PRACTICAL
ELECTRONICS

DECEMBER 1968

THREE SHILLINGS

Electronic STOCKMARKET

ALSO

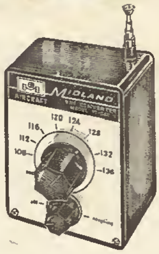
"FLIP FLOP"

**** Another Game For Partytime

Lasky's Radio

SPECIAL INTEREST ITEMS!

MIDLAND Model 10-502 VHF AIRCRAFT BAND CONVERTER



An entirely new item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535 to 1,605kc/s, 88 to 108Mc/s respectively—with no electrical conversion or connection required. The Model 10–502 (self powered by one 9V (PP3 type) battery) is merely placed close to the receiving set and then tuned over 110 to 135Mc/s which covers the whole aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position and balancing the volume controls of each accordingly. The Model 10–502 has a smartly designed black plastic cabinet with brushed metal front panel and 18in chrome telescopic antenna, size only 4 × 2¾ × 2⅜in (inc. knobs). Complete with battery and full instructions.

Lasky's Price 79/6 Post 3/6

SPECIAL TRANSCRIPTION MOTOR OFFER — FAMOUS Connoisseur Classic

2 speed transcription deck. One synchronous motor for each speed—45 and 33 r.p.m. **List Price £15.15.7.**

Lasky's Price £9.19.6. P. & P. 5/-

ALSO AVAILABLE Connoisseur SCU.1 pickup arm and cartridge. **List Price £8.13.4.**

Lasky's Price £5.19.6. P. & P. 3/6

PACKAGE PRICE IF BOUGHT TOGETHER £12.19.6. P. & P. 5/-

GARRARD RECORD PLAYERS

AUTOCHANGERS

1025	£7/19/6
2025	£8/19/6
SL95	£45/0/0
3000LM with stero cart.	£9/19/6
AT60 Mk. II	£13/19/6
A70	£13/19/6
AP75	£20/10/0
A50	£7/7/0

GARRARD BASES

WB1 £3/5/8 WB2 £4/13/8 WB4 £5/6/11

SINGLE PLAYERS

GARRARD SP25 Mk. II	£11/19/6
GARRARD SRP22	£6/10/6

TRANSCRIPTION DECKS

GARRARD 401	£27/19/0
GARRARD Lab. 80 Mk. II with base	£30/9/0

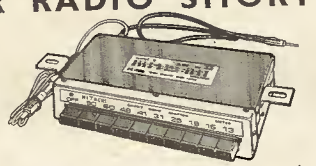
CLEARVIEW PERSPEX COVERS

SPCI £3/3/10 SPC2 £4/4/4 SPC4 £4/4/11

Postage on all above 5/- extra.

HITACHI CAR RADIO SHORT WAVE ADAPTOR

Model WM20



New from Hitachi—world famous for high quality transistor radios—a push button Short Wave adaptor enabling you to receive all foreign broadcasts in the 3-22Mc/s waveband. The WM-20 adaptor is suitable for use with any make or model of AM car radio (covering the usual 535-1,605kc/s) in any make or model of car (6 or 12V, positive or negative ground). The WM-20 as will be seen has 10 push buttons which cover metre bands: 13, 16, 19, 25, 31, 41, 49, 60 and 90 plus Off button. Having selected the required band by pushing the appropriate button—fine station tuning is effected by use of the parent radio's tuning system—details with the adaptor show corresponding centres for each short wave band on the radio dial. Double superhet IFM circuit and the use of a Zenor diode and compensating condenser, provides great stability. Switched adjustment for 6 or 12V and pos. or neg. ground; external aerial trimmer provided. Connection to the parent radio is via the aerial jack, power is taken direct from the car AUX. supply with sep. line fuse. All necessary mounting brackets, leads and jacks are provided with instruction manual. The WM-20 is very smartly styled with brushed and bright chrome front panel and black push buttons. Size 8 1/16" wide × 1⅝" high × 3½" deep.

List Price 14 Gns. **Lasky's Price £9.19.6.** P. & P. 5/-.

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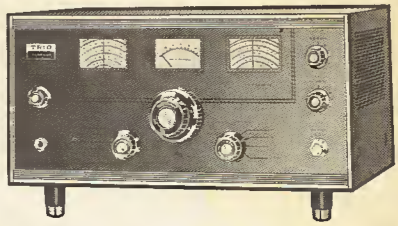
COMMUNICATION RECEIVERS

TRIO MODEL 9R-59DE

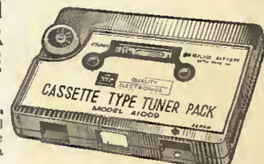


Brief spec.: 4 band receiver covering 550kc/s to 30Mc/s continuous and electrical band spread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. **Special features:** SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. band spread dial ● IF frequency 455kc/s ● Audio output 1·5W ● Variable RF and AF gain controls. For use on 115/250V a.c. Mains. Beautifully designed control layout finished in light grey with dark grey case, size 7 × 15 × 10in. Weight 19lb. Fully guaranteed, complete with instruction manual and service data.

Lasky's Price £39.15.0 Carriage and Packing 12/6

SPECIAL INTEREST ITEM JUST ARRIVED

TTC Model A.1009 AM TUNER ADAPTOR PACK FOR CASSETTE RECORDERS

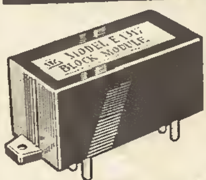


An amazingly ingenious AM Tuner that looks like and is exactly the same size as a standard tape cassette—which converts your tape cassette recorder/player instantly into a radio! The tuner pack is a completely self-contained unit with built-in ferrite rod aerial, power source (one miniature Ever-Ready type D23) giving approx. 150 hrs operation. All you do is take out the tape cassette and slip in the tuner. Tunable over 535-1,605kc/s (full Medium waveband). Suitable for use with all standard tape cassette recorders and players. Complete with battery.

Lasky's Price 89/6. P. & P. 2/6.

CONSTRUCTORS BARGAINS

LASKY'S ENCAPSULATED SOLID STATE MODULES



8 completely new special function circuit modules. Size of each module only 2¼ × 1½ × ⅜in. Ready for immediate use—just connect to power source (usually 9V batt.), input and output. Encapsulated modules are shockproof and almost indestructible. Comp. with full ins. **Post 1/6 each.**

E-1311 Phono Pre-amp Module—max. output 3V. RMS, input 50mV, input imp. 100kΩ, gain 28dB, RIAA compensation. **29/6**

E-1312 Tape Head Pre-amp Module—max. output 3V, RMS, input 50mV, input **29/6**
imp. 100kΩ, gain 25dB, NARTB compensation.

E-1313 Microphone Pre-amp Module—max. output 4V, RMS, input 50mV, input **29/6**
imp. 100kΩ, gain 28dB, response 10·50kc/s.

E-1314 Power Amplifier Module—max. output 300mW, input imp. 1kΩ, gain **29/6**
20dB, response 50-10k/cs, distortion 3% at 20mW.

E-1315 Electronic Organ (tone oscillator) **Module**—frequency 200–1,000c/s, **25/-**
output 80mW. For use with keyboard, variable resistors and 8Ω speaker.

E-1316 Morse Code Practice Oscillator Module—frequency 400c/s, output **25/-**
80mW. For use with morse key and speaker.

E-1317 Modulated Wireless Signal Transmitter for use in test bench fault finding **25/-**
—frequency 400c/s–30Mc/s, tone freq. 400c/s. For use with any AM receiver.

E-1318 Lamp Flasher Module—flashes two miniature lamps alternately. For use **25/-**
with 6V, 100/200mA bulbs and 6V power supply.

CLEAR PLASTIC PANEL METERS

Precision made in Japan by TTC. Each meter boxed and fully guaranteed with all fixing nuts and washers. Sizes are of front panel. Add 1/6 P. on each. (Quotes for quantities.)

Type KR-52 3 × 2½in (illustrated).

1mA	38/6	50μA	56/-
5mA	38/6	1mA S Meter	39/6
100mA	38/6	100μA	52/6
300V	35/-	500μA	45/-

Type MK-38A 1⅝in square

1mA	29/6
5mA	27/6
100mA	27/6
300V	27/6
50μA	37/6
1mA S meter	29/6
100μA	37/6
500μA	29/6

Type KR-65 3½ × 3in

1mA	38/6
5mA	37/6
100mA	38/6
300V	36/-
50μA	59/6
1mA S meter	42/-
100μA	56/-
500μA	46/-

Type MK-45A 2in square

1mA	29/6
6mA	28/6
100mA	28/6
300V	28/6
50μ A	49/6
1mA S meter	32/6
100μA	42/6
500μA	35/-

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OB2	6/-	6J6	3/6	30L15	15/-	ECH35	11/-	GZ34	11/6	U25	15/-
1R5	6/-	6K8	4/-	30P19	14/-	ECH42	11/-	MU14	8/-	U26	15/-
1S5	4/6	6L6	9/8	30PL1	15/-	ECH81	6/3	PABC80	7/6	U191	14/-
1T4	3/-	6Q7	8/3	30PL13	16/-	ECH83	8/6	PCC84	6/6	U281	8/-
1U4	6/-	6SG7	6/-	35L6	8/-	ECL80	7/9	PCC85	8/-	U301	11/-
1U5	7/-	6SJ7	7/-	3524	8/6	ECL82	7/-	PCC88	11/6	U801	22/6
2D21	5/-	6SL7	6/-	35W4	5/3	ECL83	10/6	PCC89	11/6	UABC80	6/-
3A5	10/-	6SM7	5/6	50B5	6/6	ECL86	9/-	PCC189	12/6	UAF42	10/-
3Q4	7/-	6U7	7/-	50C5	6/6	EF37A	8/-	PC86	11/-	UBC41	8/-
3S4	5/-	6V6	5/-	80	7/-	EF40	10/-	PC88	11/-	UBF80	7/-
3V4	6/-	6X4	4/3	AZ31	10/-	EF41	9/6	PC97	8/6	UBF89	7/-
5R4	9/-	6X5	5/-	DAF91	4/6	EF42	10/6	PC900	9/6	UCC84	10/-
5U4	5/-	7B7	7/-	DAF96	7/-	EF80	5/-	PCF80	7/3	UCC85	7/-
5V4	8/6	7C6	6/6	DF91	3/-	EF85	6/6	PCF82	7/-	UCF80	9/6
5Y3	5/9	7Y4	8/6	DF96	7/-	EF86	7/-	PCF84	9/-	UCH42	10/-
5Z4	8/-	10C2	15/-	DK91	6/-	EF89	6/3	PCF86	9/-	UCH81	7/-
6/30L2	12/6	10F1	9/-	DK92	8/9	EF91	4/-	PCF800	15/-	UCL82	8/-
6AC7	4/-	10P13	15/-	DK96	8/-	EF92	4/-	PCF801	10/-	UCL83	10/-
6A67	6/-	10P14	16/-	DL92	5/-	EF183	7/-	PCF802	10/-	UF41	10/-
6AK5	5/-	12AT6	5/-	DL94	6/-	EF184	7/-	PCF805	14/-	UF80	7/-
6AL5	3/-	12AT7	4/-	DL96	8/-	EL33	17/6	PCL82	7/6	UF85	7/6
6AM6	4/-	12AU7	5/-	DY86	6/6	EL34	11/-	PCL83	9/6	UF89	7/6
6AQ5	6/-	12AX7	6/-	E88C	12/6	EL41	9/9	PCL84	8/-	UL41	10/-
6AS6	8/-	12BA6	6/9	EABC80	7/-	EL42	11/-	PCL85	9/6	UL84	7/-
6AT6	5/-	12BE6	6/9	E180F	15/-	EL81	9/-	PCL86	9/-	UY41	7/6
6AU6	5/9	12BH7	6/8	EAF42	9/6	EL84	5/-	PFL200	12/6	UY85	6/6
6BA6	4/9	12Q7	5/6	EB91	3/-	EL85	8/6	PL36	10/6	VR105/30	5/6
6BE6	5/3	12SQ7	7/6	EBC41	9/6	EL91	4/-	PL81	7/6	VR150/30	5/-
6BH6	8/-	19AQ5	6/-	EBC81	7/-	EL95	5/3	PL82	7/-		
6BJ6	8/-	20F2	14/-	EBF80	7/6	EM80	7/6	PL83	7/-		
6BR7	11/-	20L1	13/-	EBF83	9/-	EM81	8/-	PL84	6/9		
6BZ6	7/-	20P1	12/-	EBF89	7/6	EM84	7/6	PL500	14/6		
6C4	3/6	20P3	12/-	ECC40	11/6	EM87	7/6	PY33	9/9		
6C6	4/-	20P4	22/6	ECC81	4/-	EY51	7/6	PY80	5/6		
6CD6	20/-	25L6	6/6	ECC82	5/-	EY86	7/-	PY81	6/-		
6CH6	6/-	25Z4	8/-	ECC83	6/-	EZ40	8/6	PY82	6/-		
6CL6	10/-	30C15	13/6	ECC84	6/6	EZ41	8/6	PY83	6/6		
6D6	3/-	30C18	14/-	ECC85	5/6	EZ80	5/6	PY88	7/6		
6E5	8/-	30F5	14/-	ECF80	7/-	EZ81	5/6	PY800	8/-		

MANY OTHER TYPES IN STOCK.

TRANSISTORS

2N696	5/-	AF118	4/6	BSY56	17/3	OC73	5/-
2N697	5/-	AF119	4/6	BSY65	4/6	OC74	5/-
2N706	3/-	AF186	12/-	BSY78	7/6	OC75	4/6
2N706A	4/-	ASY28	6/6	BSY79	7/6	OC76	4/6
2N708	4/-	BC107	4/6	BSY95A	3/6	OC77	4/6
2N743	4/-	BC108	3/6	BUY10	12/6	OC78	5/-
2N744	4/-	BC109	4/6	GET106	4/6	OC81	4/-
2N753	4/6	BC170	3/-	GET113	5/-	OC81M	2/6
2N914	4/6	BC172	3/3	GET873	4/6	OC81D	3/-
2N916	4/6	BC173	3/9	GET874	4/6	OC81DM	2/6
2N929	4/6	BCY31	4/6	MAT100	7/9	OC82	4/6
2N930	5/-	BCY34	4/6	MAT101	8/6	OC83	5/-
2N1613	5/-	BCY39	4/6	MAT120	7/9	OC139	7/6
2N1711	8/6	BCY42	5/-	MAT121	8/6	OC140	9/6
2N1893	8/-	BCY43	5/-	NKT210	5/-	OC169	4/6
2N2160	14/11	BF115	4/6	NKT211	5/-	OC170	4/6
2N2147	17/6	BFX12	6/6	NKT212	4/9	OC171	4/6
2N2926	3/-	BFX13	6/6	NKT213	5/-	OC200	5/-
2S102	6/6	BFY10	4/6	NKT214	3/9	OC201	7/6
2S103	6/6	BFY11	4/6	NKT215	3/9	OC202	6/-
2S104	6/6	BFY17	4/6	NKT216	9/6	OC203	6/-
AC107	4/6	BFY18	4/6	NKT217	9/6	OC204	6/-
AC126	4/6	BFY19	4/6	NKT219	4/9	ST140	4/-
AC127	4/6	BFY50	4/6	NKT223	5/-	ST141	6/-
AC128	4/6	BFY51	4/-	NKT224	3/9	XA104	4/6
AC165	4/-	BFY52	4/6	NKT225	3/9	XA124	4/6
AC167	4/6	BFY90	12/6	NKT229	5/-	XA125	4/6
ACY19	4/6	BSX19	5/6	NKT405	14/3	XB112	3/-
ACY20	4/9	BSX20	5/6	NKT403	12/6	XC141	7/-
ACY21	4/6	BSX40	13/9	OC23	8/6		
ACY22	4/-	BSX41	17/-	OC25	7/6		
ACY40	4/3	BSY10	5/-	OC26	6/-		
ACY41	4/6	BSY11	5/-	OC28	8/6		
AD140	8/6	BSY26	4/6	OC35	8/6		
AD149	16/-	BSY27	4/6	OC36	8/6		
AD161	8/-	BSY28	4/6	OC41	5/-		
AD162	8/-	BSY29	4/6	OC42	5/-		
ADT140	15/-	BSY38	4/6	OC44	4/-		
AF114	6/6	BSY39	4/6	OC45	3/-		
AF115	4/6	BSY51	7/9	OC70	3/-		
AF116	4/6	BSY52	8/9	OC71	3/-		
AF117	4/6	BSY53	8/3	OC72	4/-		
		BSY54	9/6				
		BSY55	15/9				

PHOTO TRANSISTORS
OCP71 12/6

SIGNAL DIODES

IN34A	4/-
OA5	3/6
OA70	2/-
OA79	2/-
OA81	2/-
OA90	2/6
OA95	2/6

SILICON POWER DIODES

60 P.I.V. 290 MA 2/-	6 AMP 5/6
70 P.I.V. 1 AMP 3/6	400 P.I.V. 8 AMP 7/6
140 P.I.V. 165MA 1/-	700 P.I.V. 100 AMP 35/-
150 P.I.V. 25AMP 10/-	800 P.I.V. 500MA 5/6
200 P.I.V. 6 AMP 5/6	800 P.I.V. 5 AMP 7/6
400 P.I.V. 500MA 3/6	1000 P.I.V. 6 AMP 7/6
400 P.I.V.	1000 P.I.V 650MA 6/6

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400 P.I.V. 3 AMP 7/6	200 P.I.V. 7 AMP 15/6
100 P.I.V. 7 AMP 13/6	400 P.I.V. 7 AMP 15/6

PLEASE ADD POSTAGE

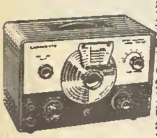
ZENER DIODES

OAZ200	12/-	OAZ208	6/6
OAZ201	10/-	OAZ209	6/6
OAZ202	8/6	OAZ210	6/6
OAZ203	8/6	OAZ211	6/6
OAZ204	8/6	OAZ212	6/6
OAZ205	8/6	OAZ213	6/6
OAZ206	8/6	OAZ227	15/-
OAZ207	9/6		

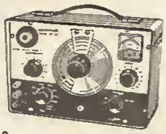
STC. 1 WATT SERIES 5% 2.4/2.7/3/3.9/4.3/13/16/18/20/30/33 volt, 5/- each.
Z series. All voltages from 3.9–50 volt. 250mW, 2/6 ea. 1.5w 4/- ea. 7w 5/- each.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120Kc/s - 260 Mc/s on 6 bands, Directly calibrated. Variable R.F. attenuator. Operation 200/240V a.c. Brand new with instructions. **£15.0.0.** P. & P. 7/6. S.A.E. for details.



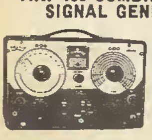
LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER



2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c.

Brand New £17.10.0. Carr. 7/6.

ARF-100 COMBINED AF-RF SIGNAL GENERATOR

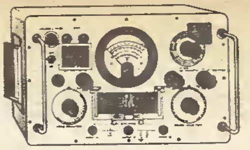


AF. SINE WAVE 20 – 200,000c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP.** 21V P/P 600Ω 3·8V P/P.
TF. 100kc/s–300 Mc/s.
Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF. output and % mod. on R.F. 220/240V a.c. **£30.0.0.** Carr. 7/6.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

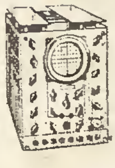
10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1.2Mc/s. Decibels – 40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

AVO CT.38 ELECTRONIC MULTIMETERS



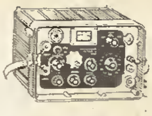
High quality 97 range instrument which measures a.c. and d.c. Voltage, Current, Resistance and Power output. Ranges d.c. volts 250mV–10,000V. (10megΩ–110megΩ input). D.c. current 10μA 25 amps. Ohms: 0–1,000mgΩ. A.c. volt 100mV–250V (with RF measuring head up to 250Mc/s). A.c. current 10μA–25 amps. Power output 50 micro-watts–5 watts. Operation 0/110/200/250V. C. Supplied in perfect condition complete with circuit lead and RF probe **£25.** Carr. 15/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



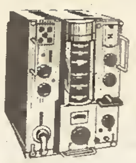
An excellent general purpose D/B oscilloscope. T.B. 2c/s–750 kc/s. Bandwidth 5-5 Mc/s. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V a.c. Supplied in excellent working condition. **£22.10.0.** Or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

AM/FM SIGNAL GENERATORS



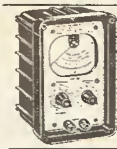
Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80Mc/s. AM/C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

ADMIRALTY B.40 RECEIVERS



Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650kc/s – 30Mc/s, I/F 500 kc/s. Incorporates 2 R.F. and 3 I.F. stages, band-pass filter, noise limiter, crystal controlled B.F.O., calibrator I/F, output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19½ × 13½ × 16in. Weight 114lb. Offered in good working condition, **£22.10.0.** Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above 15kc/s–700kc/s. **£17.10.0** Carr. 30/-.

MARCONI CT44/TF956 AF ABSORPTION WATTMETER



1 μ/watt to 6 watts.
£20. Carr. 20/-.

AVOMETERS

Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions.
Model 47A **£9.19.6.** P. & P. 7/6 each.

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A crystal controlled hetrodyne frequency meter covering 1·7–8Mc/s. Operation on 6 volts d.c. Ideal for amateur use. Available in good used condition **£5.19.6.** Carr. 7/6. Or brand new with accessories **£7.19.6.** Carr. 7/6.

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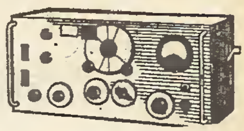
0/115/230v. Step up or step down. Fully shrouded.

150 W.	**£1.12.6,**	P. & P. 3/-
300 W.	**£2.7.6,**	P. & P. 3/6
500 W.	**£3.10.0,**	P. & P. 6/6
1,000 W.	**£5.10.0,**	P. & P. 7/6
1,500 W.	**£6.10.0,**	P. & P. 8/6
3,000 W.	**£7.10.0,**	P. & P. 12/6
7,500 W.	**£15.10.0,**	P. & P. 20/-

MARCONI TEST EQUIPMENT



EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS, 85kc/s–25 Mc/s, **£25,** carr. 30/-. TF.885. VIDEO OSCILLATOR. 0·5Mc/s, **£45.** Carr. 30/-. T.F. 195M. BEAT FREQUENCY OSCILLATOR 0–40kc/s, 200/250V a.c. **£20,** carr. 30/-. TF.142E. Distortion Factor Meter, **£20,** carr. 20/-. All above offered in excellent condition fully tested and checked. TF. 1100 VALVE VOLTMETER, Brand New, **£50.** T.F. 1267 TRANSMISSION TEST SET, Brand New, **£75.** TF.1371. Wide Band Millivolt Meter, **£50.**

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High quality construction. Input 230V 50-60 cycles.
Output full variable from 0-260V. Bulk quantities available.
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8 amp.—**£14.10.0;** 10 amp.—**£18.10.0;** 12 amp.—**£21;** 20 amp.—**£37.**

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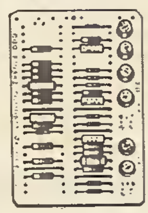
A high quality U.H.F. signal generator covering 10–310 Mc/s. Operates on 200/250V a.c. Supplied in excellent condition complete with calibration charts. **£15.** Carr. 15/-.

PRINTED CIRCUITS



Five assorted printed circuit boards with transistors, diodes, resistors, condensers, etc. Guaranteed minimum 20 transistors. Ideal for experimenters, 5 boards for **10/-.** P. & P. 2/-.

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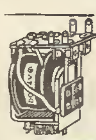

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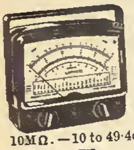
LAFAYETTE DE-LUXE 100 KΩ/VOLT "LAB TESTER"



Giant 6½in. scale. Built-in meter protection. 0/·5/2·5/10/50/250/500/1,000V d.c. 0/3/10/50/250/500/1,000V a.c. 0/10/100μA/10/100/500 MA/2·5/10A. 0/1K/10K/100K/10M/10MΩ. —10 to 49·4dB **£18.18.0.** P. & P. 5/-.

LAFAYETTE 57 Range Super 50,000 O.P.V. Multimeter. D.c. Volts 125V-1000V. A.c. Volts 1.5V-1000V. D.c. Current 25μA-10 Amp. Ohms. 0-15 MegΩ. dB. —20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

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Automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts, d.c. and a.c. 0–500μA, 10mA, 250mA. Current: 0/20K, 200K, 2 megohm. Decibels: —20 to +22dB. **£5.19.6.** P. & P. 2/6.

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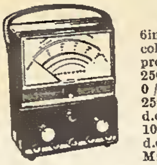
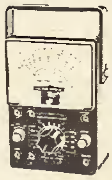
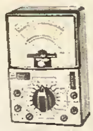


6in. full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0/25/12·5/10/50/250/1,000/5,000V d.c. 0/50μA/110/100/500mA 10A d.c. 20K/200K/20 MΩ. **£15.** P. & P. 5/-.

MODEL AS-100D. 100KΩ/VOLT 5in., mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200V. d.c. 0/6/30/120/300/600V. a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/200MΩ. —20 to +17dB. **£12.10.0.** P & P. 3/6.





MODEL AF-105. 50KΩ/Volt. Mirror scale, built-in meter protection. 0/.3/3/12/60/120/300/600/1,200v. d.c. 0/6/30/120/300/600/1,200 v. a.c. 0/30μA/6/60/300MA/12 Amp. 0/10K/1M/10M/100 MΩ —20 to +17 dB. **£8.10.0.** P. & P. 3/6.

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2mA	25/-	1A d.c.	25/-	750V d.c.	25/-
5mA	25/-	2A d.c.	25/-	15V a.c.	25/-
10mA	25/-	5A d.c.	25/-	50V a.c.	25/-
20mA	25/-	3V d.c.	25/-	150V a.c.	25/-
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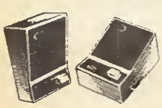

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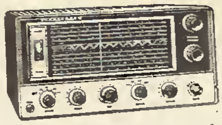
LAFAYETTE MODEL HA700 AM/CWSSB AMATEUR COMMUNICATION RECEIVER



8 valves, 5 bands incorporating 2 MECHANICAL FILTERS for exceptional selectivity and sensitivity. Frequency coverage on 5 bands 150-400Kc/s, 550-1,600Kc/s, 1·6-4·0Mc/s, 4·8-14·5Mc/s, 10-5-30Mc/s. Circuit incorporates R.F. stage, aerial trimmer, noise limiter, B.F.O. product detector, electrical bandspread, S meter, slide rule dial. Output for phones, low to 2KΩ or speaker 4 or 8ohms. Operation 220/240V. a.c. Size 7½ × 15 × 10in. Supplied brand new and guaranteed with handbook. **36 GNS.** Carr. 10/-. S.A.E. for leaflet.

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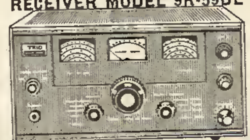
19 transistors, 8 diodes, 1HF music power, 30W at 8Ω. Response 30-20,000 ±2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3–16Ω. Separate L. and R. volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complimentary metal case. Size 10½ × 3⅜ × 7$\frac{11}{16}$in. Operation 115/230V. A.V. **£28.** Carr. 7/6.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver covering 550Kc/s to 30Mc/s continuous and electrical band spread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. band spread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V. a.c. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£39.15.0.** Carriage 12/6.

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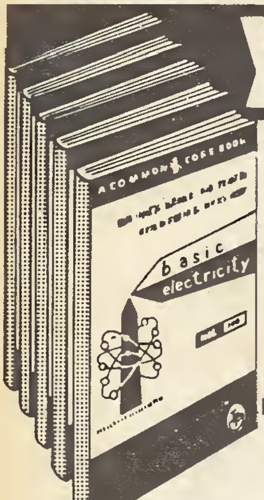

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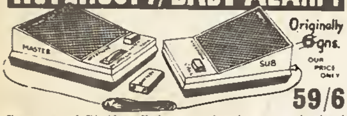

Originally 6gns.

59/6

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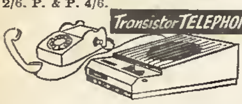

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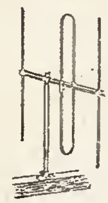

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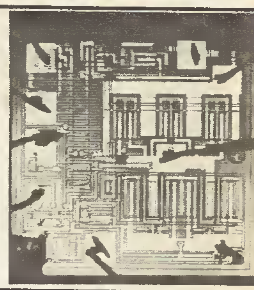
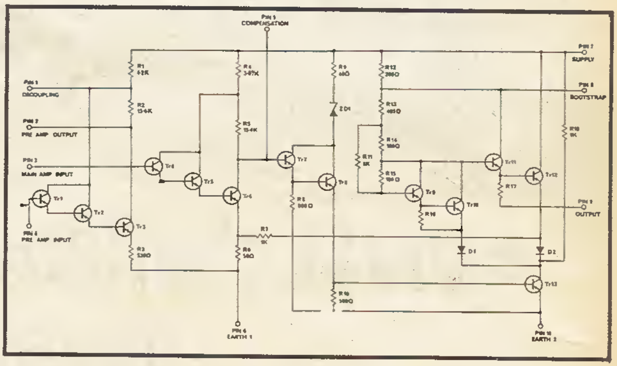
Frequency response	5 Hz to 100 KHz $\pm$1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 x 0.4 x 0.2 inches.
Sensitivity	5 mV.
Input impedance	Adjustable externally up to 2.5 M ohms for above sensitivity.

ABOVE SHOWS ACTUAL SIZE OF IC-10. TO RIGHT, VIEW OF AMPLIFIER MAGNIFIED 625 TIMES.



■ Circuit Description

The circuit diagram of the IC-10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.



■ Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

■ Applications

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud-hailers, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers.

The transistors in the IC-10 have cut off frequencies greater than 500 MHz so the pre-amp section can be used as an R.F. or I.F. amplifier making it possible to build complete radio receivers without any additional transistors.

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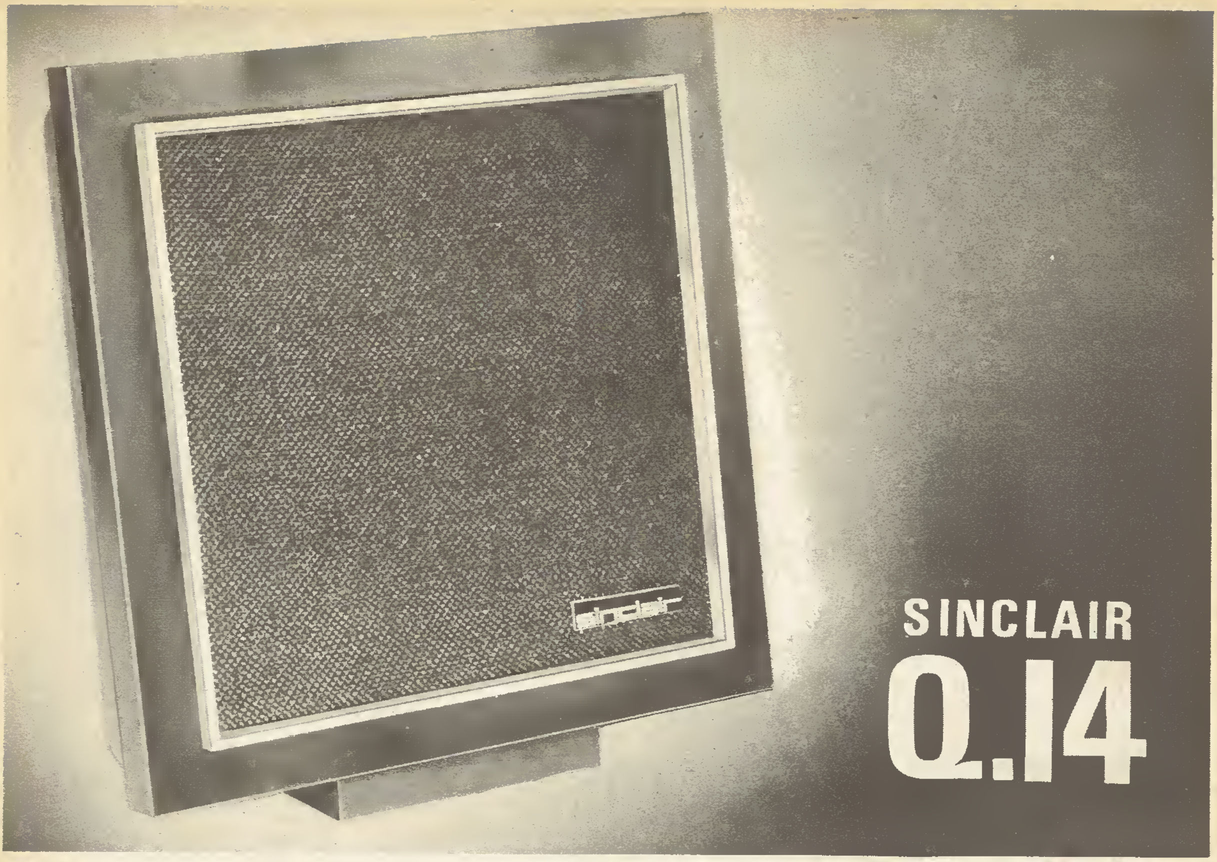

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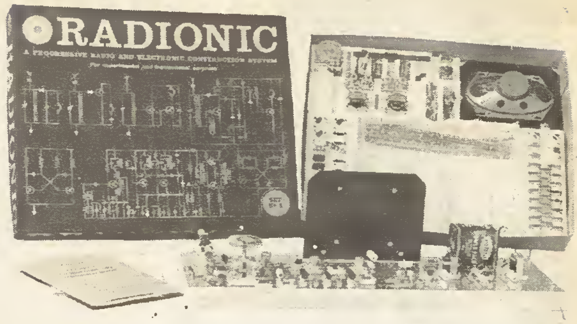

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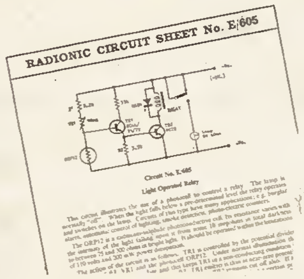
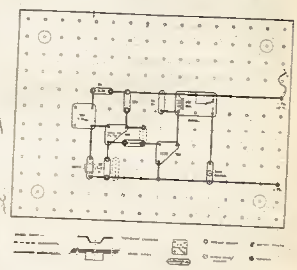


Theoretical Circuit



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BFY50	2N706	2N1711	2N3711	TIS44
BFY51	2N708	2N2904	2S102	2N2906
BFX84	2N929	2N2905	2S103	2N2907
BFX86	2N930	2N2924	2S104	2N2696
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				2N3703

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AC127	ACY28	NKT142	NKT773	2G301	2G399A
AC128	ACY29	NKT212	OC44	2G302	
AC130	ACY30	NKT213	OC45	2G303	
ACY19	ACY31	NKT214	OC71	2G308	**1/6**
ACY20	ACY34	NKT215	OC72	2G371	**each**
ACY21	ACY35	NKT271	OC75	2G374	

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OC25	OC35	NKT403	ASZ17	
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OC28	AD140	NKT405	T13028	**each**
OC29	AD149	NKT452	T13029	

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2S302 Eqvt. OC200 VcB40 Hfe 15-50 — 1-49 off **3/6** each
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Type No.	PIV	Amp	Each
2N1595	50	1	7/6
2N1596	100	1	8/–
2N1597	200	1	10/6
2N1598	300	1	14/–
2N1599	400	1	15/–
BTX30–500	500	1	22/6
BTX30–600	600	1	25/–

TO-46 CASE (STUD)

Type No.	PIV	Amp	Each
2N1771	50	4·7	9/–
2N1772	100	4·7	9/6
2N1774	200	4·7	12/6
2N1776	300	4·7	16/6
2N1777	400	4·7	19/–
2N1778	500	4·7	25/6
2N2619	600	4·7	30/–
BTY79–150	150	4·7	12/–
BTY79–250	250	4·7	14/–
BTY79–400	400	4·7	20/–

TO-48 CASE (STUD)

Type No.	PIV	Amp	Each
2N682	50	16	12/–
2N683	100	16	15/–
2N685	200	16	19/6
2N687	300	16	25/6
2N688	400	16	32/6
2N689	500	16	47/6
2N690	600	16	50/–
2N691	700	16	56/–
2N692	800	16	62/–

BRAND NEW FULLY TESTED EPOXY CASE UNIJUNCTION TRANSISTORS. Type TIS43 and BEN 3000 and replacement for 2N2646. Full data available. LOWEST PRICE AVAILABLE ANYWHERE. 100 off 4/- each = **£20**; 500 off 3/6 each = **£87.10**; 1,000 off 3/- each = **£150.** Sample devices 7/- each on request.

