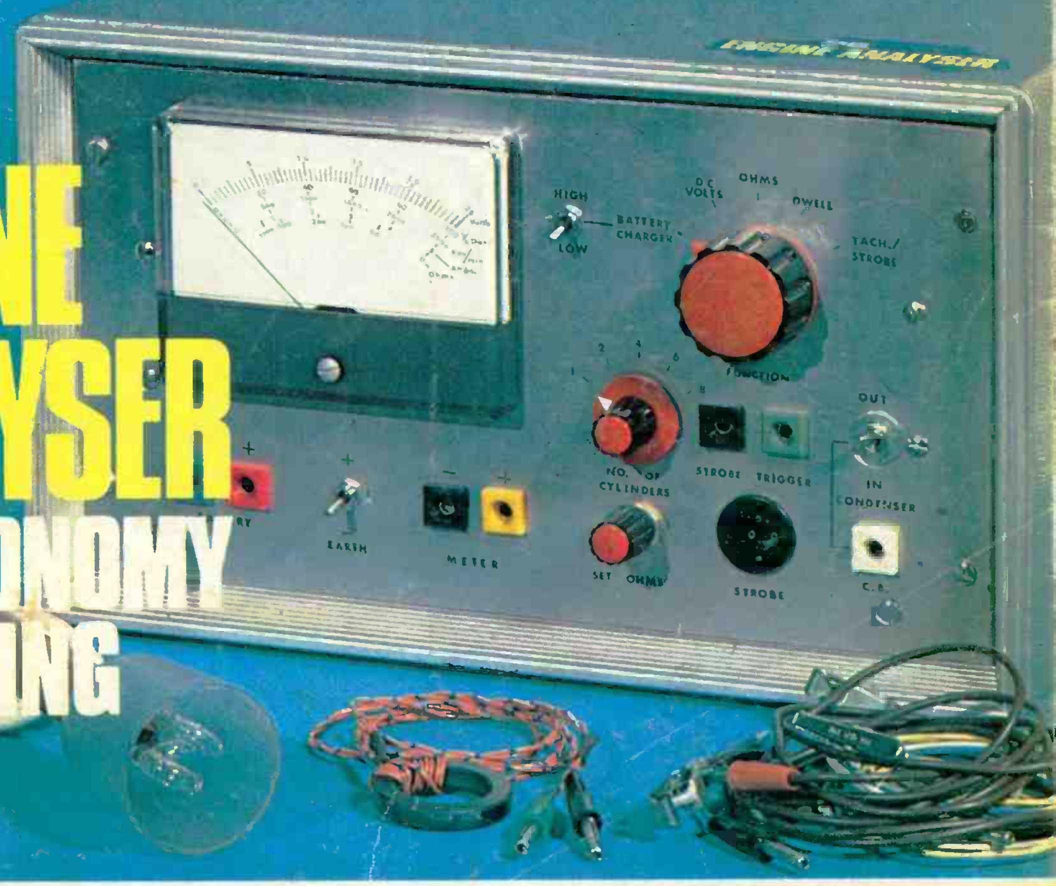
PRACTICAL
ELECTRONICS

OCTOBER 1975

35p

FREE IN THIS ISSUE! LINEAR I.C. IDENTICHART

PE
ENGINE ANALYSER
FOR ECONOMY MOTORING



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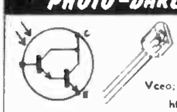

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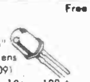


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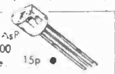
Orange	27p	24p	22p ●	33p	30p	27p ●	30p	27p	25p ●
Yellow	34p	31p	29p ●	35p	32p	29p ●	35p	33p	30p ●



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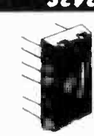
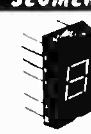

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	RED	MAN4710	MAN4720	MAN4730	MAN4740	£2.32 ●
	YELLOW	MAN4810	MAN4820	MAN4830	MAN4840	£2.32 ●
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		C.A. L/H Dec. Pt.	C.A. ± 1	C.C. L/H Dec. Pt.	C.C. ± 1	
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VOLUME 11 No. 10 OCTOBER 1975

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LINEAR I.C. IDENTICHART
At-a-glance functional equivalents of linear i.c.s.

Our November issue will be published on Friday, October 10, 1975
(for details of contents see page 824)

Connoisseur

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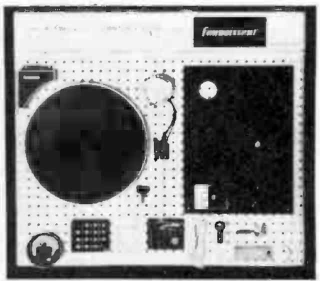

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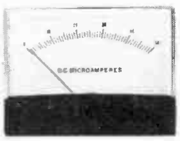

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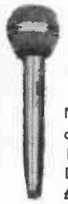

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7407	22	7465	21	74161	95
7408	14	7472	22	74163	1·05
7409	14	7473	26	74164	1·25
7410	11	7474	26	74165	1·25
7411	16	7475	41	74166	1·15
7413	35	7476	26	74173	95
7415	22	7483	70	74175	95
7416	22	7485	80	74176	95
7417	22	7486	24	74177	85
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7422	22	7490	45	74181	2·50
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7438	21	74105	60	74194	95
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7441	60	74121	32	74196	1·00
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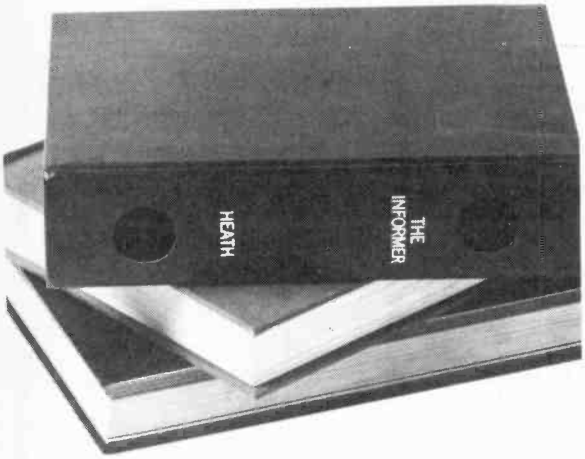

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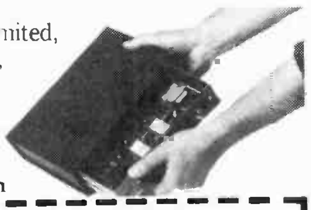

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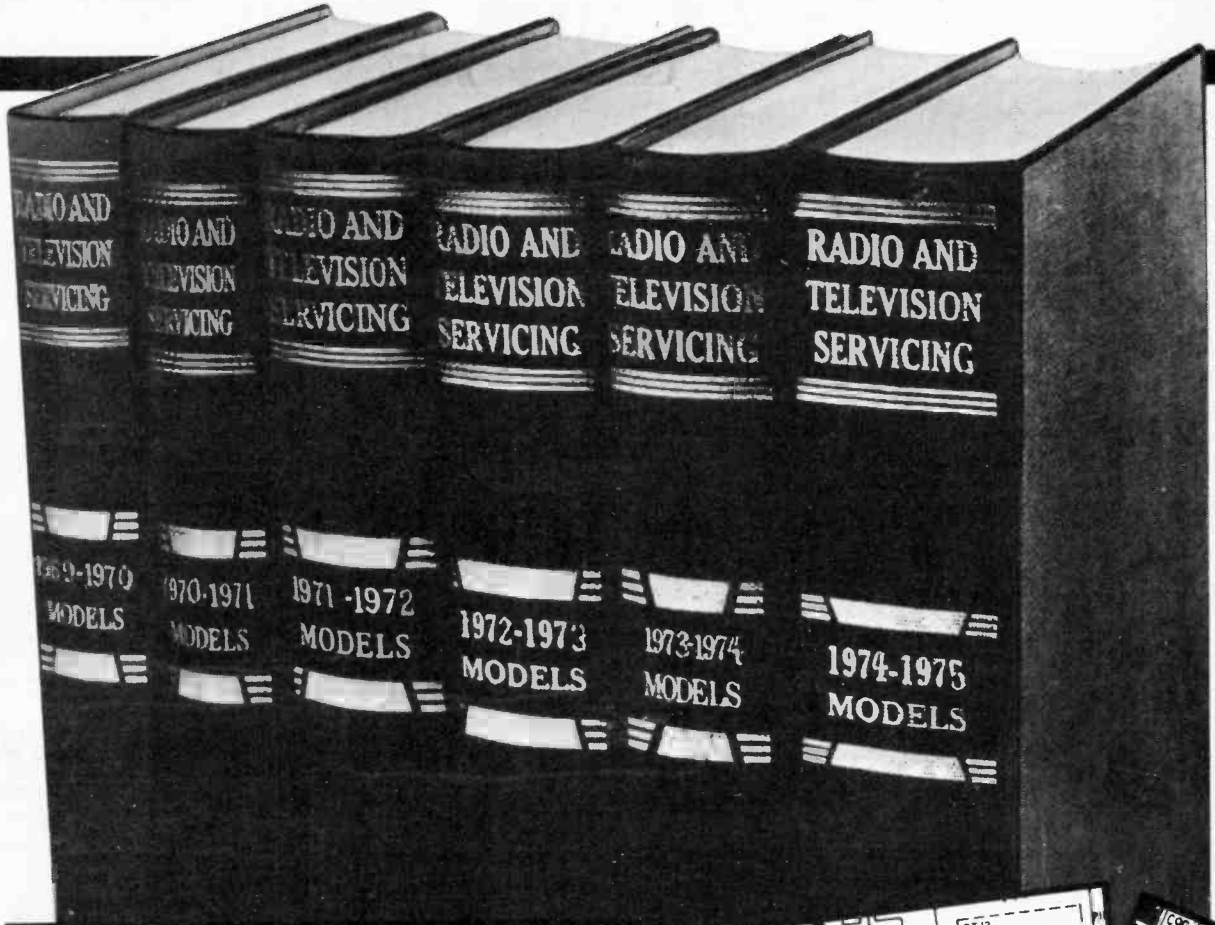

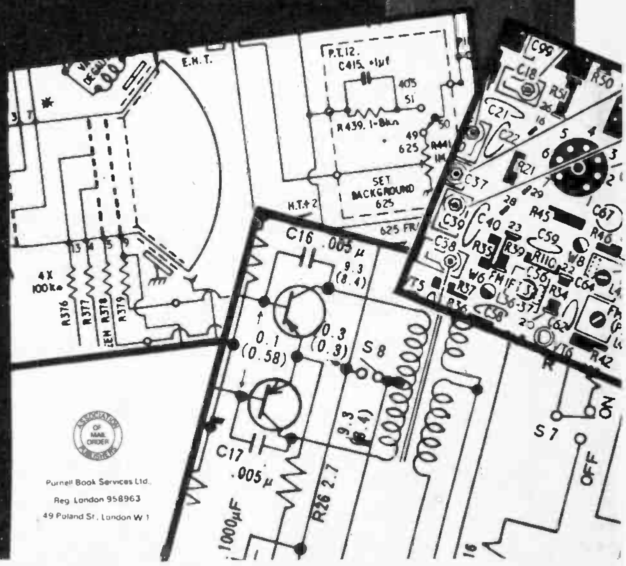

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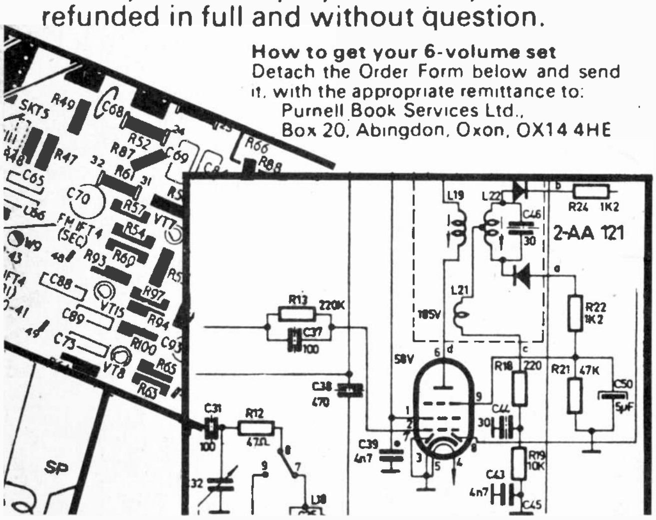

