Hyde Developments, Ltd. This may be plugged into a B9A valveholder

an idea to those readers who employ 9-volt transistor portables in their cars from time to time, and who feel that it might be economical to run these from the 12-volt battery fitted in the car. I haven't tried this idea myself, and I merely put it forward as a suggestion. It should be quite easy to put into operation provided that care is taken to prevent short-circuits between the car body and any metalwork of the radio which is at the potential of the radio chassis. Similarly, care must be taken to ensure that there is no risk of damage due to short-circuits between the car body and any aerial system external to the radio cabinet. The idea should only be tried out by those who fully understand the principles involved.

Now that high-wattage zener diodes are readily available it becomes a simple matter to obtain a well regulated 9-volt supply from a 12-volt car battery. To take very extreme figures, the car battery voltage may vary between 11 and 15 volts. If a car battery exhibiting such voltages is connected to a 9-volt zener diode by way of a 20Ω resistor the following figures apply.

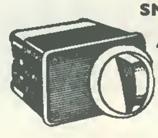
At 11 volts battery potential, 2 volts are dropped in the 20Ω resistor, resulting in a current of 100mA in this resistor and, with no load across the zener diode, in the diode as well. The resistor dissipates 0.2 watt and the diode 0.9 watt.

At 15 volts battery potential, 6 volts are dropped in the 20Ω resistor, with a consequent current of 300mA in the resistor and, assuming no load, in the zener diode. Resistor dissipation is 1.8 watt and zener diode dissipation is 2.7 watt.

I see that the ZS9.1 zener diode listed in the Henry's Radio catalogue is rated at 9.1 volts $\pm 5\%$ and 7 watts, so this would be eminently satisfactory for the zener diode. And the 20Ω resistor could be any 3 watt or 4 watt component.

By using the zener diode and resistor in series, a well regulated 9.1 volts becomes available across the zener diode and, provided that the short-circuit risks I mentioned just now are carefully avoided, should offer adequate current availability for a normal 9-volt transistor portable. In cars with a positive earth, the zener diode should be at the positive end of the series combination. With a negative earth, the zener diode should be at the negative end.

The zener diode and resistor offer a very simple 9-volt supply but they do not provide any noise suppression. It should be found that the large-value electrolytic capacitor fitted across the supply lines in a conventional transistor portable should filter out any noise that is present. And, of course, the radio *must* be connected with correct polarity across the zener diode or, apart from any other damage that might occur, that large-value electrolytic will cease to take any further interest in life!



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30C15	12/–	ECH81	5/–	PCC85	6/9	UCC84	8/–	BCY10	5/–	OC35	10/–
30C17	13/–	ECH83	7/–	PCC88	10/6	UCC85	6/6	BCY12	5/–	OC36	7/6
30C18	9/6	ECH84	6/6	PCC89	9/9	UCF80	8/3	BCY33	5/–	OC38	11/6
30F5	11/6	ECL80	6/–	PCC189	8/3	UCH21	9/–	BCY34	5/–	OC44	2/–
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30L17	13/–	EF80	4/6	PCF801	8/6	UF41	7/9	BFY52	5/–	OC72	2/–
30P4	11/6	EF85	4/6	PCF802	9/6	UF42	4/9	BF163	4/–	OC75	2/–
30P4MR	13/–	EF86	6/3	PCL82	6/3	UF80	6/9	BY100	3/6	OC76	3/–
30P12	11/–	EF89	4/9	PCL83	8/6	UF85	7/3	BY234	4/–	OC77	3/4
30P19	11/–	EF183	6/3	PCL84	7/–	UF86	9/–	BY238	4/–	OC78	3/–
30PL1	15/–	EF184	5/9	PCL85	8/3	UF89	5/6	BYZ12	5/–	OC78D	3/–
30PL13	15/–	EH90	7/6	PCL86	8/–	UL41	8/9	BYZ13	5/–	OC81	2/–
30PL14	15/–	EL33	12/–	PFL200	13/6	UL84	5/6	GET103	4/–	OC81D	2/–
30PL15	15/–	EL41	8/–	PL36	9/–	UM80	5/–	GET113	4/–	OC82	2/3
DM70	6/–	EL42	7/6	PL81	6/9	UY41	5/6	GET116	7/6	OC83	2/–
DY87	5/9	EL84	4/6	PL82	5/9	UY85	4/9	GET118	4/6	OC84	3/–
E88CC	12/–	EL95	5/–	PL83	6/–	2N404	6/–	GET119	4/6	OC123	4/6
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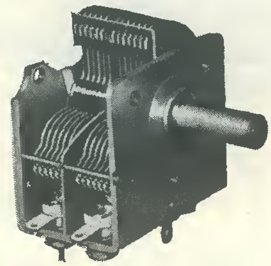

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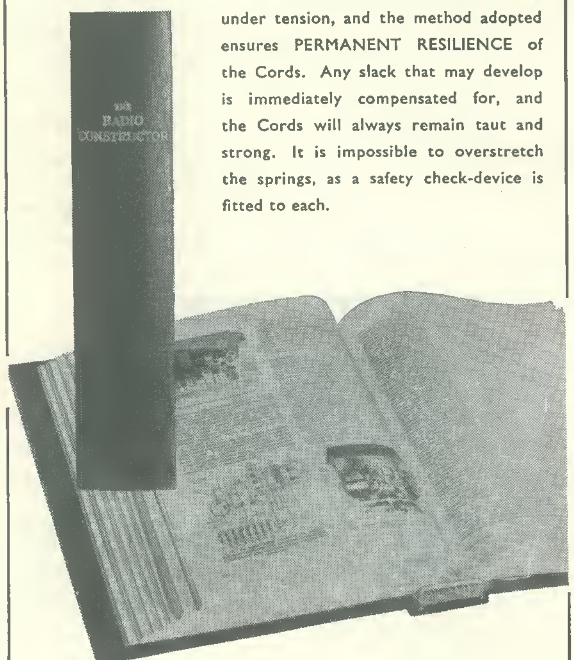

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SMALL ADVERTISEMENTS

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FOR SALE. 8-day clock by Waltham Watch Co. 3¼" diam. panel mounting, with second hand and date dial, £5. Deck watch by Jolay, 2½" diam., rotatable navigational ring graduated to 360° in fitted wooden case. £10, p.p. paid.—Box No. F311.

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