SILICON PLANAR PLASTIC TRANSISTORS. 2N3708A VcB30 Hfe 20-60. All marked, fully tested and guaranteed. 1 off **1/6** each; 100 off **10d.** each; 500 off **9d.** each; 1,000 off **7½d.** each.

TO-18 METAL CAN SILICON PLANAR TRANSISTORS. VERY HIGH QUALITY 99% good. Type 2N706 BSY27 **£7.10** per 500 pieces; **£12.10** per 1,000 pieces.

PRINTED CIRCUIT BOARDS with usable length leads on both Transistors and diodes. All Mullard devices with the exception of the 2G371 which are Texas.

EACH PANEL CONSISTS OF THE FOLLOWING:—

"A"	8 × OC43, 24 × OA81	**12/–** per Panel
"B"	64 × OA81	**20/–** per Panel
"C"	8 × 2G371	**5/–** per Panel
"D"	16 × OC84	**15/–** per Panel
"E"	8 × GET875, 24 × OA81	**11/–** per Panel
"F"	8 × GET114, 20 × OA81	**10/–** per Panel
"G"	8 × 2G371, 12 × OA81	**7/6** per Panel
"H"	8 × GET114, 12 × OA81	**8/6** per Panel
"I"	8 × OC84	**9/–** per Panel
"J"	4 × OC28, 4 × FST1/0	**15/–** per Panel
"K"	4 × OC35, 4 × FST1/0	**15/–** per Panel
"L"	32 × OA81	**12/–** per Panel
"M"	4 × GET875, 2 × OA81	**3/–** per Panel

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2,500 cross references of transistors—British, European, American and Japanese. A must for every transistor user. Exclusively distributed by DIOTRAN SALES. 15/- EACH.

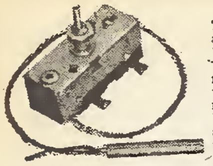
Vast mixed lot of subminiature glass diodes. Comprising of silicon germ. point contact and gold bonded types plus some zeners. 500,000 available at Lowest of Low Price.

1,000 pieces **£3.0.0.** 5,000 pieces **£13.10.0.** 10,000 pieces **£23.**

Sub-Min. Plastic
1 Amp Sil. Rect.

Type No.	PIV	Each
IN4001	50	1/3
IN4002	100	1/6
IN4003	200	2/–
IN4004	400	2/9
IN4005	600	3/3
IN4006	800	3/9
IN4007	1,000	4/9

THERMOSTAT WITH PROBE



This has a sensor attached to a 15A switch by a 14in. length of flexible capillary tubing — control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at 12/6 each. Postage and insurance 2/9.

MINIATURE WAFER SWITCHES

4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 3/6 each, 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 10/- post free.

BLANKET SWITCH

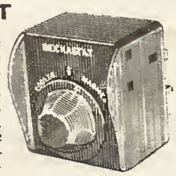
Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case. 5/6 each. 3 heat model 7/6.

PHOTO-ELECTRIC KIT

All parts to make light operated switch/burglar alarm/counter, etc. Kit comprises printed circuit, Laminated Boards and chemicals, Latching relay, Infra-red sensitive Photocell and Hood, 2 Transistors, cond., Terminal Block, Plastic case. Essential data, circuits and P.C. chassis plans of 10 photo-electric device including auto. car parking light, modulated light alarm. Simple invisible ray switch—counter—stray light alarm—warbling tone electronic alarm—projector lamp stabiliser, etc. Only 39/6, plus 2/- post and insur.

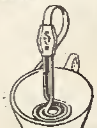
PP3 Eliminator. Play your pocket radio from the mains! Save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions. Only 6/6 plus 1/- post.

BECKASTAT



This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13 A loading. Will save its cost in a season. 19/6. Postage and ins. 2/9.

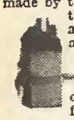
QUICK CUPPA



Mini Immersion Heater, 350W, 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. 10/6, post and insurance 1/6. 12v. car model also available.

THERMOSTATS

Type "A" 15A for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F. 9/6, plus 1/- post. Suitable box for wall mounting, 5/- P. & P. 1/-.



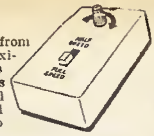
Type "B" 15A. This is a 17in long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550°F. Internal screw alters the setting so this could be adjustable over 30° to 1,000°F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm, 8/6, plus 2/6 post and insurance.

Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the 10ft. pipes from freezing. If a length of our blanket wire (16 yds. 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature, 7/6, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price 18/-, plus 2/- post and insurance.

DRILL CONTROLLER



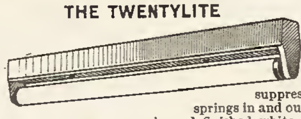
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Or available made up 25/-, plus 2/6 post.

INFRA-RED HEATERS

Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, 19/6, plus 4/6 post and insurance. Pull switch 3/- extra.

FLUORESCENT LIGHTING SNIP

THE TWENTYLITE

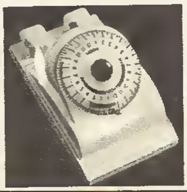


A 2ft. 20 watt lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses ½ unit). Measures 2ft. long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, 39/6 with tube. Assembled ready to install. Postage and Insurance 6/6 extra. Other "Atlas" fluorescent fittings with tubes

4ft. 40W 49/6 — 4ft. twin 40W 59/6
5ft. 80W 59/6 — 5ft. twin 80W 89/6

4ft. and 5ft. fittings carriage 10/- on each sent at purchasers risk.

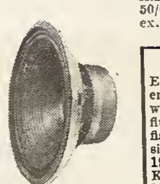
THIS MONTH'S SNIP



YOU SAVE £2-10-0

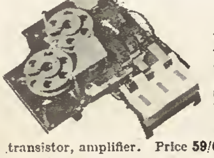
and always have a warm bed awaiting you. The wonderful DREAMLAND clock switch will automatically switch your blanket on and off each evening. It's luminous, you can always see the time and it's a really beautiful unit. An ideal gift. Can also control tape recorder, radio, lamp, etc. Up to 600 watts. Proper price £4.9.6. 39/6 plus 3/6 P. & P.

HI-FI BARGAIN



FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of this country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S.—Cone Moulded fibre—Freq. response 30-10,000c/s—Main resonance 60c/s—Chassis Diam. 12in—12⅜in over mounting lugs—Baffle hole 11in Diam.—Mounting holes 4, holes—¼in diam. on pitch circle 11⅞in diam.—Overall height 5½in. A £6 speaker offered for only £3/9/6, plus 7/6 P. & P. Specify three or fifteen ohms. Don't miss this offer.

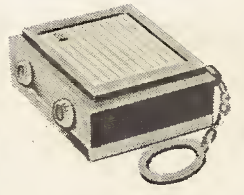
BATTERY OPERATED TAPE DECK



With Capstan control. This unit is extremely well made and measures approx. 6 × 5 × 2in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 volts. Supplied complete with 2 spools ready to install. Record, Replay head is the sensitive M4 type intended for use with transistor, amplifier. Price 59/6. Post and insurance 4/6.

BARGAIN OF THE YEAR

MICRO-SONIC



7 transistor Key chain loudspeaker Radio in very pretty case, size 2¾×2¼×1¼in—complete with soft leather zipped bag. Specification: Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600kc/s. Sensitivity: 5mv/m. Intermediate frequency: 465kc/s, or 455kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: permanent magnet type. In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new. 19/6 plus 2/6 post and ins., less batteries. A pair of rechargeable everlasting batteries 7/- pair.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B, working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 16/6, plus 3/6 postage.

Spring coil leads as fitted to telephones, 4 core 2/6 each. 3 core 2/- each.
Indicator lamp. Panel mounting, consists of neon lamp in red plastic lens with resistor in leads for mains operation. 2/6 each. 24/- dozen.
Appliance switch double pole 16A 230v rating spindle for pointer knob control, 3/6.
0005 tuning condenser for crystal or transistor radio, 24/- dozen.
16mm Zoom Lens for closed circuit TV camera, brand new, £75. (Half current price list.)
Baulkhead Aerial lead out two cone shaped porcelain insulators with OBA brass rod through centre fitted terminals 8/6.
12V Blower heavy duty motor with centrifugal blower coupled to one end, ideal for car heater. 12/6 plus 4/6 post.

COPPER CLAD ELEMENTS

1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above. 12/6 each, plus 4/6 post. £6 doz. post paid.

BLANKET SIMMERSTAT

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching the blanket on for varying time periods, thus giving a complete control from off to full heat. Also suitable for controlling the temperature of any other appliances using up to 1 amp. Listed at 27/6 each, we offer these while our stock lasts at only 12/6 each.

0-1mA Full Vision Moving Coil Meter. 2in. sq. full vision. 19/6 plus 2/- post.
0–500mA 3in. Flush Mounting Moving Coil Meter 10/-.
G.E.C. Black Light Tube for experiments and special lighting effects—40W 2ft. tubes only 14/6 each, holders and control gear 19/6 plus 4/6 post.
You never need buy another battery for your transistor radio. Stupendous offer this month—a 6–9V Nickel Cadmium battery stack together with a mains operated charger which you mount on the back of your set. The mains flex unplugs so the set remains completely portable. Offered for less than the cost of the batteries alone. ONLY 29/6 plus 3/6 post.
Experimenting with Ultra Violet? Phillips UV lamp 16/6, holder and control gear 19/6 plus 4/6 post.
Double pole push to test switch. Spring return 10 amp. 250V. 2/9 each. 30/- doz.
A.E.I. FRACTIONAL H.P. MOTOR. 200/250V. 50/60c./s. enclosed, continuous rating 1/40 h.p., ex. equipt. Perfect order 19/6 plus 4/6.

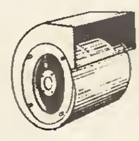
FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15–20W, 19/6. Kit B—30–40W, 19/6. Kit C—80W, 19/6. Kit D—125W, 22/-. Kit E—65W, 19/6. Kit MF1 is for 6in., 9in. and 12in. miniature tubes, 19/6. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

REED SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor belt switching. These are simply glass in cased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at 2/6 each, or 24/- a dozen. Suitable magnets are 1/- each.

CENTRIFUGAL FAN



CENTRIFUGAL BLOWER or extractor by Torrington, very low noise but large capacity air flow, designed for central heating and air conditioning; ideal also for fume extraction over cooker, duct type outlet, 200–250V. 50c/s motor. £3.19.6, post and insurance 7/6.

16 RPM GEARED MOTOR

Made by Smith's Electrics, there are almost silent running, but are very powreful. They operate from normal to 240V mains and the final shaft speed is 16 r.p.m. 15/-. Post and insurance 2/9.

Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

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VOL. 4 No. 12
December 1968

PRACTICAL ELECTRONICS

TRIAL AND ERROR DESIGN

DESIGNING by soldering iron, rather than by pencil and paper, is a "failing" most of us would admit to, sometime or the other. Once a rudimentary circuit has been sketched out, the temptation to wire up some components and see what happens is often irresistable. The resulting assemblage of parts is not exactly a joy to behold, not that we are under any delusions in this regard, for do we not describe it by some unflattering name such as a "bird's nest", a "lash-up", or a "breadboard design"? Nor of course are we surprised when the circuit fails to "go" first time. At this point we really start to think in earnest, though our thoughts, if we are honest, are likely to be directed towards component substitution, rather than back to first principles.

This is where the soldering iron takes over as an essential design tool. Why get involved in time consuming paper calculations when it is but a few seconds work to disconnect a component and insert a substitute? If the new one does not work, the process can be repeated *ad infinitum* until success is achieved. By the time this happy moment arrives, our "bird's nest" will have changed its geometry many times and the final arrangement may bear little resemblance to the original set-up. But now the circuit diagram can be drawn in its final form and those little details like component values filled in.

The purist can argue that this empirical approach to electronic design is completely wrong. True it is a back-to-front process, but it suits many private designers to arrive at the answer mainly through practical experiments.

Some non-professionals may be surprised to learn that the "trial and error" method of design is not uncommon in industry either. Indeed it is sufficiently widely practised to have provoked strong criticism from two members of the University of Edinburgh, Prof. W. E. J. Farvis and J. Murray, in a paper which they presented to a Conference on Electronics Design last September. The authors argue that this casual, undisciplined approach to design is not found in any other branches of engineering, and that it is uneconomical and inefficient, and is a serious liability that has to be borne by our electronics industry.

Amateur designers must be excused if they permit themselves a wry smile at this confirmation of what has long been suspected—that their "weakness" is shared by the professionals. For the industry, this criticism of its design methods is food for thought indeed. Will it prove indigestible?

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our January issue will be published on Friday, December 13

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., 15/17 Long Acre, London, W.C.2. Phone: 01-836 4363. Telegrams: Newnes London. Subscription Rates including postage for one year, to any part of the world, 42s.

DOOR CHIME

OPEN pipe door chimes have almost usurped the common or garden clamourous electric bell. The sweetly sonorous tones linger with each chime lulling you to the door.

Electronics offers a variant on these mechanical tintinnabulations for the unit to be described, whilst producing the true ringing sound of a bell, may be adjusted for rate of chiming, pitch, volume and sustain.

For hoteliers and guest house managers who would prefer a push button alternative to the dinner gong simple modifications to the unit are provided.

PULSE GENERATOR

The pulse generator is built around a complementary pair TR1, TR2 shown in Fig. 1. Assuming C1 and C2 are both discharged. When S1, the bell push switch, is made C1 charges by way of diode D1 and R3 whilst C2 charges via R2 and R3.

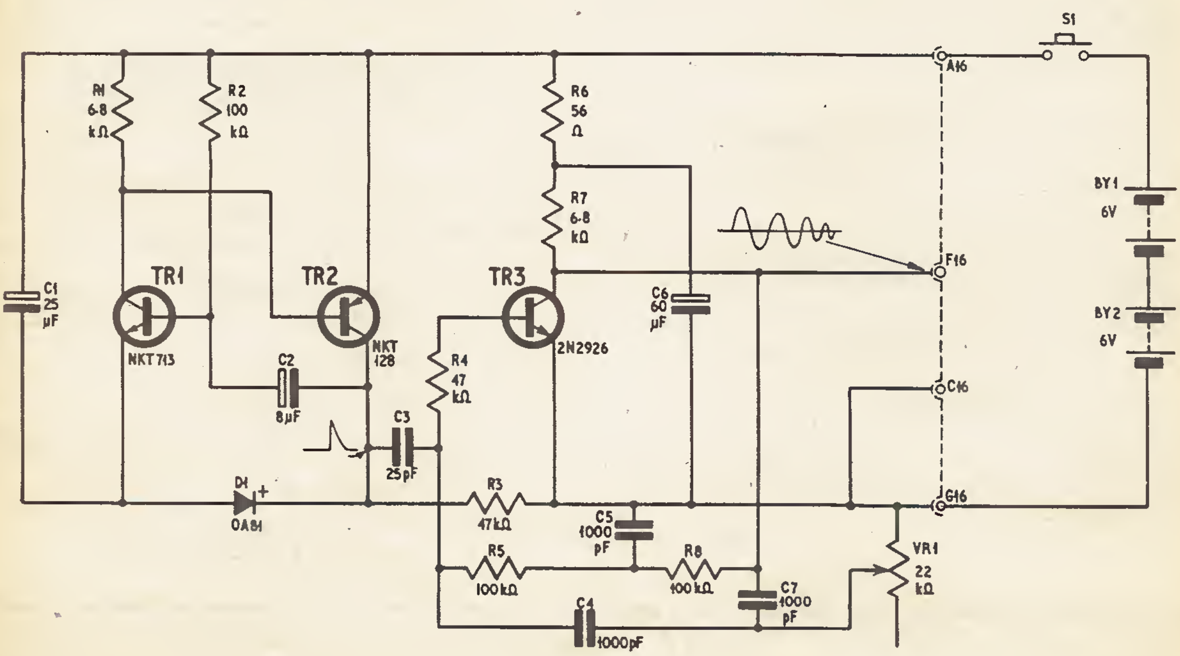
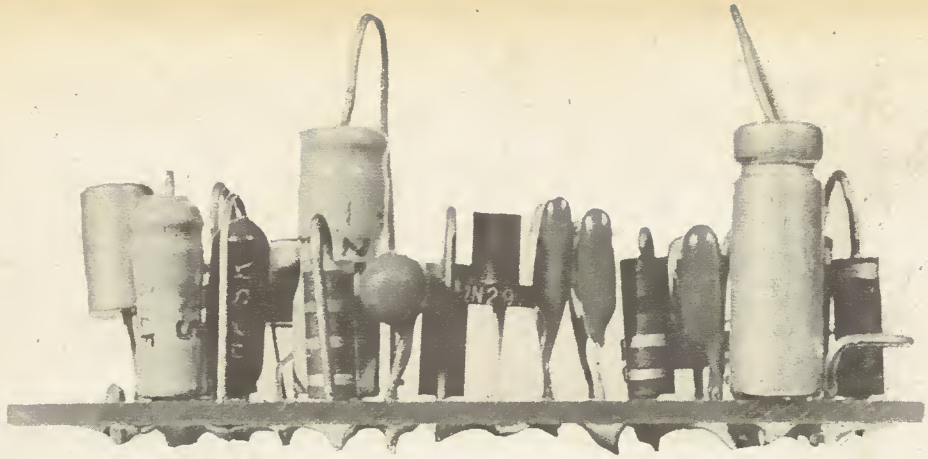


Fig. 1. Circuit diagram of chimes unit. Note that S1a and S1b are ganged. S1b switches the amplifier shown in Fig. 3



With the charging of C2, TR1 is held off by the negative voltage appearing across R2. Since no collector current is flowing no voltage appears across R1 and TR2 is similarly non conducting.

When C2 has charged the *npn* transistor TR1 conducts and switches TR2 hard in so that a positive going pulse appears across R3 and is applied to TR3 via the coupling capacitor C3.

This pulse reverse biases diode D1 so that capacitor C1 maintains TR1 in conduction.

As C1 discharges so does C2 and with the completion of these processes the circuit reverts to its initial passive state before another pulse cycle.

To increase the pulse repetition frequency either C1 or C2 should be diminished in value. To decrease the p.r.f. raise these values.

TWIN-T TONE GENERATOR

The chimes producing circuit is a twin-T oscillator consisting of a high gain silicon transistor TR3 and attendant RC networks which determine the frequency of operation.

The twin-T geometry derives from the arms R5, C5, R8 and C4, C7 and VR1. As is common with sinusoidal RC oscillators frequency varies inversely with these component values. In this unit values were selected to produce a frequency of about 3kHz consistent with bell sounds.

SHOCKING

To produce a ringing tone the oscillator must be shocked into activity. This means that in its passive

COMPONENTS . . .

Resistors

R1	6·8kΩ	R5	100kΩ
R2	100kΩ	R6	56Ω
R3	47kΩ	R7	6·8kΩ
R4	47kΩ	R8	100kΩ

All 10%, ½W carbon

Potentiometer

VR1 22kΩ miniature carbon preset

Transistors

TR1 NKT713 TR3 2N2926 (Green spot)
TR2 NKT128

Diode

D1 OA81

Capacitors

C1 25μF 15V sub-miniature elect.
C2 8μF 15V sub-miniature elect.
C3 25pF
C4 1,000pF
C5 1,000pF
C6 1,000pF
C7 60μF 15V sub-miniature elect.

Switch

S1 Push-to-make 2 pole miniature (Radiospares)

Batteries

BY1, BY2, BY3 Three PP1 6V batteries

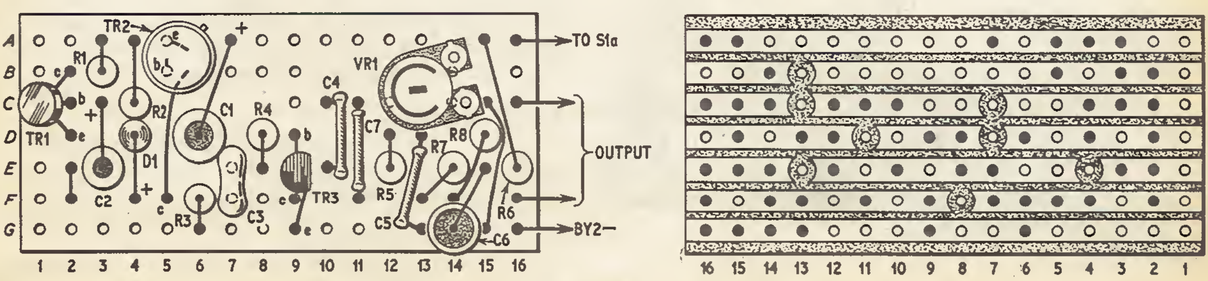


Fig. 2. Component layout on board and underside view showing the breaks in the copper strips

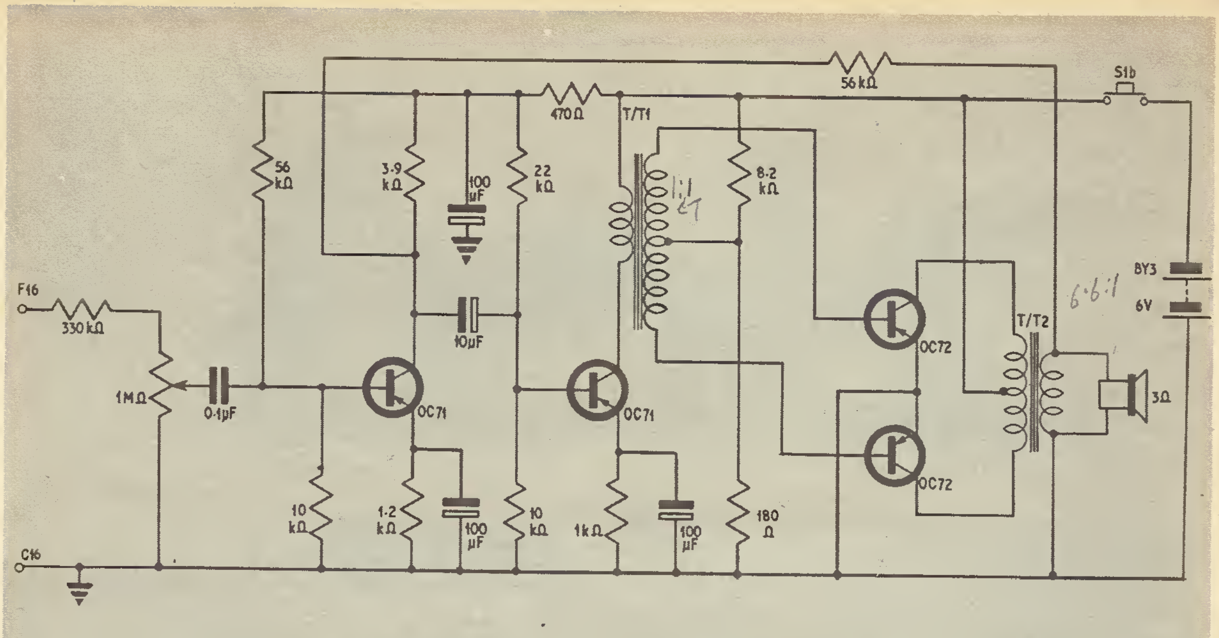


Fig. 3. Suitable 200mW amplifier (Mullard) for use with chimes unit

state no oscillations are produced, a condition which is determined by the setting of VR1.

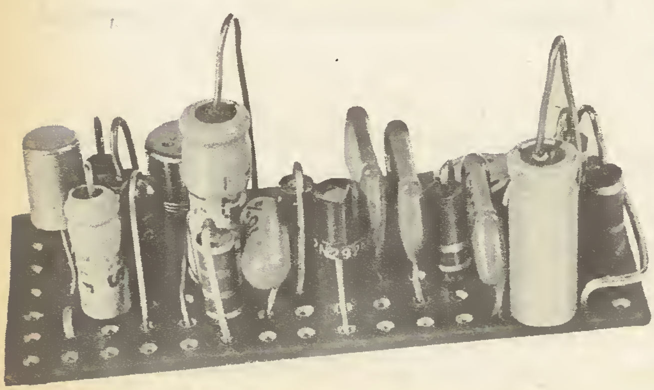
With the arrival of incoming positive pulses developed across R3 the twin-T oscillator produces a train of progressively damped sine wave.

The R6/C6 combination sustains this so that the tone lingers gradually diminishing in intensity.

Adjustment of this time constant must be in accord with the p.r.f. of the pulse generator. As a rule of thumb the higher the frequency, the shorter the time constant. This means a reduction of C7 capacitance.

CONSTRUCTION

The complete circuit can be assembled on a piece of Veroboard, similar to that given free with the October issue of PRACTICAL ELECTRONICS. See Fig. 2 for arrangement of components and wiring.



AMPLIFIER

The output at F16 can be applied to any high input impedance amplifier but for those constructors who have no such unit a suitable design is given in Fig. 3. This will provide an output of up to 200mW. Volume is, of course, adjustable to suit personal requirements.

S1 ensures that no battery power is consumed until this switch is depressed when S1a and S1b route the required 12 and 6 volt supplies to the chime and amplifier circuits.

GONG

To produce the sound of a gong the capacitors C4, C5 and C7 should be changed to 0·01uFd. No other alterations are necessary.

FUNCTIONAL CHECKS

To check that the pulse generator is working successfully a 6V, 0·06A pilot bulb should be substituted for R3 when the wiring of this half of the circuit according to Fig. 3 is completed.

If the lamp continuously blinks the supply can be disconnected, R3 substituted and then the tone generator assembled. For checking the tone generator the amplifier must be attached. Rotation of VR1's wiper will produce an oscillation. This should be adjusted to the point when single chiming tones are produced; this completes the setting up of the unit.

TWO TONES

For those constructors wanting two tones at different pitches, another twin-T circuit is required. The pulse output of R3 can be applied to a flip flop circuit which would gate the two tone generators, the outputs being taken out to the amplifier.

For pitch variation the C4, C5 and C7 capacitors should be collectively altered. ★

D.C. FEEDBACK PAIR

By P. Williams B.Sc.

VERY simple circuits can be designed using the characteristics of silicon planar transistors to their best advantage. The biasing technique in particular has proved to be of great benefit in industrial practice and variations on it are very common in the design of integrated circuits. It is worth considering whether circuits can be further simplified without losing too much in performance.

POTENTIAL DIVIDER BIAS

The base-emitter voltage of a silicon transistor is surprisingly steady for a wide range of currents and temperatures. For example it will be changed by only 10 per cent for an eight-fold increase in current or a 30 degree C change in temperature. So under the conditions normally met by the home experimenter this voltage can be assumed constant for any one transistor and is not likely to differ by more than a few per cent for other transistors of the same type.

Even transistors from different manufacturers can be expected to be sufficiently close for most purposes. As a check on this two planar *npn* silicon transistors, an ME101 and a 2N3707, were operated at room temperature with emitter currents of 1mA. The corresponding base-emitter voltages were 675mV and 630mV respectively. As can be seen from their data sheets, these two are very different transistors by different manufacturers and yet the V_{be} is within 10 per cent in each case, a closer tolerance than the resistors often used in biasing networks. For most small signal planar transistors these figures are typical.

Consider Fig. 1; if the current in the potential divider chain can be made much greater than the base current, then, since the voltage across R2 is 600mV (the base-emitter voltage of the transistor) the voltage at the collector must be $\frac{R_1 + R_2}{R_2}$ 600mV.

The errors in this figure will be due to:

1. The base current disturbing the potential divider.
2. Change in V_{be} with temperature replacement of the transistor, etc. As outlined above these changes are small.

In Fig. 2, an emitter follower is added in which the current can be higher, permitting a potential divider of as low a resistance as desired thus allowing the elimination of error (1) if desired. Too low a value of resistance in the divider will shunt the input signal too severely and reduce gain.

To achieve the highest possible voltage gain without sacrificing d.c. stability the emitter resistor of TR2 may be bypassed and a load inserted in the collector circuit (Fig. 3). Where this form of circuit is used, the emitter potential of TR2 is constant regardless of signal and the base of TR2 and hence the collector of TR1 will only have a small voltage swing. It is here that a further characteristic of transistors, not shared by valves, comes to our aid in producing a simple, stable design.

It is often assumed, since a transistor can be represented by two diodes back-to-back in explaining the bias voltage polarities, that it is necessary for the collector-base diode to be reverse-biased. Deeper investigation shows that what is required is only that the collector-base diode shall not be forward-biased sufficiently for it to conduct.

Thus in an *npn* transistor the base potential with respect to ground will be approximately equal to 600mV while the collector may fall to 200mV or less with only a small effect on the gain. This can be checked by looking at the saturation region characteristics of the transistor.

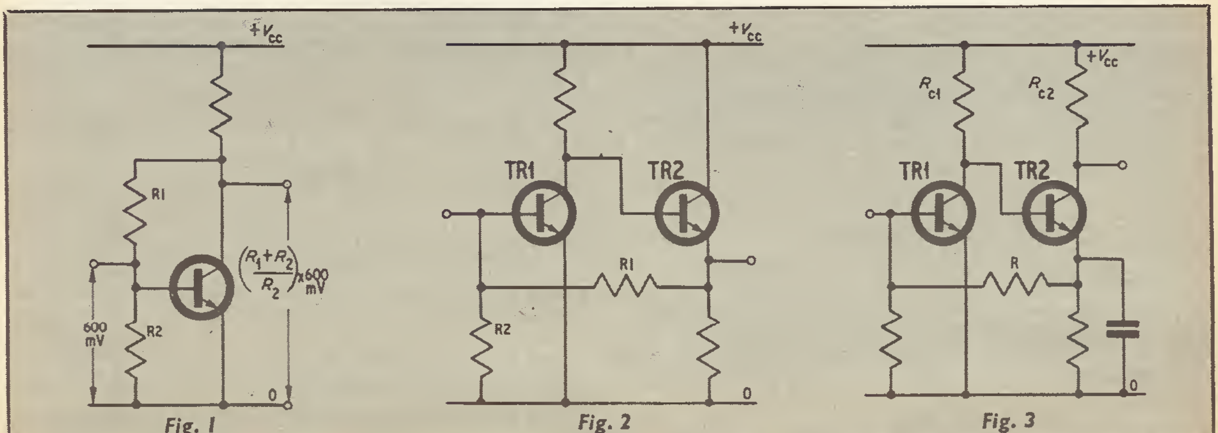


Fig. 1 Fig. 2 Fig. 3

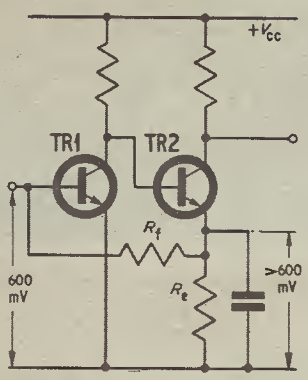


Fig. 4

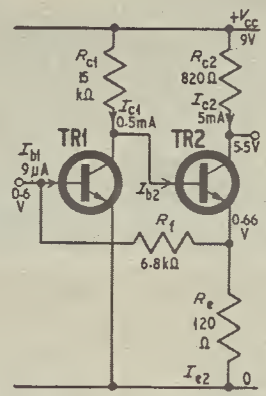


Fig. 5

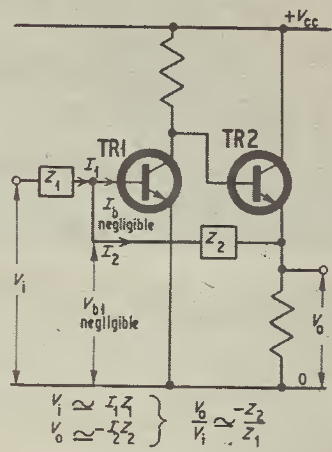


Fig. 6

SINGLE RESISTOR BIAS

Replace the potential divider by a single resistor again of a low enough value that base current provides only a small voltage drop. The voltage at the emitter of TR2 will now be little higher than that of TR1 base, i.e. approximately equal to 600mV. Thus the emitter resistor will have to be of a lower value if the current in TR2 is to be maintained (Fig. 4). Note that the collector of TR1 is now at about 1·2V giving an adequate safety margin for the avoidance of saturation.