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OC36	0·51
OC41	0·20
OC42	0·25
2N918	0·31
2N929	0·21
2N930	0·21
2N1131	0·20
2N1132	0·22
2N1302	0·15
2N1303	0·15
2N1304	0·18
2N1305	0·18
2N1306	0·21
2N1307	0·21
2N1308	0·24
2N1309	0·24
2N1613	0·20
2N1711	0·20
2N1889	0·32
2N1890	0·46
2N1893	0·38
2N2147	0·73
2N2148	0·58
2N2192	0·36
2N2193	0·36
2N2194	0·36
2N2217	0·22
2N2218	0·20
2N2219	0·20
2N2220	0·22
2N2221	0·20
2N2222	0·20
2N2368	0·18
2N2369	0·15
2N2369A	0·15
2N2411	0·25
2N2412	0·25
2N2646	0·48
2N2711	0·21
2N2712	0·21
2N2714	0·21
2N2904	0·18
2N2904A	0·21
2N2905	0·21
2N2905A	0·21
2N2906	0·16
2N2906A	0·19
2N2907	0·20
2N2907A	0·22
2N2923	0·15
2N2924	0·15
2N2925	0·15
ACY35	0·21
ACY36	0·29
ACY40	0·18
ACY41	0·19
ACY44	0·36
AD130	0·39
AD140	0·49
AD142	0·49
AD143	0·39
AD149	0·51
AD161	0·36
AD162	0·36
AD161 & AD162(MP)	0·69
ADT140	0·51
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·25

Type	Price
AF118	0·36
AF124	0·31
AF125	0·31
AF126	0·29
AF127	0·29
AF139	0·31
AF178	0·51
AF179	0·51
AF180	0·51
AF181	0·51
AF186	0·51
AF239	0·38
AL102	0·68
AL103	0·68
ASY26	0·26
ASY27	0·31
ASY28	0·26
ASY29	0·26
ASY50	0·26
ASY51	0·26
ASY52	0·26
ASY54	0·26
ASY55	0·26
ASY56	0·26
ASY57	0·26
ASY58	0·26
ASY73	0·26
ASZ21	0·41
BC107	0·08
BC108	0·08
BC109	0·08
BD136	0·41
BD137	0·46
BD138	0·51
BD139	0·56
BD140	0·61
BD155	0·81
BD175	0·61
BD176	0·61
BD177	0·67
BD178	0·67
BD179	0·71
BD180	0·71
BD185	0·67
BD186	0·67
BD187	0·71
BD188	0·71
BD189	0·77
BD190	0·77
BD195	0·87
BD196	0·87
BD197	0·92
BD198	0·92
BD199	0·98
BD200	0·98
BD205	0·81
BD206	0·81
BD207	0·98
BD208	0·98
BDY20	£1·02
BF115	0·25
BF117	0·46
BF118	0·71
BF119	0·71
BF121	0·46
BF123	0·51
BF125	0·46
BF127	0·51
BF152	0·56
BF153	0·46
BF154	0·46
BF155	0·71
BF156	0·49
BF157	0·56
BF158	0·56
BF159	0·61
BF160	0·41
BF162	0·41
BF163	0·41
BF164	0·41
BF165	0·41
OC44	0·16
OC45	0·13
OC70	0·10
OC71	0·10
OC72	0·15
OC74	0·15
OC75	0·16
OC76	0·16
OC77	0·26
OC81	0·16
OC81D	0·16
OC82	0·16
OC82D	0·16
OC83	0·20
OC139	0·20
OC140	0·20
OC169	0·26
OC170	0·26
OC171	0·26
OC200	0·26
OC201	0·29
OC202	0·29
OC203	0·26
OC204	0·26
OC205	0·36
OC309	0·41
OCP71	0·44*
ORP12	0·44*
ORP60	0·41*

Type	Price
ORP61	0·41*
P20	0·51*
P346A	0·20
P397	0·43
ST140	0·13
ST141	0·18
TIP29	0·44
TIP30	0·52
TIP31A	0·56
TIP32A	0·68
TIP41A	0·68
TIP42A	0·81
T1843	0·31*
UT46	0·28*
ZN414	1·11
2G301	0·19
2G302	0·19
2G303	0·19
2G304	0·25
2G306	0·41
2G308	0·36
2N2926 G	0·13
2N2926 Y	0·11
2N2926 O	0·10
2N2926 R	0·10
2N2926 B	0·10
2N3010	0·71
2N3011	0·15
2N3053	0·18
2N3054	0·47
2N3055	0·42
2N3319	0·15
2N3391 A	0·17
2N3392	0·15
2N3393	0·15
2N3394	0·15
2N3395	0·18
2N3402	0·21
2N3403	0·21
2N3404	0·29
2N3405	0·43
2N3414	0·16
2N3415	0·16
2N3416	0·29
2N3417	0·29
2N3525	0·77*
2N3614	0·69
2N3615	0·76
2N3616	0·76
2N3646	0·09
2N3702	0·12
2N3703	0·12
2N3704	0·13
2N3705	0·12
2N3706	0·12
2N3707	0·13
2N3708	0·08
2N3709	0·09
2N3710	0·09
2N3711	0·09
2N3819	0·29
2N3820	0·51
2N3821	0·36
2N3823	0·29
2N3903	0·29
2N3904	0·31
2N3905	0·29
2N3906	0·28
2N4058	0·12
2N4059	0·10
2N4060	0·12
BC113	0·10
BC114	0·16
BC115	0·16
BC116	0·16
BC117	0·19
BC118	0·10
BC119	0·31
BC120	0·81
BC125	0·12
BC126	0·19
BC132	0·12
BC134	0·19
BC135	0·12
BC136	0·16
BC137	0·16
BC139	0·41
BC140	0·31
BC141	0·31
BC142	0·31
BC143	0·31
BC145	0·46
BC147	0·10
BC148	0·10
BC149	0·12
BC150	0·19
BC151	0·20
BC152	0·18
BC153	0·29
BC154	0·31
BC157	0·19
BC158	0·12
BC159	0·12
BC160	0·46
BC161	0·51
BC167	0·12
BC168	0·12
BC169	0·12
BC170	0·12
BC171	0·15

Type	Price
BC172	0·15
BF167	0·22
BF173	0·22
BF176	0·36
BF177	0·36
BF178	0·31
BF179	0·31
BF180	0·31
BF181	0·31
BF182	0·41
BF183	0·41
BF184	0·26
BF185	0·31
BF187	0·28
BF188	0·41
BF194	0·12
BF195	0·12
BF196	0·15
BF197	0·15
BF200	0·46
BF222	0·98
BF257	0·46
BF258	0·61
BF259	0·87
BF262	0·56
BF263	0·56
BF270	0·36
BF271	0·31
BF272	0·81
BF273	0·36
BF274	0·36
BFW20	0·61
BFX29	0·28
BFX84	0·22
BFX85	0·31
BFX86	0·22
BFX87	0·25
BFX88	0·22
BFY50	0·20
BFY51	0·20
BFY52	0·20
2G309	0·37
2G339	0·20
2G339A	0·17
2G344	0·19
2G345	0·17
2G371	0·17
2G371B	0·12
2G373	0·18
2G374	0·18
2G377	0·31
2G378	0·17
2G381	0·17
2G382	0·17
2G401	0·31
2G414	0·31
2G417	0·26
2N388	0·36
2N388A	0·56
2N404	0·20
2N404A	0·29
2N524	0·43
2N527	0·50
2N598	0·43
2N599	0·46
2N696	0·13
2N697	0·14
2N698	0·25
2N699	0·36
2N706	0·08
2N706A	0·09
2N708	0·12
2N711	0·31
2N717	0·36
2N718	0·25
2N718A	0·51
2N726	0·29
2N727	0·29
2N743	0·20
2N744	0·20
2N914	0·15
2N4061	0·12
2N4062	0·12
2N4284	0·18
2N4285	0·18
2N4286	0·18
2N4287	0·18
2N4288	0·18
2N4289	0·18
2N4290	0·18
2N4291	0·18
2N4292	0·18
2N4293	0·18
2N5172	0·12
2N5194	0·56
2N5294	0·56
2N5296	0·56
2N5457	0·32
2N5458	0·32
2N5459	0·41
2N6122	0·69
2S301	0·51
2S302A	0·43
2S302	0·43
2S303	0·56
2S304	0·71
2S305	0·80
2S306	0·80
2S307	0·80
2S321	0·75

* 74 SERIES T.T.L. I.C's

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Type	Quantities 1	25	100+
7400	0·14	0·13	0·12
7401	0·14	0·13	0·12
7402	0·14	0·13	0·12
7403	0·14	0·13	0·12
7404	0·14	0·13	0·12
7405	0·14	0·13	0·12
7406	0·36	0·31	0·29
7407	0·36	0·31	0·29
7408	0·23	0·22	0·21
7409	0·23	0·22	0·21
7410	0·14	0·13	0·12
7411	0·23	0·22	0·21
7412	0·26	0·25	0·24
7413	0·30	0·29	0·28
7416	0·28	0·27	0·26
7417	0·28	0·27	0·26
7420	0·14	0·13	0·12
7422	0·28	0·27	0·26
7423	0·37	0·36	0·35
7425	0·37	0·36	0·35
7426	0·37	0·35	0·33
7427	0·37	0·35	0·33
7428	0·42	0·39	0·37
7430	0·14	0·13	0·12
7432	0·37	0·35	0·33
7433	0·39	0·37	0·35
7437	0·32	0·30	0·28
7438	0·32	0·30	0·28
7440	0·14	0·13	0·12
7441	0·69	0·66	0·59
7442	0·69	0·66	0·59
7443	£1·11	£1·06	£1·02
7444	£1·11	£1·06	£1·02
7445	£1·48	£1·44	£1·39
7446	£1·11	£1·06	£1·02
7447	£1·02	0·99	0·97

Type	Quantities 1	25	100+
7448	£1·02	0·99	0·97
7450	0·14	0·13	0·12
7451	0·14	0·13	0·12
7453	0·14	0·13	0·12
7454	0·14	0·13	0·12
7460	0·14	0·13	0·12
7470	0·30	0·27	0·25
7472	0·30	0·27	0·25
7473	0·38	0·36	0·32
7474	0·38	0·36	0·32
7475	0·56	0·54	0·52
7476	0·41	0·40	0·39
7480	0·56	0·54	0·51
7481	1·02	0·97	0·93
7482	0·83	0·79	0·74
7483	£1·11	£1·06	0·97
7484	0·93	0·90	0·88
7485	£1·48	£1·44	£1·39
7486	0·32	0·31	0·30
7489	£3·70	£3·47	£3·24
7490	0·60	0·58	0·56
7491	£1·02	0·97	0·93
7492	0·69	0·66	0·59
7493	0·69	0·66	0·59
7494	0·79	0·76	0·69
7495	0·79	0·76	0·69
7496	0·89	0·86	0·80
74100	£1·39	£1·34	£1·30
74104	0·56	0·54	0·51
74105	0·56	0·54	0·51
74107	0·41	0·39	0·37
74110	0·56	0·51	0·46
74111	0·83	0·81	0·78
74118	0·93	0·88	0·83
74119	£1·39	£1·30	£1·20
74121	0·46	0·44	0·41

Type	Quantities 1	25	100+
74122	0·65	0·63	0·60
74123	0·69	0·68	0·65
74141	0·79	0·76	0·73
74145	£1·20	£1·16	£1·11
74150	£1·39	£1·30	£1·20
74151	£1·02	0·97	0·93
74153	0·93	0·88	0·83
74154	£1·57	£1·43	£1·48
74155	£1·11	£1·06	£1·02
74156	£1·11	£1·06	£1·02
74157	0·93	0·88	0·83
74160	£1·30	£1·25	£1·20
74161	£1·30	£1·25	£1·20
74162	£1·30	£1·25	£1·20
74163	£1·30	£1·25	£1·20
74164	£1·67	£1·62	£1·55
74165	£1·67	£1·62	£1·55
74166	£1·48	£1·44	£1·39
74174	£1·48	£1·44	£1·39
74175	£1·02	0·97	0·93
74176	£1·16	£1·11	£1·06
74177	£1·16	£1·11	£1·06
74180	£1·16	£1·11	£1·06
74181	£3·66	£3·56	£3·47
74182	£1·16	£1·11	£1·06
74184	£1·67	£1·62	£1·55
74190	£1·81	£1·76	£1·71
74191	£1·81	£1·76	£1·71
74192	£1·81	£1·76	£1·71
74193	£1·81	£1·76	£1·71
74194	£1·20	£1·16	£1·11
74195	£1·02	0·97	0·93
74196	£1·11	£1·06	£1·02
74197	£1·11	£1·06	£1·02
74190	£2·55	£2·50	£2·45
74199	£2·31	£2·21	£2·11

Devices may be mixed to qualify for quantity price. (TTL 74 series only) data is available for the above series of I.C's in booklet form. PRICE 35p.