The advantages of this circuit are two-fold:

1. The stability is as good as that of the original but with one less resistor.

2. A smaller voltage drop occurs across R_e, permitting a lower supply voltage, or alternatively, a slightly increased gain by increasing the load resistances and maintaining the currents constant.

The design procedure is then as follows:

1. Assume that R_f can be low enough that the voltage drop across it is negligible. Decide the current required in TR2 from a knowledge of the load. The voltage across R_e will now approximate to the V_{be} of TR1 (600mV). If R_e is in ohms

$$I_{c2} = I_{e2} = \frac{600}{R_e}\text{ mA}$$

2. The supply voltage will already be known either because the amplifier is to be fitted to an existing system or because the load voltage requirement has to be met. A safe procedure is to drop half the remaining volts across R_{c2}

$$\text{i.e. } R_{c2} = \frac{V_{cc} - 0{\cdot}6}{2.\ I_{c2}}$$

if V_{cc} is in volts, I_{c2} is in mA, R_{c2} is in kilohms.

3. TR1 must carry sufficient current to supply the base of TR2 comfortably. If the d.c. current gain of TR2 is known (h_{FE2}) then the base current can be calculated as

$$\frac{I_{c2}}{h_{FE2}}$$

Otherwise a minimum gain of, say, 30 may be assumed, and the resulting value calculated for R_{c1} may be increased if experience shows this to be pessimistic.

The collector load current of TR1 can then be made at least twice the maximum expected base current of TR2; for safety a factor of three or four times might be preferable. The voltage at the collector of TR2 is, as previously indicated, about 1·2V. Hence

$$R_{c1} = \frac{V_{cc} - 1{\cdot}2}{4 \times I_{b2}}$$

where I_{b2} is in mA and R_{c1} in kilohms.

The safety factor used here is 4, i.e. the base current will be one quarter of the collector resistor current and the collector current of TR1 three-quarters of it. Since the input impedance of TR2 is relatively low (operating at a larger current, r_{in} falls) then even larger safety factors may be used without R_{c1} falling enough to shunt the signal away from the base of TR2 and lower the gain.

For most silicon planar transistors the gain will be maintained even at low currents, but with alloy junction units or germanium ones it may be necessary to reduce R_{c1} considerably so that TR1 has sufficient current for satsifactory operation.

4. R_f can now be chosen so that the voltage drop across it is negligible compared with the 600mV at the base of TR1. If it is to be limited to say 10 per cent, then first calculate

$$I_{b1} = \frac{I_{c1}}{h_{FE1}}$$

Then

$$R_{f(max)} = \frac{60}{I_{b1}}$$

where, if I_{b1} is in mA, $R_{f(max)}$ will be in ohms; the voltage is 60mV.

PRACTICAL EXAMPLE

The above procedures may seem complicated so let us now apply them to a practical example. An output of

2V r.m.s. is required into a load of 2 kilohms. The peak load voltage is $2\sqrt{2}$ volts, i.e. peak load current is about 1·4mA. To give a safe margin on both voltage and current, a supply voltage of say 9V should be used with a standing current in the last transistor of 5mA.

Thus

$$R_{c2} = \frac{9 - 0{\cdot}6}{2 \times 5} = 0{\cdot}84 \text{ kilohms}$$

Choose the nearest preferred value of 820 ohms.

Similarly

$$R_e = \frac{600}{5} = 120 \text{ ohms},$$

which is itself a preferred value. Note that in practice the voltage at the emitter of TR2 will be somewhat higher than at the base of TR1 and in choosing the nearest preferred value for R_e it would be preferable to err on the high side.

Now take current gains for the two transistors as being typically 40 each.

$$I_{b2} = \frac{I_{c2}}{40} = 0{\cdot}125\text{mA}.$$

We can now make the current in the collector load of TR1 say four times this, i.e. 0·5mA, leaving a collector current in TR1 of 0·5 – 0·125 = 0·375mA.

$$R_{c1} = \frac{9 - 1{\cdot}2}{0{\cdot}5} = 15{\cdot}6 \text{ kilohms},$$

i.e. a preferred value of 15 kilohms may be used.

The base current

$$I_{b1} = \frac{I_{c1}(\text{mA})}{40} = 9{\cdot}4\mu\text{A}$$

If the voltage drop across R_f is not to exceed, say, 10 per cent of the V_{be} for TR1, i.e. 60mV.

$$R_f = \frac{60}{9{\cdot}4} = 6{\cdot}4 \text{ kilohms}.$$

A preferred value of 6·8 kilohms would not be unreasonable, and the values are now shown in Fig. 5. The capacitors are not shown but would be required as usual at input and output, and one to bypass R_e.

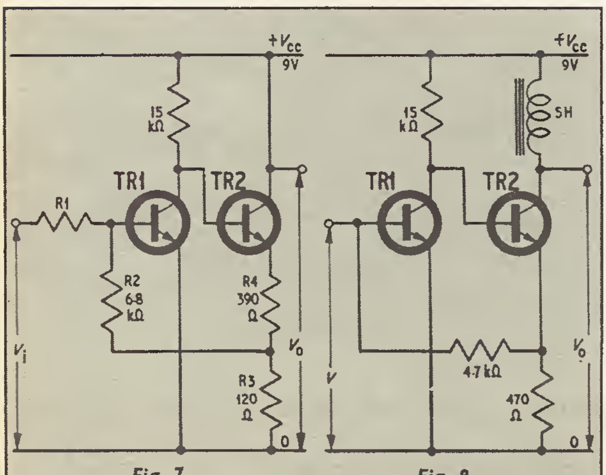


Fig. 7   Fig. 8

Typical values for input and output might be 25μF; for bypass a similar capacitance is used although at a lower voltage working. These would give a lower cut-off frequency somewhere around 100Hz depending on source and load resistances.

AMPLIFIER BUILDING BRICK

This block is a most useful general purpose amplifier and can be made the basic building brick of most audio and many r.f. circuits. For example, if TR2 emitter is left unbypassed and its collector taken straight to the positive supply (Fig. 6) we have a very simple example of an operational amplifier, the basic circuit for analogue computers.

The voltage and current at the base of TR1 are both negligible compared with those at the output and for a.c. purposes the base may be considered as a "virtual earth". From this, $V_{out}/V_{in} \simeq -Z_2/Z_1$ since Z_2 and Z_1 carry the same current and have a common point which is effectively at earth potential. Making Z_1 and Z_2 both resistors, we have an amplifier whose gain is almost independent of the transistor characteristics, provided that one aims at a gain very much less than the maximum of which the circuit is capable.

Fig. 7 shows a practical form of the circuit in which the feedback is taken from a tapping on the emitter resistor. This raises the emitter potential allowing a larger voltage swing at the output, but the gain calculation becomes a little more complicated. Consider Fig. 8, if the gain of the amplifier is high then V will be negligibly small compared to the output voltage and we may conveniently take it as zero. If, as before, we similarly ignore the base current then we have the following relationships:

$$I_f \simeq I_{in}$$

$$\therefore \quad \frac{V_f}{R_2} = -\frac{V_{in}}{R_1}$$

and

$$\frac{V_f}{V_{in}} = -\frac{R_2}{R_1} \qquad \ldots (1)$$

But

$$\frac{V_o}{V_f} \simeq -\frac{(R_4 + R)_3}{R_3} \qquad \ldots (2)$$

Multiplying equations (1) and (2),

$$\frac{V_o}{V_{in}} \simeq -\frac{R_2}{R_1} \times \frac{(R_4 + R_3)}{R_3}$$

Thus the working gain of the amplifier with feedback is defined by the value of the resistors and hence can be extremely stable. Unfortunately the initial gain of a two-transistor amplifier is not very high (perhaps a couple of hundred at most and often less). The actual gain will be appreciably less than that predicted by the equation unless, for example, the ratio R_2/R_1 is made so small that the overall gain is only 5 or 10. Even so the amplifier gain holds fairly steady in the region of 20 for a wide range of transistors.

If these are planar units, the response is to within 3dB up to at least 500kHz and in some cases to beyond 1MHz. It is not surprising that this particular circuit is commonly used in integrated form as a wide-band r.f. amplifier with bandwidths up to 10MHz and above. Note that R_1 plays no part in the biasing of the circuit but determines the input impedance of the circuit.

A given output voltage depends only on a specified input current, and this can be provided either by a small input voltage if R_1 is low, or a larger voltage if R_1 is high (Fig. 7). In the first case the input impedance is low and is more affected by the characteristics of the transistors, while the higher input impedance of the latter also means that the overall voltage gain is reduced.

RECORD AMPLIFIER

If the load is re-inserted in the collector of TR2 as in Fig. 5, but with no bypass capacitor across the emitter circuit, we have an output that is back in phase with the input. The output resistance at the collector is high because the current in the collector is almost equal to that in the emitter and the latter is closely controlled by the negative feedback. The overall output impedance at the collector is then roughly equal to the collector load.

If the collector can receive its current through some component with a very high impedance, then the circuit can deliver a current to an external load regardless of its impedance. For example, using a choke of high inductance as in Fig. 8 the circuit can serve as the final stage in the record amplifier of a tape recorder. The requirement is for a linear response of output current into the tape-head to provide a flat response (in practice some high frequency boost is required to help overcome head losses).

The head being inductive has a rising impedance with frequency, and the technique with valve amplifiers was often to swamp this by using a large series resistance, thus requiring a large voltage swing. With transistors, the same high source impedance must be duplicated by feedback as in this circuit. For a record current of up to $200\mu A$, a standing current of 1mA in the output transistor is adequate.

The circuit is not complete in that it would require a bias filter to prevent the amplifier being overloaded by the h.f. bias being fed to the head by the oscillator. Secondly, the boost in high frequency performance can be conveniently added in the output stage. Neither of these have been checked with these particular component values, though interested readers will find the ideas discussed in more detail in articles on tape recorder design that appear from time to time elsewhere.

In Fig. 9 some suggested values are given for the high frequency boost circuit to give a rising characteristic at about 3kHz, with a limit in this rise to a few decibels by the series resistor. The response will be limited by the falling impedance of the collector choke above its own self-resonant frequency.

PLAYBACK AMPLIFIER

Following up the characteristics of tape heads leads to a further application of the circuit in the playback amplifier. The e.m.f. generated in a tape head increases with the frequency of the recorded signal. In valve amplifiers the resulting voltage was fed to the grid of the first valve, with equalisation applied by negative feedback in the following stages. Since the impedance of the tape head rises with frequency at the same rate as does the e.m.f. generated, then the current flowing in a short circuit placed across the head will be independent of the frequency of the recorded signal.

Such an approach would be difficult with valves with their high input impedance, but the transistor is a "natural" in this circuit. Aided by a little judicious negative shunt feedback as in this form of circuit, the input impedance can be made sufficiently low to appear as a short circuit compared with the relatively high impedance of a large inductance tape head (about 0·5H). Thus the circuit of Fig. 9 provides an output voltage which would be constant with frequency were it not for the fall-off in head and tape characteristics above one or two kilohertz.

Again the solution is to boost the gain at these frequencies by shunting the emitter of TR2 with a capacitor. More care has to be taken in the playback system in that tape noise will also be boosted, and, for that reason, in more sophisticated systems the high frequency compensation is achieved by carefully calculated tuned circuits in the record amplifier. (The writer has found that circuits similar to Fig. 9, but using general purpose germanium transistors, gave adequate performance with tape-heads originally intended for valve amplifiers.)

It should be noted that low-impedance tape-heads would not provide a suitable current drive for this circuit unless its input impedance were lowered still more by heavier feedback. These heads have been specially designed for use with transistor amplifiers in a manner similar to the standard valve circuits.

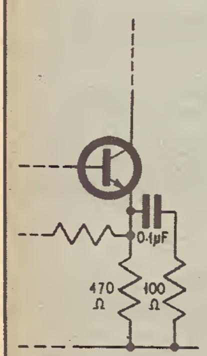


Fig. 9

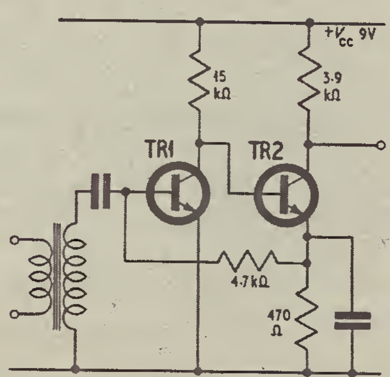


Fig. 10a

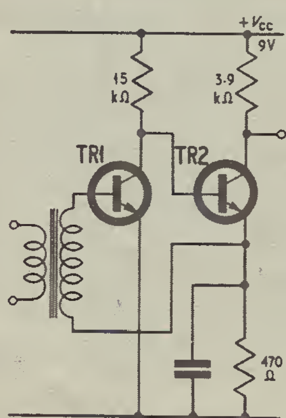


Fig. 10b

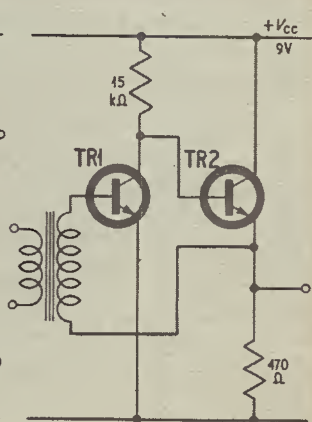


Fig. 11

HIGH IMPEDANCE INPUT

We have now seen how to achieve and apply both low and high output impedances (emitter and collector outputs of TR2) and low input impedance. It remains to be seen whether the circuit can provide a high impedance input if desired, and if so, how to make use of this characteristic. As a first step, return to Fig. 4 and reconsider the function of R_f.

It serves to provide bias current for the base of TR1 and for best stability bias conditions should be as low as possible. The lower limit is set by the resulting loading of the source which is effectively in parallel.

Now take the particular case of a transformer coupled input as from, say, a low impedance microphone and step-up transformer. This could be connected as in Fig. 10a but would require a coupling capacitor to preserve the d.c. bias conditions, while R_f would provide an additional shunt path for signal current. If now R_f is replaced by the secondary of the transformer, the bias is fed via an almost zero resistance path, while the shunting effect of R_f is removed.

The secondary is still effectively earthed via the bypass capacitor on the emitter of TR2 and the result is a circuit from which one resistor and one electrolytic capacitor has been removed, the bias stability has been improved and the possibility is of a slight increase in gain. The input impedance, however, is still that of a grounded emitter stage, so our earlier question of high input impedance has not yet been answered.

VIRTUAL EARTH

Now remove the bypass capacitor from the emitter of TR2. The circuit characteristics are radically changed, most particularly in regard to the input impedance. Realising that the voltage gain between the base of TR1 and the emitter of TR2 can be large, we see that as in the operational amplifier (of which this is really a special case) the majority of the voltage across the secondary of the transformer appears between the emitter of TR2 and ground, i.e. TR1 base is again a "virtual earth".

For example, a secondary voltage of 1 volt might produce 0·99 volt at the emitter with only 0·01 volt at the base of TR1. This latter voltage will cause only a small current flow in the base, i.e. only a small current is drawn from the transformer. With the component values as shown in Fig. 10b this input current might be as little as one or two microamps, and this, for an input voltage of one volt, gives an input impedance of several hundred kilohms. Having removed the capacitance shunt on TR2 emitter, both collector and emitter become available as output points, see Fig. 11.

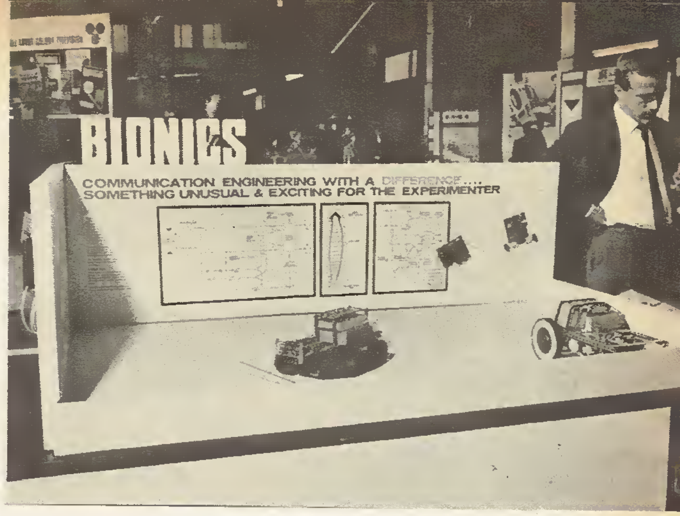
The emitter has the advantage of low impedance and is tolerant of heavier loads including capacitance of cables, but the voltage gain is slightly less than unity. It is worth noting that in these respects the circuit is comparable to a Darlington pair.

FLOATING INPUT

A disadvantage is that both sides of the input are floating and so the circuit is limited to cases where neither end of the source need be grounded. It is quite feasible to use it in conjunction with a crystal microphone, for example with a 1 : 1 transformer, though it is certainly not the best circuit for that application.

It is hoped that these examples illustrate the flexibility of the d.c. feedback pair and will persuade more readers to experiment with it. With the ever-falling cost of transistors such circuits are bound to replace single transistors as basic building blocks. ★

R.S.G.B. EXHIBITION



THE 21st International Radio Engineering and Communications Exhibition, the yearly meeting place of hams from many countries, was formally opened by Mr W. J. Sharp C.B.E., the Director of Communications, Diplomatic Wireless Service, on October 2. More than 30 officials attended the opening luncheon and mobile visitors were "talked-in" by a live transmitting station which continued operation throughout the exhibition. The 38 stands, set up in the New Horticultural Hall, London, showed a variety of equipment and displays from many manufacturers, clubs and distributors.

This year's innovation was presented by the Diplomatic Wireless Service who exhibited some modern sensitive equipment used in the "Piccolo" overseas radio telegraph and broadcasting system. The G.P.O. stand, which displayed methods of dealing with television interference and measuring the power output of S.S.B. transmitters, was well attended both by hams and visitors who were also enquiring about transmitting licences. Also of interest to hams was the new "Solid State 2 Metre A.M. Transceiver" which was shown by Daystrom Limited.

P.E. WAS THERE!

The combined stand of PRACTICAL ELECTRONICS, PRACTICAL TELEVISION and PRACTICAL WIRELESS attracted great attention from those particularly interested in working practical projects—the PEAC (Analogue Computer) was demonstrated and the new "Bionics" series was represented by a working display of the two electronic "animals" described in last month's issue. A "Wideband Triple Conversion Communications Reciever", which is to be a future project, commanded considerable interest from radio hams, who readily understood the impressive specification provided. Other items on the P.E. stand included the series of "IC Projects" and the "Hi Fi Transistor Microphone".

Other stands displayed a wide range of transceiver, receiver, audio, test, experimental and ancillary equipment from British, American and Japanese manufacturers. A large range of components were displayed on a number of stands and many visitors took advantage of the "special offers".

Specialised groups and clubs concerned with amateur communications who held displays were—the Radio Amateur Invalid and Bedfast Club, The Radio Amateur Emergency Network, the British Amateur Television Club and the British Amateur Radio Teleprinter Club. Over 8,000 enthusiasts visited the exhibition.

POINTS ARISING

RADIO CONTROL FOR MODEL BOATS—3

(August 1968)

The author has had experience of three transmitters, which have all operated similarly, and has discovered that depending on where the coil of L3/L4 (Fig. 13) is with respect to the former, an ambiguity in setting-up procedure can exist if the technique used in the published articles is used. This was not apparent on the first transmitter. This ambiguity can result in reduced transmitter output.

If the following procedure is adopted instead of that outlined under Transmitter Alignment in the August issue, more positive control will result.

Open link 2 and set VR2 to a maximum. This is to ensure that TR4 does not overheat during setting up with link 2 open. Insert current meter (0–50mA) in emitter of TR3 (between emitter connection and L1) and if a further meter (0–20mA) is available insert in place of link 1. The antenna should be connected.

Screw L3/L4 slug out to one end of the former, and observe that both TR3 and TR5 current is very small (<1mA). Commence screwing in the slug, and TR3 current will rapidly increase to a maximum (10–20mA), TR5 current will also increase. Further insertion of the slug (which should be at least ½in long) will cause a reduction in TR3 current but little change in TR5 current. Adjust the slug so that TR3 current is maintained at a maximum and stable state when S2 is repeatedly opened and closed.

Adjust C8 for a minimum "dip" in TR3 current. TR5 current should be 5–10mA.

Reconnect link 2 and set VR2 midway (100 ohm). Rotate VR1 so that TR3 current is a maximum. This will be less than when link 2 was open. The optimum maximum setting of L3/L4 should not have changed.

Remove meters and reconnect circuit. The transmitter is now aligned.

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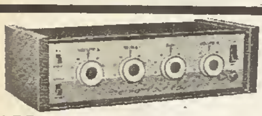

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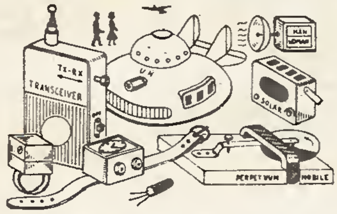

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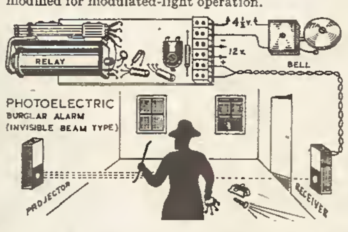

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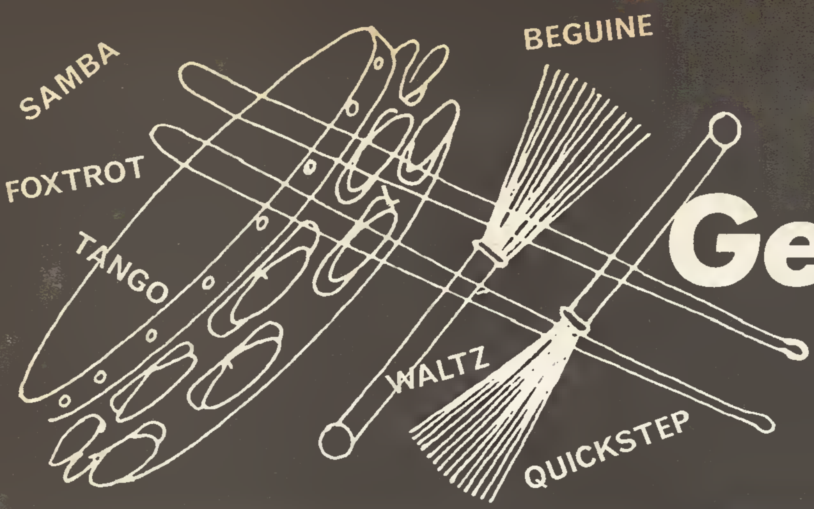


Rhythm Generator

By P. R. Allcock

Dip.Tech. (Eng)., C.Eng., M.I.E.E.

PULSE forming circuits and rhythm switch assembly were completed last month. In this second and final article operation of the sound generating circuits and their construction will be presented together with final wiring details.

SOUND GENERATION CIRCUITS

Fig. 10 shows the block diagram of the circuits involved in the sound generating half of the unit. Pulses from the two sets of differentiators are routed to the wipers of the rhythm selector switch S3. In selecting a dance tempo switch position pulses are steered to the associated sound forming circuits producing a rhythmic percussion pattern of high and low bongoes, bass drum and brushes as desired. As described in the last article these patterns are contained in the framework of the 6 or 8 pulse cycle produced from the twisted ring counter. The panel controls VR1 and S2 permit both control of tempo and extension of the rhythm pattern up to a maximum of 12 or 16 beats to the bar.

The noise generator produces a random combination of frequencies embracing the audio gamut. This is fed to two transistor gates which are separately triggered by pulses of different duration to produce long and short brush sounds after amplification. Fig. 11 gives the complete circuit of the various stages. With reference to this a more detailed description of operation follows.

HIGH BONGO

This sound is produced by feeding a pulse or pulses into the circuit comprising D35, R68, C34 and L2 the latter winding being encapsulated in an LA7 ferrite pot core. 700 turns of 36 s.w.g. enamelled wire are wound on to the bobbin the ends being taken out and soldered to the tags. The bobbin is then placed in the core assembly and the clamps tightened down. (Two should be wound for both bongo circuits.)

The coil inductance should be between $\frac{1}{2}$ and 1 Henry, and depending on the choice of parallel capacitor a wide range of bongo type sounds are possible. The circuit can be used to produce bongo or "scull" sounds.

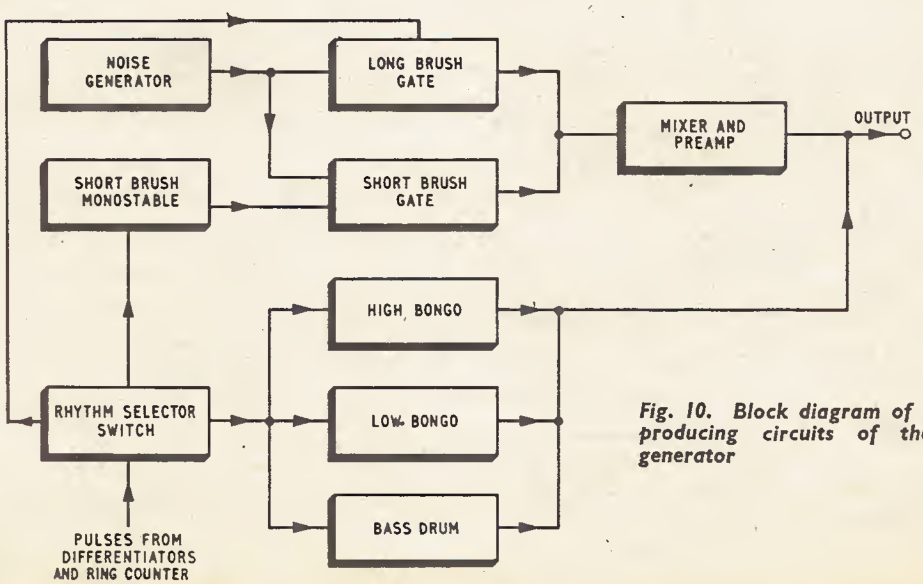


Fig. 10. Block diagram of the sound producing circuits of the rhythm generator

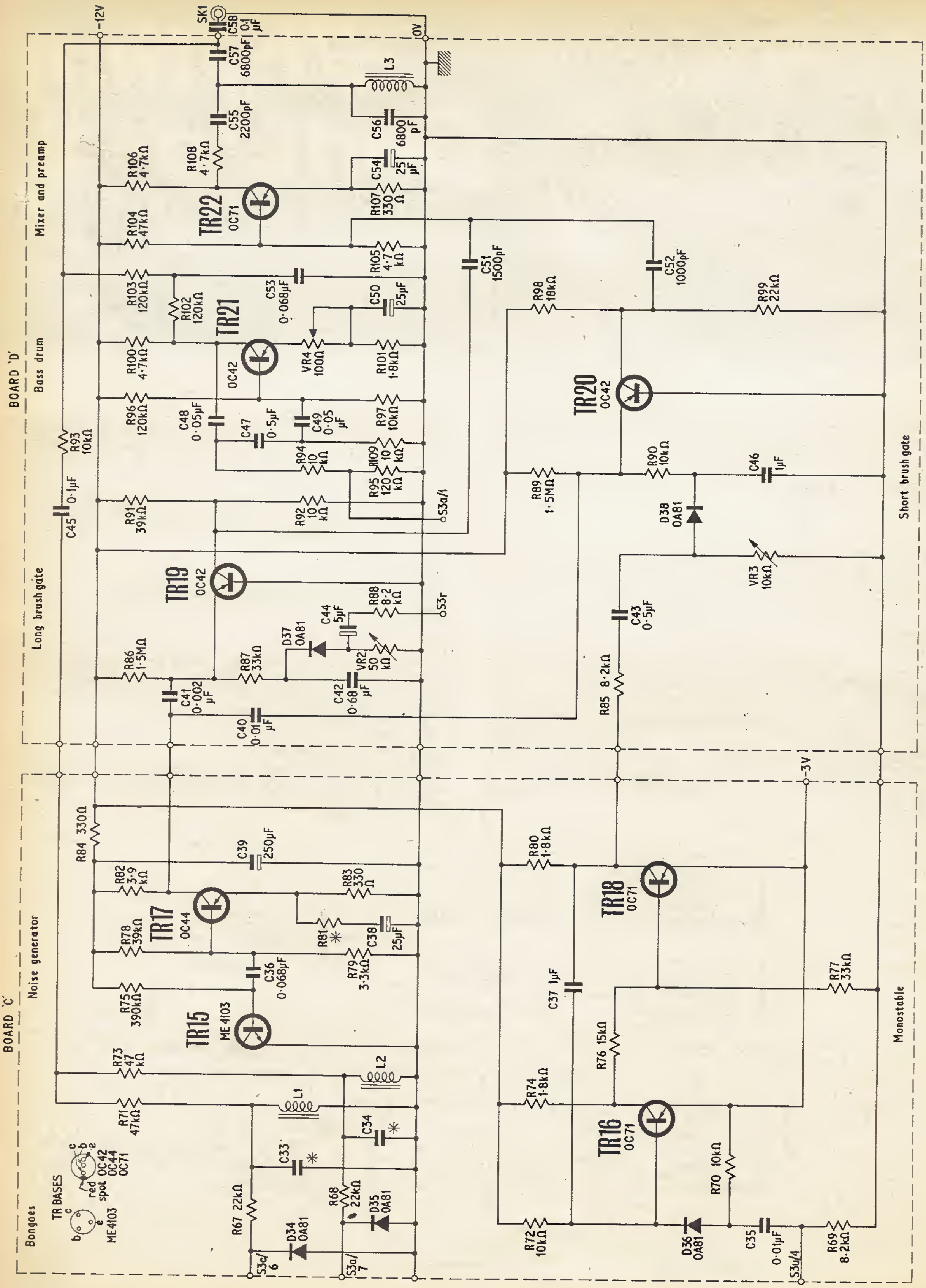
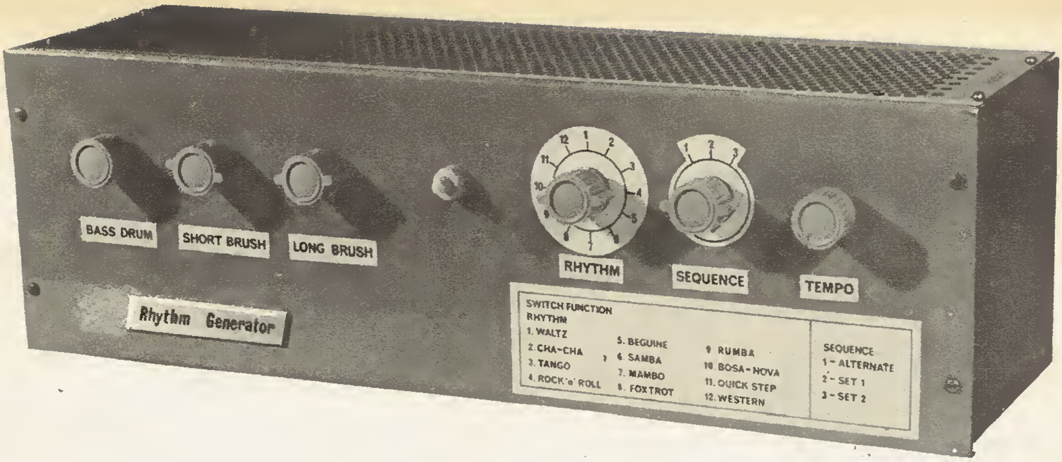


Fig. 11. *Circuit diagram of noise generator and percussion elements*



The capacitor is best selected by experiment to give the pitch of sound required. This in fact will be found to lie in the range of $0{\cdot}1\mu F$ to $1\mu F$. In the prototype C34 was $0{\cdot}1\mu F$ for high bongo.

LOW BONGO

Both bongo sounds are the result of pulse exciting a "ringing" circuit consisting of a parallel *LC* resonator. Since the coil inductances of both circuits are designed to be identical pitch variation will depend on the value of the capacitor used. In the prototype C34 was $0{\cdot}25\mu F$ but this should be tailored by experiment.

NOISE GENERATING AMPLIFIER

The amplifier is conventional except for the input transistor TR15. The prototype uses the noise generated by a reverse-biased *pn* junction, but equal performance may be obtained with a noisy Zener diode.

The transistor used is a silicon planar type which has a maximum emitter-base reverse bias of 5V. When operating from a 12V supply the junction breaks down and acts like a Zener diode, the current being limited by resistor R75.

The amplifier transistor TR17 should preferably have a gain, or h_{fe}, in excess of 100, to give adequate noise output. Alternatively an extra stage of amplification could be added.

The output amplitude can be adjusted by inserting a feedback resistor R81 the value of which should be resolved by experiment. Lowering the value of this resistor increases the noise output.

MONOSTABLE PULSE GENERATOR

The monostable pulse generator has one stable and one semi-stable state. In its stable state TR16 is on and TR18 off. With the application of a positive trigger pulse, routed via S3, TR16 switches off and TR18 on; the circuit is now astable.

After a period determined by the C37, R72 time constant, the circuit reverts naturally to the stable state with TR16 on and TR18 off.

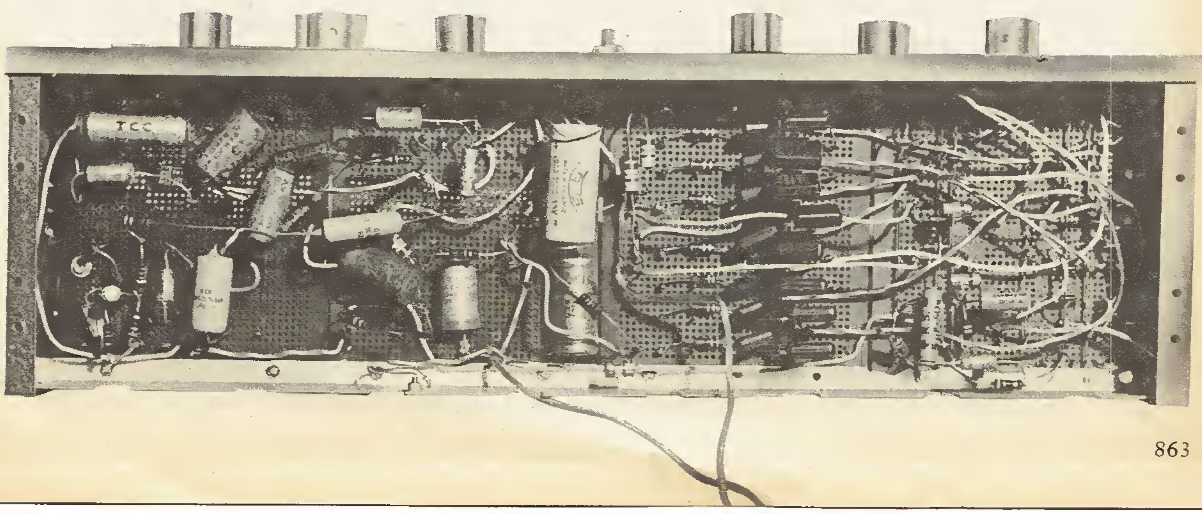
The monostable timing element determines the width of the positive output pulse appearing at the collector of TR18 and ensures that the short brush gate receives a constant duration input pulse irrespective of the tempo setting.

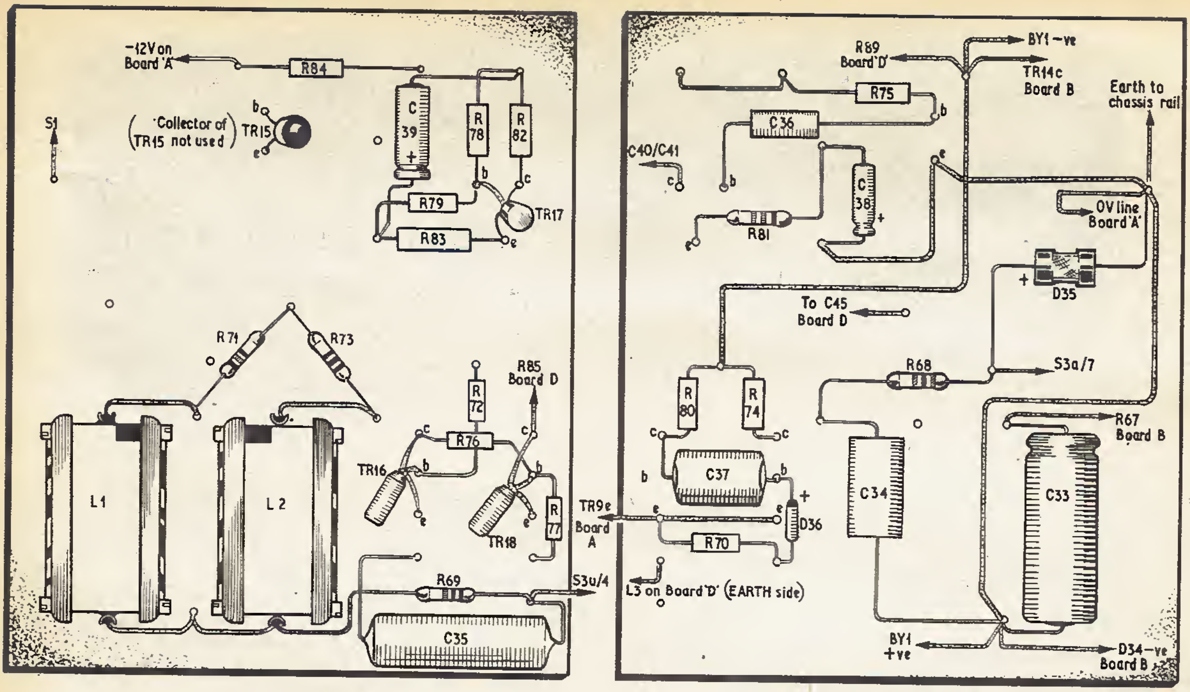
The triggering of the monostable is taken from either the clock pulse output, which gives a repetitive brush every beat, or one or more differentiator outputs via the rhythm switch S3.

SHORT BRUSH GATE

The short brush gate consists of a common base amplifier configuration. When a short brush sound is required on each beat the clock pulse generator provides positive pulses to D38 so gating TR20.

In the idle condition the gating circuit is held off by a small negative bias on the emitter. This bias should be just sufficient to prevent the noise signal from passing via the gate and this may be set by altering the value of R89. The panel mounted control VR3 enables muting of short brush sounds by setting to zero resistance.

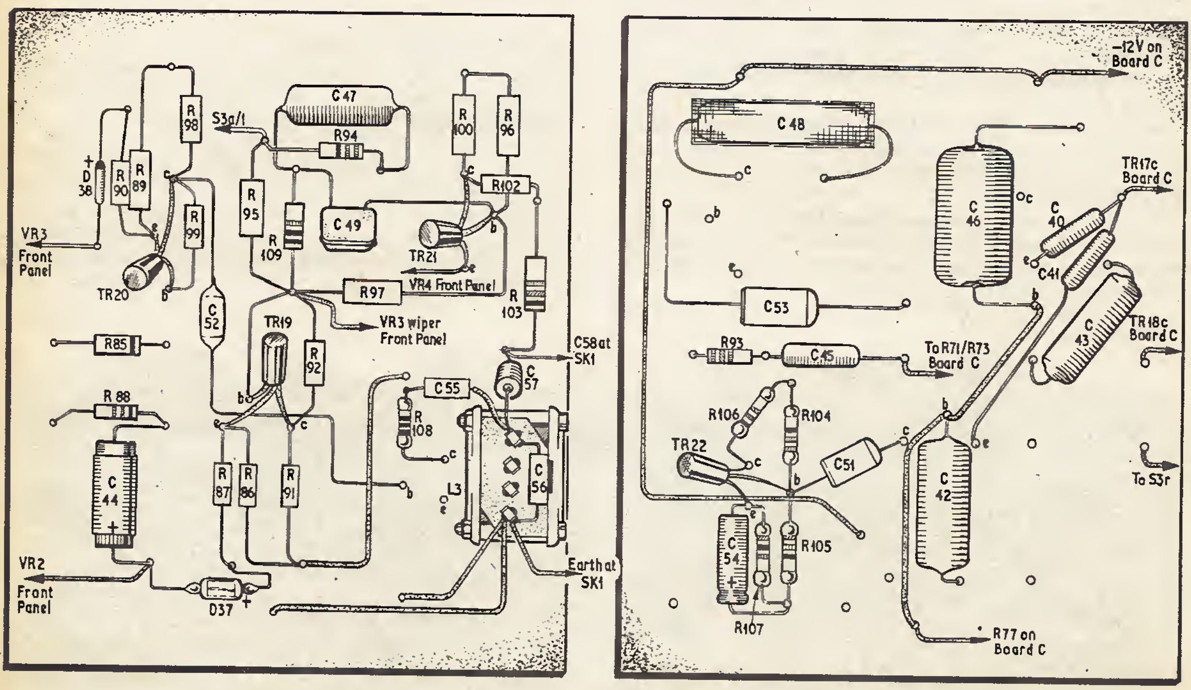




(a) topside view

(b) underside view

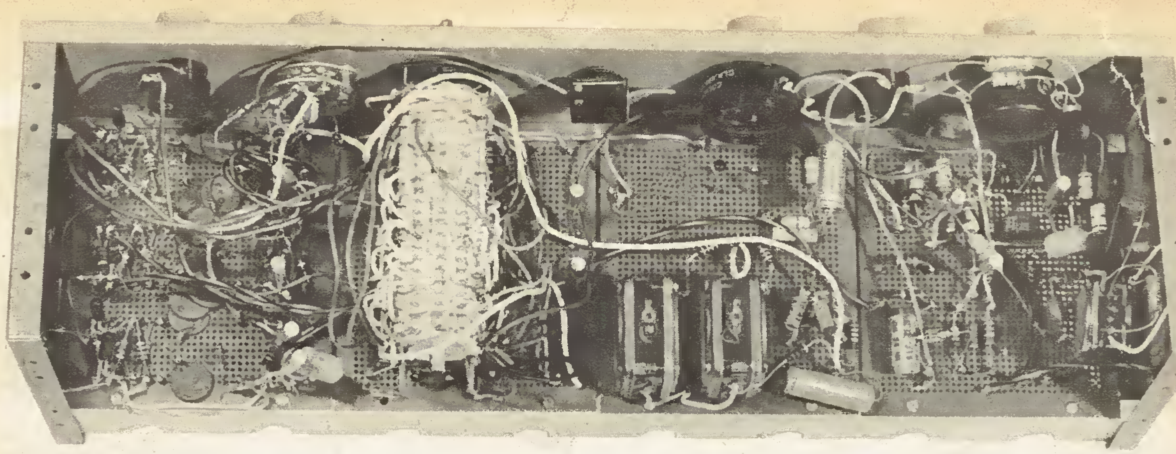
Fig. 12. Component layout and wiring for noise and monostable generators and bongo circuits on board "C"



(a) topside view

(b) underside view

Fig. 13. Component layout and wiring for brush gates, bass drum and pre-amplifier circuits on board "D"



LONG BRUSH GATE

The long brush gate input is connected to the wiper of wafer S3r at the rhythm switch. This provides a selection of any one bistable output which may be applied to diode D37 for gating TR19.

As with the short brush gate, bias tailoring is by adjustment of the value of R86. It should be noted that the larger the noise input to the gates the lower the value of bias resistor needed. Panel control VR2 provides both muting by zero resistance setting and adjustment of noise pulse duration to suit personal requirement.

BASS DRUM

A fair imitation of a bass drum can be provided by the bongo circuit using a larger capacitance and so producing a low resonant frequency. However, a high *Q* coil is desirable and higher resistance values must be used to avoid the sound being too dead.

A better method is to employ a low frequency phase shift oscillator, TR21, which is set by means of VR4 so that the circuit cannot sustain continuous oscillation. The circuit now becomes a selective amplifier and the input pulse from S3a causes a transient disturbance, and the output obtained is similar to that for the bongo drum. VR4 can be set to give a much longer decay to the output and if set too low in value the circuit will oscillate continuously.

This particular circuit can be used to generate more realistic bongo drums than the resonant circuit given and if constructors wish to use this circuit for such sounds it is only necessary to select different values of capacitors for the feedback network to alter the frequency of operation. (It should be noted that R109 was omitted from the components list. This is normal rating, i.e. 10%, $\frac{1}{2}$W.)

BEAT EMPHASIS

For some rhythms it is desirable, for emphasis, to trigger both the bass drum and bongo drum circuit together on the same beat. This accentuation is provided by the wafer S3q.

Reference to Fig. 6, the rhythm switch wiring diagram given in the first article, shows that in the "Mambo" setting of the rhythm switch, connection is made to O1/B1 and this is passed to the drum circuit at wafer S3a via C32.

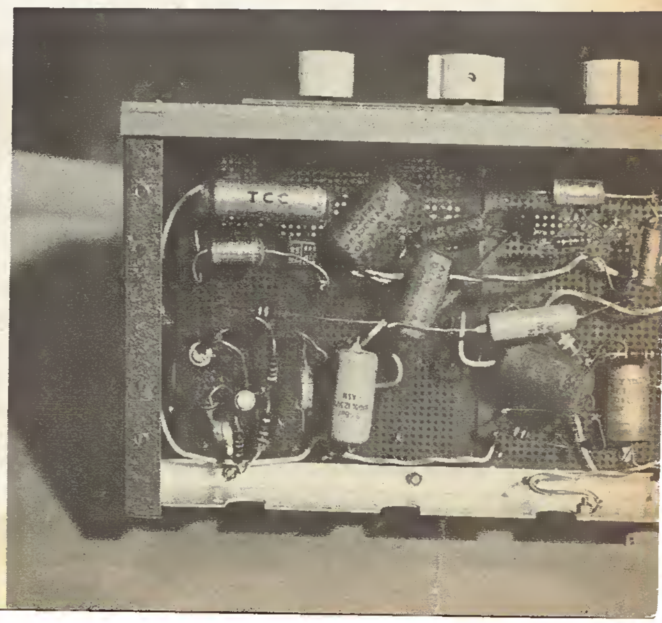
Since the wiper of this switch is also connected to the O1/B1 output via D17, a differentiator diode, the high bongo circuit is also triggered when the bistable 1 changes state so providing beat emphasis.

It should be emphasised that none of the switch wafers, S3a to S3p should be used to operate two sound circuits simultaneously as this would mean that these circuits would have a common input and would always sound together in other rhythm switch positions.

MIXER AND PREAMPLIFIER

The outputs from the two brush gates are amplified by a single stage amplifier TR22 which drives a resonant filter circuit C56, L3. This circuit gives a characteristic formant to the noise pulses to produce a more realistic imitation of the brush sounds.

The bass drum and bongo outputs are combined and together with the preamplifier brush signals require further amplification in a power amplifier. In the equipment used by the author, the extra amplification is provided by the power amplifier of an electronic organ, into which the rhythm unit is fitted.



BOARD ASSEMBLY

Reference to Fig. 12a shows the topside of board C. Solder pins should be located at the positions indicated and components assembled and soldered to them.

With these attachments completed the board should be reversed and components assembled as in Fig. 12b.

Board D assembly, Figs. 13a and 13b should be completed and both boards laid temporarily aside.

RING COUNTER CHECK OUT

Constructors should first test the clock pulse generator and ring counter and rhythm patterns can be tried out.

During development the author decreased the speed of the clock pulse generator by using 20μF coupling capacitors for C1 and C2. This allows the counter operation to be examined in slow motion using a 20,000Ω/volt voltmeter.

FLYING CONNECTIONS

After the boards are checked for proper function they should be attached to the rails of the chassis assembly (See Fig. 9) and inter board flying connections made. This operation should proceed through from board A to board D.

Next, flying lead connections to the switch bank S3 should be made, referring to Fig. 6. Sleeved lead lengths should be cut according to board location. Again connections should be systematic working from wafer S3a through to S3u.

The switch assembly should now be tightly bolted to the front panel and solder connections to the boards made.

With front panel control wiring completed and connection made to C58 at output socket SK1 the unit is ready for final testing. (C58, omitted from the components list, is a 0.1μF ceramic type.)

Before connection to an amplifier a further wiring check out should be undertaken.

SIMPLIFICATION

The equipment can be simplified, if required, by omitting the fifth bistable. This means that only one set of eight differentiators and associated switching wafers are required.

Because of this, TR13, TR14 and S2 in Fig. 4 can be omitted and the 10 kilohm differentiator resistors taken down to the -3V bias line. The bias line resistor R48 should be increased to about 150 ohms.

This simplification means that the maximum number of beats in any rhythm is six or eight. The "Bosa-Nova" rhythm requires a total cycle of 16 beats and so cannot be generated correctly with this reduced system.

No power supply circuit has been given as this will most likely be provided from existing sound equipment. The circuits will operate from less than 12 volts, but if the voltage is reduced too far the noise generating transistor will not be operating in a breakdown mode and the noise output will most certainly be inadequate. The supply used should be well smoothed to avoid hum on the output signal.

SOUND PROOF, INDEED!

Readers will be interested to learn that earlier this year the author demonstrated this Rhythm Generator before a meeting of the Electronic Organ Constructors Society. We understand the performance of this unit created quite an impression upon the audience—Ed.

★

MANCHESTER SHOW

Of the many electronics exhibitions held throughout the course of each year, few can compare with that of the Institution of Electronics, which took place, as usual, in the Lancaster Hall, Belle Vue, Manchester, in September. Immediately one is aware of the informal friendly atmosphere and helpful technical advice received on the various stands.

The lectures in the adjacent rooms are equally informal, and it is interesting to note the popularity in particular of the demonstration and talk on the Wyvern electronic church organ. This is a fine instrument with two manuals and 30-note radiating pedalboard.

COMPONENT SUPPLIES

Readers of PRACTICAL ELECTRONICS are frequently interested in obtaining small quantities of specialised electronic components, so our visit to the exhibition paid particular attention to this aspect. All too often one is told, when asking about supplies of "one off" orders: "Well we can, but . . ."

The sad tale is that some component specialists who handle products from several manufacturers just don't want to supply in "one off" quantities because overheads are high and the resulting profit margin is very nearly eliminated. The products are there but the problem is how to get them.

How about the retailers? Their job is to sell to the private consumer, the goods that *he* wants. If he wants a particular type of integrated circuit, or switch, or relay, or what have you, he should be able to walk into a shop and get it, either over the counter or on order. The retailer should have few problems—at least, that is what we deduce by talking to representatives of firms like Sasco, Jermyn Industries, Waycom, Newmarket, Mullard and so on. These companies, and others, supply in quantity to industry and the trade.

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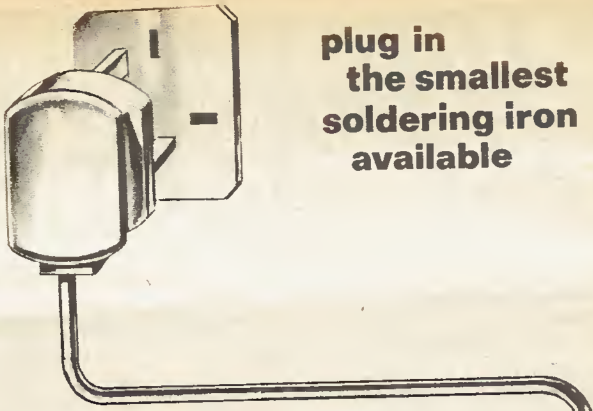
Of particular interest to educational establishments is the "Locktronics" circuit construction system. This is a base board with pillars and clips, on which can be mounted almost any combination of circuitry in the form of clip-on components. Link wires, junctions and crossovers are also supplied in this form. Each piece or component has the circuit symbol painted on its upper surface so that when complete the circuit diagram is shown.

A novel method of encapsulating dry reed switch relays has been employed by Electrothermal Engineering. These are called the "Flat Pack" range and are made in miniature and standard sizes (using single or multiple replaceable switch capsules) or in printed circuit style.

Model control enthusiasts will welcome the news of the Deac Universal constant current automatic electronic charger. This has been specially designed to handle 1 to 20 Deac cells in series connection up to 5Ah in capacity. Charge rate is adjustable in two ranges up to 50mA and 500mA. A charge timer is also incorporated so that the charger can be left unattended.

Deac introduced the new Varta 10/SD 1·6V control cell or "Third electrode cell battery" enabling the battery to be fully charged in one hour. A special charging unit or circuit can be supplied with this on application to the makers.

★



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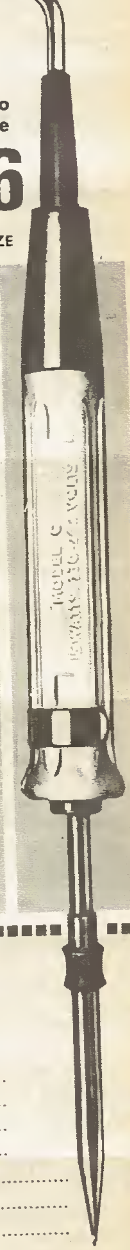
ACTUAL SIZE



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- Interchangeable spare bit, $\frac{3}{32}$″.
- Reel of resin-cored solder
- Felt cleaning pad
- Stand for soldering iron
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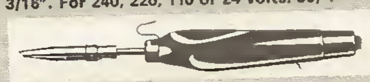
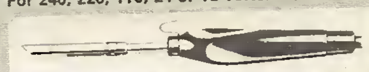


ES 25 watts. Fitted with 1/8″ bit. Interchangeable bits 3/32″, 3/16″ and 1/4″. Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. 35/-.



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A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

CAR LIGHTS ALARM

THIS circuit was designed to overcome the annoying habit of continuously leaving the car sidelights on and, consequently, running down the battery.

The circuit, Fig. 1, gives an audible warning that the sidelights, foglight, etc. have been left on each time the ignition is turned off. It is basically a simple OR gate (D1, D2, D3) and an indicator. In the prototype a simple Woolworths' doorbell was used as the indicator.

When both sidelight and ignition switches are on, and S1 in the "Drive" position, −12V appears at both sides of D1 and the latter does not conduct, and no current flows through the indicator. If the ignition is now switched off, point X is grounded via the ignition coil causing D1 to conduct, allowing current to flow through the indicator, producing a suitable warning. If the lights are now switched off the indicator will cease to function.

When the sidelights are switched off and the ignition switch is on, D1 is reverse biased and no current is allowed to flow through the indicator. This prevents the alarm sounding when driving normally with the lights off.

On some occasion it will be necessary to leave the sidelights on when the ignition is off. To prevent the alarm operating continuously in this condition, S1 is switched to "Park". When the ignition is again switched on, the alarm will operate warning the driver to switch S1 back to the "Drive" position.

Any number of lights or auxiliary circuits can be monitored simply by adding further diodes to the gate as shown (D2, D3). For negative earth cars, the diodes should be reversed.

F. Cogger,
Sevenoaks, Kent.

ELECTRONIC CONTROLLED PUMP

I FOUND the conventional bi-metal strip type of thermostat, controlling the pump of a central heating installation, to be very inefficient despite the use of devices such as accelerators to prevent overshoot. My own produced actual temperature ranges of up to 5 degrees Fahrenheit so I decided to adapt Mr. Michaelis's Chemostat (August and September 1967 issues) to control the circulating pump.

The printed circuit board is made slightly longer to enable RLA, C13 and D6–9 to be mounted on the board. By slightly widening the board the positive connection may also be taken to diodes D6–9. The transformer need only have an 18V 1A output (the 6·3V winding is not necessary) as all the other relays and circuit breakers are not required. RLA should have contacts capable of carrying 5 amps at 250V. RLA1 contacts in the circuit diagram are connected as shown and RLA2 contacts are used to switch the circulating pump of the central heating. A 0·1μF capacitor and 100 ohm resistor in series was placed across RLA2 contacts to reduce the slight spark when the pump circuit was breaking. A blocking loop is included in this latter circuit, being a fish tank type thermostat set to about 75 degrees Fahrenheit. This acts as a safety control in the unlikely event of electronic failure of the main control.

The circuit board and transformer is mounted in a box 11in × 5in × 2½in (conveniently hidden away in the hall cloakroom), leaving only TR1, VR1, and the blocking loop thermostat to be placed in a small case mounted on the wall. The wall unit is thus no larger than the conventional bi-metal strip type unit. The only other variation to the circuit is to make VR1 15 kilohms instead of 100 kilohms, giving a temperature range of about [illegible] to 80 degrees Fahrenheit, which is a more suitable range for the purpose.

Components C[illegible] and D3 must be very high quality with minimal leakage in order that sufficient voltage can be applied via R[illegible] (4·7 megohms) to trigger the driver circuit. Also D4 was dropped to 4V to give the quoted figure of 8V at the base of TR7.

Switching control is now so good that, with a change-over down to nearly ±¼ degree Fahrenheit, room temperature never varies by more than ¾ degree Fahrenheit at the most. Because of this very much closer temperature control I estimate that I shall save the cost of the unit in one year's fuel bill.

G. R. Skeates,
Harrow, Middlesex.

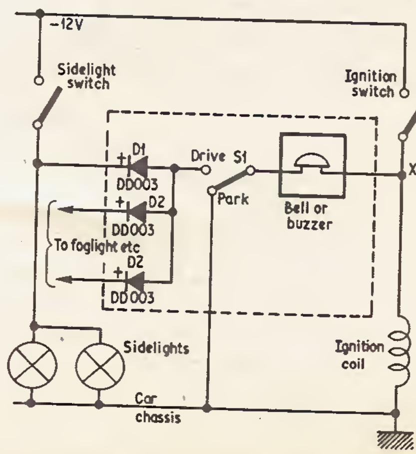
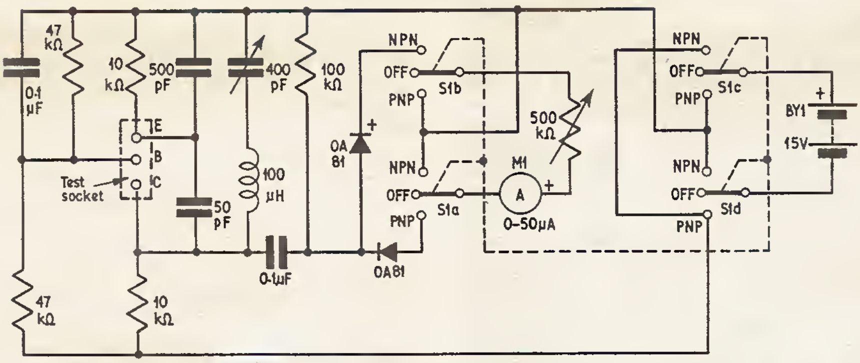


Fig. 1. Circuit diagram for a car lights alarm

COMPARISON TESTER FOR R.F. TRANSISTORS



THE accompanying circuit was developed to check whether or not transistors were suitable for r.f. applications.

The components as shown cause the transistor under test to oscillate at approximately 3MHz. If the transistor is capable of oscillating at this frequency, the output will be detected and will be shown as a reading on the meter. The amount of this reading has no real importance, only that it is used as a comparison with a reading from a transistor known to be good.

The frequency at which the test transistor is made to oscillate can be varied by the preset capacitor in series with the 100μH choke. The meter can be built into the instrument, or it could be the 50μA range of a multimeter.

The preset potentiometer control is used to set the output reading to approximately mid-scale for an average transistor. Switch S1 is a 4-pole 3-way, key or rotary type.

R. D. McGilliuray,
New Zealand.

SCREEN WIPER DELAY

IF ANY readers are contemplating wiring a screen wiper delay unit to the BMC 1100 or 1300 models, it should be noted that these models have a set of contacts that short out the wiper motor when the wipers are switched off and returned to the parking position; this acts as a brake (Fig. 1.) If any of these delay circuits are used on these cars the thyristor will be destroyed.

The circuit of the wipers in these cars and a suggested circuit to avoid the destruction of the thyristor is given in Fig. 2.

This circuit breaks the shorting path before the thyristor fires and makes again before the contacts close to cut out the motor. It is necessary to incorporate a time delay (approximately 0·25sec) in the relay circuit to allow adequate braking of the motor.

R. End,
Sunningdale.

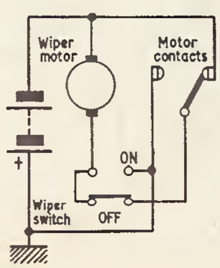


Fig. 1

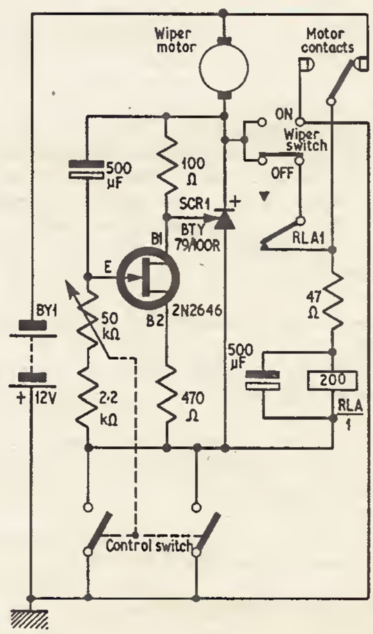


Fig. 2. Thyristor protection circuit diagram. The relay used is a GPO 3000 type with heavy duty N.C. contacts

Readers might be interested in the intercom system described. Fig. 1 shows the circuit for a two-wire, two-way intercom, with call facility from either end: it consists of a fairly conventional amplifier preceded by a diode gate.

Under normal talk/listen conditions the diode is reverse biased and has no effect. When the appropriate call button is closed, however, the diode becomes forward biased and closes a positive feedback loop between output and input, generating an audible output at about 4kHz. Change in this frequency is achieved by altering the feedback capacitance.

The input transistor was selected to have a gain of at least 40 at 0·5mA collector current.

S.G.S. Fairchild devices, such as BC154 and BC113 may be used for the *pnp* and *npn* respectively and BA130 for the diodes.

The speakers were moving armature types, similar to those used in telephone receivers, but any unit from 75 ohms upwards could be used.

Fig. 2 shows the additional circuitry required for operating a number of sub-stations from one master, being just a lamp driving circuit, one being required for each sub-station. The 2N3703 was selected to have a gain of at least 40 at 3mA. A BC154 may be used here, but a BC115 or BC125 must be used for the *npn*.

The Zener diode may be omitted and the 39 kilohm resistor increased to 82 kilohms if lighting of the indicator lamp can be tolerated in the talk position of the main station.

A power supply with greater current capacity is required for this circuit than is required for Fig. 1, the quiescent consumption of the former being only about 5mA.

M. Tucker,
Ilford.

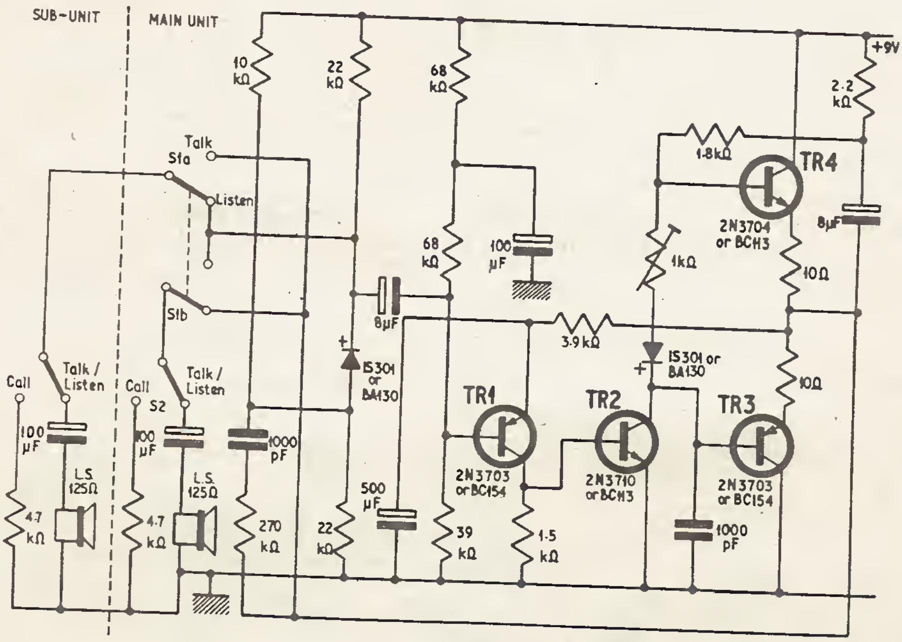


Fig. 1. Circuit diagram for a two-wire, two-way intercom, with call facility from either end

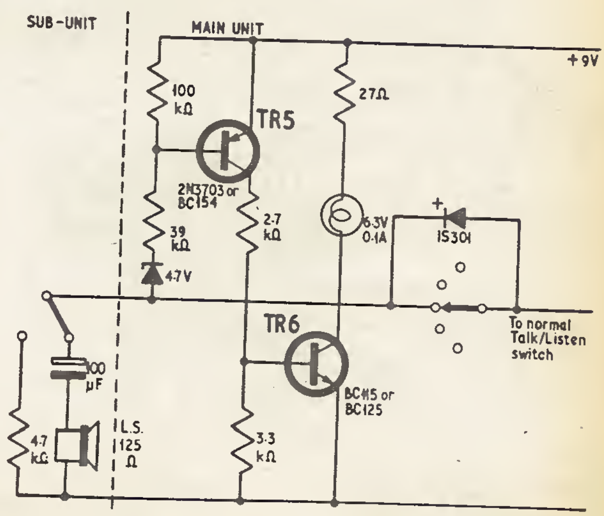


Fig. 2. Additional circuitry for operating a number of sub-stations from one main unit

Electronic STOCKMARKET

ELECTRONIC stockmarket is a game combining skill and chance in proportions such as to provide endless hours of amusement for all the family. Costing little over £7 in parts, it is simple to construct and can be depended upon to outlast many other conventional games, except, perhaps, chess.

The model illustrated accommodates four players or less, but extra players' positions can be accommodated on the board if required for an outlay of approximately 15s per position for components.

The game is designed to simulate very closely the thrills and hazards met in investing in the stockmarket proper. In the game, however, monetary gains and losses are substituted by changes in electrical charge on capacitors. These charges are checked by the players throughout the game so that each player can keep a thrifty eye on his business "potentials" and "capacity"!

Briefly, each player makes intelligent transactions on 11 different market commodities, the individual "share" prices of which are constantly changing under the control of dice throws. A good memory is beneficial in playing, so that transactions will be made only on commodities whose shares have risen. This ensures that the player makes the most advantageous use of his transaction.

The ultimate object of the game is to build up one's cash (i.e. potential on "cash" capacitor) and to transfer it at intervals to a "bank" capacitor until the accumulated bank balance reaches a preset level, representing one "million". As soon as this point is reached, the player's "million" lamp starts flashing, so identifying the winning player.

By B. H. Baily

HAZARDS IN PLAY

The play is not as easy-going as may be indicated from the above, however, and deliberate hazards have been introduced to add interest to the game. For instance, if a player throws a "5", he is compelled to push his "bank raid" button. This at once puts a short-circuit across his "bank" capacitor and reduces all his accumulated bank savings to nil, leaving him with only his cash balance. Other dice throws affecting levels are as follows:

1. Demands that the shares of the selected commodity be brought "down"; press "shares down" button.

6. Raise the shares of the selected commodity, by the pressing of the "shares up" button. Players either gain or lose by transacting with commodities whose shares are up or down, respectively.

Shares are raised to a set high level by the "shares up" button, the actual level being preset by means of a preset potentiometer. Shares are lowered by the "shares down" button, which reduces the shares capacitor charge by a proportion of its original value only. A time constant is incorporated to make shares vary in their drop, if the down button is pressed twice within about 30 seconds.

A realistic "tax" system is incorporated which taxes or rebates players from time to time, according to their "financial" position.

PLAYERS' CONTROLS

The basic circuit is simple, see Fig. 1, and consists of three separate parts: a meter and associated emitter follower stage, the "Stock Exchange" capacitors and associated rotary selector switch and push-buttons, and finally the players' circuits.