* D.T.L. 930 SERIES

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
BP930	0·14	0·13	0·12	BP944	0·15	0·14	0·13	BP962	0·14	0·13	0·12
BP932	0·15	0·14	0·13	BP945	0·28	0·26	0·23	BP9093	0·42	0·40	0·38
BP933	0·15	0·14	0·13	BP946	0·14	0·13	0·12	BP9094	0·42	0·40	0·38
BP935	0·15	0·14	0·13	BP948	0·28	0·26	0·23	BP9097	0·42	0·40	0·38
BP936	0·15	0·14	0·13	BP951	0·65	0·60	0·56	BP9099	0·42	0·40	0·38

* TRIACS

	Case	100V	200V	400V
2 Amp	TO5	0·31	0·51	0·71
6 Amp	TO66	0·51	0·61	0·77
10 Amp	TO48	0·77	0·92	£1·12

* D.I.L. SOCKETS

		1	25	100+
TSO14	14 pin type	0·31	0·28	0·25
TSO16	16 pin type	0·35	0·32	0·30
TSO24	24 pin type	0·69	0·64	0·62
BPS 8	8 pin type (low cost)	0·14	0·12	0·10
BPS14	14 pin type (low cost)	0·15	0·13	0·11
BPS16	16 pin type (low cost)	0·16	0·14	0·12

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LINEAR I.C's

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
72702	0·46	0·44	0·42	SL701C	0·46	0·42	0·37	uA723C	0·45	0·43	0·40
72709	0·23	0·21	0·19	SL702C	0·46	0·42	0·37	76003	£1·39	£1·34	£1·30
72709P	0·19	0·18	0·17	TAA263	0·74	0·65	0·56	76023	£1·39	£1·34	£1·30
72710	0·32	0·31	0·28	TAA293	0·93	0·88	0·83	76660	0·88	0·86	0·83
72741	0·28	0·27	0·26	TAA350A	£1·71	£1·67	£1·57	LM380	0·93	0·90	0·88
72741C	0·26	0·25	0·24	uA703C	0·26	0·24	0·22	NE555	0·45	0·43	0·40
72741P	0·28	0·27	0·26	uA709C	0·19	0·18	0·17	NE556	0·88	0·86	0·83
72747	0·79	0·74	0·61	uA711C	0·32	0·31	0·28	TBA800	£1·39	£1·34	£1·30
72748P	0·35	0·33	0·31	uA712C	0·32	0·31	0·28	ZN414	£1·11	—	—
SL201C	0·46	0·42	0·37								

SILICON RECTIFIERS

PIV	300mA (DO 7)	750mA (SO 16)	1 Amp Plastic		1·5Amp (SO 16)	3Amp (SO 10)	10Amp (SO 10)	30Amp (TO 48)
50	0·05	0·06	1N4001	0·05	0·07	0·14	0·19*	0·56*
100	0·05	0·07	1N4002	0·06	0·09	0·16	0·21*	0·69*
200	0·06	0·09	1N4003	0·07	0·12	0·20	0·23*	0·93*
400	0·07	0·14	1N4004	0·08	0·14	0·28	0·35*	£1·25*
600	0·08	0·16	1N4005	0·09	0·16	0·33	0·42*	£1·76*
800	0·11	0·18	1N4006	0·10	0·18	0·35	0·51*	£1·94*
1000	0·13	0·28	1N4007	0·11	0·23	0·44	0·60*	£2·31*
1200	—	0·32			0·28	0·54	0·69*	£2·88*

PO BOX 6 WARE HERTS

SUPER UNTESTED PAKS

Pak No.	Description	Price £p
U 1	120 Glass Sub-min. General purpose Germ. diodes	0·60
U 2	50 Mixed Germanium transistors AF/RF	0·60
U 3	75 Germanium gold bonded sub-min. like OA5, OA47	0·60
U 4	30 Germanium transistors like OC81, AC128	0·60
U 5	60 200mA sub-min. silicon diodes	0·60
U 6	30 Sil. Planar trans. NPN like BSY95A, 2N706	0·60
U 7	16 Sil. rect. TOP-HAT 750mA VLTG. RANGE up to 1000	0·60
U 8	50 Sil. planar diodes DO-7 glass 250mA like OA200/202	0·60
U 9	20 Mixed voltages, 1 Watt Zener Diodes	0·60
U10	20 BAY50 charge storage diodes DO-7 glass	0·60
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U13	30 PNP-NPN Sil. transistors OC200 & 28104	0·60
U14	150 Mixed silicon and germanium diodes	0·60
U15	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	0·60
U16	10 3Amp sil. rectifiers stud type up to 1000 PIV	0·60
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0·60
U18	8 6 Amp sil. rectifiers BYZ13 type up to 600 PIV	0·60
U19	20 Silicon NPN transistors like BC 108	0·60
U20	12 1·5 Amp sil. rectifiers top hat up to 1000 PIV	0·60
U21	30 AF. Germ. alloy transistors 2G300 series & OC71	0·60
U23	25 MADT's like MHz series PNP transistors	0·60
U24	20 Germ. 1 Amp rectifiers GJM series up to 300 PIV	0·60
U25	25 300 MHz NPN silicon transistors 2N708, BSY27	0·60
U26	30 Fast switching silicon diodes like IN914 Micro-Min	0·60
U29	10 1 Amp SCR's TO-5 can. up to 600 PIV CRS1/25-600	£1·20*
U32	25 Zener diodes 400 mW DO-7 case 3-33 volts mixed	0·60
U33	15 Plastic case 1 Amp sil. rectifiers IN4000 series	0·60
U34	30 Silicon PNP alloy trans. TO-5 BCY26 28302/4	0·60
U35	25 Silicon planar transistors PNP TO-18 2N2906	0·60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	0·60
U37	30 Silicon alloy transistors SO-2 PNP OC200, S2322	0·60
U38	20 Fast switching silicon trans. NPN 400 MHz 2N3011	0·60
U39	30 RF. Ger. PNP transistors 2N1303/5 TO-5	0·60
U40	10 Dual transistors 6 lead TO-5 2N2060	0·60
U43	25 Silicon trans. plastic TO-18 A.F. BC113/114	0·60
U44	20 Silicon trans. plastic TO-5 BC115	0·60
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U46	20 Unijunction transistors similar to T1843	0·60*
U47	10 TO220AB plastic triacs 50V 6A	£1·20*
U48	9 NPN Sil. power transistors like 2N3055	£1·20
U49	12 NPN Sil. plastic power trans. 60W like 2n5294/5296	£1·20

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µA.7812/L130 12V (Equiv. to MVR12V) £1·25p
µA.7815/L131 15V (Equiv. to MVR15V) £1·25p
µA.7818 18V (Equiv. to MVR18V) £1·25p

QUALITY TESTED PAKS

Pak No.	Quality Tested Paks	Price
Q 1	20 Red spot transistors PNP	0·60
Q 2	16 White spot R.F. transistors PNP	0·60
Q 3	4 OC 77 type transistors	0·60
Q 4	6 Matched transistors OC44/45/81/81D	0·60
Q 5	4 OC 75 transistors	0·60
Q 6	5 OC 72 transistors	0·60
Q 7	4 AC 128 transistors PNP high gain	0·60
Q 8	4 AC 126 transistors PNP	0·60
Q 9	7 OC 81 type transistors	0·60
Q10	7 OC 71 type transistors	0·60
Q11	2 AC 127/128 Complementary pairs PNP/NPN	0·60
Q12	3 AF 116 type transistors	0·60
Q13	3 AF 117 type transistors	0·60
Q14	3 OC 171 H.F. type transistors	0·60
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0·60
Q17	5 NPN 2 × ST.141 & 3 × ST.140	0·60
Q18	4 MADT'S 2 × MAT 100 & 2 × MAT 120	0·60
Q19	3 MADT'S 2 × MAT 101 & 1 × MAT 121	0·60
Q20	4 OC 44 Germanium transistors A.F.	0·60
Q21	4 AC 127 NPN Germanium transistors	0·60
Q22	20 NKT transistors A.F. R.F. coded	0·60
Q23	10 OA 202 Silicon diodes sub-min	0·60
Q24	8 OA 81 diodes	0·60
Q25	15 IN 914 Silicon diodes 75PIV 75mA	0·60
Q26	8 OA95 Germanium diodes sub-min IN69	0·60
Q27	2 10A 600 PIV Silicon rectifiers IS425B	0·60*
Q28	2 Silicon power rectifiers BYZ 13	0·60
Q29	4 Sil. transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·60
Q30	7 Silicon switch transistors 2N706 NPN	0·60
Q31	6 Silicon switch transistors 2N708 NPN	0·60
Q32	3 PNP Sil. trans. 2 × 2N1131, 1 × 2N1132	0·60
Q33	3 Silicon NPN transistors 2N1711	0·60
Q34	7 Sil. NPN trans. 2N2369, 500MHz (code P397)	0·60
Q35	3 Silicon PNP TO-5 2 × 2N2904 & 1 × 2N2095	0·60
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0·60
Q37	3 2N3053 NPN Silicon transistors	0·60
Q38	5 PNP transistors 3 × 2N3703, 2 × 2N3702	0·60
Q39	5 NPN transistors 3 × 2N3704, 2 × 2N3705	0·60
Q40	5 NPN transistors 3 × 2N3707, 2 × 2N3708	0·60
Q41	3 Plastic NPN TO18 2N3904	0·60
Q43	5 BC 107 NPN transistors	0·60
Q44	5 NPN transistors 3 × BC 108, 2 × BC 109	0·60
Q45	3 BC 113 NPN TO-18 transistors	0·60
Q46	3 BC 115 NPN TO-5 transistors	0·60
Q47	4 NPN high gain transistors 2 × BC 157, 2 × BC 168	0·60
Q48	3 BCY 70 PNP transistors TO-18	0·60
Q49	3 NPN transistors 2 × BFY 51, 1 × BFY 52	0·60
Q50	7 BSY 28 NPN switch transistors TO-18	0·60
Q51	7 BSY 95A NPN transistors 300MHz	0·60
Q52	8 BY 100 type silicon rectifiers	£1·20
Q53	25 Sil. & Germ. trans. mixed all marked new	£1·50
Q54	6 TIL 209 Red LED	£1·20*

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ONLY £1.85p

UNTESTED LIN PAKS

Manufacturers "Fall Outs" which include Functional and part Functional Units. These are classed as 'out-of-spec' from the makers' very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price
ULIC709 =	10 × 709	0·60
ULIC710 =	7 × 710	0·60
ULIC741 =	7 × 741	0·60
ULIC747 =	5 × 747	0·60
ULIC748 =	7 × 748	0·60

C280 CAPACITOR PAK

Containing 75 of the C280 range of capacitors assorted in values ranging from ·01uF to 2·2uF. Complete with identification chart.

FANTASTIC VALUE
ONLY £1·20p.

SIL. G.P. DIODES

300 mW 40 PIV (min) SUB-MIN FULLY TESTED
Ideal for Organ builders

30 for 50p, 100 for £1.50, 500 for £5, 1000 for £9.

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TO18 SIM. TO 2N706/8 BSY27/28/95A

All usable devices. No open and shorts. ALSO AVAILABLE IN PNP similar to 2N2906, BCY 70

20 for 50p, 50 for £1, 100 for £1.80, 500 for £8, 1000 for £14.

When ordering please state NPN or PNP

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30 WATT GERMANIUM TO3 METAL CASE

Vcbo 80V, Vceo 50V, IC 10A, Hfe 30-170 replaces the majority of Germanium power Transistors in the OC, AD NKT range.

1–24	25–99	100+
44p	41p	37p

G.P. 300

115 WATT SILICON TO3 METAL CASE

Vcbo 100V, Vceo 60V, IC 15A, Hfe, 20-100 suitable replacement for 2N3055, BDY11 or BDY20

1–24	25–99	100+
50p	48p	46p

THYRISTORS

*

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	0·13	0·15	—	—	—	—	—	—	—	—
20	0·15	0·18	—	—	—	—	—	—	—	—
30	0·19	0·22	—	—	—	—	—	—	—	—
50	0·22	0·28	0·20	0·25	0·36	0·36	0·48	0·51	0·54	£1·18
100	0·25	0·30	0·25	0·25	0·48	0·48	0·51	0·57	0·58	£1·43
150	0·31	0·38	—	—	—	—	—	—	—	—
200	0·38	0·44	0·25	0·30	0·50	0·50	0·57	0·62	0·62	£1·63
400	—	—	0·30	0·39	0·55	0·57	0·62	0·71	0·77	£1·79
600	—	—	0·39	0·48	0·69	0·69	0·78	0·99	0·90	—
800	—	—	0·58	0·65	0·81	0·81	0·92	£1·22	£1·39	£4·07

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA119	0·08	BY101	0·12	BYZ16	0·41	OA85	0·09
AA120	0·08	BY105	0·18	BYZ17	0·36	OA90	0·07
AA129	0·08	BY114	0·12	BYZ18	0·36	OA91	0·07
AAY30	0·09	BY124	0·12	BYZ19	0·28	OA95	0·07
AAZ13	0·10	BY126	0·15	CG62 (OA91Eq)	0·06	OA200	0·07
BA100	0·10	BY127	0·16	CG651 (OA70-OA79)	0·07	OA202	0·07
BA116	0·21	BY128	0·16	OA5 Short Leads	0·21	SD10	0·06
BA126	0·22	BY130	0·17	OA10	0·14	SD19	0·06
BA148	0·15	BY133	0·21	OA47	0·07	1N34	0·07
BA154	0·12	BY164	0·51	OA70	0·07	1N34A	0·07
BA155	0·15	BYX38/300	0·43	OA79	0·07	1N914	0·06
BA156	0·14	BYZ10	0·36	OA81	0·07	1N916	0·06
BA173	0·15	BYZ11	0·31			1N4148	0·06
BB104	0·15	BYZ12	0·31			1S021	0·10
BY100	0·16	BYZ13	0·26			1S951	0·70