The players' circuits are all identical, irrespective of the number of players accommodated. Each comprises a "cash" capacitor and a "bank" capacitor. The cash capacitor has push-buttons marked "check cash", "transact", and "cash to bank" to allow for the required functions.

The bank capacitor has a push-button marked "bank raid" which is connected so as to short-circuit the bank capacitor when the button is operated. A two-transistor level detecting and lamp-drive circuit monitors the bank capacitor potential at all times, and starts to flash the player's "million" lamp when it detects a certain minimum "winning" level in the player's bank.

CHECKING CHARGE LEVELS

The meter used in the prototype has an f.s.d. of $50\mu A$, but one of $100\mu A$ would do equally well provided that the series resistor is modified suitably.

Since the meter circuit is used to check charge levels on capacitors, the greater sensitivity used the better, or undue current drain would result through the base circuit of the meter circuit, so robbing the players of

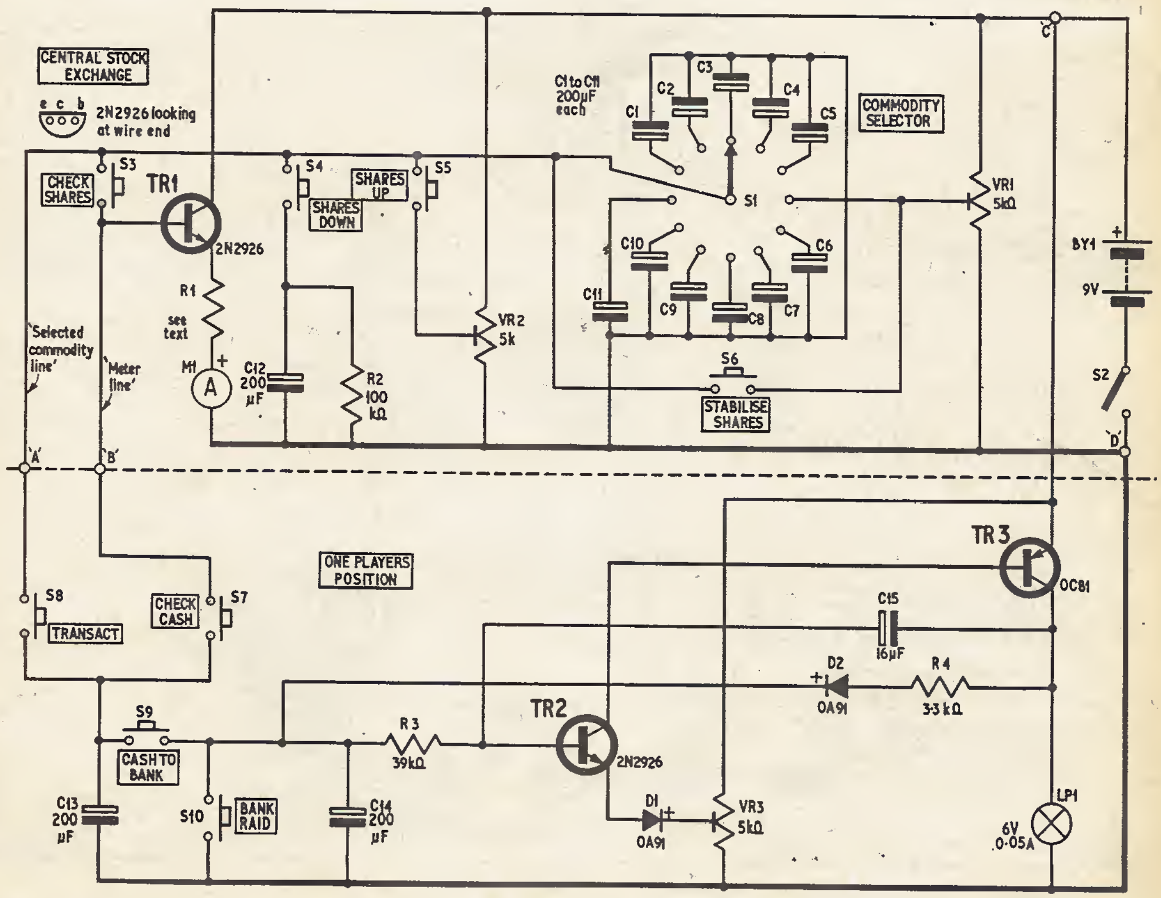


Fig. 1. Circuit diagram of the Central Stock Exchange and one Player's Position. Additional players' positions are connected similarly at "A", "B", "C" and "D"

Each player has four push button controls and a "million" lamp

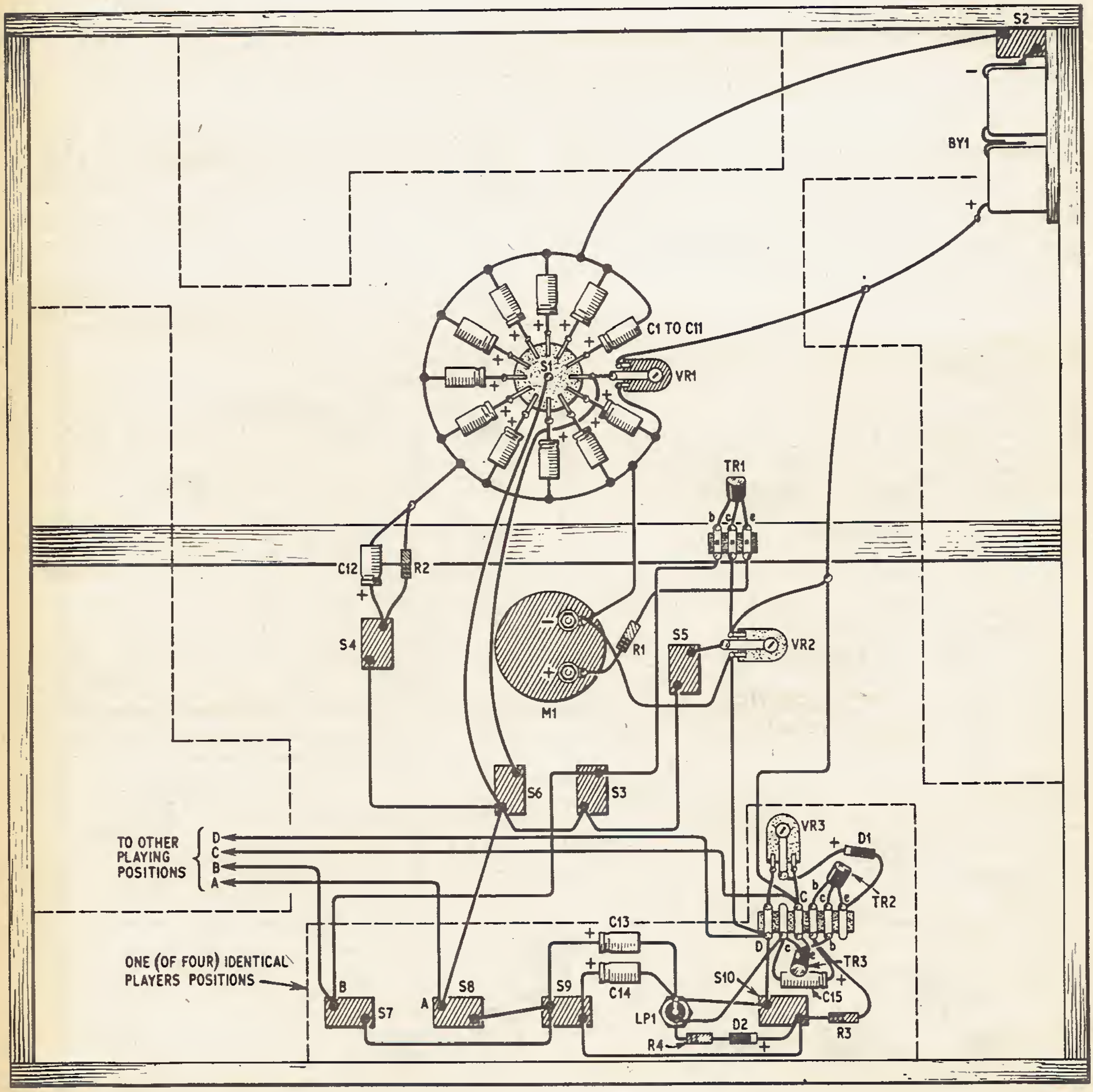


Fig. 2. Layout and wiring diagram of the Central Stock Exchange and one Player's Position. The player's position wiring within the dotted segment is repeated at the three other dotted positions. All players' positions are connected similarly at points "A", "B", "C" and "D"

part of their accumulated "cash". The transistor emitter follower circuit is designed to reduce this drain to a minimum, due to its characteristically high input impedance.

STOCK EXCHANGE COMMODITY SWITCH

The Stock Exchange is a simple common negative array of 11 200μF electrolytic capacitors, the positive terminals of which are connected to the stationary contacts of a 12-way single-pole rotary switch. The switch *must* be of the continuously rotating type, and it may be necessary to bend the stop on some types of switch to allow for this function.

COMPONENTS . . .

CENTRAL STOCK EXCHANGE

Resistors
R1 100kΩ if M1 is 50μA; 50kΩ if M1 is 100μA
R2 100kΩ

Potentiometers
VR1 5kΩ linear preset
VR2 5kΩ linear preset

Capacitors
C1 to C12 200μF elect. 10 or 12V (12 off)

Transistors
TR1 2N2926

Switches
S1 Single-pole 12-way rotary, continuous break before make type
S2 Single pole on/off toggle
S3 to S6 Push to make, release to break, Castelco type or similar push button switches (4 off)

Meter
M1 50μA or 100μA type MR65P (see R1 above)

Battery
BY1 4½V flat pack type 1289 (2 off)

Miscellaneous
Materials (hardboard and wood) to make the board according to requirements (see text)
Tag strips

PLAYER'S POSITION

One off each component referenced per player's position

Resistors
R3 39kΩ R4 3·3kΩ

Potentiometer
VR3 5kΩ linear preset

Capacitors
C13 200μF elect. 10 or 12V
C14 200μF elect. 10 or 12V
C15 16μF elect. 10 or 12V

Transistors and diodes
TR2 2N2926 TR3 OC81 D1, D2 OA91

Switches
S7 to S10 Push-to-make, release-to-break, Castelco type push button switches (4 off per position)

Lamp
LP1 6 to 8V 0·05 or 0·1A lamp in holder, panel indicator type

The twelfth stationary contact of the switch is taken to the wiper of a 5 kilohm preset potentiometer. This provides an arbitrary "tax" level, and the corresponding switch position is marked "tax". All other 11 positions of the switch pointer knob are marked with a set of stock-market commodities, e.g. "mining", "leather", "oil", etc. Ideas can be found in the financial pages of any national newspaper.

The Stock Exchange selector switch wiper is connected to a line termed the "selected commodity" line. It is to this line that each player connects his cash capacitor when transacting, in the hope of "milking" the selected capacitor of some of its wealth. The line may also be connected to a preset high level via the "shares up" button, or to a discharged capacitor via the "shares down" button.

This reduces the selected capacitor's charge by about half, whether pushed once or more times, and also compensates for varying degrees of length of push, since the discharged capacitor has a long time constant resistor across it. All shares are stabilised at the commencement of a game by pushing the "stabilise shares" button and rotating the selector switch slowly. This levels all selected capacitors to the preset level of "tax".

PLAYERS' POSITIONS

The cash and bank capacitors of each player's position are connected by push-buttons to various lines as follows:

1. The "transact" button connects the cash capacitor to the selected commodity line.
2. The "check cash" button connects the cash capacitor to the common meter circuit, to allow the player to see his cash balance before and during transactions, etc.
3. The "cash to bank" button connects cash and bank capacitors together to allow high cash levels to be transferred to bank.
4. The "bank raid" button shorts out the bank capacitor.

All capacitors use a common "earth" or return line, and switching is achieved in the live lines.

The level detection and lamp drive circuit is simple, using a silicon 2N2926 transistor and a germanium OC81. Alternatively, two OC71's could be strapped in parallel for the second transistor. "Million" lamps should preferably be of 0·05A, but 0·01A types will serve since their use is intermittent during play.

CONSTRUCTION

The prototype was constructed on a hardboard sheet about 2ft square, supported underneath with wood battens to form a shallow inverted box. Controls and lamp holders were mounted through the hardboard, as was the meter, and all electronic circuits were built on single row strips of tag-board. These were later glued to the underside of the hardboard at convenient positions. All "floating" components were affixed by similar treatment.

Power lines from the batteries were attended to first, and this was followed by the wiring of basic lines, e.g. earth, selected commodity, transact, meter lines and so on. Wiring is quite a simple procedure if tackled in this manner. Note that all storage capacitors are 200μF 10 or 12 volt, and that they all have their negative ends connected to "earth".

THEORY OF OPERATION

Charges stored on capacitors are distributed and redistributed as the game progresses. Each transfer of charge is made from one capacitor to another, with the exception of "bank raid", "shares up" and "tax" operations.

Under normal play conditions "bank raid" occurs only occasionally to any one player, and the loss of potential to earth by this hazard is more than compensated for by the raising of selected shares by the "shares up" button. This effect is cumulative as the game progresses. Charges progress from the battery to the players' banks as follows:

(a) Battery to selected commodity capacitor via "shares up" button.
(b) Selected commodity capacitor to player's cash capacitor via his "transact" button.
(c) Player's cash capacitor to his bank capacitor via "cash to bank" button.

At each transfer *a*, *b*, and *c* the charge (under the worst conditions) is halved, so that at each stage the original source is never completely depleted by a transfer. Note that there is a relatively long time constant on the "shares down" button capacitor. This adds interest to the game, in that if two "down" actions occur consecutively, the second results in less reduction of shares.

Initially, small charges may be transferred, but as charge builds up on a player's cash or bank capacitor, he has to note that he will only gain from an action in which he connects to a charge which is higher than his own—otherwise he will lose to the source. For instance, he may find himself buying shares instead of selling them for cash. In this case the share price will rise at the expense of his cash balance.

For the same reason the game's taxman is considerate. If a player transacts with low cash balance, he will gain, but if he has more than the tax level, the latter will trim his balance down to size! As the rules explain, transaction with the taxman is compulsory when one's throw lands the selector switch to "tax".

PLAYING RULES

The suggested rules were compiled as a result of many trial games and have resulted in games lasting anything from 15 to 40 minutes, whilst giving dramatically exciting playing.

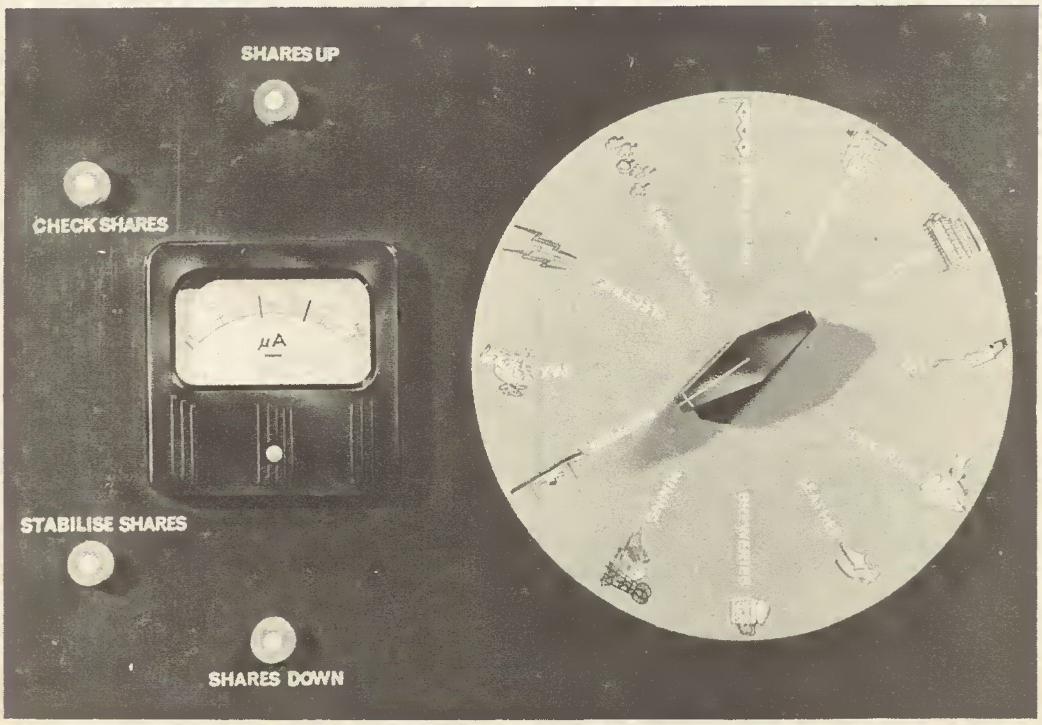
Before commencing a game, switch on the main battery switch, set "Stock Exchange" selector switch to "tax" and press "check shares" and "stabilise shares" buttons. Hold both down and slowly rotate the selector switch around all 12 positions. Stop on each position for about 3 seconds, or until the reading has stabilised to the tax level.

Next, ask each player to press his "bank raid" button, so that each starts without any bank balance.

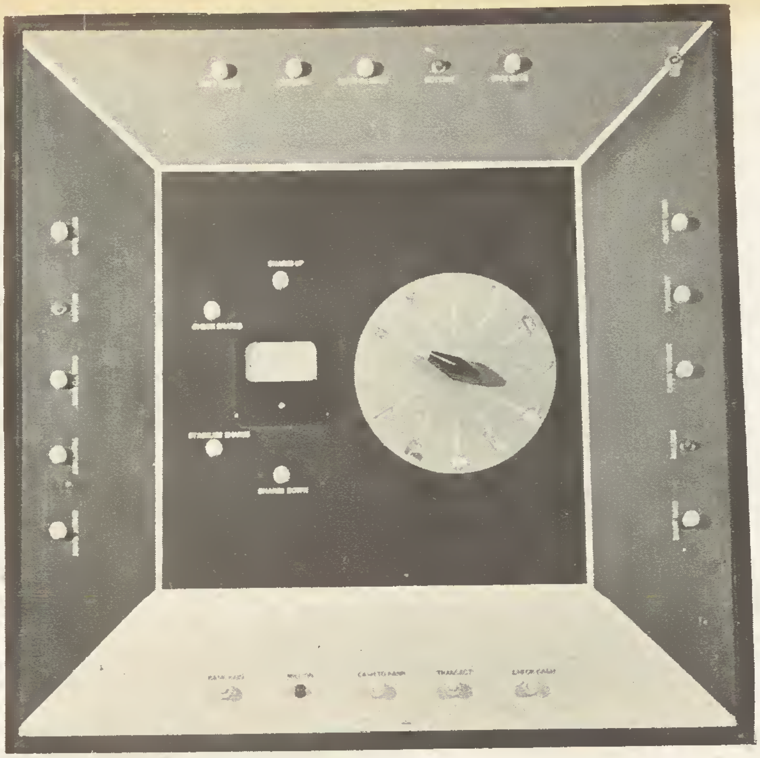
With the selector back at tax position, ask each player *in turn* to press his "transact" button for about 3 seconds. This gives each player a starting cash potential equal to the tax level.

Stress to each player that he must never push any buttons out of turn, but to await his own turn of dice throw before doing anything.

The game is played by each player taking turns at throwing a dice. Dice throws are interpreted as in Table 1.



Close-up view of the Central Stock Exchange controls with meter



If, after moving the selector switch the required number of positions, it ends up pointing to "tax", the player *must* transact. He may watch what results by holding his "check cash" button down whilst transacting.

USE OF A CALLER

With the four-player version of this game, it is inevitable that the various labelling of share commodities will be read by some players better than by others. The prototype was labelled to be read from one position only, and this player was asked to move the selector, and to call out any share price changes as they occurred. He could be unofficially called the "stock broker's runner".

Table 1: DICE INTERPRETATION

Number thrown	Turn Selector Switch clockwise this number of positions	Other action by thrower
1	1	Press "shares down" button.
2	2	*Free choice of action unless switch lands on "tax".
3	3	Ditto.
4	4	Ditto.
5	1	Unless switch lands on "tax", must push own "bank raid" button.
6	1	Unless switch lands on "tax" push "shares up" button.

**Free Choice* means that the player may press his "check cash" button to observe his cash balance, and choose whether he wishes to "transact" *or* put his cash to his bank by "cash to bank" button.

SUGGESTED LEVEL SETTINGS

The following levels were decided upon for the various presets, and were found by experiment to work out satisfactorily for normal lengths of play.

Shares Up Preset

Set to give hard over deflection on meter, but avoid turning to full 9 volt position. Press "shares up" and "check shares" buttons together with selector to any position but *not* "tax".

Tax Preset

Set selector switch to "tax" and press "check shares" button. Adjust to give half-scale deflection on meter.

Players' Positions "Million" Presets

Set selector switch to "tax" and hold down the "transact", "check shares", and "cash to bank" buttons together. Adjust preset to full 9 volt end and very slowly turn it back until "million" lamp flashes. Adjust very cautiously, since there is a delay in the lamp firing. Treat all positions similarly, and afterwards check each for final adjustment. The "million" lamps flash two or three times, and then remain on.

Length of Play Adjustment

The "shares up" preset will affect the length of play, as will the individual adjustment of the players' "million" presets. It may be necessary to make the players' "million" circuits fire at anything down to half of "tax" level. This is done by "inching" the "bank" capacitor up in small steps by repeated short depressions of the "transact" buttons, on "tax", with the "check cash" and "cash to bank" buttons held down on each position in turn. Alternatively the tax level could be reduced to half for the duration of the settings of the players' positions, and afterwards restored to half-scale.

The author has applied for Patent Rights on this Electronic Stockmarket game.

★

2 SIGHT & TOUCH

BIONICS

BY G. C. BROWN
M.S.H.A.A., A.M.R.S.H.

HAVING discovered the general lines upon which the conditioned reflex may be evoked, we can now utilise the knowledge to work out how we might synthesise it.

Examine the block schematic in Fig. 2.1. It will be seen that it has been drawn in the "black box" configuration; there are the two inputs S_s and S_n, and two outputs E_s and E_n. We now know that by application of input signals, reflex responses will appear at the output. Furthermore, we would expect to find evidence of a conditioned response to S_n at E_s, following the repeated combination of input S_n a short time prior to S_s. This pre-supposes that for S_n to remain effective up to the time S_s appears, it must be extended in time; put in another way, we need to include a short term memory for S_n.

A MEMORY DEVICE

When S_s makes its appearance for the first time, no *observable* reaction takes place; it is not until the input combination has occurred several times that an effect is elicited. Hence it would not be unreasonable to assume that some form of counting mechanism existed within the "black box", which had the ability to sum the number of times S_s had appeared just after S_n.

It would seem that this device therefore had the ability to exclude all reasonable possibilities for chance combinations of stimuli, by giving no output until an acceptable number of repetitions had occurred. We would then suppose that a gate (G2) would be opened by the summer which now allowed S_n to produce a conditioned response at E_s. (We might conceive of the summer as a type of long term memory). Once R_c has been established it will also be necessary to inhibit the normal response to S_n; this is provided by gate G3.

DIFFERENTIATOR

Just to tidy up the "black box", a differentiator, and another gate (G1), have been added. We need to know the *number* of times S_s has been applied, rather than the duration of its individual appearances; hence it is necessary to differentiate S_s prior to its summation with S_n. The extra gate has been included so that the short term memory can have a direct control over S_s once it has been differentiated.

The gates used here have been devised by the author to simplify explanation of the black boxes because their functions are largely analogue. Unlike the more normal logic gates which are either open or closed, these can be partly open, or partly closed. The cross-hatched gates are open until energised, and the remaining gates closed until energised.

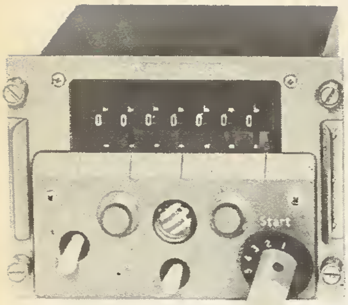
INHIBITION SYNTHESIS

As yet, the black box has only fulfilled a few of its promises—it is to be expected that in addition to the excitation responses, we should be able to observe some aspects of inhibition too. A look at Fig. 2.2 will disclose that this should not be difficult to synthesise either.

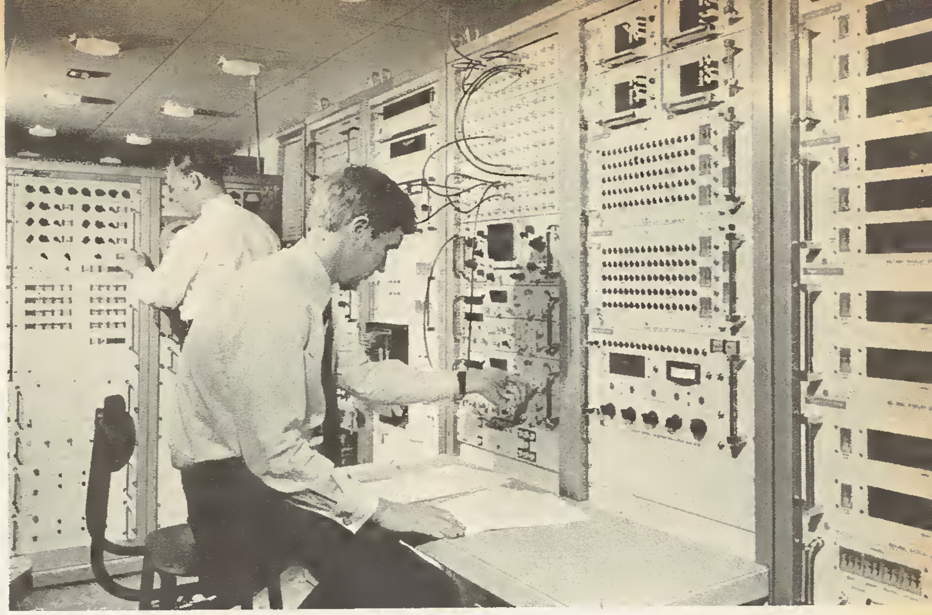
Let us go back then, to where we investigated inhibition and ponder upon what we should expect to find inside the black box that could give rise to this phenomenon. As we only have two inputs available for stimulation, further distracting stimuli may of course be considered here as irrelevant. However, inhibition which is consequent upon application of S_n without S_s might be demonstrated. To accomplish this we need a further summer and two inhibit gates.

Assume that the "box" has been conditioned, and that S_n is being applied only, resulting in an output at E_s via G4 and G2. Seemingly, S_n would be passed via G5 to No. 2 summer, with the eventual result that G4 would be closed and hence inhibit further action for a while.

The design and construction of electronic "animals" or machines with artificial intelligence



Digital display for the Plessey Flight data recorder



ESRO Satellite Checker

THIS second Elliott-Automation mobile satellite check-out station will exercise and test satellites from factory trials to launching for the European Space Research Organisation (ESRO).

NORAMA
ROUGH 1968

Phantom Reconnaissance Pod

THE latest McDonnell-Douglas Phantom F4M jet strike aircraft will carry a reconnaissance pod under the fuselage, which houses sideways and downwards looking radar, data converter for translating data into binary code for film storage, low level infra-red line scan equipment for ground close-ups, and cameras for day and night surveillance. The equipment has been developed by E.M.I. Electronics.

280,000-Channel Transceiver

A NEW military manpack transceiver, the Plessey B20 operates over the 2–30MHz range with 280,000 channels available in the a.m., c.w., and s.s.b. modes.

Nodding Heightfinder

THIS rather unusual looking scanner is the new Marconi "Heightfinder", part of the S600 series of radar equipment, designed for use in the C frequency band. It can be made static or transportable and will fold up for transportation. It is operated through a simple backwards and forward "nodding" action by computer control with height elevation angles between −5 and +55 degrees at velocities up to 45 degrees per second.

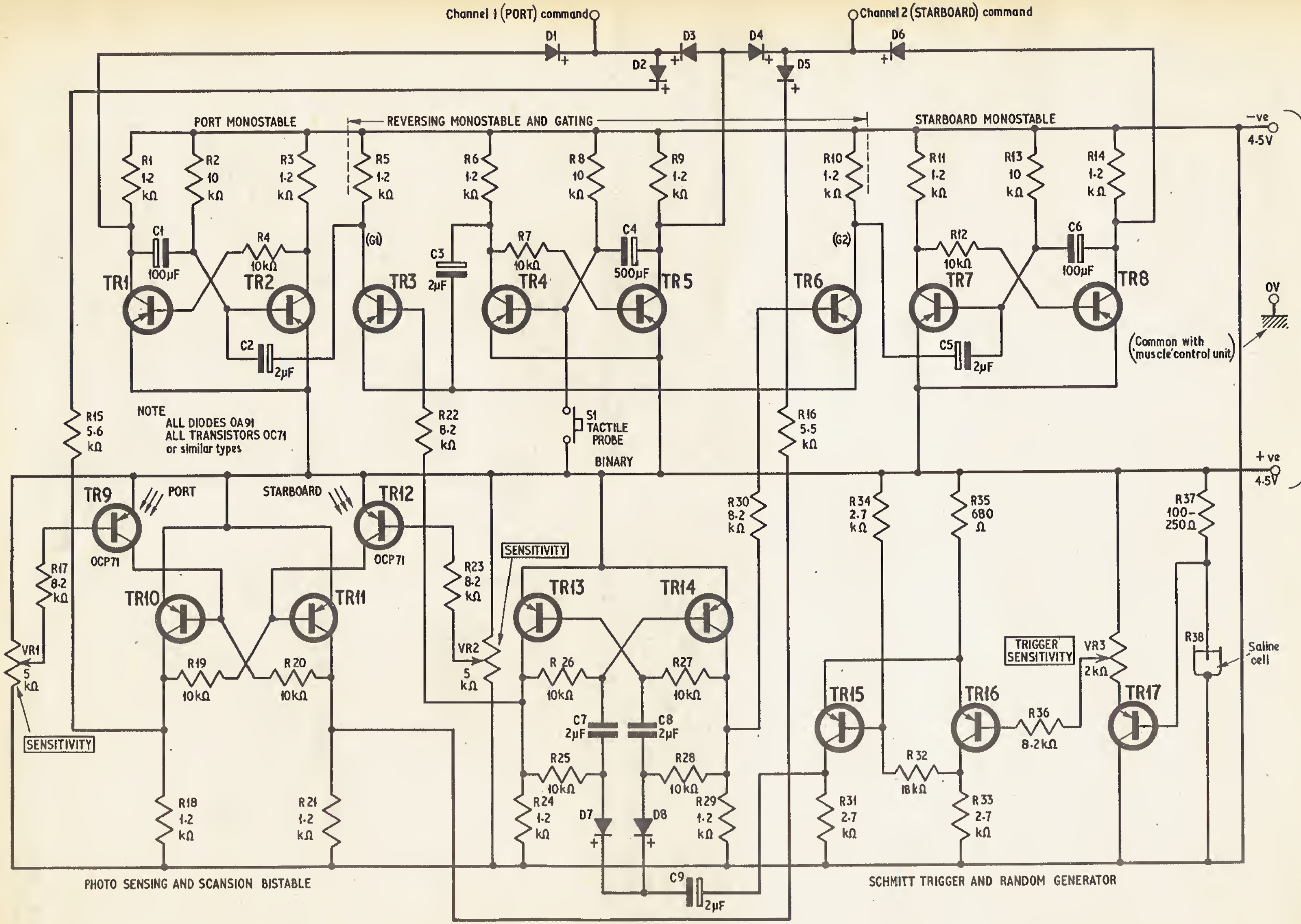


Fig. 2.4. Circuit diagram for the photo and tactile sensors and reflex sections of the system outlined in Fig. 2.3

DISINHIBITION SYNTHESIS

Using the same building bricks, disinhibition may also be included. On the assumption that R_c has been inhibited, if S_s is now presented, No. 2 summer will be cleared and G4 will then open again: the conditioned response will once more appear. As this summer has a decay characteristic, it follows that disinhibition will also occur with the passage of time.

Our "paper" model seems to function as we would wish. It appears to demonstrate simple learning, has the ability to store data in its memory, and shows certain preferences for particular meaningful combinations of stimuli. Readers here may object that we have *built* all this into the design: this, to a degree is correct but it must not be forgotten that this is true for a real live animal as well. After all, it is *endowed* with the equipment to learn, but these innate qualities cannot develop other than of the animal's own volition.

ELECTRONIC "GRAFTING"

The electronic counterpart of the learning aspects demonstrated by the black box model will be considered in the next article. However, in the meantime we must attend to the job of "grafting" in the sensory electronics, also the circuitry associated with scansion and reflexes. It must be remembered that most of the hardware is only temporary, so it would be as well to make provision for this in the "mobile breadboard" mentioned in Part 1 of this series.

Examination of Fig. 2.3 and 2.4 will familiarise the constructor with the circuitry being added to the existing breadboard. It will be noticed that we have effectively included two channels; one a combination of photosense and scansion, and the other dealing with tactile (or touch) stimuli. Although the building blocks used in the "animal" are fairly conventional, their interconnection and operation are a trifle unorthodox and so require some explanation. (The muscle control and motor drive circuits appeared in Fig. 1.2 last month.)