* UNTESTED T.T.L. PAKS

Manufacturers "Fall Outs" which include Functional and part Functional Units. These are classed as 'out-of-spec' from the makers' very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00 =	12 × 7400	0·60	UIC72 =	8 × 7472	0·60
UIC01 =	12 × 7401	0·60	UIC73 =	8 × 7473	0·60
UIC02 =	12 × 7402	0·60	UIC74 =	8 × 7474	0·60
UIC03 =	12 × 7403	0·60	UIC75 =	8 × 7475	0·60
UIC04 =	12 × 7404	0·60	UIC76 =	8 × 7476	0·60
UIC05 =	12 × 7405	0·60	UIC80 =	5 × 7480	0·60
UIC06 =	8 × 7406	0·60	UIC81 =	5 × 7481	0·60
UIC07 =	8 × 7407	0·60	UIC82 =	5 × 7482	0·60
UIC10 =	12 × 7410	0·60	UIC83 =	5 × 7483	0·60
UIC13 =	8 × 7413	0·60	UIC86 =	5 × 7486	0·60
UIC20 =	12 × 7420	0·60	UIC90 =	5 × 7490	0·60
UIC30 =	12 × 7430	0·60	UIC91 =	5 × 7491	0·60
UIC40 =	12 × 7440	0·60	UIC92 =	5 × 7492	0·60
UIC41 =	5 × 7441	0·60	UIC93 =	5 × 7493	0·60
UIC42 =	5 × 7442	0·60	UIC94 =	5 × 7494	0·60
UIC43 =	5 × 7443	0·60	UIC95 =	5 × 7495	0·60
UIC44 ×	5 × 7444	0·60	UIC96 =	5 × 7496	0·60
UIC45 =	5 × 7445	0·60	UIC100 =	5 × 74100	0·60
UIC46 =	5 × 7446	0·60	UIC121 =	5 × 74121	0·60
UIC47 =	5 × 7447	0·60	UIC141 =	5 × 74141	0·60
UIC48 =	5 × 7448	0·60	UIC151 =	5 × 74151	0·60
UIC50 =	12 × 7450	0·60	UIC154 =	5 × 74154	0·60
UIC51 =	12 × 7451	0·60	UIC193 =	5 × 74193	0·60
UIC53 =	12 × 7453	0·60	UIC199 =	5 × 74199	0·60
UIC54 =	12 × 7454	0·60	UIC X1	25 Assorted 74's	£1·50
UIC60 =	12 × 7460	0·60			
UIC70 =	8 × 7470	0·60			

INDICATORS

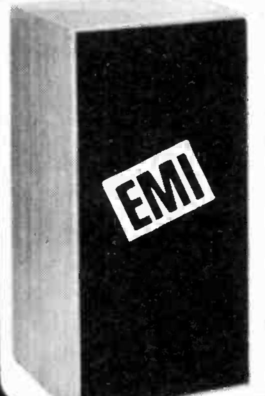
3015F Minitron 7 Segment Indicator £1.11p*
MAN 3M L.E.D. 7 SEGMENT DISPLAY 0.127" High Characters £1·76p*

ZENER DIODES

FULL RANGE IN STOCK
VOLTAGE RANGE 2-33V

400 mw	1·5 w	10 w*
8p	17p	30p

RT-VC FOR SPEAKERS AT FANTASTIC REDUCTIONS



LE-4 SPEAKERS

Superb performance and beautifully finished in selected teak veneers. A professional standard four-way speaker system giving 25 watts RMS power handling. Bass unit is 14"×9" with 8"×5" unit for mid-range and twin 3" high frequency units to give monitor type quality and performance.
Specification – Size 33"×14"×16" approx. Impedance 8 ohms. Power handling 25W RMS. (Peak 50 watts.) Frequency range 35 Hz–20 KHz.

Our Price £34.00 each
(normally £66.00)+£5.80 p & p.
Scotland and the Orkneys
P & P Surcharge £3.50

NEW!

THE 'COMPACT'

EASY BUILD SPEAKER KIT

A compact bookshelf speaker system giving a high electro accoustic efficiency for the low powered amplifier.
The professional finish can be obtained with the minimum of tools, the infinite baffle type enclosures come ready mitred and professionally finished, simply apply glue, fold up around baffle board, and fix together with masking tape till glue dries.
The cabinet measures 12"x9"x5" deep approx finished in simulated teak, incorporating a quality 7"x4" elliptical speaker, power handling 4 watts, flux density 30,000 maxwells, impedance 8-15 ohms nominal, voice coil dia $\frac{3}{4}$" magnet size $2\frac{7}{8}$" approx.

£6.00
pair inclusive P & P £1.70

EMI 350 KIT

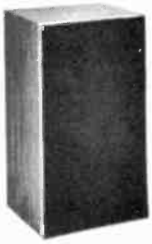
System consists of a 13" × 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

£6.50 +£1.20 p & p.

Complete with crossover Components and circuit diagram

EASY TO BUILD SPEAKER KITS

These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" × 8" woofer, $3\frac{1}{4}$" tweeter and matching crossover.
Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20–20,000 Hz. Size 20" × 11" × $9\frac{1}{2}$" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.



£22.00 pair complete +£5.20 p & p.

Complete with crossover Components and circuit diagram

RT-VC*

NEW!

VISCOUNT IV STEREO SYSTEM

System 1a. £65.00

The new 20+20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls – volume, bass, treble, balance, mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear – for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion @ 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. – 3 millivolts @ 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. – 50 millivolts @ 50 K ohms (R.I.A.A.); 3. 4. 6. Tape Tuner/Aux. – 140 millivolts @ 50 K ohms (flat frequency response); 5. Microphone – 3 millivolts @ 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response**: 25 Hz to 25 KHz @ full rated output. **Signal to noise ratio**: better than –50 dB on all inputs. **Tone control range**: Bass ±15 dB @ 50 Hz; Treble ±12 dB @ 10 KHz. **Power requirements**: 200-250V A.C. mains @ 60 watts. **Approx. size**: $15\frac{1}{4}$" × 3" × 10".
MP60 type deck with magnetic cartridge, de luxe plinth and cover.
Two Duo Type IIa matched speakers – Enclosure size approx. $19\frac{1}{2}$" × $10\frac{3}{4}$" × $7\frac{3}{4}$" in simulated teak. Drive unit 13" × 8" with 3" tweeter. 15 watts handling. 30 watts peak.
Complete System with these speakers £65.00 +£6.50 p & p.

System 2. £81.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers – Enclosure size approx. 27" × 13" × $11\frac{1}{2}$". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range – 20 Hz to 18,000 Hz.
Complete System with these speakers £81.00 +£7.60 p & p.

PRICES: SYSTEM 1a
Viscount IV R103 amplifier £25.00+£1.90 p & p.
2 Duo Type IIa speakers £30.00+£6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £20.00+£3.30 p & p.
Total if purchased separately: £75.00
Available complete for only: £65.00 +£6.50 p & p.

PRICES: SYSTEM 2
Viscount IV R103 amplifier £25.00+£1.90 p & p.
2 Duo Type III speakers £46.00+£7.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £20.00+£3.30 p & p.
Total if purchased separately: £91.00
Available complete for only £81.00 +£7.60 p & p.

20x20 SYSTEM

Scotland and the Orkneys P & P Surcharge
System 1a £1.75 System 2 £3.50

PE

MICRO MASTER MINDS

When one hears lavish claims made in respect of some contemporary development in technology and predictions concerning its likely profound effect upon life in general in the future, one tends to be a little cautious and tries to avoid the temptation to get "carried away". This *may* or *may not* be a milestone in the making. Time alone will tell. Yet in the face of known facts, it is hard to resist the thought that a new chapter in electronic expansion is upon us, *right now*. Certainly it is evident that the total domination of machinery—in the widest sense of the word—by electronic control and supervisory systems has become much closer to reality with the arrival of the microprocessor. This device—virtually a minicomputer of great programming flexibility which may be contained within just four l.s.i. packages—appears to offer the key to the widespread and uninhibited use of powerful computing systems. It is a force to be reckoned with, and we endeavour to put readers in the picture with a special introductory article which commences this month.

U.S. semiconductor manufacturers are now producing, between them, a variety of different microprocessors. These devices have already been installed in aircraft; more recently they have been incorporated in advanced types of oscilloscopes, and now the search for additional areas for their profitable and useful employment is on. Other actual, or seriously proposed, applications range from automated industrial plants to sewing machines; from automobiles to washing machines; and from bowling alleys to vending machines.

Was it clever timing by the microprocessor makers or was it just chance that these devices made their first appearance during the onset of the present fuel and energy crisis? Certainly conditions at this time are very propitious for any device or system that will enable greater mileage to be obtained from a gallon of petrol—to say nothing of reducing the amount of pollution. There can be little doubt that microprocessors will be built into cars of the future.

Exciting, and full of promise all this may be—yet we have to end on a despondent note. What are the British semiconductor manufacturers doing about microprocessors? Very little it seems.

ENGINE ANALYSER

Until the day when we all drive computerised motor cars, we have to motor-on as best we can in face of ever-increasing fuel costs and garage servicing charges. Yet some assistance is here at hand—this month—for all our motorist readers. Through prevailing economic conditions more and more private motorists are being forced to do their own car maintenance. Here electronics can offer aid in the very practical form of a piece of test equipment known as an Engine Analyser. Constructors who run a car will be wise to make the PE Engine Analyser the first job they tackle this autumn, as the major and busiest season for home construction gets under way. This instrument could repay its cost many times over in the months ahead.

F.E.B.

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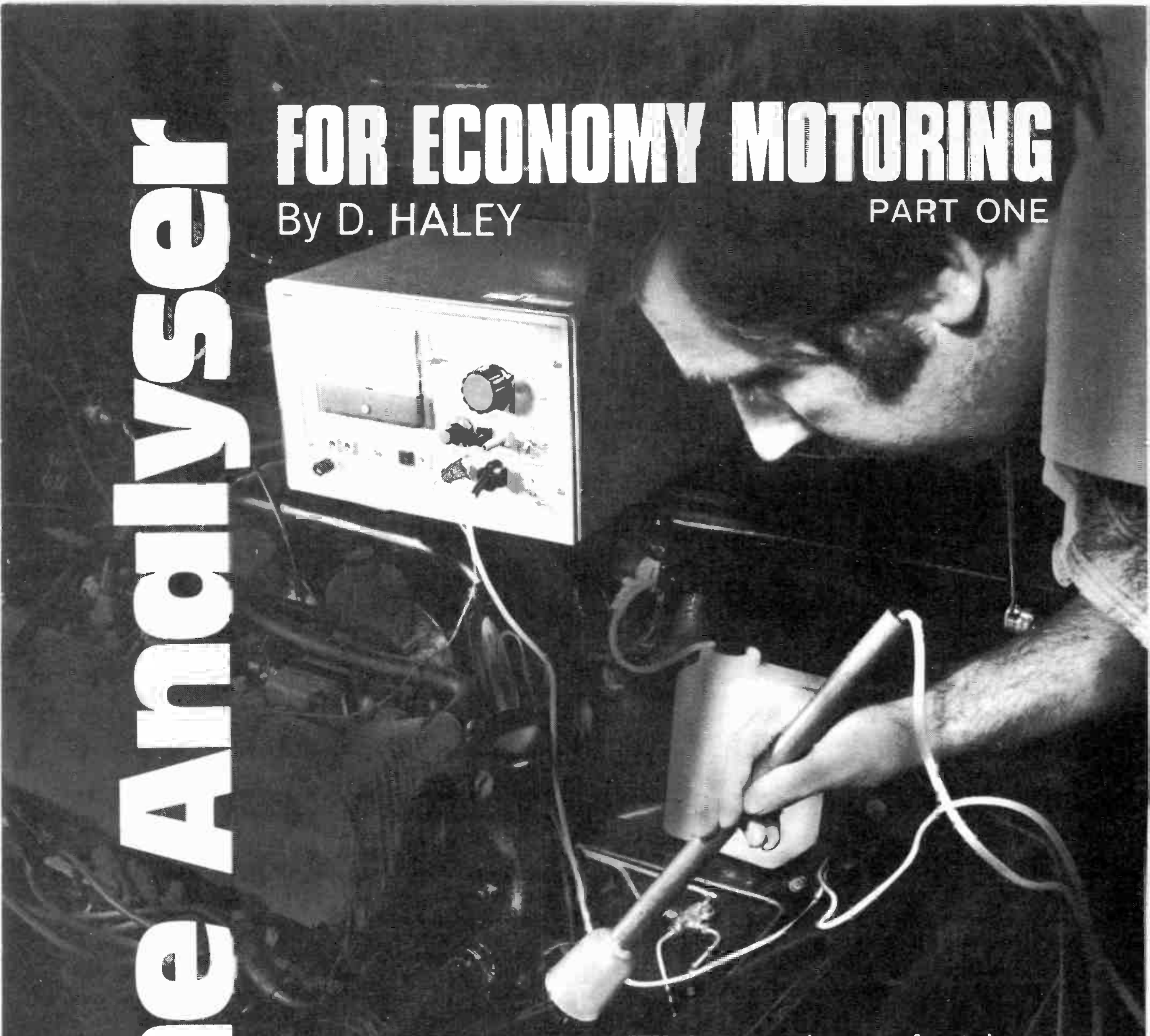
PE Engine Analyser

FOR ECONOMY MOTORING

By D. HALEY

PART ONE



WITH the ever soaring costs of motoring more and more people are turning to do-it-themselves servicing of their own motor cars. Whilst much of this servicing can be carried out with the aid of a handbook and a few tools, the electrical components need a more sophisticated approach. The P.E. Engine Analyser described in this series of articles is designed for people with electronics as their hobby, who also wish to service their own car. The unit is quite simple and should not be any trouble to readers of this magazine. It is much simpler than the equipment garages use, but it is a lot cheaper, very easy to use and relatively easy to build. The cost of building the equipment can probably be recovered by hiring the Analyser, for a nominal charge, to friends and neighbours.