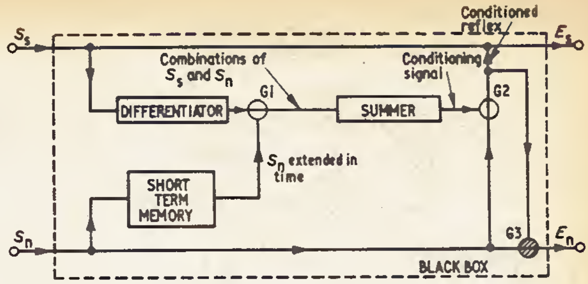


Fig. 2.1. Block diagram of a basic arrangement for synthesising conditional reflex action

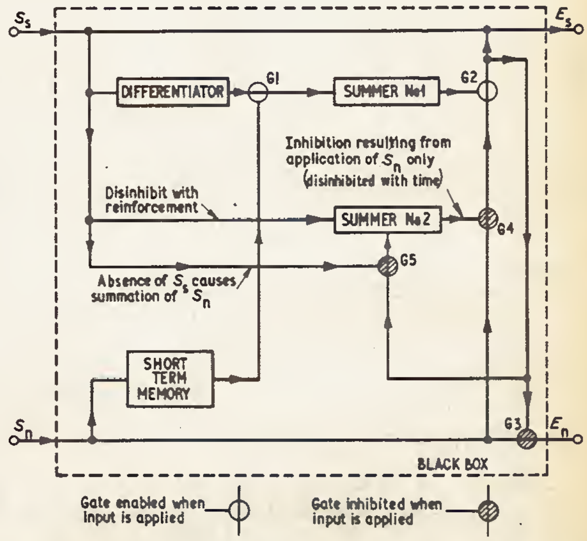


Fig. 2.2. The basic arrangement of Fig. 2.1 now developed to include inhibition synthesis

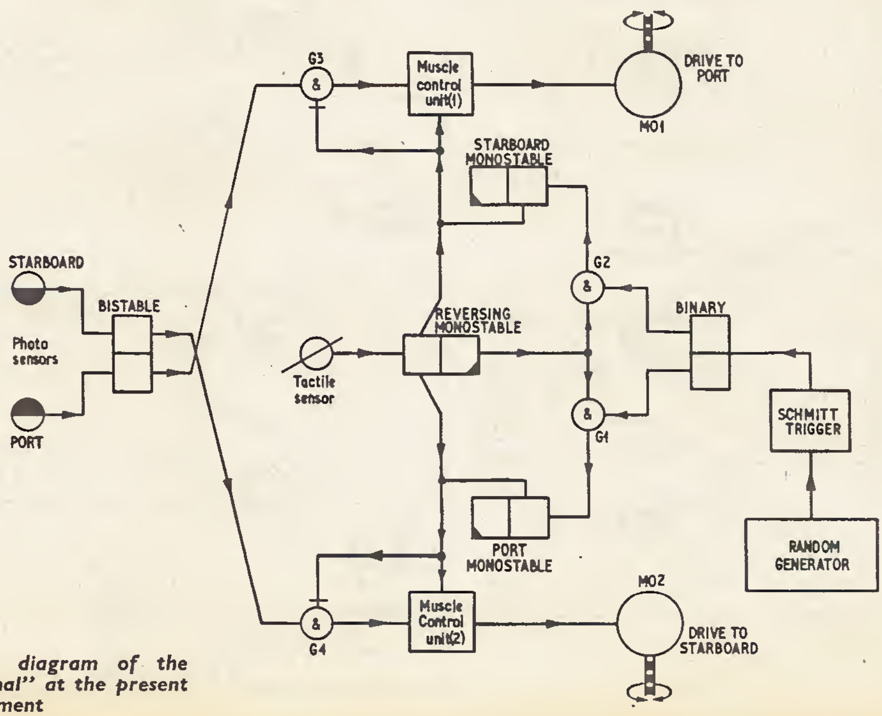


Fig. 2.3. Block diagram of the electronic "animal" at the present stage of development

later found necessary to introduce some randomness into the actual direction of turn. This was because there were occasions when if the "animal" experienced difficulties in extricating itself from a situation, a change of turn in the opposite direction often proved successful.

TOUCH SENSOR PROBE

In order to sense tactile stimuli, a probe system has been incorporated at the forward end of the "animal" (Fig. 2.5). This amounts to a simple pivoted affair, made from heavy gauge wire, and controlling a micro-switch or a pair of relay contacts. Upon contact with an obstacle in the "animal's" path, the probe will swing inwards to operate the switch, thereby generating a pulse.

The avoidance reaction is provided by three mono-stable flip-flops: one to provide the reversing characteristic, and the other two in order to produce turns.

When a current is passed through the cell, gassing occurs at the electrodes. Because the gas is given off rather irregularly, and because the "pockets" of gas surrounding the electrodes vary the dielectric of the cell, the current through it changes intermittently. These changes will produce a stream of pulses, each pulse varying in amplitude.

In the model we first amplify these pulses at TR17, then use the Schmitt to select those pulses with the highest amplitude. Finally the binary is switched by pulses from the Schmitt, resulting in G1 and G2 being enabled alternately. The "animal's" turning mode is thus quite random.

If during the "animal's" response to light it encounters an obstacle, the tactile sense will take priority and override or inhibit the photo reflex. This is brought about by interaction between the reflexes at diodes D1 to D6, the tactile response taking precedence due to the absence of resistors in the D3/D4, D1, and D6 lines.

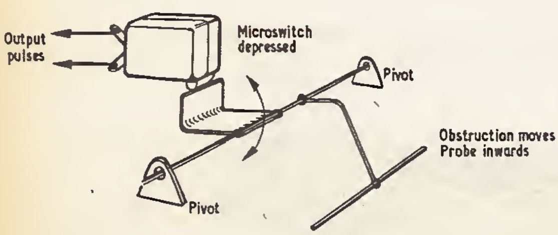


Fig. 2.5. A simple touch sensor probe

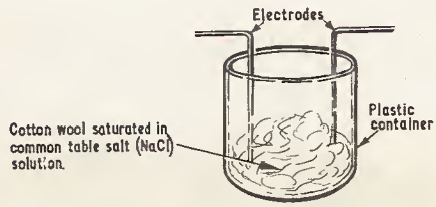


Fig. 2.6. A saline cell (R38) used as a random signal generator

The pulse produced by the probe first triggers the reversing monostable, which causes the animal to move backwards; when the monostable flips back, a positive pulse will be fed to one or other "turn" monostables via either gate G1 or G2, resulting in the "animal" executing an appropriate turn. Once this final phase has been completed the "animal" will move in its normal forward direction.

RANDOM GENERATOR

The gates G1 and G2 are alternately switched in a random fashion under the control of a binary, driven via a Schmitt trigger, and a random generator. The design of the random generator posed quite a problem, for it was at first thought that the only basic pre-requisite would be some form of white noise generator. However, it turns out that nearly all white noise generators produce pulse repetitions of too high an order (even after selecting pulses of only high amplitude). Eventually a relatively simple system was discovered that produced low occurrence pulses—this we shall use in our model.

The "noise" source (Fig. 2.6) is essentially a saline cell R38, consisting of two electrodes surrounded by a pad of cotton wool just saturated with a solution of ordinary table salt. The size of the container is not very important. It could be ¼in to 1in diameter, and about ½in to 1in high.

SEPARATE POWER SUPPLIES

It should be noted that separate power supplies are utilised for the muscle control and reflex circuits. This is necessary since it is extremely likely that the motors will generate sufficient "noise" to interfere with the switching circuits. If the constructor intends using a common supply for both circuits, a very large measure of decoupling will be required in the muscle control circuit. In the recommended arrangement, the "OV" line is common to both circuits, i.e. Fig. 1.2 and Fig. 2.4.

In the present example a probe has been suggested for tactile sensing because this is a simple way of tackling the problem. However, other methods could be used as an alternative. The mercury switch is one example, but a more sophisticated scheme which we will consider in a later article makes use of the change in motor current accompanying increased mechanical loads. This concept will also open a vista of other interesting possibilities, but in the meantime we must be content with simplicity.

Anyhow, we now have a model that will respond to two kinds of stimuli. In the next article we will consider the design of the "learning" and "memory" electronics, and how they might be interconnected with existing functions.

To be continued

PHOTO SENSE AND SCANNING SYSTEMS

The photo sense and scansion systems have been designed to be positively photo-tropic; that is, light stimuli result in the "animal" moving towards, rather than away from, light. The circuit for this is a fairly simple arrangement comprising a pair of photo-transistors (photo-sensors) controlling a bistable flip-flop, which in turn feeds signals to the muscle control units mentioned in the previous article.

The photo-sensors are situated at the forward end of the "animal" and are located close together with their respective emitter areas facing port and starboard. In addition the areas of the sensors facing one another are painted black to prevent light pick up from the opposite side—this would otherwise result in an incorrect response.

Operation of the circuit is quite straightforward. Assuming that the supply has been switched on, but that the photo-sensors are not illuminated; then the bistable will be in one or other states—say TR10 switched off (collector negative) causing the muscle control units to drive the "animal" to port. It will therefore maintain a counter-clockwise movement, and thereby scan the field.

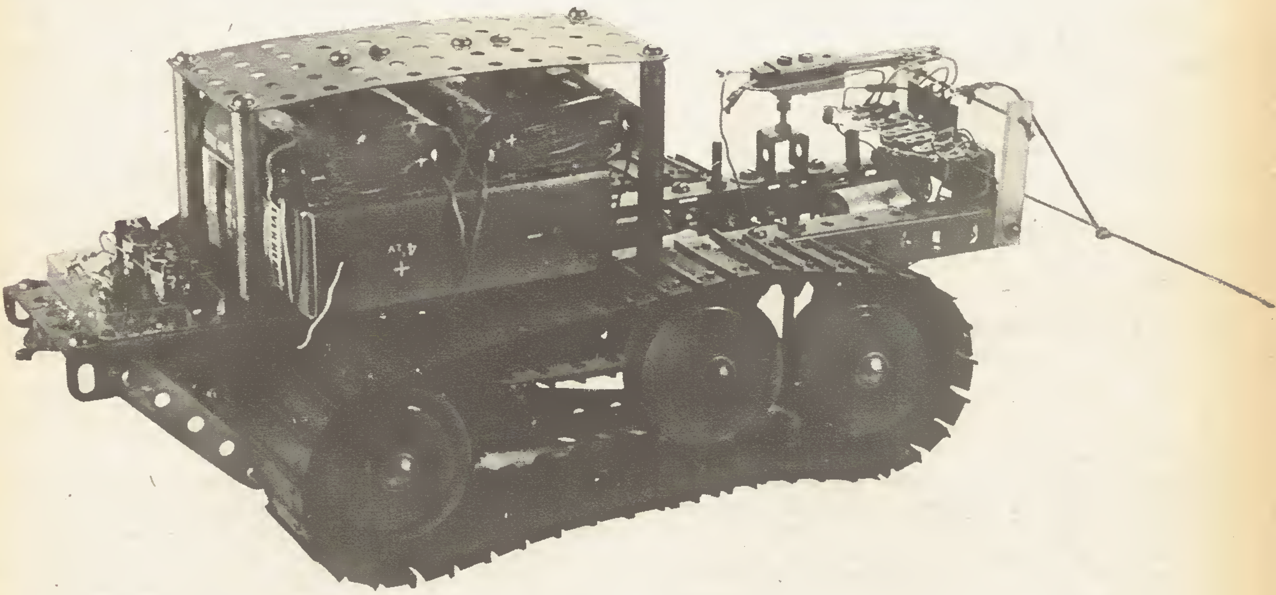
If during this scansion condition the starboard sensor encounters a light of sufficient strength, it will conduct, with the result that TR11 will be turned off and TR10 turned on. The port channel will now be inactive and the animal will turn to starboard homing on to the light.

When the light is encountered again, the bistable will switch once more causing a turn to port, and so on. The resulting gait of the "creature" will thus be cycloidal during scansion, and a rather wobbly line composed of short arcs when attracted to a source of illumination. In the absence of light the scanning mode is of course resumed.

LIGHT SENSITIVITY ADJUSTMENT

Sensitivity to light may be varied by adjustment of VR1 and VR2. These controls are necessary since TR9 and TR12 must not conduct during dark conditions. They are also of importance in preventing premature responses caused by ambient lighting conditions. The diodes D2 and D5 are included in the outputs of the bistable to maintain only negative or zero conditions, and also to prevent inter-action with other "forward" reflexes that could be added later.

There are obviously many ways in which the basic scansion configuration could be improved. One which might be considered would be to convert the bistable into a binary, and feed it with low occurance pulses from a random generator similar to the type we shall be discussing for use in the tactile sense. The "animal", even in complete darkness, would then periodically change its direction of scansion, giving it a somewhat improved chance of locating a light source.



An electronic "animal" built by the author. This model uses a tracked drive. The tactile (touch) sensor probe and associated switch can be clearly seen

AVOIDANCE REACTION

Stimulation of the tactile sense has been designed to result in what might rightly be called an "avoidance reaction" (negatively tactile-tropic).

During its adventures, the "animal" is obviously going to meet a considerable number of obstacles in its path. With this in mind and after much trial and error, the best avoidance reaction found seemed to be that of a "reverse and turn" configuration. In addition it was

SINE WAVE TEST OSCILLATOR

This is the fourth project in our five-part series featuring the integrated circuit linear amplifier Type SL701C

In the previous three articles we have considered, in effect, how we can use the Plessey SL701C integrated circuit for a.c. and d.c. amplification, but we have not yet used the circuit for signal *generation*. One simple circuit for generating a fixed frequency sine wave is dealt with this month, while the last of the practical circuits of this series (next month) deals with a fixed frequency square wave generator.

WIEN BRIDGE

Since the integrated circuit has both inverting and non-inverting inputs, a high input impedance, a low output impedance, and a high open loop gain, it can be used as the amplifier section of any of the well-known audio oscillators. Fig. 1 shows the Wien bridge oscillator circuit.

This network has zero phase shift and an attenuation of three times at a frequency given by:

$$f = \frac{1}{2\pi\ CR}\ \text{Hz}$$

In the oscillator circuit a non-inverting gain of three times is needed for the amplifier, to complete the positive feedback loop via the *C* and *R* network; while R2 and R3 provide negative feedback to maintain the gain at the required value of three times. A thermistor is normally used in the R2 position to provide automatic amplitude stabilisation. If the output of the amplifier tends to increase, more current passes through the thermistor and its resistance decreases, more negative feedback is applied around the amplifier, and the output is decreased. In this way the amplitude of the oscillator can be kept almost constant.

This circuit is used extensively as a variable frequency RC oscillator, since *R* can be made variable over a ten to one range with a double gang potentiometer, and the *C*'s can be switched.

Since the attenuation of the network is only three times at the oscillation frequency, its selectivity is not too good, and we would expect distortion to be in the order of 0·25 per cent. For a fixed frequency oscillator where we have no intention of attempting to switch components to cover a frequency range, we can with advantage use a much more selective network (even though it has more components) since we have a high gain available from our amplifier.

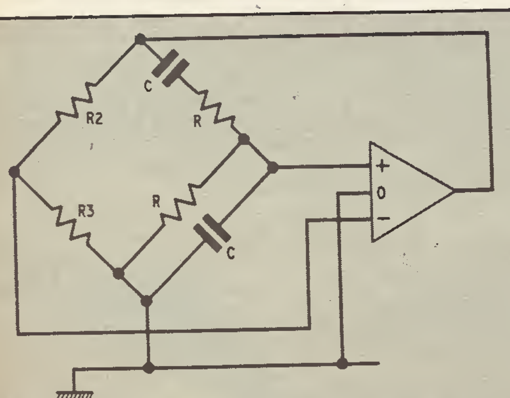


Fig. 1. Block diagram of a Wien bridge oscillator

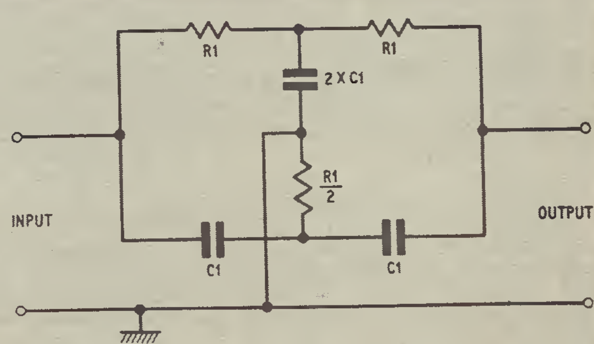


Fig. 2. The circuit diagram of the parallel-T frequency selective network

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

LIGHT DIMMER WITH SUPPRESSOR

The PH200 Dimlite lighting control from **Photain Controls Ltd.** incorporates a patented radio interference circuit which is believed to be the first of its kind to comply fully with the B.S.800 specification on radio interference.

Designed to fit a standard plaster depth switch box without modification it is easily fitted in place of most existing light switches. Installation is carried out by simply removing the front plate and connecting the lighting wires to the dimmer and screwing the unit to the recessed wall box.

The dimmer will control 200 watts of tungsten lighting load at 240V a.c. and measures 3¼in × 3¼in × 1¼in. The unit incorporates an on/off switch and will vary the amount of the lighting from full brilliance down to 15 per cent of total load.

The cost of the PH200 Dimlite is £4 19s 6d and is available from **Photain Controls Ltd.**, Randalls Road, Leatherhead, Surrey.

SOLDERING AND WIRE

A complete soldering kit for the home handyman and hobbyist has been marketed by **Weller Electric Ltd.** The kit, retailing at £2 1s 6d, contains a Marksman 25 watt soldering iron, two spare tips, a soldering aid—heat shunt, scraper and wire grip, and a coil of 60/40 solder.

Four standard interchangeable tips are available for the Marksman range, comprising a cone tip, screwdriver tip, and chisel double-flat and single flat tips. Soldering tips are made from pre-tinned nickel plated copper and are simply screwed into the end when required.

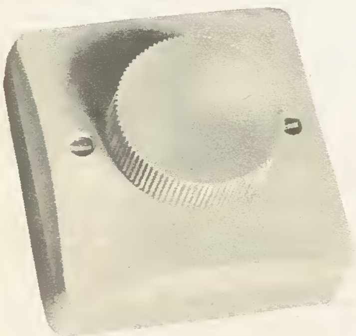
An improved soldering iron is the Litesold 60 watt model from **Light Soldering Developments Ltd.** This iron is an improved version of the 55 watt model, which it replaces, and has a new style moulded nylon handle.

Other improvements feature spring collet mounting bit and the simplification of the element fixing arrangement.

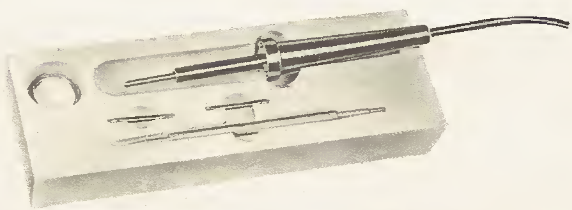
The handle is also available in translucent nylon so that an internal indicator lamp can be installed to show when the iron is switched on, reducing the risk of accidental burns. This feature is to special order only.

A useful aid to the preparation of soldering is the Bib Model 6 wire stripper and cutter from **Multicore Solders Ltd.**

This new product, similar to other wire strippers manufactured by the same company, is sprung at the handle so that the tool automatically opens after any operation.

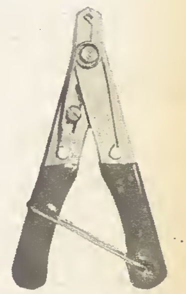


The PH 200 Dimlite from Photain Controls



Soldering Kit marketed by Weller Electric

Litesold 60 watt iron from Light Soldering Developments



Bib Model 6 Wire Cutter and Stripper

The Model 6 enables the insulation to be easily removed from the ends of cables and flex, without nicking the wire. The aperture setting for different diameter wires is simply adjusted by a sliding screw in one of the handles. There are two cutting positions, one for normal flex, and the other on the tip for cutting wire after it has been connected to a tag or bolt. The handles are plastic covered and the tool is retained in the closed position by a handle slip ring.

The Bib Model 6 wire stripper retails at 8s 6d.

POWER TRANSISTOR

A safe-area power rating of 100W is the feature of the latest discrete-emitter power transistor BLY72 from **SGS-Fairchild.**

Discrete-emitter transistors are high performance power devices which instead of the usual single emitter, utilise a compound emitter made up of a multiplicity of discrete emitter sites each linked to a common busbar by an integrated thin-film feedback resistor. This construction results in a claimed improved operating characteristics.

The BLY72 can be used for amplification or switching. Amplifier uses include r.f. communications, audio and servo amplifiers. Switching applications include inverters/converters, solenoid and relay drivers, and regulators.

Further details can be obtained from **SGS-Fairchild Ltd.**, Planar House, Walton Street, Aylesbury, Bucks.

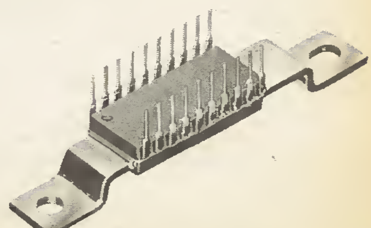
IC PACKAGE

An inexpensive new power plastic package for integrated circuits, the P20, has been introduced by **Plessey Microelectronics** of Swindon.

Planned eventually to accommodate a variety of chips, the P20 has already made its commercial debut in colour TV receivers. This encapsulation, which is particularly suited to commercial applications, will also be used for the fully integrated Plessey car radio, and 3 and 5 watt audio amplifiers, all due to appear later.

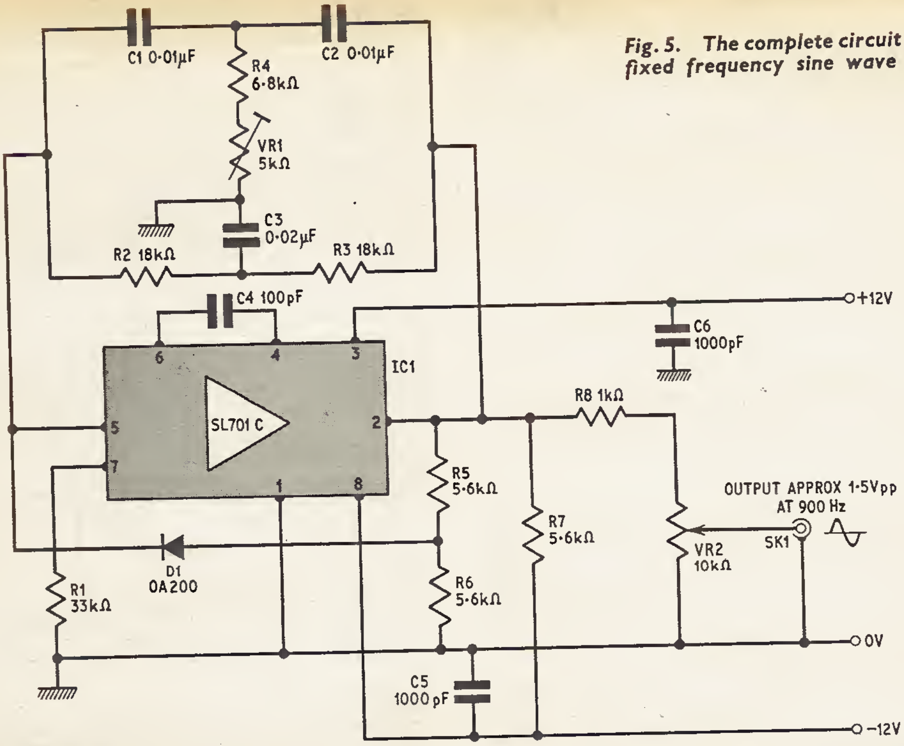
Main features of the P20 package are its low cost and effective power dissipation. Basically a 20-lead in-line plastic package with an integral heatsink, it can be bolted to a further heatsink, or simply to an equipment chassis. The package is designed to dissipate at least 3 watts when used with a suitable heatsink.

It can't be long now before these integrated circuits are available to the amateur as "off the shelf" items from any of the dealers in "Tottenham Court Road."



Plessey IC package type P20

Fig. 5. The complete circuit diagram of the fixed frequency sine wave test oscillator



COMPONENTS . . .

Resistors

R1	33kΩ	R5	5·6kΩ
R2	18kΩ	R6	5·6kΩ
R3	18kΩ	R7	5·6kΩ
R4	6·8kΩ	R8	1kΩ

All 10%, $\frac{1}{4}$W carbon

Potentiometers
- VR1 5kΩ preset (Radiospares)
- VR2 10kΩ linear

Capacitors
- C1 0·01µF paper
- C2 0·01µF paper
- C3 0·02µF paper
- C4 100pF ceramic
- C5 1,000pF ceramic
- C6 1,000pF ceramic

Semiconductors
- IC1 Linear integrated circuit, d.c. coupled amplifier —SL701C. (Available direct from the makers: The Plessey Co. Ltd., Components Group, Cheney Manor, Swindon, Wiltshire. Price 18s)
- D1 OA200 or IN14

Miscellaneous
- SK1 Coaxial socket
- Die-cast box $4\frac{3}{4}$in × $3\frac{3}{4}$in × 1in (Electroniques 46R.043A)
- Perforated s.r.b.p. $3\frac{1}{4}$in × $2\frac{1}{2}$in
- Three insulated feed-through terminals
- Control knob
- 22 s.w.g. plastics covered wire
- 6B.A. screws and nuts

A few figures will show why we can use a diode in this instance. If we assume that the diode conducts at 0·5V, then the output will be ±0·5V and if the network has a loss of 40dB, the amplifier input must be ±5mV. If the amplifier had a gain greater than 40dB the output would tend to build up, and if it reaches ±0·505V the diode conducts to feed back +5mV to reduce the input level, at this time, from −5mV to 0V. The diode only has to, in effect, clip 5mV off the output in order to completely reduce the input to zero. So our sine wave output is reduced from a possible ±0·505V to +0·5V and −0·505V and has a 1 per cent flat top.

In practice the onset of diode conduction is gradual, and we can adjust the network so that its loss is slightly less than the amplifier gain, and oscillations are maintained with a good waveform.

PRACTICAL CIRCUIT

For the values chosen:

$$f = \frac{1}{2\pi\ C_1 R_1}\,\text{Hz} = \frac{1}{2\pi\ 0{\cdot}01.10^{-6}.18.10^{3}}\,\text{Hz} = 900\text{Hz}$$

The complete circuit of the 900Hz oscillator is shown in Fig. 5. Positive feedback is applied via the network to the inverting input of IC1 (pin 5), and VR1 is a preset potentiometer to ensure that the bridge is unbalanced by the exact amount required to maintain oscillations. This control is adjusted from maximum towards minimum resistance until the circuit oscillates reliably, at this point the waveform is excellent. If the resistance is reduced still further the waveform becomes poor and the frequency departs from the theoretical value of 900Hz, but there is no difficulty in setting this control; especially if the waveform is observed on an oscilloscope.

PARALLEL-T NETWORK

The use of the parallel-T network of Fig. 2 to produce a null is well known. Without delving too much into the mathematics of this arrangement, we can see that there are two parallel, frequency selective paths between input and output. For the one path the time constant is:

$$t_1 = C1 \frac{R1}{2} \text{ secs}$$

For the other path the time constant is:

$$t_2 = R1.2C1 \text{ secs}$$

so that:

$$4t_1 = t_2 \text{ balance equation.}$$

For this arrangement, the null frequency is given by:

$$f = \frac{1}{2\pi\, C_1 R_1} \text{ Hz}$$

The depth of rejection at this frequency depends on the balance of components, obviously in practise (even if close tolerance components are used) the circuit *must* be unbalanced to some extent and only (say) 40dB of attenuation may be achieved at the null frequency. The gain characteristic is shown in Fig. 3 (a).

For the phase characteristics there are two possibilities, depending on the direction of unbalance. If $4t_1$ is greater than t_2 the phase characteristic returns through 0 degrees at f, as in Fig. 3 (b). If $4t_1$ is less than t_2, the phase rotates through -180 degrees at f, and continues lagging to approach -360 degrees, as in Fig. 3 (c). The gain characteristics are identical, since we are talking in terms of *slight* unbalance.

We can use this network to form an oscillator by choosing the phase characteristic of Fig. 3 (c) and using the basic arrangement of Fig. 4. At low frequencies (below f) the resistive section provides an almost direct coupling between the output and input of the amplifier, and heavy negative feedback sets up our d.c. conditions. At f the network provides an extra 180 degree phase shift around the loop so that positive feedback occurs at this point and the circuit will oscillate provided that the attenuation of the parallel-T network is overcome by the gain of the amplifier.

For this circuit to work and give a reasonable waveform the degree of unbalance must be kept small, and the network attenuation will be large, so that a high gain amplifier is essential.

DIODE LIMITER

In Fig. 4 the diode D provides a large amount of negative feedback when the positive signal peak just brings the diode into conduction, and hence limits the signal output. Since the network has a high Q (good selectivity) this does not cause a distorted output waveform. The process can be likened to preventing the build up of oscillation of a swing. A child on a swing can move her legs with sufficient power just to cause oscillations to increase in amplitude, while a parent can maintain any desired peak to peak amplitude by applying a retarding force at one peak of the excursion only.

If we had used a less selective network (such as the Wien bridge) then the diode limiter would have to be replaced by a less drastic (non-clipping) arrangement (such as a thermistor) as the gain determining element in order to maintain distortion at an acceptable level.

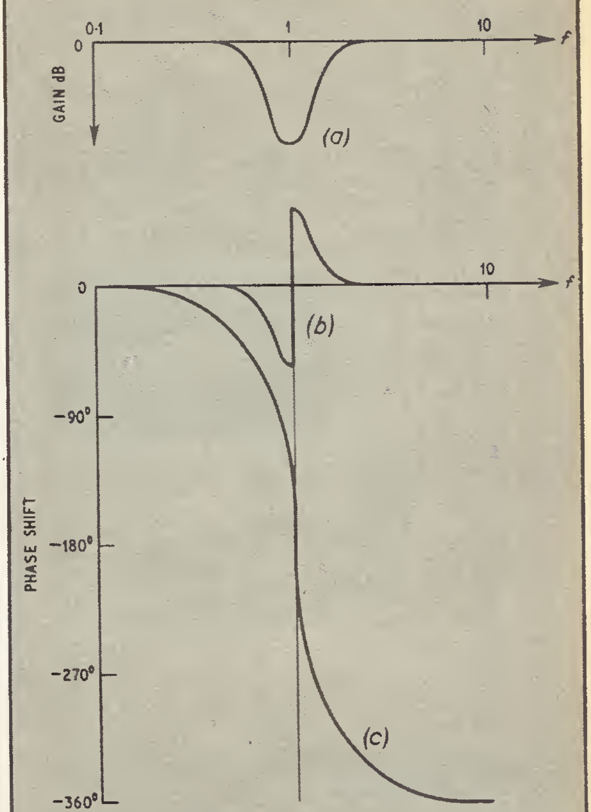


Fig. 3. The gain characteristic of the parallel-T network at point (a). The phase characteristic for one condition of unbalance of the network is given at point (b) and the other possible condition of unbalance is shown at point (c)

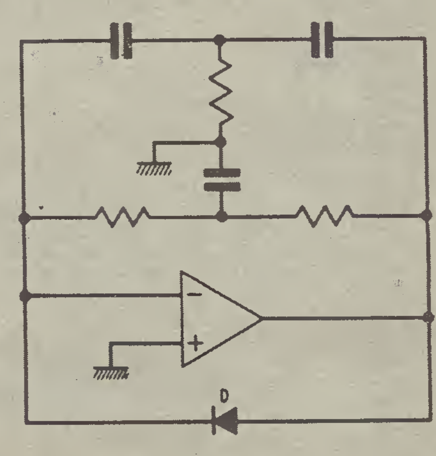


Fig. 4. The block diagram of a parallel-T oscillator

POLAR WIND

During September there was a symposium held in Washington on the Physics of the Magnetosphere. From the University of California at San Diego came Dr Peter Banks with an announcement of his discovery of a "polar wind". Some 300 or so scientists from all parts of the world attended this symposium to review the progress and assess what had been learned about the magnetosphere.

It is well known that the magnetosphere forms an invisible envelope that is shaped somewhat like a tear drop. The larger part is on the sunward side of the Earth and the tail extends outwards on the opposite side for some three million kilometres. It is forced into this shape by the solar wind which sets up tremendous forces along the Earth's magnetic field. This has been established by many observations which have been made of artificial satellites and records from satellites.

Now comes the discovery of this "polar wind" streaming out from the north and south poles of the Earth. It is in fact a portion of the Earth's atmosphere escaping into space. Though it consists of atmospheric electrons and atoms of oxygen, helium, nitrogen and hydrogen the loss of the Earth's atmosphere is negligible. There is no threat to the life supporting oxygen or other necessary constituents of the atmosphere. Once again the discovery has been confirmed by a satellite and this time it was *Explorer 31*.

It seems that the action results from the warming pressure of sunlight. This causes an expansion and the "polar wind" blows down the magnetic tail of the Earth and escapes through the magnetic field lines at the poles. An interesting comment was made by Dr I. A. Zhulin of the Soviet Union who suggested that here there was an opportunity to set up a solar-terrestrial warning system for passengers who will ride in supersonic transports. Such craft which will be flying at 20 miles altitude would be subject to the hazards of radiation from solar storms, auroral storms and residual radiation from the Van Allen belts. It should be noted that the U.S. is already operating a solar-terrestrial warning system with headquarters at Boulder, Colorado.

ROUND THE MOON AND BACK

The U.S.S.R. successfully launched a space vehicle which under automatic control circumnavigated the Moon and returned to Earth to be safely recovered from a touch down in the Indian ocean. It seems certain that this was a test not only for the control systems but also for a vehicle some six tonnes in weight to be brought near to the moon. *Zond 5*, as it was called, was almost certainly one of the Voyus line of vehicles.

The previous test flight in near-Earth orbit of *Zond 4*, also a Voyus type of craft, was no doubt the beginning of a series of tests prior to sending a vehicle round the moon and back with one or more astronauts on board. The Voyus are known to have special facilities for automatic docking and rendezvous techniques. Following the usual carefully planned method used by Soviet scientists in arranging the sequence of testing it would seem that an attempt to go on to the next step is imminent. This could mean that the margin between the U.S. and U.S.S.R. technology is very narrow. However the vital question of who will be first remains to be answered in the not too distant future.

A test flight of *Apollo 7* with three astronauts aboard in an Earth orbit practice mission was launched on October 11 and was equipped to allow for up to 11 days in orbit. It was arranged as an "open ended" flight, that is to say the astronauts were to remain in orbit as long as there was no malfunction which compelled the termination of the mission. Its 165 revolutions were successful; *Apollo 8* will follow in December and *Apollo 9* in the early part of 1969.

Dr Thomas O. Paine who succeeded James Webb as secretary of the National Aeronautics and Space Administration (NASA) said that the prospect of a lunar landing in late 1969 depends upon the success of the *Apollo* space vehicles *7*, *8* and *9*. *Apollo 8*, though capable of going round the moon and back, is at the moment scheduled as a repeat of *Apollo 7* and will be the first manned flight of the *Saturn-Five* moon rocket. *Apollo 9*, the first manned flight with full moonship complement (service, command and lunar landing modules) is scheduled for the first quarter of 1969 as a far out earth orbit flight, subject to what may happen in December. Dr Paine also had something to say about the requirements for a moon landing by the U.S.S.R.