The Engine Analyser provides in one box a number of facilities to optimise the efficient and economical running of a car engine. Later, details are given for setting up procedures but for now a brief rundown of the functions provided will be given.

IMPORTANCE OF TIMING

Improper ignition timing may cause overheating, loss of power, poor acceleration and performance and may even shorten the life of an engine. It is for these reasons that accurate timing adjustment at the correct r.p.m. is vital. In the Analyser this is achieved with a very bright Xenon flash which allows timing to be achieved even in bright sunlight.

The dwell angle is the angle through which the distributor shaft turns while the points are closed and current is able to flow through the coil primary. Normally the points are 50 per cent closed and 50 per cent open, however when dwell time is specified there is no need to use feeler gauges, just set to the correct reading on the dwell meter to ensure maximum efficiency.

The voltmeter and ohmmeter is extremely useful for fault location and regulator adjustment.

The Analyser need not lay idle between services, since it may also be used as a batter charger. Frequent starting of the engine, with short journeys, will reduce the life of a battery. This can be offset with frequent topping-up by the charger. Two charging rates are provided.

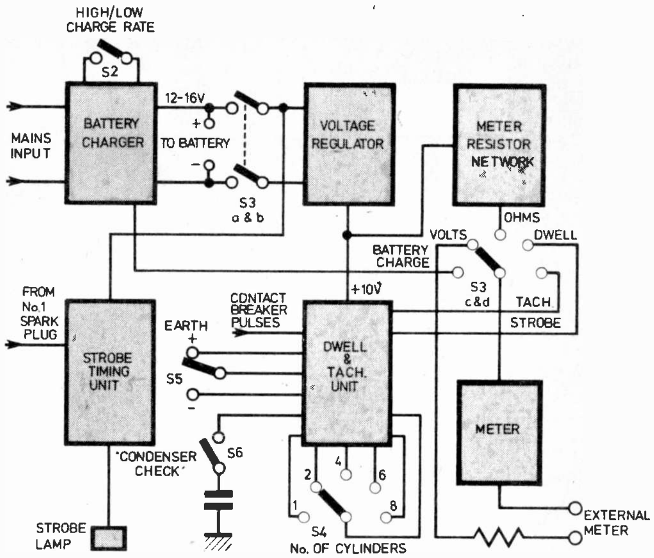


Fig. 1.1. Block diagram of Engine Analyser

BLOCK DIAGRAM

A block schematic diagram of the Engine Analyser is shown in Fig. 1.1. A battery charger transformer and bridge rectifier provide full wave rectified output at 12V for charging the battery at 4A. The rectifier can also be switched to half wave for a low charge of 2A. The 12 volt output can also be used to drive the Engine Analyser circuits or if mains supply is not available, these will work equally well from the car battery.

A voltage regulator circuit is included to regulate the supply to the circuits at 10 volts, so that outputs and meter calibrations will remain constant.

SPECIFICATION . . .

- **Ignition timing** — By strobe lamp fired from inductive coupling to No. 1 spark plug lead.
- **Tachometer** — 0 to 2500 r.p.m. on 1, 2, 4, 6 or 8 cylinder engines.
- **Dwell measurement** — 10 per cent to 80 per cent at 1000 r.p.m.
- **Ohmmeter** — 0 to 1000 ohms. 150 ohms centre scale.
- **Battery Charger** — 12 volt 4A (High rate) or 2A (Low rate) or 6 volt 4A (High rate) or 2A (Low rate).
- **Voltmeter** — 0 to 25 volts d.c. ± 5 per cent f.s.d.
- **Condenser check** — 0·22 μF condenser is substituted across contact breaker.
- **Power input** — 240V a.c. at 50Hz or 12–16V d.c. at 1A.

The meter is switchable to the various functions as indicated in Fig. 1.1. The "Volts" and "Ohms" positions connect in circuit the necessary resistor networks for meter calibration. On battery charge the meter is connected across a shunt in the negative lead to read charging current from 0 to 5A.

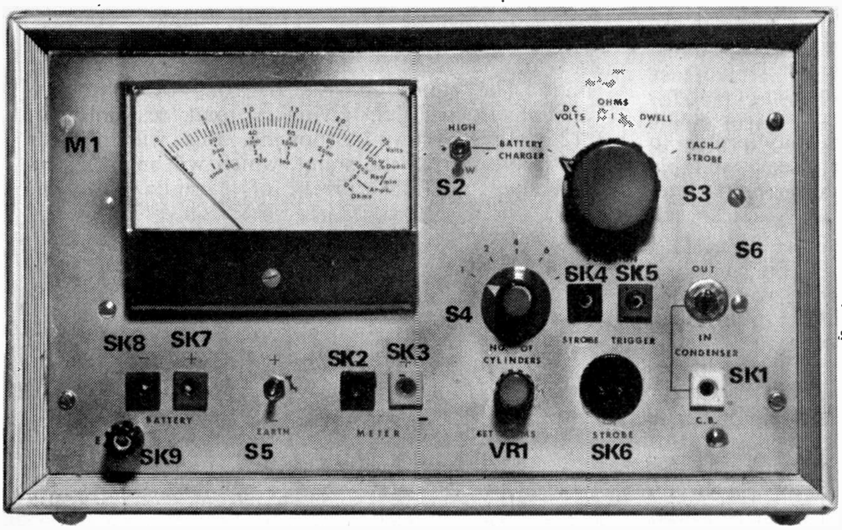
The dwell and tachometer unit derives its information from the contact breaker pulses. Dwell is metered by cleaning up the contact breaker pulses and applying them to the meter to give a reading proportional to the "contacts closed" period. For tachometer readings, standard pulses are produced from the c.b. pulses, which give a meter reading proportional to their repetition rate.

The strobe timing unit produces a high voltage supply and triggering for a stroboscopic discharge lamp. When triggered from No. 1 spark plug, the lamp is used to illuminate the timing marks on the engine and fan belt pulley while the engine is running. The stroboscopic light pulse freezes the motion of the engine at the instant of firing of No. 1 cylinder, enabling the timing to be checked under dynamic conditions.

CONTROL PANEL

The photograph shows the control panel of the finished instrument. The meter is a 0—1mA moving coil meter with scale length just over 3 inches. There are five calibrated scales to indicate d.c. volts (0 to 25), dwell angle (0 to 100 per cent), r.p.m. (0 to 2500), amps (0 to 5) and ohms (0 to 1000). The dwell scale is calibrated in per cent rather than angle in order that the same scale shall apply for all types of engine. The maximum angle varies with number of cylinders, but the circuit is designed to produce deflection proportional to dwell angle for all engines.

Below the meter are two pairs of sockets. The pair marked "Battery" are for use in either charging the battery from the mains or powering the instrument from the car battery. The other pair,

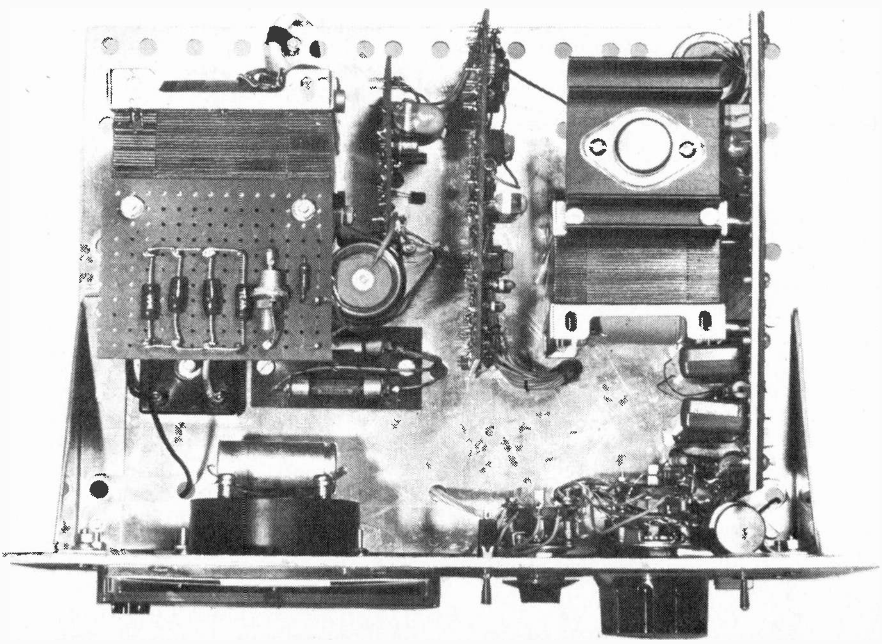


The Engine Analyser front panel showing layout of controls and sockets

marked "Meter" are for use for voltage and continuity or resistance tests. The switch between the two, marked "Earth," should be set to whichever of the two battery terminals is connected to car chassis. The earth terminal (E) is provided to connect instrument chassis to car chassis.

The five position selector switch S3 on the top right hand side of the panel, switches the meter to the appropriate circuit and also switches power to the circuit boards when required. Associated with the battery charger is a "High/Low" charge rate switch which allows a low rate (2A) for overnight charging, or to limit initial charge current into a flat battery. The "No. of Cylinders" switch adjusts the r.p.m. and dwell circuits for the type of engine under test. "Set Ohms" is adjusted so that the meter reads zero on ohms setting with the two meter leads shorted together. The strobe socket connects to the strobe lamp unit and the two trigger sockets above it to a small coupling coil, L1, for picking up a trigger pulse from No. 1 spark plug lead.

Finally, the c.b. socket in the bottom right hand corner is for connection to the contact breaker terminal on the ignition coil. Associated with this socket is a standard ignition condenser which can be switched into circuit by the switch above the socket, thus enabling a test to be made for a faulty condenser.



FRONT PANEL AND CHASSIS ASSEMBLY

The actual front panel dimensions and layout can be varied slightly to suit the particular case to be used. An R.S. Type 1 was used in the prototype. Since the case is about the most expensive single item in the kit, many constructors may prefer to build their own wooden case, or use a suitable housing already to hand. The components and printed circuit boards are mounted on a flat chassis 9$\frac{1}{4}$in × 7$\frac{1}{2}$in (235 × 190·5mm) fixed to the rear of the front panel by two right-angled brackets.

A photograph shows the chassis layout, and the circuit diagram for the main wiring is shown in Fig. 1.2. The mains transformer, T1, is mounted at the rear left hand side of the chassis, with the bridge rectifier and fuse-holder in front of it. To obtain the half charge rate, a diode D1 is connected in series with the bridge, on the a.c. side, converting the rectifier to half wave. D1 is a stud type power diode, and is mounted on one a.c. terminal of the bridge rectifier by means of a solder tag on its stud terminal. For high charge the diode is short circuited by the charge switch S2.

The positive output of the bridge rectifier connects through a 5A fuse to the battery positive socket, and to the last 3 positions, ("Ohms," "Dwell" and "Tach/Strobe") of one section of the four pole, five way selector switch S3. The negative output is similarly connected to the battery negative terminal and another section of S3, through the ammeter shunt. The shunt consists of four 0·5 ohm 3W resistors in parallel, giving a total resistance of 0·125 ohms. With 5A flowing, this will produce 0·625 volts across the shunt, which will in turn produce the full scale current of 1 milliamp in the meter and its series resistor R5. This voltage will also just bring D6 to the point of conduction, which will limit any excessive overload of the meter due to currents greater than 5A. The meter shunt and series resistors and the protection diode are mounted on a small piece of Veroboard which is bolted to the top of the mains transformer, and the meter is connected through position 1 of the remaining two sections of S3. This completes the battery charger section of the circuit. 5A capacity wire must be used for wiring the bridge rectifier and battery sockets.

D.C. VOLTMETER

On position 2 of the function switch the meter is connected to the external meter sockets via two series resistors R8 and R9, to give a 25 volt d.c. measuring facility. The value of R8 may need to be selected to suit individual meters. R8 and R9 are mounted on the rear of the selector switch S3, using

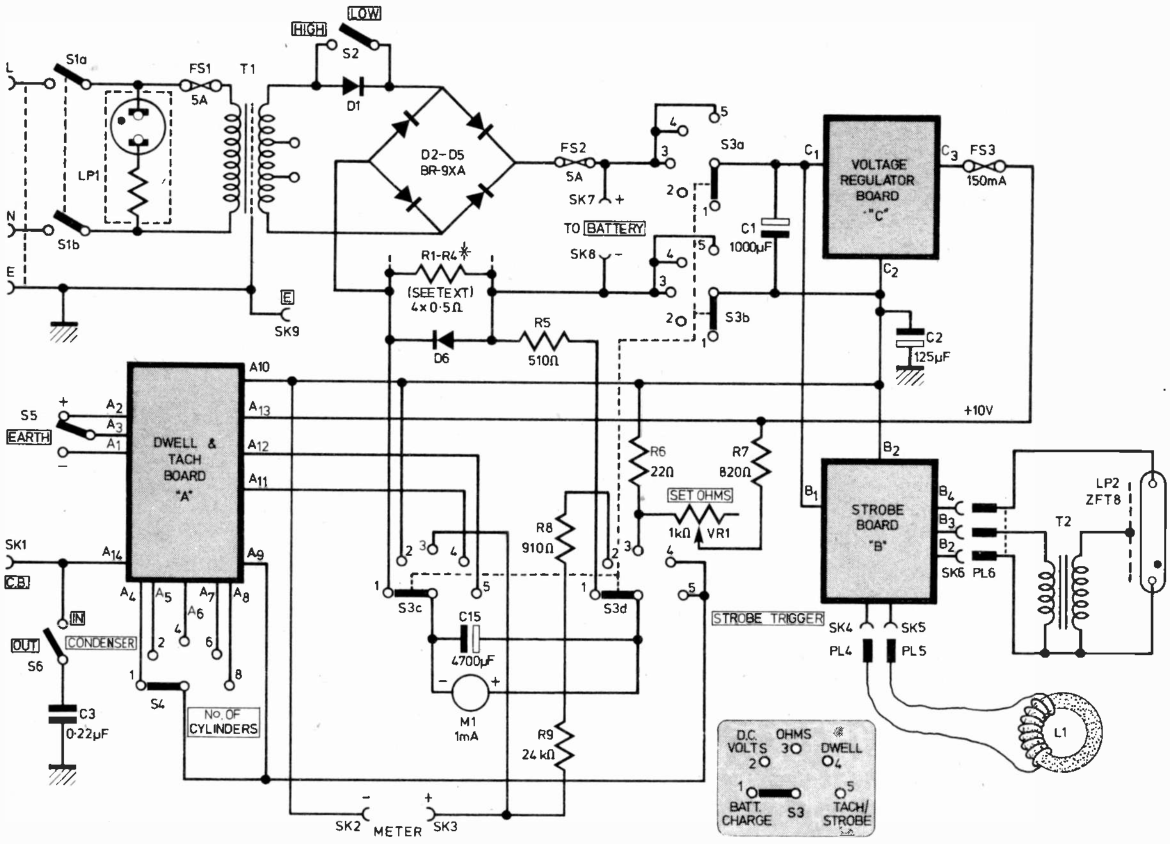


Fig. 1.2. Main wiring for Engine Analyser. Note that in the prototype S1, FS1 and LP1 are omitted

a spare tag for the junction. The remaining circuits require a d.c. power supply which will be described next.

POWER SUPPLY REGULATOR

Changes in engine speed will cause variations in generator voltage and hence the voltage appearing across the battery may be anything between 12·5 and 16 volts. As this will affect meter zero and calibration settings it is necessary to stabilise the supply for changes in battery volts. A simple series regulator circuit is used to produce a 10V 50mA regulated supply from the 12—16V input.

Fig. 1.3 shows the circuit diagram. A proportion of any variation in the output voltage is applied to the base of TR2, the emitter being held constant by the reference potential on the base of TR1. The amplified error voltage at the collector of TR2 is applied to the base of series regulator transistor TR3, the phasing is such as to reduce the variation at the output, changes in input voltage are compensated by a corresponding change in the voltage drop across TR3. This circuit is built on a piece of printed circuit board 2¾in × 2½in at 0·1in (69·85 × 63·5) pitch, with component layout as shown in Fig. 1.4. The assembled board is mounted by two small brackets on the chassis, adjacent to the mains transformer.

There are two electrolytic capacitors, C1 and C2, which are mounted separately from the board. C1 is bolted by a cleat to the side of the mains transformer and C2 is connected between the negative supply and chassis (positive terminal to chassis).

COMPONENTS . . .

Resistors

R1–R4	0·5Ω 3W (4 off)	R20	1·8kΩ
R5	510Ω	R21	2·2kΩ
R6	22Ω	R22	120Ω
R7	820Ω	R23	330Ω 5W
R8	910Ω	R24	15kW 9W
R9	24kΩ	R25	1MΩ
R10–11	240Ω	R26	1·2kΩ
R12	2kΩ	R27	150kΩ 1W
R13	3·3kΩ	R28	470Ω
R14	10kΩ 2%	R29	820Ω
R15	22kΩ 2%	R30	270Ω
R16	16kΩ 2%	R31	2·2kΩ
R17	4·7kΩ 2%	R32	1kΩ
R18	3·3kΩ 2%	R33	1kΩ
R19	2kΩ 2%		

All ½W except where otherwise stated.

Potentiometers

VR1 1kΩ
VR2 1kΩ } All linear
VR3 3·3kΩ

Capacitors

C1	1000μF elect. 25V
C2	125μF elect. 25V
C3	0·22μF
C4	0·1μF
C5	0·1μF
C6	1μF polyester
C7	16μF elect. 10V
C8	1·5μF polyester
C9	1μF polyester 400V
C10	1μF polyester 400V
C11	1μF polyester 400V
C12	0·1μF
C13	1000μF elect. 25V
C14	2·2μF polyester
C15	4700μF elect. 6V
C16	0·047μF

Transformers and Inductor

T1 240 pri. 12V sec. — Douglas battery charging transformer.
T2 TT51B (Henry's Radio)
L1 Trigger coil (see text) wound on Ferroxcube ring FX1588 (Home Radio)

Semiconductors

TR1–2	BC184 (2off)
TR3	2N3053
TR4	2N3055
D1	10A 100V
D2–D5	70V, 6A type BR-9XA
D6	10A 100V
D7	BZX85-5·1V 1·3W Zener
D8	BZY88-8·2V 400mW Zener
D9	BZY88-5·1V 400mW Zener
D10	1N4006 (800V rectifier)
D11	1N4006 (800V rectifier)
D12	150V 1W Zener
D13	BZX85-5·1V 1·3W Zener
CSR1	C106B silicon controlled rectifier (Henry's)
IC1	SN74121N
IC2	SN7402N

Switches

S1 Double-pole mains on/off
S2 S.p.s.t. toggle
S3 4-pole 5-way (made up of 2-pole, 6-way break-before-make wafers) (2 off) (R.S.)
S4 Single pole, 5-way
S5 S.p.c.o. toggle
S6 S.p.s.t. toggle

Xenon Tube

LP2 ZFT8 (Henry's Radio)

Meter

M1 1mA SEW model SD830

Miscellaneous

FS1/FS2–5A fuses, FS3–150mA fuse, fuseholders (2 off) p.c.b. 3in × 2·4in × 0·2in (76·2 × 60·96) (main chassis), p.c.b. 2·6in × 2·7in × 0·1in (66·04 × 68·58) (10V regulator), p.c.b. 2·7in × 4·8in × 0·1in (68·58 × 121·92) (tach. and dwell), p.c.b. 6·4in × 3·4in × 0·2in) (162·56 × 86·36 × 5·08mm) (ignition timing) Veropins (31 off), 14 pin d.i.l. i.c. sockets (2 off), brackets: 2¼in × 3½in (2 off) (57·15 × 88·9mm) (main chassis), (½in × ⅜in × ⅜in) (Lektrokit LK2321) (2 off) (tach. and dwell), paxolin tube for strobe 12in × 1in (304·8 × 25·4mm), Case-Type 1 instrument case (R.S.) SK2, SK3, SK4, SK5, SK7, SK8, SK9–4mm sockets (R.S.) (7 off). SK6, miniature socket (R.S.)

Its purpose is to complete the circuit for the contact breaker pulses to the dwell and tachometer circuits. The input to the voltage regulator board connects through the last 3 positions of S3a and b. A 150 milliamp fuse is connected in the 10 volt output line.

CONTINUITY METER

Position 3 of the function switch connects the meter for resistance and circuit continuity measurement. R6, R7 and VR1 ("Set Ohms") are connected across the 10-volt regulated supply, and VR1 adjusted so that with the meter leads short-circuited, full scale deflection (zero ohms) is produced. R6 plus the internal resistance of the meter should give a total source resistance of 150 ohms. To check the calibration, set the zero control, and connect a 150 ohm resistor across the meter sockets, and the meter should read half scale. If not, a different value may be selected for R6, and the check repeated. If the reading is too high, reduce R6 and vice versa. When using the continuity tester on car wiring, the battery should be disconnected from the car to prevent possible short circuit or erroneous readings.

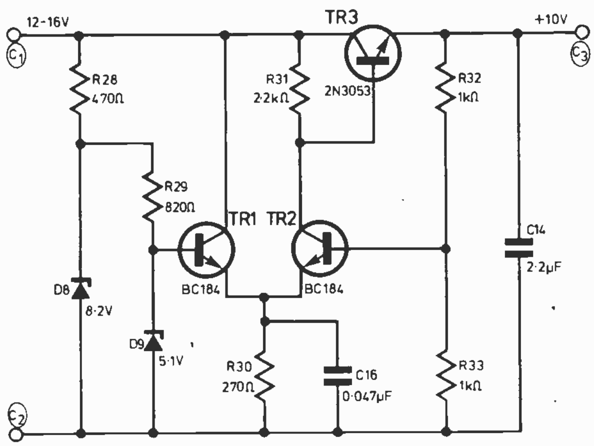


Fig. 1.3. Circuit of Voltage Regulator Board 'C'

CONTACT CONDENSER

The test ignition condenser, C3, may be conveniently mounted by its flange to the chassis bracket bolt above the switch and contact breaker socket. A test for faulty condenser can be made by simply closing the switch. This completes the assembly of the static test circuits. In the next article we shall deal with the dwell and tachometer measurements.

CARS WITH 6 VOLT BATTERY

The engine analyser may be used on a car with a 6 volt system, provided it is supplied from 240 volt mains, or an independent 12 volt battery. If 6 volt battery charging is required, the a.c. input to D1 and the bridge rectifier must be moved to the 6 volt tappings on the mains transformer secondary. This bridge will not then give sufficient d.c. output to supply the circuits, and an additional 25 volt, 1A bridge rectifier must be connected across the 12 volt tappings. The input connections to S3a and S3b must be removed from the "Battery" sockets and taken to the d.c. output terminals of this second bridge. There may also be a change necessary in the dwell and tachometer circuit, and this will be mentioned when the circuit is described.

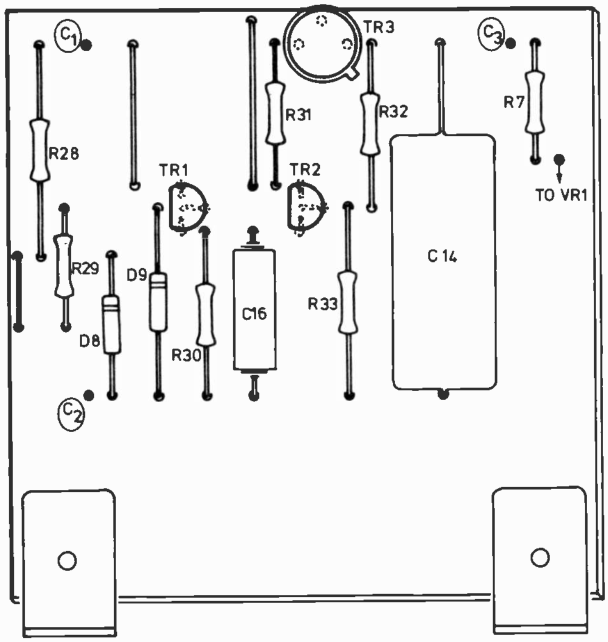


Fig. 1.4. Component layout and track cutting details for Board 'C'

NEXT MONTH: The remaining circuits involving dynamic engine tests

ASSEMBLING THE SABCHRON L.E.D. WRISTWATCH KIT

If you want to be really with it, no doubt the digital watch is the thing of the moment. But, before you rush ahead and buy that expensive kit, make certain you have both the tools and the skill needed to undertake this deceptively simple task.

ANYONE with an interest in electronics will have noted the trend over recent years towards miniaturisation of almost everything. We have gone from large to small radios, computers and pocket calculators at an ever-increasing pace.

The latest development is the truly electronic watch. Made possible by the development of c.m.o.s., with its low power consumption and compact packaging density, this concept has in two short years managed to go from development prototype to kit construction in one of the fastest development curves in our exploding technology.

Various watches are coming on to the British market but these are mostly in the ready-made form and the prices are a little awe-inspiring to the would-be owner. For example there is one rather large item which boasts solar power and the ability to cope with both normal and leap-year counting once set. This is available at around £300.

At the other end of the scale at the time of writing there is a fairly simple ready-built unit which is capable of indicating merely hours and minutes, with a flashing hyphen to give some idea of seconds. Apparently such a device can be obtained for around £50.