"The U.S.S.R. problem was to develop a rocket with more than the 3·1 million pounds thrust vehicle they now had and there was evidence that they were doing this. The alternative for them was to assemble in an earth orbit the 50 tonnes or so of equipment needed with smaller rockets."

APOLLO 7

Though there is no information from the U.S.S.R. about their vehicles there is plenty from the U.S. about the *Apollo* craft. The arrangement of *Apollo 7* is in seven distinct parts with total height of 67m (224ft). At the bottom of the stack is the first stage of Saturn 1B rocket 24m high (80·2ft) and 6·5m in diameter (21·5ft) and weighing about 450,000 kilograms (almost a million pounds) when fueled. On this is a three rocket second stage, the S-4B. This is 17·5m high (58·4ft) and 6·5m (21·5ft) in diameter with a weight when fueled of 112,000 kilograms (250,000lb).

Then follows a ring 0·9m high and 6·25m (nearly 21ft) in diameter. This is the section which houses the instrument unit and contains the sophisticated electronic equipment for monitoring and controlling the vehicle from the moment of lift-off until its insertion into orbit.

Above the instrument unit is a conical section called the Spacecraft Lunar Module Adapter. This is 8·4m high (28ft) and has a bottom diameter of 6·7m (22ft) and tapers to a diameter of 3·9m (nearly 13ft). It is a container for the Lunar Module, the four-legged lunar landing vehicle. The Module has to be in this container to protect it from the atmosphere during launch since it is designed for operation in space.

On the first flight of *Apollo 7* the Lunar Module was not included, which reduced the weight of this section. Above this is the Service Module with a height of 6·6m (22ft) and a diameter of 3·9m (nearly 13ft). Above this again is the Command Module, the conical unit in which the astronauts lived between the time of launch and landing. This is 3·6m high and 3·9m in diameter at the bottom, tapering almost to a point at the top. Of the seven units only the Command Module returned to earth intact. The last one to be jettisoned was the Service Module which was not needed for re-entry.

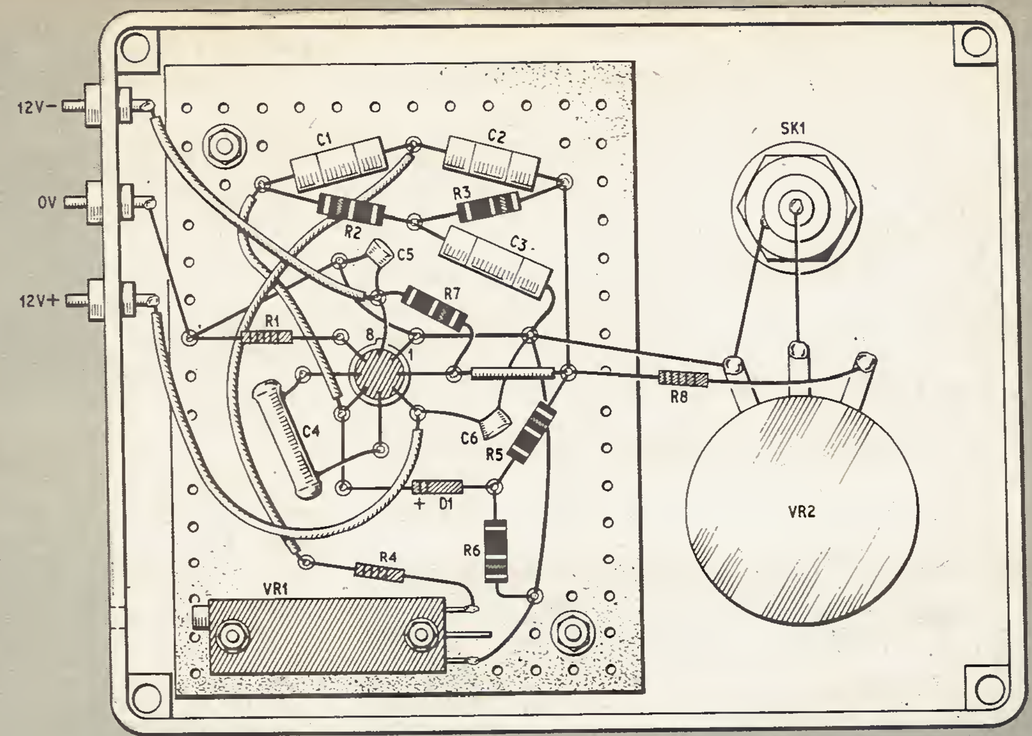
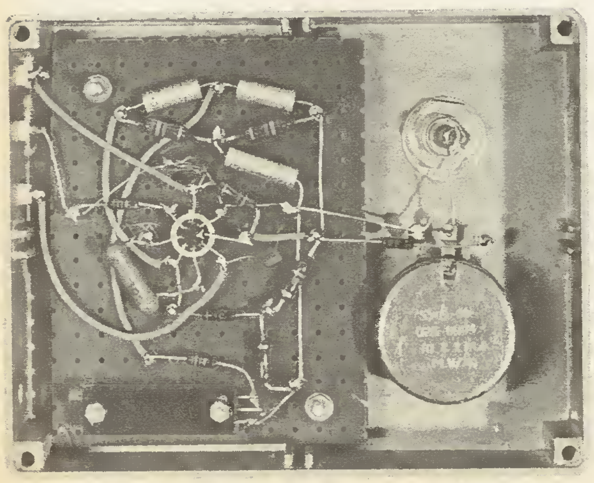


Fig. 6. Layout and wiring of the fixed frequency sine wave test oscillator

Since only a small amount of negative feedback is required to amplitude limit the oscillations, it is essential to use a silicon diode for this purpose as a germanium diode would have too high a leakage current and would not have a high resistance in the non-conducting state. The onset of diode conduction is lower than the 0·7V normally associated with the forward volt drop of a fully conducting silicon diode, so the diode is tapped down the output in order to maintain a reasonable output level of about 1V peak to peak. The output can be increased if required by decreasing the lower 5·6 kilohm resistor R6 to a value of 2·7 kilohm in order to provide the extra swing required.



Other fixed frequencies could be generated by altering the components for the T network, while maintaining the relationships outlined in the theoretical section of the article.

The level of signal applied to the output socket SK1 is controllable by the potentiometer VR2.

CONSTRUCTION

The construction is straightforward and on similar lines to previous articles. The s.r.b.p. board should be drilled for mounting in the case, and the soldering pins carefully inserted as indicated in Fig. 6. The integrated circuit IC1 and components should then be soldered in position. Particular care should be taken to avoid damage through excessive heat when soldering the IC.

The case should be drilled to receive the three power supply feed-through terminals, output socket SK1 and level control VR2. A small hole should be drilled in the side of the case to allow adjustment of the preset control VR1. The position of the hole should be ascertained by first laying the s.r.b.p. board in the case as a guide, and then marking the side of the box.

The board is secured in the die-cast box, using extra nuts or spacers to provide clearance between the metal and live points on the circuit board. Once the board has been mounted in the case, to complete the wiring of the unit all interconnecting leads and resistor R8 should be soldered in position.

ERRATUM

Switched Gain General Purpose Amplifier—Sept. 68, page 619. In Table 1 noise referred to the imput should be in microvolts, i.e. 200μV and 24μV.

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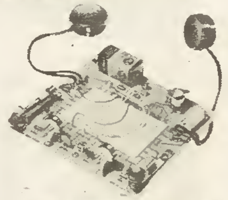

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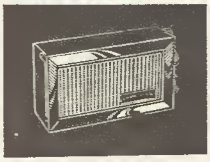

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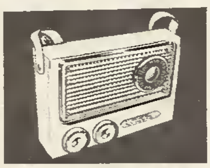

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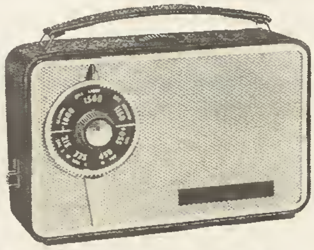

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BOOK REVIEWS

HI-FI IN THE HOME

By John Crabbe
Published by Blandford Presss Ltd.
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BOOKS on high fidelity sound reproduction are to be found in abundance, most of which give technical details of the equipment used. It is a welcome change, therefore, to find an author who has introduced this subject from an objective point of view—the aural appreciation of real music through an artificial medium. Concert-goers and record lovers alike can now read of the direct purpose of hi-fi at home in relation to something more than just a gimmick or status symbol.

The author, as a well-known journalist, is already recognised as a convincing authority, and has always taken great pains in promoting the theories behind hi-fi for the purpose of helping the music industry to find and maintain a truly appreciative audience.

One feels here that we are being carried through a "world tour" in the author's living room through the medium of recorded music during the last two chapters, having earlier discovered the association of music with electronics, and found how to assess the relative merits of commercial equipment for individual requirements.

Space here does not permit a comprehensive description of this book; no doubt one can imagine how much can be packed into 327 pages of small but clear type.

A glossary and bibliography are appended and no doubt will receive repeated reference. For the non-technical addicts, do not be deterred, for you will soon appreciate this adventure more fully having grasped its purpose. This book is recommended to all for its musical, technical, and literary merits.

M.A.C.

WORLD AT THEIR FINGERTIPS

By John Clarricoats, O.B.E., G6CL
308 pages, 8½in × 5½in. Price 12s 6d

RADIO COMMUNICATION HANDBOOK

Fourth Edition
710 pages, 10in × 7½in. Price 63s

AMATEUR RADIO TECHNIQUES

By J. Pat Hawker G3VA
160 pages, 9½in × 7½in. Price 12s 6d
All published by The Radio Society of Great Britain

MAYBE the recent exhibition has something to do with the sudden appearance of a number of books from the R.S.G.B.; anyhow, whatever the cause, "propagation" is seemingly not applicable only to radio waves!

Amateur radio is as old as radio itself. John Clarricoats is probably fully justified in describing Prof. D. E. Hughes as Britain's first radio amateur. In 1879 Hughes received signals in a telephone earpiece while walking in a London street some quarter of a mile from a primitive transmitter. This important episode is recalled in the opening chapter of **World at Their Fingertips** and from such historical beginnings the story of the amateur radio movement in this country is narrated through the 30 succeeding chapters.

The Radio Society of Great Britain grew from the London Wireless Club which was formed in 1913. The author is uniquely qualified to recount the significant events of the ensuing years, since he held office as the Secretary of the Society from 1930 until 1963. The birth pangs of the new organisation, the frequent tussles with officialdom about licences and operating conditions, and the achievements of individual amateurs in the developing hobby of radio communication, all add up to a fascinating tale.

The R.S.G.B. has been constantly involved in politics, negotiating both with the home government and with international bodies on behalf on the radio amateur. Not surprisingly these activities and the personalities involved make up a considerable part of this story, and one is a little disappointed to be given just tantalisingly brief accounts of the important successes in radio communication and of the techniques and equipment employed by the various amateur stations concerned. However, an excellent selection of photographs do help make amends in this respect, for many of these are of great historical interest and show transmitting and receiving equipment used in epic making "contacts".

The phenomenal success of the R.S.G.B.'s first major publication *The Amateur Radio Handbook* is referred to in *World at Their Fingertips.* This handbook was eagerly seized upon as a valuable text book by the Services during the second world war, and was reprinted many times before being replaced by a third edition in 1961. Last September a fourth edition, now renamed the **Radio Communication Handbook** was published.

The pattern of that earlier book is still discernible in this greatly enlarged work but the subject matter reflects the immense technical changes and advances that have taken place over the years. It incorporates the combined efforts of a number of specialist contributors. The novice is catered for in the first chapter which deals with basic principles in a fairly elementary way; then follow further accounts of valves and semiconductors. Four chapters are devoted to receivers and transmitters (h.f. and v.h.f./u.h.f.), and these include practical designs for home construction; some are valve circuits and some use semiconductors. A chapter on single sideband transmission extends to over 100 pages—by far the longest chapter in the book—and indicates the completely up-to-date outlook of this work.

There is much more besides, but it will suffice here to add that anyone interested—as amateur or professional—in radio communication will hardly be able to resist acquiring a copy once they examine this excellently produced copious volume of technical information.

From a "combined op" to a solo effort. The name Pat Hawker is familiar to all readers of the R.S.G.B. Bulletin as the author of a lively series entitled "Technical Topics", first introduced in 1958.

Little of significance to the amateur seems to escape the eye of this diligent gleaner of technical news items. New components, circuits, and ideas are presented to his readers in an informal communicative style.

Under the title **Amateur Radio Techniques** is now presented, in paper back form, a selection from these items originally published over the past 10 years, together with some additional material. This book is a revised second edition of that published in 1965 under the title *Technical Topics for the Radio Amateur*. It contains over 350 circuit diagrams.

D.D.R.

WIRELESS WORLD DIARY 1969

Published by T. J. & J. Smith Ltd. in conjunction with Iliffe Technical Publications Ltd.
79 pages of information plus diary section, 4⅛in × 2⅝in.
Price 6s 6d in rexine cover, 9s in leather cover

THIS well established diary maintains its aims in up-dating the information section to include current practices and is a useful condensed reference work for all branches of electronics. Of particular interest are the recent sections dealing with the PAL colour television system; stereo sound reception on BBC Radio 3, including a decoder circuit diagram; some transistor near equivalents and coding nomenclature. However, it is surprising to find, with a journal of this kind, that the circuit symbols in many cases still do not comply with British Standard specifications, particularly among semiconductor devices.

NEWS BRIEFS

Faraday Lecture

THIS YEAR'S Faraday Lecture arranged by the Institute of Electrical Engineers will be given by Mr P. E. Trier M.A., C.Eng., F.I.E.E., F.I.M.A., Director of Research and Development, Mullard Ltd., and Director of Mullard Research Laboratories. The subject is to be "Microelectronics"—the Deputy Lecturer will be Mr E. T. Emms B.Sc., C.Eng., F.I.E.E., Head of the Mullard Central Application Laboratory.

The lecture will be delivered in 12 towns throughout Britain, and is intended to inform the general public, in straightforward language, about microelectronics. Mr Trier will cover the history, demand and physical principles of microelectronics and proceed to explain the technology for making microcircuits and the standards of the industry formed to meet the demand. Applications will be highlighted and described with the aid of models, demonstrations and films which are intended to introduce the subject in an enjoyable and entertaining way.

Members of the public are admitted (free) by ticket, obtainable (with details of dates and venues) on application to the Institute of Electrical Engineers, Savoy Place, W.C.2.

Golf Drive Measurement

ELECTRONIC equipment was used at the Alcan "Golfer of the Year" Championships for distance measurement of players' drives. The equipment used has a wide application in surveying and mapping. Drive distances can be measured within inches by transmission of microwaves from a "master" to a "remote" unit, mounted on a motorised golf cart. The equipment, which is made by Tellurometer (U.K.) Ltd., can provide instant readout and offers a means of measuring the tee-to-hole distances on any golf course with greater accuracy than conventional devices.

New Stock Market Computers

TWO COMPUTERS valued at almost £¾ million will serve as the master systems of the Ultronic quotation service to stockbrokers from the United States to the Far East covering Canada, Europe and South America.

The two computers, supplied by Univac—a division of Sperry Rand—will be installed in a new computer centre in Mount Laurel, New Jersey. When installed, the incoming information from most major markets will be processed and transmitted to 26 satellite computer centres at high speed. From the centres the information is routed to some 2,000 brokerage offices in more than 400 cities. In-depth information on more than 8,000 individual stocks and commodities is available continuously.

Cheaper Printed Circuits

"NEW TECHNOLOGY" the MinTech news magazine reports on a new process for etching holes in the plastic insulation of printed circuit boards having two or more interconnected conducting layers. The process replaces costly mechanical methods and is based on the discovery of a new chemical action.

To permit the connection of integrated circuit packages and the interconnection of layers of conductors, holes are made in the p.c. board and the walls are plated with copper. The new process makes it possible to etch these holes, which are sometimes as dense as 100 per square inch. After etching the holes, the board is masked and plated with copper to form the conductors and connections through the walls of the holes.

I.T.A. Colour O.B. Vehicle

GRANADA Television have ordered a five-camera colour outside broadcast vehicle from EMI Electronics. The unit consists of three individually air conditioned areas for production, sound and vision control. Mixers for sound and vision are of modular solid state construction.

The new company of Thames Television has also been buying colour equipment from the same manufacturer. The orders include: 14 colour cameras and 10 video switching matrixes, each with 28 inputs and 5 outputs, for use in the new studio complex to be built for Thames Television at the Euston Centre, London.

Light Emission from Plankton May Help Food Shortage

THE possibility that plankton might be used as a means of solving the universal food shortage has placed an increased importance on the study of its behaviour and environment. A comprehensive study into light emission by plankton is being carried out in the Firth of Clyde by the Scottish Marine Biological Association using special equipment made by Plessey.

A photo-multiplier light detector, which is considerably more sensitive than the human eye, is housed in a pressure-tight case from which signals are relayed via underwater cables to a research vessel. The signals are automatically recorded together with temperature and depth measurements.

Television Advisory Committee Reports

THE GOVERNMENT'S decision to adopt the PAL system of colour television and to authorise the duplication of BBC-1 and independent television programmes on u.h.f. with a definition standard of 625 lines were announced in 1966 and 1967. The technical considerations which led up to these decisions have now been published in the "Report of the Television Advisory Committee 1967", obtainable from Her Majesty's Stationery Office, price 2s 6d.

In 1962 the Government decided, on the advice of the Advisory and Pilkington Committees, to change to a 625-line standard system.

Since 1959 the Advisory Committee has been considering methods of changeover—methods of "overnight switchover" and "duplication" were considered. The committee found that the final solution would have to be a mixture of the two methods and advised the Government that the work necessary for duplication should be put in hand at once, also that duplication should be continued until the residue of the public watching the 405-line standard was small enough to effect an "overnight switchover". The Committee also recommended the use of the PAL system in the United Kingdom for colour television.

In March 1966 the Government accepted the recommendations of the Committee and the first moves were made in the changeover. In December 1967 a full colour service began on BBC-2 using the PAL system.

Airborne Advertising

AN AIRCRAFT to be used as an advertising medium has been built by Slingsby Aircraft Ltd. The aircraft carries on its sides illuminated panels, consisting of a matrix of special tungsten lamps which can reproduce messages, nominally 50 words in length, whilst airborne.

The project is based on a memory system, supplied by Mullard, which accepts information from an electric typewriter; this information is stored so that messages can be reproduced at will. Logic circuitry converts the memory output into a suitable form to drive the thyristors which control the lamps. The messages are then flashed on alternate sides of the aircraft to save power.

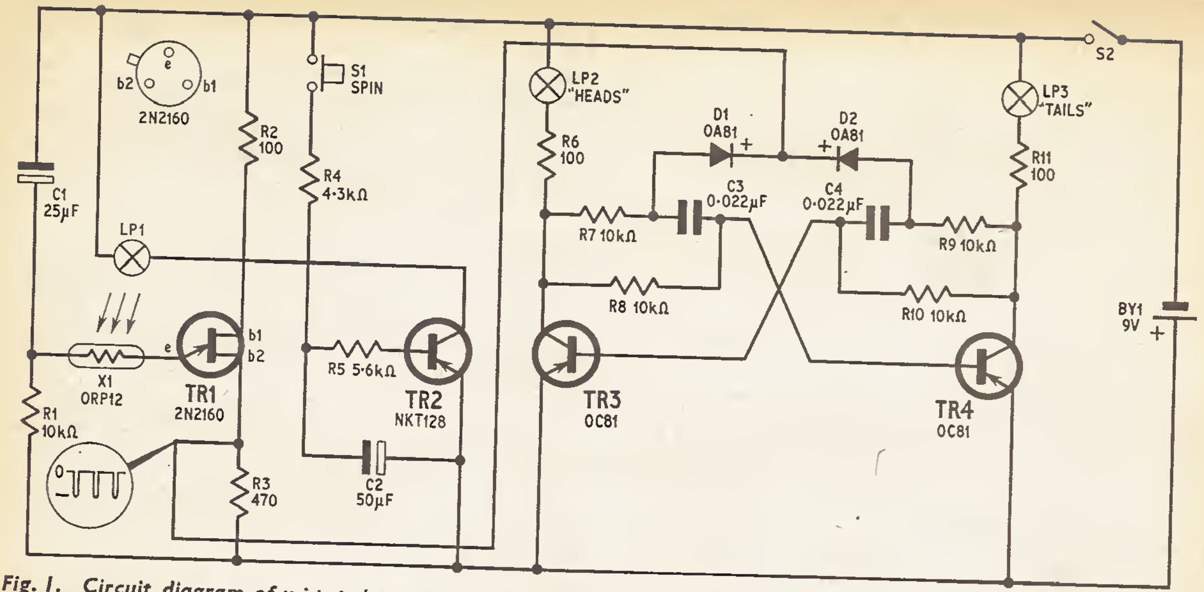


Fig. 1. Circuit diagram of u.j.t. pulse generator, timer and flip flop elements. To increase "spin" time the value of C2 may be increased

CONSTRUCTION

The components were assembled on a piece of Veroboard similar to that given away free in the October issue. Component mounting should follow that given in Fig. 2a. When soldering is completed layout should again be checked. Copper strips should then be cut as in Fig. 2b using a spot face tool or knife. If LP1 and X1 are attached to the board 20 s.w.g. wire should be used for a rigid fixture. An M.E.S. batten holder will prove suitable for holding this lamp, and can be screwed to the bottom of the box, inside. X1 is then suspended by the stiff wires in close proximity to the lamp and facing it.

The small size and battery required permit a small housing to be used. No constructional details of this are given here but if anything prefabricated is used make sure that there are no gaps for unwanted light to come through as this will upset circuit action.

DECORATION

Decorating the box top where the lamps protrude is a matter of taste. The lamps should be labelled "heads" and "tails" and S1 "spin".

Panel lampholders come in a variety of transparent lens colours such as amber, blue, green or red and these can be used in addition to identify the coin faces. ★

COMPONENTS . . .

Resistors

R1	10kΩ	R7	10kΩ
R2	100Ω	R8	10kΩ
R3	470Ω	R9	10kΩ
R4	4·3kΩ	R10	10kΩ
R5	5·6kΩ	R11	100Ω
R6	100Ω		

All ½ watt ±10% carbon

Capacitors

C1	25μF elect. 15V	C3	0·022μF
C2	50μF elect. 15V	C4	0·022μF

Transistors

TR1	2N2160	TR3	OC81
TR2	NKT128	TR4	OC81

Light Dependent Resistor
X1 ORP12 (Mullard)

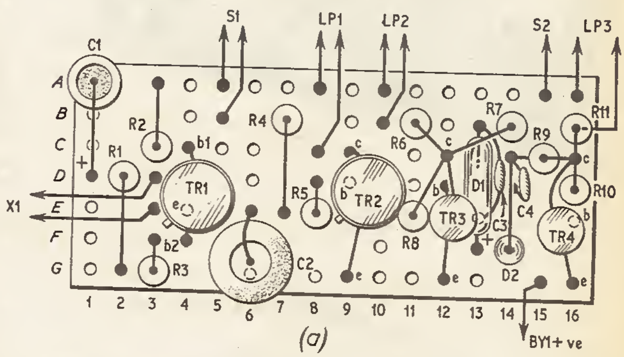
Diodes
D1, D2 OA81

Switches
S1 Miniature single pole push-to-make switch
S2 On/off toggle switch

Lamps
LP1, LP2, LP3 M.E.S. 6V 0·06A (3 off)

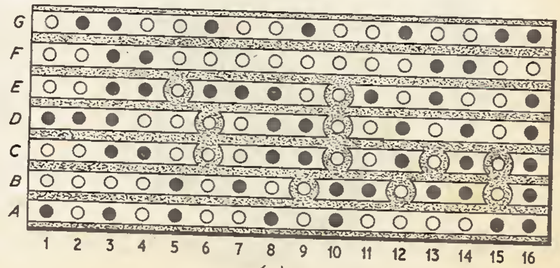
Battery
BY1 9 volts (type PP7)

Miscellaneous
M.E.S. Battenholder (1 off). Panel lampholders (2 off)



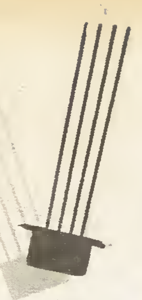
(a)

Fig. 2. The circuit board. (a) Component layout with connection details to other components



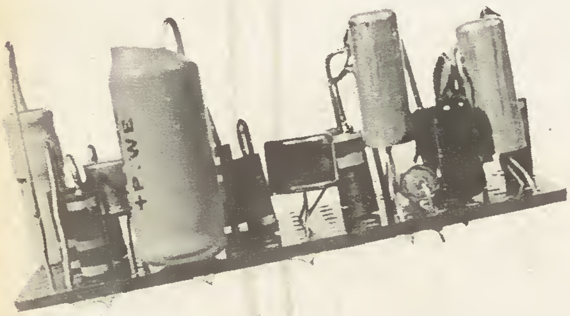
(b)

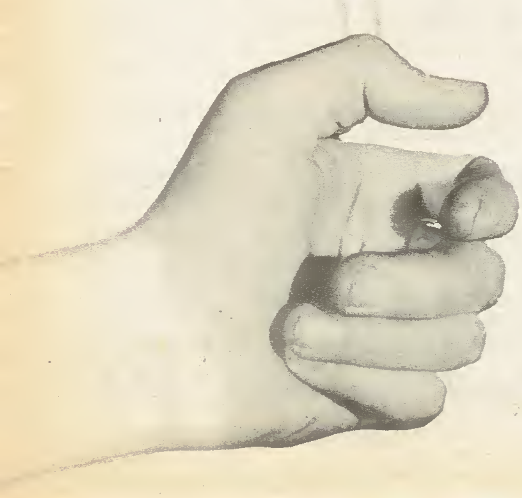
(b) Underside of board showing breaks in copper strips

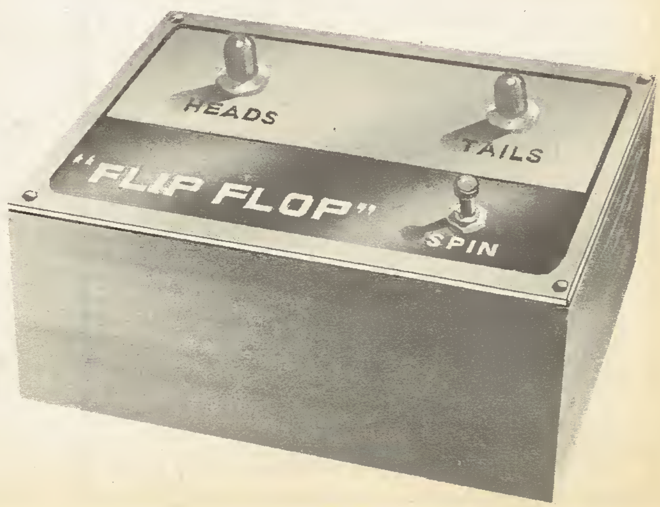


FLIP FLOP

ELECTRONIC PARTY GAME







Here is a novelty that should amuse the young over Christmas. It is a solid state version of the popular "heads or tails" game using neons which has already been described. Unfortunately that circuit, although simple, requires a battery supply of about 100 volts which is rather prohibitive when thinking in terms of portability.

The unit described in this article requires only 9 volts and the filament lamps present a better twinkling display when simulating a coin spin.

UNIJUNCTION TRANSISTOR

TR1 is a unijunction transistor working as a relaxation oscillator, see Fig. 1. With S2 switched on the electrolytic capacitor C1 charges through R1. With the omission of the photoconductive cell X1, TR1 would normally fire when its peak point voltage appears at the capacitor. In unijunction devices this is a fixed percentage of the base-1 to base-2 voltage.

At this voltage the emitter to base-1 evinces a negative resistance characteristic, which means that the capacitor discharges although its voltage falls below the original peak point. The charge and discharge at C1 is reflected at R2 and R3 as positive and negative pulse trains. In dark conditions the high resistance of the light cell X1 holds off firing at TR1.

TIME DELAY

TR2 forms part of a time delay circuit the action of which is initiated by depressing the "Spin" push switch S1. This causes C2 to charge and the transistor to conduct, lighting the lamp LP1. With the release of S1, TR2 is maintained in conduction with the discharge of C2 through R5.

LP1 is arranged in close proximity to X1 and its light reduces the resistance of the cell to a few tens of ohms. The result is that TR1 conducts and its negative pulse output is taken off at R3 and applied to the diodes D1 and D2.

FLIP FLOP

The flip flop circuit containing TR3 and TR4 is the "coin" in the novelty. Each of its faces is represented by a lamp LP2 or LP3; a head or a tail.

With S2 depressed either TR3 or TR4 is switched on and its corresponding lamp lit. With the spin switch S1 depressed pulses arrive alternately "flipping" TR3 and TR4 into conduction and causing the lamp loads to light. After a period determined by the time delay the pulse train is cut short. The flip flop assumes a stable condition showing either a "head" or a "tail".

Building two complete circuits enables you to play that two coin variant of "odds" or "evens" which is calling for unmatching or matching coin faces to appear in the final combination.

Some of the relay equipment for transmitting instructions to the trains

There is another code, 270 impulses per minute, which is used for re-starting a train after a signal to stop. This code permits the train to run at the same speed as the 180 code, a nominal 22 mph, but provision is made for the train to run at a controlled speed of 20 to 23 mph, with switching in of the motors or brakes.

A fourth code of 120 pulses per minute is also used, but this is in connection with the operation of signalling equipment only and is not picked up by the train.

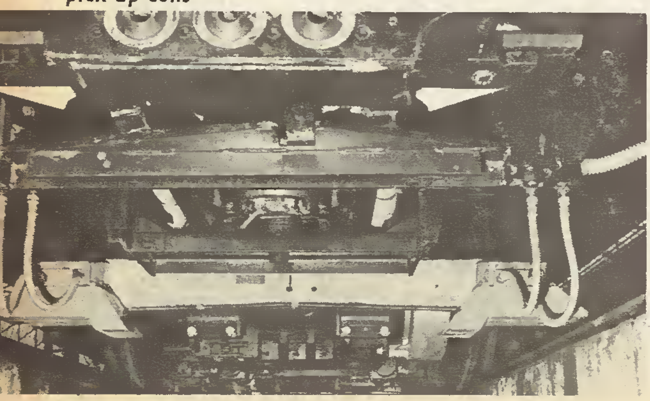
The lines are divided into sections for the track circuiting purposes in the same way as for normal purposes, but the state of the track circuits ahead, showing whether the line is occupied, automatically determines the code to be fed to the track in any section.

The 125Hz frequency and the safety signalling code are checked by filter circuits before being passed to the appropriate relays.

The codes do not control normal braking, but they do operate a "trip valve" which makes an emergency brake application in the same way as the mechanical type. The trip valve is held in all the time when the train is running under the 420 (clear) code, but under the 180 (or 270) code it is fed through contacts on a mechanical governor driven from a trailer axle. This is arranged so that the valve will drop out if the speed exceeds 25 mph

The absence of any code causes the valve to drop out and it must be made operative again by pressing a reset button. It cannot be reset if the cause is still present.

Underside view of the front of the train showing the pick-up coils



AUTOMATIC DRIVING SYSTEM

So far we have dealt with the safety signalling system, which over-rides commands related to the driving of the train. These command signals are given to the train by feeding audio frequency currents into 10ft sections of running rails, and are known as command spots. No special insulation is necessary for these sections.

The current used is produced by an electronic generator, and a frequency of 100Hz for 1 mph is used for spots or sections where specific train speeds are required, as in stopping a train at a station.

The automatic driver command signals are picked up by the separate induction coils, only one coil is used at a time, but with two coils available the "spot" can be placed on the most convenient running rail. The command signal frequency is detected and compared with a frequency produced by a generator mounted on the end of a motor on the train.

The train generator has a continuous output but the spot generator produces "bursts" of 127Hz at a time. A counter on the train starts as soon as a signal is received from the track and counts 127. No comparison is made unless this count is exactly right. If it is, a comparison is made with the train generator, which has been subject to simultaneous count. This comparison shows whether the train is moving faster or slower than the pre-determined speed and adjusts the braking of the train accordingly.

RUN-AND-COAST OPERATION

When the train operator closes the doors and presses the twin start button simultaneously, the train is receiving the 420 pulse code, provided the track is clear, and will move off under power. The train proceeds under power until it reaches the point at which power should be cut off, and here there is a command spot with a 15Hz frequency current passing through the track. This is a special frequency, outside the speed range of the train, which is recognised by a circuit in the train mounted equipment. This causes the supply to the motors to be cut off and the train then coasts.

The train will continue to coast, given a clear track, until it approaches a station, where it meets the first of a series of speed related frequency command spots to gradually slow the train down.

The first of the series of spots might dictate a speed of 35 mph and have a frequency of 3·5kHz, the impulses following each bringing the speed down by approximately 5 mph The speed reduction is achieved by a comparison of the actual speed of the train, in terms of frequencies produced by a train mounted tachometer generator, with the frequencies received from the track. The brakes are applied as required until the speed drops to 4 mph, the braking is then "eased out" to give a smooth stop. The braking rate down to this speed is controlled by mercury retarder switches.

Command spots are also provided to control train speed where there are speed restrictions or signals.

TRACK SIDE EQUIPMENT

The provision of coded track circuits to operate the safety train equipment required special arrangement of the track circuits at those parts of the track involving junction work.

To give proper operation the track circuit current must always flow towards the front of an approaching train. Some of the track circuits associated with junctions have, therefore, been made reversible and are normally operated with two track relays.

MERRY CHRISTMAS

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PICK-UP ARM Complete with ACOS LP-78 Turnover GP67 and Stylii 25/-; GP67 15/-; Stereo Ceramic 35/-.