Of course all these equipments come from overseas at this time and so they are subject, in price terms, to the vagaries of international financial adjustments, usually to the British purchaser's detriment, so it is heartening to see a kit appearing on the market with an associated lower cost.

Euray Trading Inc. of Dallas have started to advertise a kit for a watch which incorporates most of the features the non-specialist would need. Called the Sabchron Digital, the watch offers the ability to indicate, on one depression of a small button in its side, hours and minutes, the month and day numbers on a second depression, and minutes and seconds if the button is initially held down for three seconds.

THE SABCHRON

Using an l.e.d. display with up to four digits and housed in an attractive case of only slightly larger than a normal wrist-watch thickness dimension, the Sabchron when completed is certainly a reasonable project to undertake.

This kit makes use of current m.o.s. l.s.i. technology in the form of one small 24-lead chip which houses all the logic and basic electronics. The display is only switched on for a matter of seconds after the operating the main push-switch and is, in addition, strobed to reduce power consumption. Battery life is claimed to be about one year.

An additional function is the automatic control of l.e.d. brilliance dependent on ambient light. This is achieved by using an l.d.r. (light-dependent resistor) positioned inside the case to measure the amount of light falling on the display. This feature is optional.

CIRCUIT DESCRIPTION

The component count is kept fairly low by designing the integrated circuit in such a way that it is capable of driving the display directly rather than through driver transistors as can be seen from the general block circuit diagram of Fig. 1. Here the layout is for drafting convenience, obviously the i.c. pin numbers follow in order on the board used, as seen from Fig. 2 and Fig. 3.

The built-in oscillator circuit (input at pins 16 & 17) works in conjunction with the quartz crystal, C1, C2 and C3. The trimmer capacitor, C3 is included to adjust for accurate frequency. C1 and C2 are included to further stabilize the frequency, but the circuit would work without them. However, it is recommended that they be used. The oscillations are counted and divided by the i.c.

Power for the complete circuit is supplied by silver-oxide $1\frac{1}{2}$V cells, B1 and B2. The l.d.r. varies the current available to the display drive circuitry. The l.d.r. resistance increases in bright light, permitting more current flow to this circuit, in total darkness, the resistance increases to reverse the effect.

Outputs from the i.c. are provided through pins 2, 3, 4, 5, 6, 7, 8, 19, 20, 21 and 22 for driving the display, thus omitting the need for additional driver transistors. Time display is made via S2 on an on-demand basis to conserve battery power. Internal logic elements within the i.c. keep the display lighted for about 1 to $1\frac{1}{2}$ seconds after demand is made. The logic elements are always powered and driven; only the display is on-demand. Since the i.c. draws only 18 μW of power, the two silver-oxide cells will last up to one full year or more, depending on how frequently display demand is made.

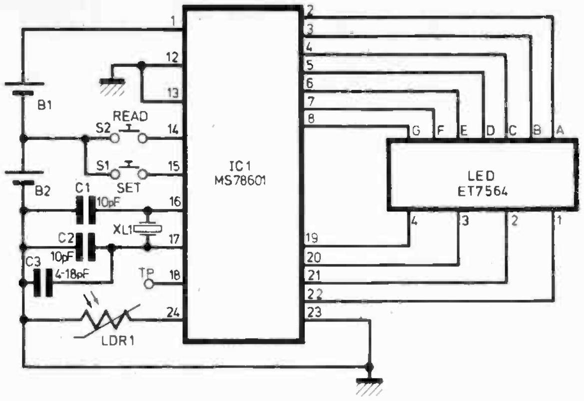


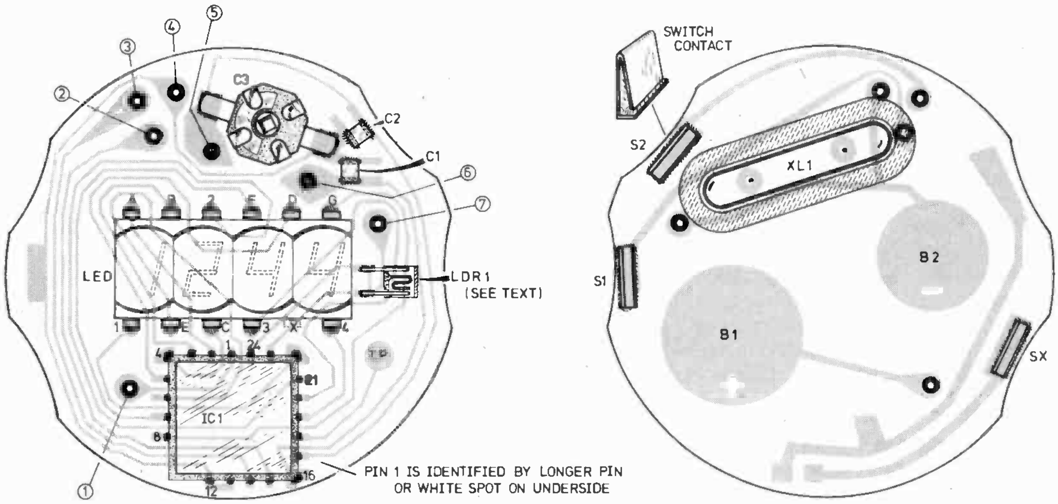
Fig. 1. Circuit diagram of the Sabchron digital wristwatch

Once the complete watch is assembled, operation is simple and uncomplicated. Depressing S2 once, displays the hours and minutes. Keeping S2 depressed after that, causes the minutes and seconds to be displayed. Depressing S2 twice in succession causes the month and date to be displayed, in that order (e.g. a display of 1204 indicates the 12th month and 4th day of the month). This is the way dates are written in the United States.

PRECAUTIONS

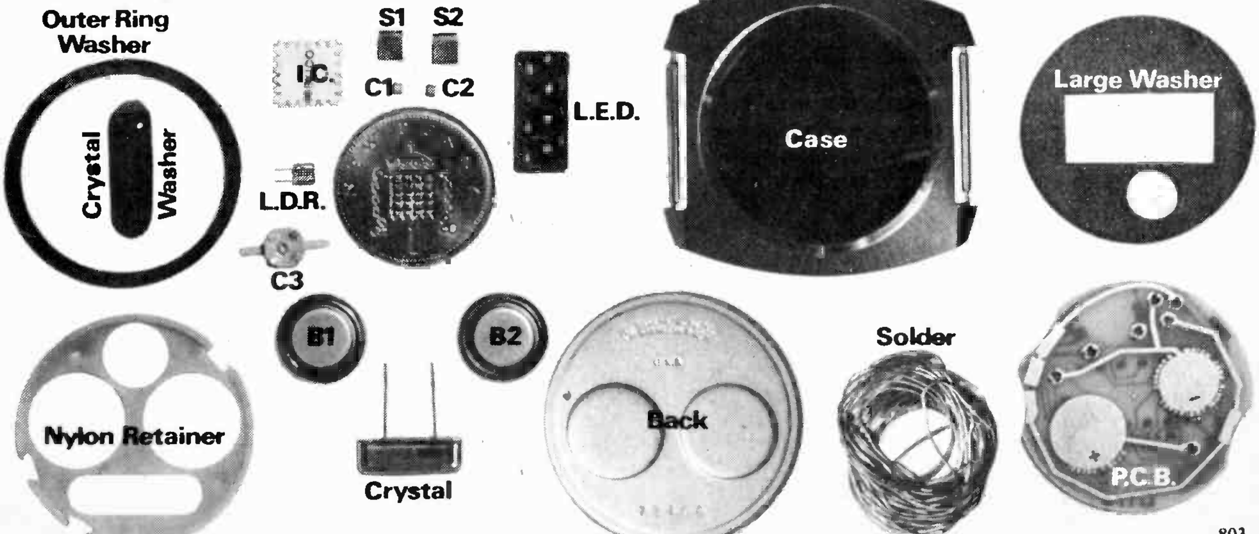
Before any construction at all is considered there are several precautions which need to be taken.

First of all there is the question of skill level required. No doubt someone with a reasonably mechanical bent could cope if he followed the instructions painstakingly and laboriously. However, as both miniature soldering and the handling of an m.o.s. l.s.i. in involved there is considerable risk of damage to the product in the process.



Figs. 2 and 3. Components mounted on the double-sided printed circuit board

Components...



Thus it would be advisable that a prospective constructor have at least some experience with quite small soldering problems and the handling of c.m.o.s. with its attendant danger of electrostatic damage.

TOOLS

Then there is the matter of suitable tools. No doubt most enthusiasts have a fairly miniature iron but here it is really necessary for the bit to be smaller than 3/64in diameter, so for many this will involve the purchase of a suitable iron and miniature bit. In fact a pointed rather than a chisel end might be found more suitable.

The kit calls for a plastic tweezers but, as anyone who has tried to purchase a pair will know, there are very few around so it behoves one to make them as the writer did.

Finally, there is provision for speed adjustment through a tiny trimmer capacitor which has to be set using a very small square socket tool. To the best of our knowledge there is no version of this available in the U.K., so one will have to be made.

With these thoughts in mind and dealt with one way or another construction can be considered.

THE KIT

The Sabchron kit comes complete with quite comprehensive instructions and all the parts carefully packaged in small plastic bags. The first words on the instructions say "Read before starting assembly" and we heartily endorse this. Currently there is also some Addenda material which bears similar careful scrutiny.

First of all the watch specification is discussed and then a list of required tools is noted. Here it might be sensible to add a pair of small snipe-nosed pliers and a pair of side cutters for holding small objects and cutting leads to length respectively.

KIT INSTRUCTIONS

As in most kits, the instructions are written in a numbered step-by-step sequence which any constructor will find easy to follow. The only steps which might cause some baulking are those concerned with a repetition of a series of resistance checks which, on the face of it, seem unduly laborious. However, they are none-the-less absolutely necessary.

Starting from an untouched p.c.b., the first stage involves a decision to use the optional light level control for the l.e.d.s. If one decides, as we did, to make use of this facility then a small section of track shorting the location of the l.d.r. has to be removed.

FIRST SOLDERING

The board is double-sided, with interconnection between the sides provided by so-called "bif" rivet. These have to be soldered to both sides of the board and in fact this step provides good practice in handling the small iron before more important components are attached.

After this first soldering exercise a series of continuity tests is carried out between both sides of the board and various pads for the i.c. and l.e.d. to ensure proper soldering and no damaged tracks. This and similar checks are very important and should not be skipped no matter how convinced of one's soldering ability one might be. Any fault now can become very embarrassing later.

FIDDLY BITS

Probably for many, the hardest task will be the next step, involving attaching two tiny capacitors in the oscillator circuit.

Again, the use of these components is optional in that without them the watch maintains a claimed accuracy of 3 minutes per year whilst with them this figure can be considerably bettered.

Two points come up at this time. One is the use of so-called reflow soldering in which both parts of a joint are first tinned and then subsequently placed together, heated and thus bonded. The second is the nature of the solder compound used in the tiny chip capacitor which, in the prototype, appeared to be a somewhat pasty material when heated, rather than a free-flowing solder. Thus it behoves the constructor to apply solder to the capacitor joints when making them rather than relying only on the solder on the capacitor themselves as is suggested in the instructions.

The trimmer, C3, comes with longer leads than necessary and these need trimming to suit the board prior to tinning, a step not mentioned in the instructions.

Handling the tiny C1 and C2 capacitors is quite a problem and the writer found that any excess of pre-tinning on the board copper caused them to lie at odd angles when assembling before soldering. A bit of solder wick is handy in this case for removing excess solder, but probably some extra solder will be needed to obtain a good bond. In fact, in a second assembly operation no pre-tinning was done and this was found to be an easier operation.

After assembling the capacitors, the l.d.r. is soldered on, taking care to watch orientation both in terms of the exposed side of the tiny chip and in terms of orientation with respect to the edge of the board as the l.e.d. display has to be subsequently assembled in the centre of the board.

CONTINUITY CHECKS

At this point a comprehensive continuity check is carried out and again one must emphasise that this step is imperative since the next steps involve mounting the rather sensitive circuitry which, if some lines are not connected or are shorted, can be damaged on applying power.