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1½ × ⅜in. 6/6; ACOS 1⅜ × ⅜in. 8/6. BM3, 1" dia. 9/6
MOVING COIL MIKE with Remote Control Switch 19/6

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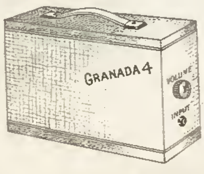

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I.F. P50/2CC 470 kc/s	5/7	Printed Circuit, PCA1	9/6
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PINS 36 per packet 3/4. FACE CUTTERS 7/6.
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⅜in. 16/-	1in. 19/6	1¼in. 20/6	1¾in. 29/-	2½in. 57/3
¾in. 16/9	1$\frac{1}{16}$in. 19/6	1⅜in. 21/6	2in. 39/-	1in. sq. 36/6

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Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.
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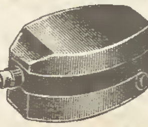

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4/350V	2/3	250/25V	2/6	16/600V	12/6
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32/450V	3/9	8+16/450V	3/9	50+50/350V	7/-
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CERAMIC. 500V 1pF to 0.01mF, 9d. Discs 1/-.
PAPER 350V-0·1 9d, 0·5 2/6; 1mF 3/-; 2mF 150V 3/-.
500V-0·001 to 0·05 9d; 0·1 1/-; 0·25 1/6; 0·5 3/-.
1,000V-0·001, 0·0022, 0·0047, 0·01, 0·02, 1/6; 0·047, 0·1, 2/6.
SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF-0·01, mfd 6/-; each
TWIN GANG. "0-0" 208pF+176pF, 10/6; 365pF, miniature 10/-; 500pF standard with trimmers, 9/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 18/9. Single "0" 365pF 7/6. Twin 10/-.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 5/6 each. Can be ganged. Couplers 9d each.
TUNING. Solid dielectric. 100pF, 300pF, 500pF, 4/6 each.
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250V RECTIFIERS. Selenium ½ wave 100mA 5/-; BY100 10/-.
CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
Full wave Bridge 75mA 10/-; 150mA 19/6; TV rects. 10/-.
NEON PANEL INDICATORS 250v. AC/DC 3/6.
RESISTORS. Preferred values, 10 ohms to 10 meg.
¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-.
Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.

5 watt	0.5 to 8.2 ohm 3 w.	2/-
10 watt	WIRE-WOUND RESISTORS	2/-
15 watt	10 ohms to 6,800 ohms	2/-

10K, 15K, 20K, 25K, 68K, 10W. 3/-.

FULL WAVE BRIDGE CHARGER RECTIFIERS:
6 or 12v. outputs. 1½ amp. 8/9; 2a., 11/3; 4a., 17/6.
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WIRE-WOUND 3-WATT POTS. T.V. Type. Values 10 ohms to 30 K., Carbon 30 K to 2 meg. **4/6**

WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE 50 OHMS to 100 K. **7/6**

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TT45. Push Pull Drive, 9:1 CT. 6/-. TT46 Output, CT8:1 6/-.
TT49. Interstage, 20:1, 6/-; TT52 Output 3 ohms, 4·5:1, 6/-.

TRANSISTOR MAINS POWER PACK. FAMOUS MAKE. FULLY SMOOTHED. FULL WAVE CIRCUIT **49/6**
9 Volt 500mA Size 5 × 3½ × 2in.
TRANSFORMER ONLY. Size 2¼ × 1¾ × 1¾ in 9 volt 10/6

MAINS TRANSFORMERS

Post 5/- each

250-0-250 50 mA. 6.3 v. 2 amps, centre tapped	19/6
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	30/-
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MINIATURE 200 v. 20 mA., 6.3 v. 1 a.	12/6
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HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a.	12/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	12/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	30/-
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3 amp., 0-12 v. and 0-18 v.	19/6

AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 30/-; 500w. 92/6; 1000w. 175/-.

COAXIAL PLUG 1/3, PANEL SOCKETS 1/3. LINE SOCKETS 2/-. OUTLET BOXES. SURFACE OR FLUSH 4/6.
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JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. DIN 3-pin 1/6, 5-pin 2/-; Lead 3/6.
Phono Plugs 1/-. Phono Socket 1/-. 2·5mm; 3·5mm 1/9
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WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 17/-. 3 wafer 22/-
Additional wafers 5/- each up to 12 max.
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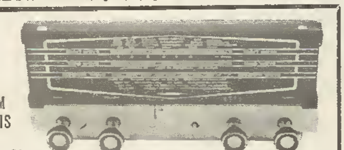
1969 GRAM CHASSIS



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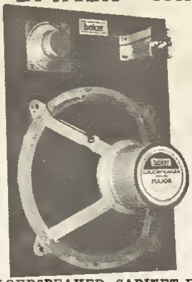

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SPECIAL OFFER! 8 ohm, 2½in; 80 ohm, 2½in, 2½in; **15/6** EACH TYPE 25 ohm, 6 × 4in; 35 ohm, 3in; 15 ohm, 10 × 2½in., 7 × 4in.
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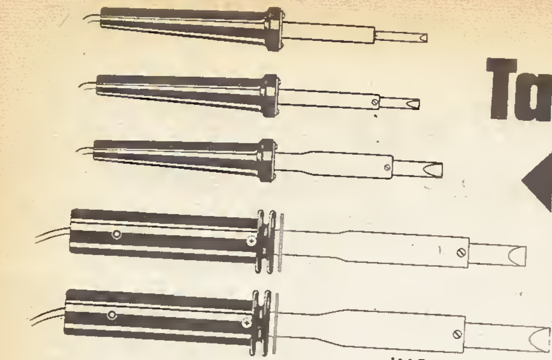

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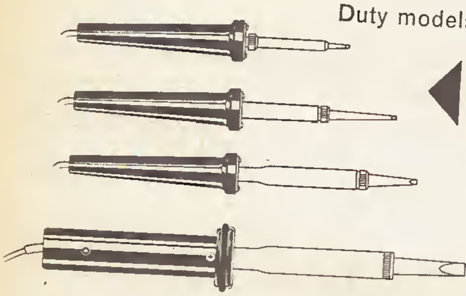
INSTANT HEAT FOR RAPID SOLDERING

THE tool for intermittent work such as servicing. Working heat in a few seconds. The job is done in less time than it takes a normal iron to heat up. Expert dual-heat and Heavy Duty models.



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An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel

BLACK LEATHERETTE SIDE PANELS

Dimensions: 52" × 17½" × 12". Speaker positions for Twin 10" × 5" Speakers

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2"—75Ω. 2½"—35Ω. P. & P. 2/6.

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STICK MIC. 2gns. P. & P. 3/6.

ASSORTED CONDENSERS
10/- for 50. P. & P. 7/6.

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TRANSISTORS
MULLARD MATCHED OUTPUT KIT
9/- OC81D—2 OC81's. P. & P. FREE.

FERRITE RODS 3/6
6", 8" × ⅜" complete with LW/MW COILS. P. & P. FREE.

17in.—£11.10.0 Carr. 30/-

19in. SLIM-LINE FERGUSON 24 gns.

TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS

FREE ILLUSTRATED LIST OF TELEVISIONS
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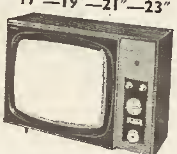

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Cloth covered, many colours. Size 9½" × 6½" × 3½". P. & P. 3/6. Similar cases in plastic 7/6.

AUTOCHANGERS £8.19.6
Garrard 3000 with Sonotone 9T HC. D/S Stereo Cartridge.

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SAME DAY SERVICE
NEW! TESTED! GUARANTEED!

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OZ4	4/6	12AX7	4/9	DK96	7/-	EL42	9/9	PEN36C	15/-	UCC85	6/6
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7B6	10/9	DAF91	4/3	EF85	5/6	PCF802	9/6	UABC80	6/3	OC44	2/3
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7Y4	6/6	DF96	6/-	EF183	5/9	PCL82	7/-	UBC81	7/-	OC75	2/6
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12AT7	3/9	DK32	7/9	EL33	8/9	PCL85	8/3	UBL21	9/-	OC82	2/3
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Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any Parcel Insured against Damage in Transit 6d. extra.

The recently opened Victoria Line is the first new "tube" railway to be built under central London for over 60 years. Probably the most technically advanced railway in the world, this line relies heavily upon electronics for its automatic running

Electronics Underground

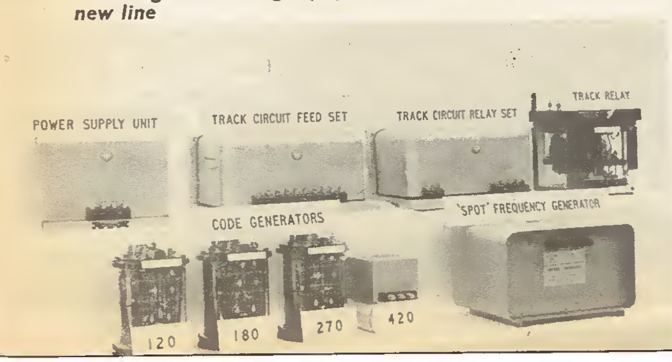
THE travelling habits of many thousands of London commuters underwent a major change on September 2, 1968. On this day the first fully automatic train pulled away from Walthamstow Central station, marking the opening of the first section of the new Victoria Line. The first section runs from Walthamstow Central to Highbury and Islington, the next section, due to commence running in December, is from Islington to Warren Street and the third section from Warren Street to Victoria will be completed in the early spring. A fourth section will be completed in 1970, which will extend the line to Brixton.

ROLE FOR ELECTRONICS

Apart from the enormous task of the tunnelling there was the task of station and train design to be considered. This is where electronics plays a starring role in the form of automatic trains, automatic ticket issuing, automatic passenger barriers, closed circuit television, and for the first time in this country the use of carrier wave equipment for intercommunicating with traffic regulators in control rooms and in other trains, whilst still running underground.

Most of the design of the complete system has been done by London Transport design departments in close consultations with subcontractors.

Tracking and coding equipment of the type used on the new line



THE AUTOMATIC TRAIN

The first train fitted with automatic driving equipment to be tried in passenger service began way back in April 1963. Since then many exhaustive tests and experiments to ensure safety and reliability of running have been carried out.

Automatic driving apparatus incorporates two separate systems, the safety signalling system which ensures the safety of the train and its passengers, and the automatic driver signal command system. Both systems rely on electrical currents, either coded or of different frequencies, being picked up by induction coils mounted at the front of the train.

SAFETY SIGNALLING SYSTEM

The safety signalling system uses coded signals which take the place of the usual visual signalling system, although enough visual signals are provided to allow trains to proceed manually if any emergencies arise.

The basic principle of the system is that a train cannot run unless it is receiving a continuous series of coded pulses transmitted through the running track. The coded signals inform the train whether the track is clear or if another train is ahead. The train must receive one or other of the safety codes continuously. If a code ceases to be received then the brakes are automatically applied.

The safety signals are derived from mains current at 125Hz, which is interrupted into the necessary codes by means of pendulums swinging at different rates and operating electronic switches.

CODED SIGNALS

The codes used are: 420 impulses per minute, indicating that the track is clear for full speed running; and 180 pulse, which indicates that the train cannot proceed at more than 25 mph. Indications of the codes are given by lights in the cab for the information of the train operator.

caution ensures that no power will be supplied to the traction motors unless the air brakes are fully operative.

CLOSE RUNNING

A feature of the equipment is the provision of a 20kHz command spot which works in conjunction with a stop signal and is switched on and off with it. The purpose of this special command pulse, outside the train speed frequency, is to enable a train to approach an occupied section at reduced speed.

If a train is standing in a station under the protection of the home signal, the 20kHz pulse is automatically switched on. Any other train approaching receives this signal and is caused to make a service brake application so as to stop before reaching the signal itself. The train will re-start by itself as soon as the train ahead leaves the station and the signal is cleared, but will continue into the station at the reduced 20 to 23 mph speed until it comes to the braking points for the station stop.

The effect of the 20kHz spot is to cause the train to be stopped at a signal position before it runs on to a lower or no-code section when it would be stopped by means of the emergency trip valve. Full safety braking distances are incorporated in the positioning of the safety signalling equipment applying the codes to the tracks.

AUTOMATIC TICKET GATES AND FARE COLLECTION

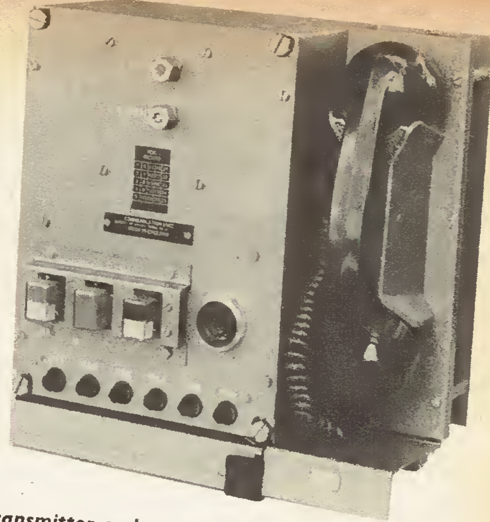
In the new stations full use is made of automatic ticket issuing, automatic barriers and closed circuit television.

This automatic system has been developed to act as a deterrent to fraudulent travel and to cut costs.

Two types of gates are used—the four-door gate and the tripod turnstile. Entry and exit gates are worked by yellow tickets with magnetic tape backing on which the journey details are electronically encoded. When passengers place their tickets in the appropriate slot, these details are "read" electronically by the gates, which open only if the ticket is valid.

A high percentage of tickets sold in station booking halls will come from automatic machines including a

"Four-door" automatic collection gates, one of two types used on the Victoria Line



V.H.F. transmitter and receiver used on the new automatic trains

new multi-fare machine which has a range of 20 fares; this accepts any coin and gives change as necessary. Note changing machines will also be used at stations; these accept banknotes and, after checking electronically, deliver two shilling pieces as necessary.

CLOSED CIRCUIT TELEVISION

Closed circuit television, designed by Peto Scot Ltd., will help maintain a smooth flow of passengers to and from the trains.

Seventy-four cameras and 42 monitor sets and distributive equipment will be used between Walthamstow Central and Victoria to cover the 10½ mile, 12 station section of the new line.

At most stations on the new line an operations room, generally at ticket level, will be equipped with two 11in monitor screens on which the supervisor in charge will be able to select pictures from any of the cameras at his disposal. A microphone connected to loudspeakers on the platforms will enable him to make announcements to passengers.

Television also gives a visual link with all Victoria Line stations to the line controller. At the control centre at Cobourg Street, Euston, he will have two 19in monitors on which to pick up pictures from cameras on any of the station platforms throughout the whole system.

In the event of a delay to the service he will be able to see the effect of the trouble at a glance.

A two-way sound system, linked to the TV set-up, will enable the line controller to hear as well as see what is going on with the range of each camera, and to speak through the platform public address system if required.

For the train operators, monitor screens are sited on each platform opposite the point where the front of the train stops. These show the picture transmitted by the camera mounted at the opposite end of the same platform.

SUMMARY

Finally, the cost of the Victoria Line, which has a carrying capacity of equivalent to eleven motorways running across the heart of London, will be about £80 million and will have a rush hour capacity of 25,000 passengers an hour in either direction.

But is the money well spent? Will it ease the congestion and frayed tempers during rush hour? Only time will tell.

★

Short of a lead?

With a 3-pin DIN plug on one end and 3.5mm jack on the other? With the Goldring Screened Audio Lead Set, you've got it—instantly—at your finger tips. *And 37 other different* equipment-to-equipment connections as well. With cable lengths of 20", 40", or 60" according to the combinations you use. All tidily and instantly to hand in a small neat storage box. There's no longer any need to have an unwieldy collection of dozens of different leads . . . and still be short of the right one! This new Goldring set will give you most of the connections you're ever likely to want—without searching for cables and plugs, without soldering, without waiting, without further expense. The Goldring Audio Lead Set, from your Hi-Fi dealer, is a real investment at **£3.6.0**

*Goldring are now marketing an extremely useful range of individually packed leads, plugs, sockets and connections for audio enthusiasts.

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No.	Sec. Taps	Amps	Price	Carr.
1A	25-33-40-50	15	£9 10 0	10/6
1B	25-33-40-50	10	£6 19 6	8/6
1C	25-33-40-50	6	£5 19 6	8/6
1D	25-33-40-50	3	£3 12 6	7/6
2A	4-16-24-32	12	£6 10 0	7/6
2B	4-16-24-32	8	£4 17 6	7/6
2C	4-16-24-32	4	£3 5 0	6/–
2D	4-16-24-32	2	£2 2 6	5/–
3A*	25-30-35	40	£14 17 6	15/–
3B*	25-30-35	20	£9 7 6	9/6
3C	25-30-35	10	£6 10 0	7/6
3D	25-30-35	5	£3 15 0	6/6
3E	25-30-35	2	£2 15 0	6/6
4A*	12-20-24	30	£11 15 0	10/–
4B	12-20-24	20	£7 10 0	8/6
4C	12-20-24	10	£4 15 0	7/6
4D	12-20-24	5	£3 5 0	6/6
5A	3-12-18	30	£8 15 0	7/6
5B	3-12-18	20	£6 10 0	7/6
5C	3-12-18	10	£3 17 6	6/6
5D	3-12-18	5	£2 12 6	6/6
6A	48-56-60	2	£3 5 0	5/6
6B	48-56-60	1	£2 7 6	5/6
7A*	6-12	50	£9 7 6	9/6
7B	6-12	20	£5 10 0	7/6
7C	6-12	10	£3 10 0	6/6
7D	6-12	5	£2 10 0	5/6
8A	12-24	1	£1 9 6	5/6
9A	17-32	8	£5 12 6	5/6
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(3) 350–0–350V, 25m.a., 6·3V, 1A., 6·3V, 6A. 19/6. P. & P. 5/6.

AUTO TRANSFORMERS

240V-110V or 100V. Completely Shrouded fitted with Two pin American Sockets or terminal blocks. Please state which type required.

Type	Watts	Approx. Weight	Price	Carr.
1	80	2½ lb	£1 17 6	4/6
2	150	4 lb	£2 7 6	5/–
3	300	6½ lb	£3 7 6	6/–
4	500	8½ lb	£4 15 0	6/6
5	1,000	15 lb	£6 12 6	7/6
6*	1,750	25 lb	£13 10 0	10/6
7*	2,250	30 lb	£16 10 0	12/6

* Completely enclosed in beautifully finished metal case fitted with two 2-pin American sockets, neon indicator, on/off switch, and carrying handle.

ISOLATION TRANSFORMERS

All primaries and secondaries 220/240V. Terminal block connections. Fully shrouded. (*excepted).

Amps.	Price	Carr.
1	£3 19 6	6/6
2	£7 10 0	8/6
3	£8 19 6	10/6
4	£10 19 6	10/6
*6	£17 10 0	15/–
*8	£21 10 0	15/–

ADVANCE CONSTANT VOLTAGE TRANSFORMERS: Input 190–260V, 50 cycles. Output 230V at 60 watts. Type M.T.161A. £4.15. P. & P. 7/6.

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Manufactured by Papst. A.C. 220-240 volts. Complete with fibre-glass filter 3½in fan. Capacitor start. Ex equipment. Guaranteed in perfect order. Size: 28 × 5 × 5in, 59/6, carr. 8/6.
FANS ONLY (ILLUSTRATED) 45/-, carr. 5/-.

DIGITAL HOUR METERS

6 figs. inc. 1/10ths, 1/100ths. 40V a.c. but complete with transformer for 240V a.c. operation. All in plastic case. Size 6½ × 6½ × 3in. Condition as new 45/-. P. & P. 5/-.

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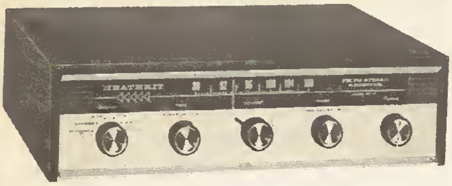


Low-cost FM Stereo Receiver, AR-17

Kit K/AR-17

£39.0.0

P.P. 10/6

Cabinet walnut or teak finish **£3.10.0** extra

28 transistor, 7 diode circuit, 14 watts music power, 10 watts r.m.s. from 25–35,000Hz @ ±1dB. Automatic stereo indicator light. Adjustable phase control. Complete front panel controls. Flywheel tuning. Factory assembled and aligned FM front-end. Circuit board assembly. Compact 10⅜″ deep × 3″ high × 12″ wide. Use free standing with Heathkit cabinet optional extra.

Quality FM Stereo Receiver, AR-14

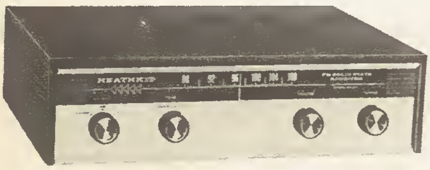
Kit K/AR-14

£54.0.0

P.P. 13/6

Cabinet walnut or teak finish **£4.10.0** extra

31 transistor, 10 diode circuit can deliver ±1dB, 15 to 50,000Hz at 10 watts per channel (20 watts total) 15 watts per channel 1HF music power (30 watts total). Wide-band FM/FM stereo tuner plus two preamps, two power amplifiers. Compact only 3⅞″ high × 15¼″ wide × 12″ deep. Install in a wall, free standing or in Heathkit cabinet optional extra. 210–240V 50Hz a.c.



Low-cost FM Mono Receiver, AR-27

Kit K/AR-27

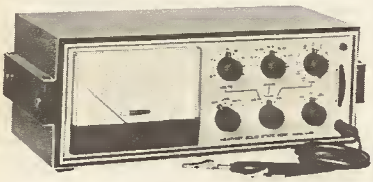
£22.10.0

P.P. 10/6

Cabinet walnut veneered **£3.10.0**

13 transistor, 6 diode circuit. 7 watts music power. ±1db, 25 to 60,000Hz at 6 watts. Input connectors for phono and aux. Complete front panel controls. Flywheel tuning, factory pre-aligned FM tuner. Circuit board assembly. Compact bookshelf size. Install in a wall, free standing or in cabinet optional extra. 210–240V 50Hz a.c. operation.

Solid-State Volt-ohm-Milliammeter, IM-25

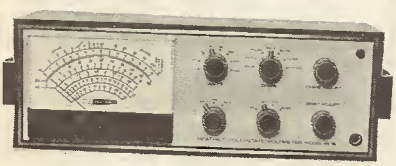


Kit K/IM-25

£48.10.0

P.P. 10/6

9 a.c. and 9 d.c. ranges 150mV up to 1,500V f.s. 7 resistance ranges, 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . measures from 1 ohm to 1,000Mohms. 11 current ranges from 15μA full scale to 1·5A full scale. 11Mohm input impedance d.c. 10Mohm input impedance a.c. 6″ 200μA meter. Internal battery power or 120/240V a.c. 50Hz supply. PCB construction.



Solid-State Volt-ohm Meter, IM-16

Kit K/IM-16

£28.8.0

P.P. 10/6

8 a.c. and 8 d.c. ranges 0–5V to 1,500V f.s. 7 ohm-meter ranges with 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . 11Mohm input on d.c., 1Mohm on a.c. Internal battery power or 120/240V a.c. 50Hz supply.

Solid-State Low Voltage Power Supply, IP-27

Kit K/IP-27

£46.12.0

P.P. 10/6

0·5 to 50V d.c. with better than ±15 Millivolts regulation. Four current ranges 50mA; 150mA, 500mA, and 1·5 amperes. Adjustable current limiter: 30 to 100% all ranges. Panel meter for output voltage or current.

SEE HEATHKIT MODELS IN LONDON, Tottenham Court Road. **BIRMINGHAM,** St. Martin's House. **GLOUCESTER,** factory

This special trackside equipment has been installed in special "relay rooms". The equipment transmits instructions to the train in the form of electrical impulses which are fed to the running rails and picked up by the induction coils on the train; they are then passed to the "brain", which is a box of electronic equipment and electrical relays housed in special compartments on the train. The impulses convey commands to the train which operate the electrical circuits. These in turn actuate the brakes or the motors so that the train can accelerate, coast, and brake accordingly.

The impulses having been pre-set to give the most efficient running section by section over the line, act as automatic check points to ensure that the speed is dropping correctly to halt the train in proper alignment with the platforms regardless of its passenger load.

CAB DESIGN

Automatic train operation has involved considerable changes in the cab as compared with that of a standard train. The train operator has a folding seat on the rear bulkhead on the near side, with the more important controls and dials grouped on a desk in front of him.

Immediately in front of the operator and duplicated on both sides of the cab are the twin push-button switches used for starting the train—the only driving control required in normal automatic working.

For use when the train is being operated manually, as in entering the depot or in the event of a failure of the automatic system, there is a combined traction/brake controller to the left of the desk. The handle is pushed forward for motoring and pulled back for braking. On the right hand side is a switch for selecting manual (forward or reverse) or automatic driving, or "off".

To operate the train when no signalling codes are being fed to the track, the train operator must first raise a "slow manual" flag switch on the off-side of the cab which restricts speed to approximately 10 mph. When signalling codes are being picked up by the train the train operator can drive in manual control at up to 25 mph.

Cab of the Victoria line train. The operator's desk, with controls for manual operation when required, is on the front wall of the cab, with other controls and switches on the desk in the right foreground

DOOR CONTROL AND DRIVING LIGHTS

There are two other controls in regular use—the near and off-side door controllers. These are levers moving through 90 degrees and can be worked while the operator is looking, from the cab drop window, back along the train. To protect against inadvertent opening of the doors, the door controllers cannot be operated until a lock has been depressed.

As automatic train operation is used, there are few of the colour-light signals, which, on a standard Tube line, act as points of visual reference to drivers. Because of their absence, the new trains have been fitted with headlights which will light up the tunnel for some distance ahead, giving a visual relationship between the movement of the train and its surroundings.

An unusual item in the cab is an emergency calling light switch. When switched on from the operator's position, a light on the outside of each cab acts as a breakdown calling light. The light at the front of the train acts as a repeater to show the operator that the rear call light is also functioning.

COMMUNICATION SYSTEM

Each train cab is fitted with a v.h.f. transmitter and receiver, supplied by Nelson Tansley Ltd., with an aerial mounted on the front of the train. Fitted with a telephone handset and selector panel there are three positions on which the operator selects Public Address, Intercommunication, or inter-train communication.

Selection of inter-train communication position by depressing an associated push button will, after alerting the called train, enable a normal two-way radio-telephone conversation to take place. This enables the operators of the two trains to speak to each other before coupling so that the man in the following train can be told the nature of the fault in the train ahead.

This avoids the risk of, say, an electrical fault being inadvertently transmitted from the disabled train to the one behind as the couplers make contact. Means are provided for isolating the electrical connections in these circumstances.

Selecting Public Address on the selector panel enables train operators to convey information and/or instructions to passengers via six loudspeakers in each coach. This facility will normally only be used when the train is stationary.

Carrier wave equipment is also fitted, operating via the conductor rails, to allow the train operator to speak to the Central Control Room and vice versa. The carrier wave system operates whether the train is moving or not.

STARTING THE TRAIN

Each train has a one-man crew who is called a train operator. He travels in the front cab and can switch over to manual control at any time in the event of a failure of any part of the automatic system. He uses a control in the cab to open doors at station stops, and to close them again he must carry out two safety procedures before the train will commence its journey. They are, that he must close the cab drop window and press twin start buttons simultaneously; this way no train can be sent on its journey without an operator. The twin starting buttons are also provided so that a fault in one wire cannot cause a false start.

Interlocking devices ensure that the train cannot start until all doors are properly closed and unless the 420 code is in operation. Indicator lights are provided near the buttons to show the train operator whether these conditions have been fulfilled. An additional pre-

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CERAMIC DISC CAPACITORS (Hunts.). 500V ±20%; 100, 220, 330pF. −20%, +80%; 470, 680, 1,000pF. **5d** each.

ELECTROLYTIC CAPACITORS (Mullard). −10% to +50%.

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

Small (all values in μF)

4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

POLYESTER CAPACITORS (Mullard)
Tubular, 10%, 160V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/3.** 0·47μF, **1/6.** 0·68μF, **2/3.** 1μF, **2/8.**
400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022μF, **7d.** 0·033μF, **8d.** 0·047μF, **9d.** 0·068, 0·1μF, **11d.** 0·15μF, **1/2.** 0·22μF, **1/6.** 0·33μF, **2/3.** 0·47μF, **2/8.**
Modular, metallised, P.C. mounting, 20%, 250V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/5.** 0·47μF, **1/8.** 0·68μF, **2/3.** 1μF, **2/9.**

POLYSTYRENE CAPACITORS: 5%, 160V (unencapsulated): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, **5d.** 1,000, 1,500, 2,200pF, **6d.** 3,300, 4,700, 5,600pF, **7d.** 6,800, 8,200, 10,000pF, **8d.** 15,000, 22,000pF, **9d.**
1%, 100V (encapsulated): 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820pF, **1/-.** 1,000, 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900pF, **1/3.** 4,700, 5,000, 5,600, 6,800, 8,200, 10,000, 12,000, 15,000pF, **1/6.** 18,000, 22,000, 27,000, 33,000, 39,000pF, **1/9.** 0·047, 5,000, 0·056μF, **2/-.** 0·068, 0·082, 0·1μF, **2/3.** 0·12μF, **2/9.** 0·15, 0·18μF, **3/-.** 0·22μF, **4/-.** 0·27, 0·33μF, **5/-.** 0·39μF, **5/9.** 0·47, 0·5μF, **6/3.**

JACK PLUGS (Screened): Heavily chromed, ¼in Standard: **2/9** each. Side-entry: **3/3** each.
Standard (Unscreened): With black, grey, white, red, blue, green or yellow covers, **2/3** each.

JACK SOCKETS (¼in Plug): With black or white bezel and chrome nut, **2/9** each. Available with: Break/Break, Make/Break, Break/Make, Make/Make contacts.

POTENTIOMETERS (Carbon): Long life, low noise, ¼W at 70°C. ±20% ≦ ¼M, ±30% > ¼M. Body dia., ¾in. Spindle, 1in × ¼in. **2/3** each. Linear: 100, 250, 500 ohms, etc., per decade to 10M. Logarithmic: 5k, 10k, 25k, etc., per decade to 5M.

SKELETON PRE-SET POTENTIOMETERS (Carbon): Linear: 100, 250, 500 ohms, etc., per decade to 5M.
Miniature: 0·3W at 70°C. ±20% ≦ ¼M, ±30% > ¼M. Horizontal (0·7in × 0·4in P.C.M.) or Vertical (0·4in × 0·2in P.C.M.) mounting, **1/-** each.
Submin. 0·1W at 70°C. ±20% ≦ 1M, ±30% > 1M. Horizontal (0·4in × 0·2in P.C.M.) or Vertical (0·2in × 0·1in P.C.M.) mounting, **10d** each.

RESISTORS (Carbon film), very low noise. Range: 5%, 4·7Ω to 1MΩ (E24 Series); 10%, 10Ω to 10MΩ (E12 Series).
¼W (10%), **1¾d** (over 99, 1½d), 100 off per value **12/-.** ¼W (5%), **2d** (over 99, 1¾d), 100 off per value **13/9.** ½W (10%), **2d** (over 99, 1¾d), 100 off per value **13/9.** ½W (5%), **2¼d** (over 99, 2d), 100 off per value **15/6.**

SEMICONDUCTORS: OA5, OA81, **1/9.** OC44, OC45, OC71, OC81, OC81D, OC82D, **2/-.** OC72, **2/3.** OC170, OC171, **2/6.** AF115, AF116, AF117, **3/-.** OC73, **3/3.** OC140, **4/3.**

SILICON RECTIFIERS (0·5A): 170 P.I.V., **2/9.** 400 P.I.V., **3/-.** 800 P.I.V., **3/3.** 1,250 P.I.V., **3/9.** 1,500 P.I.V., **4/-.**

SWITCHES (Chrome finish, Silver contacts): 3A 250V, 6A 125V. Push Buttons: Push-on or Push-off (with white, black, green or red buttons) **5/-.** Toggle Switches: SP/ST, **3/3.** SP/DT, **3/6.** SP/DT (with centre position) **3/9.** DP/ST, **4/3.** DP/DT, **5/-.**

PRINTED CIRCUIT BOARD (Vero).
0·15in Matrix: 3¾in × 2½in, **3/3.** 5½in × 2½in, **3/11.** 3¾in × 3¾in, **3/11.** 5in × 3¾in, **5/6.**
0·1 Matrix: 3¾in × 2½in, **4/-.** 5in × 2½in, **4/6.** 3¾in × 3¾in, **4/6.** 5in × 3¾in, **5/3.**

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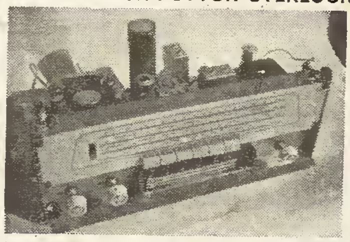

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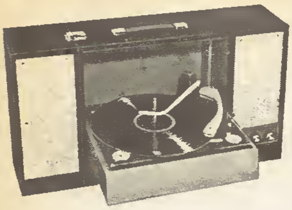

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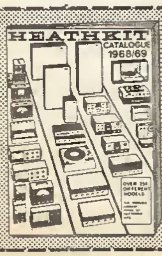

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1·25μF	16 volt	5μF	6 volt	25μF	12 volt	320μF	10 volt
2μF	3 volt	6μF	6 volt	25μF	25 volt	400μF	6·4 volt
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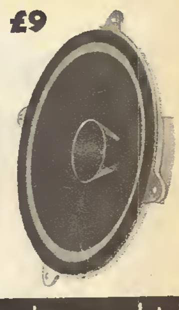

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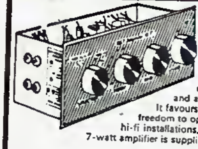

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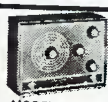

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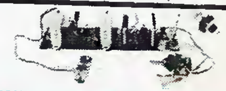

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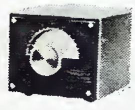

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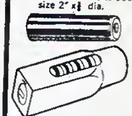

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401	27	15	0
AP75	21	10	0
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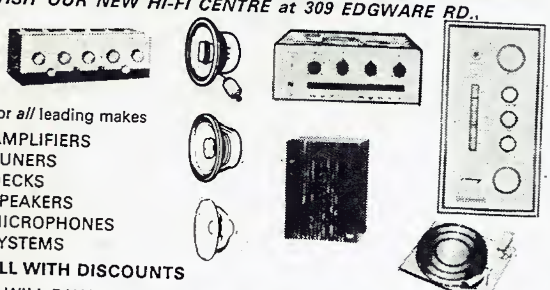

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