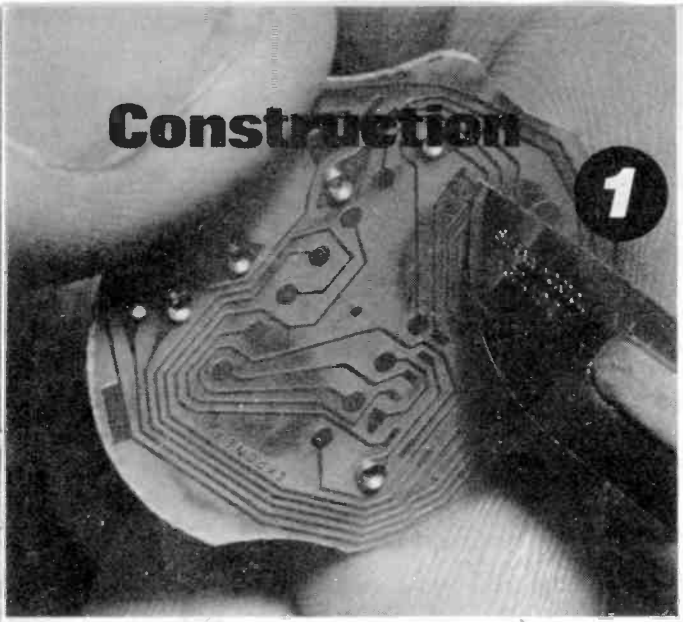
CRITICAL STEPS

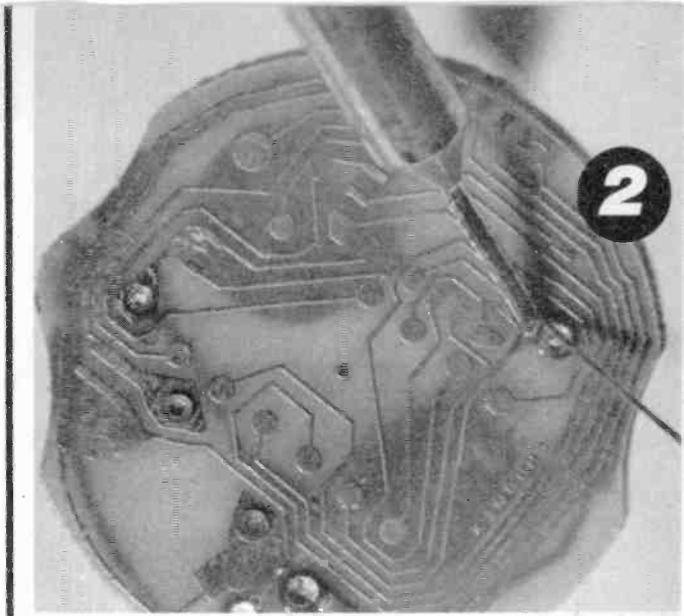
Now we come to the trickiest part of the assembly. Tricky because even if damage is done to the i.c. you will not know till you power the watch. And it is very easy to do damage because of static electricity. Thus the suggestions as to earthing everything to a common earth are most important. This is dealt with in the instructions in some depth.

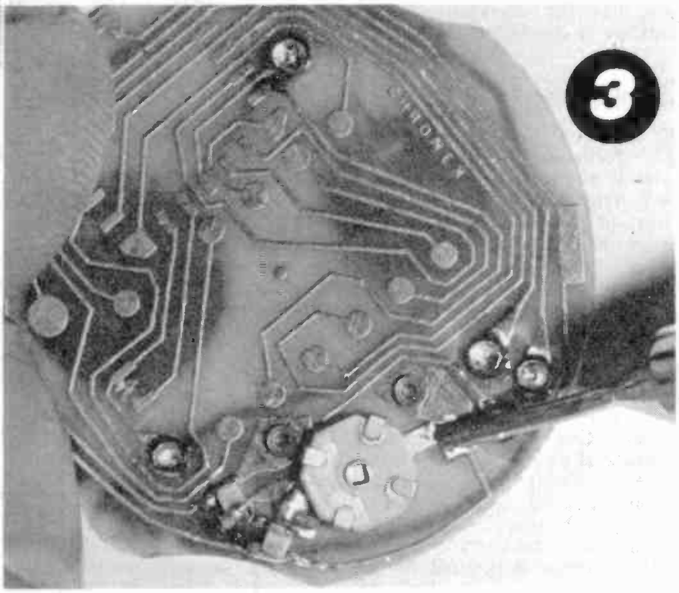
The writer used a normal desk for assembly, overcoming the earthing problem by using two sheets of aluminium foil to work on. Wearing cotton clothes (nylon can create a great deal of static electricity, and working with bare arms on the working surface at all times makes certain both you and the tools are grounded.

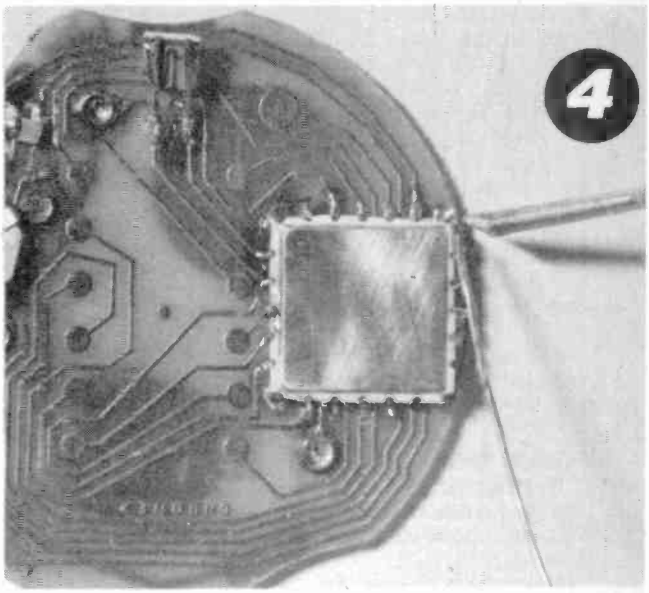
The soldering iron must be connected to this ground surface and it is advisable, when handling the i.c., to keep it insulated from every thing until the soldering is done. The writer applied the first solder joints to the chip whilst the p.c.b. was resting on a sheet of cardboard on the aluminium foil and

Construction









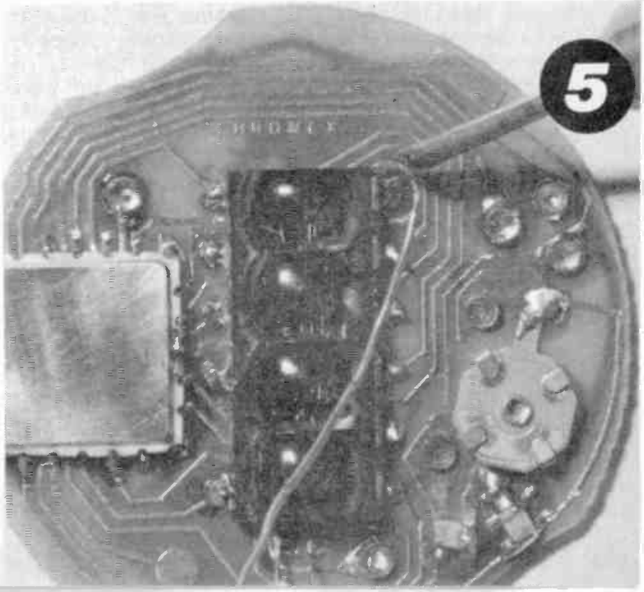
1 — Cutting the l.d.r. shorting strip out (Step. 1)

2 — Soldering the BIF rivets to provide the conductive path through the board (Step. 2). An Antek 15W iron with a No. 6 tip being used. The kit supplier recommends a smaller tip

3 — Soldering C3 in position. C1 and C2 can be seen already soldered on the board and the size of finger gives some idea of the scale involved

4 — The most important operation is soldering on the integrated circuit. The solder and iron tip are displayed for scale only, as the i.c. and l.d.r. have been soldered in position

5 — Soldering the l.e.d. in position



completed some of the soldering after the first three steps whilst holding the p.c.b. with the hand.

The orientation of the chip is obviously important and care should be taken to ensure it is both the correct way up and with pin 1 facing the pin 1 pad on the p.c.b. before the final pressure is applied to make the double-sided adhesive sheet used to temporarily hold it down actually stick firmly.

Patience at this stage is imperative. Do not do more than one joint at a time between inspection steps. The delay in the sequence introduced by each examination is very useful as it allows things to cool down after heat from the iron has been applied. In this way the chip does not become too hot and heat, it should be remembered, can destroy the chip.

The soldering operation itself at this stage requires quite a lot of dexterity and great care must be exercised to avoid too much solder as well as too much heat. It is very easy to run solder over more than one track on the p.c.b. but a good loupe (magnifying glass) will show such an error fairly clearly.

FINISHING ASSEMBLY

From this point on the assembly is fairly simple with the possible exception of the application of three small switch contacts. These latter are in the form of bent-up phosphor-bronze strip which has to be soldered to the p.c.b. at three points on the periphery. In itself the soldering is not difficult providing one can hold the spring steady whilst the solder cools.

The three switch contacts engage in three slots formed in a nylon moulding which serves to locate the board and contacts in the watch body. The engagement is very tight and some relieving with a small file or, indeed, the hot iron bit, is needed to finally get the assembly to go together smoothly.

After all components are assembled on the p.c.b. and prior to power application, a further and final continuity check is carried out.

FIRST TRIAL

The instructions now lead the constructor through the first trials of the watch, including powering the unit up, checking it out and finally closing up the case.

In the writer's case the prototype worked first time round on all tests, apart from one l.e.d. segment which was clearly due to a faulty l.e.d. No doubt, the kit being a prototype explains this particular item. The second, final form, kit operated properly the first time power was applied.

Measurements on the two models made up were quite interesting. The first, prototype version, without any alteration at all gained some 15 seconds in 14 days according to TIM. The second version, the final form of model, lost some 30 seconds in 48 hours, clearly a matter for heavy adjustment. Indeed both watches constructed need adjustment to meet the claimed accuracy and this brings up the matter of the tool required for this job.

To the writer's knowledge there is no available device so again one has to be made up and could be filed from a length of steel or brass rod to give the required very small rectangular end shape. In fact, the adjustment can be effected using any fairly small object which is shaped so as to engage with the flats or the diagonals of the square hole in the capacitor spindle. ★

NEWS BRIEFS

A Stitch in Time . . .

THE latest domestic sewing machine instroduced by Singer in the United States, the Athena 2000, is controlled electronically by a m.o.s. l.s.i. system produced for Singer by AMI Microsystems.

Designed to Singer's own specification, the AMI module operates in conjunction with touch contact controls to replace as many as 350 mechanical parts, including the manual levers and dials conventionally used for the selection of the various machine functions.

Pattern selection, for example, is effected simply by touching the relevant contact: the appropriate machine settings are then made automatically by the m.o.s. control system. This facility also allows one unit of a selected pattern to be sewn, following which the machine automatically stops. Similarly, the AMI module causes the adjustment of machine settings according to the selected stitch length and width, and the fabric in use.

At present, the Athena 2000 is available only in the US domestic markets. A version of the machine for Europe is currently under development.

TV Innovations

FOR those of us who like to watch t.v. but find following a programme difficult when others start talking in the room, a recent innovation from Germany may help put an end to our plight. Mounted on the front of the new set from Loewe Opta GmbH is an array of l.e.d.s which transmit a frequency modulated beam of infra-red to a photo diode mounted on a pair of headphones; the beam being modulated with the t.v. sound. The headphones are thus completely independent of the t.v.

Infra-red was chosen since light in that frequency band tends to be reflected around the room and therefore can be picked up by the receiving photo diode without it having to be in line of sight with the transmitter. One is able to listen to a programme without being disturbed by others talking, and without fear of anyone tripping over leads to the headset.

Besides their sophisticated ultrasonic control system (see Inter Navex '75 report) Grundig are to incorporate yet another new feature in their latest range of t.v.s. On pressing either a control on the ultrasonic control unit, or a plate on the t.v. itself, four-centimeter high light-green digits giving the time in hours and minutes appear on the bottom of the screen. Also, whenever the channel is changed a similar display giving the programme number is shown on the screen. The digits automatically disappear after ten seconds.

Going Dutch

THE Wilhelmina Gasthuis Hospital in Amsterdam is the first hospital in Holland to be equipped with an EMI-Scanner, a revolutionary X-ray machine for the diagnosis and investigation of brain disorders.

The order was placed with EMI's Dutch Company ANRU, and followed a visit by Professor Westra of the hospital, to the Company's X-ray Systems division at Hayes, Middlesex and to several existing clinical installations of the system in UK hospitals.

The EMI-Scanner produces pictures of brain tissue with exceptional clarity and high definition, giving doctors 100 times more information on tissue than is possible with conventional X-ray techniques.

As patients can frequently be accepted for examination by the EMI-Scanner on an out-patient basis this contributes greatly to reduced patient anxiety.

BY FRANK W. HYDE

THE EARTH AND EARTHQUAKES

Geophysicists have been working for some time on evidence of a number of related facts which suggest that an earthquake is but one of a number of manifestations of a chain of physical events.

Dr. Donald Anderson, Director of the Seismology Laboratory at the Californian Institute of Technology, has discovered a number of curious data relationships which occurred at the beginning of this century. Between 1897 and 1914 there was a 17 year period of seismic violence. During that time no less than 71 earthquakes were reported with a intensity greater than 8 on the Richter scale.

Coincident with these happenings there were volcanic eruptions and "Tsunamis". These "Tsunamis" are giant waves and in the time of the 17 year cycle of events some of these were more than 100 feet high. Perhaps surges are a more apt description of them for they are the result of earthquake crustal movement and not tidal effects.

Now at the same time as these events were operating, the "wobble", known as the Chandler Wobble after its discoverer, was at its peak. This wobble is a spinning top effect which varies in such a way that the north geographical pole describes varying diameter circles. This normally has a slight effect on the speed of the rotation of the Earth which over a period of time averages out.

However, at the period in question, the length of the day changed because the Earth had slowed up. In five years the rotation decreased more than it had previously done in the last 2000 years. At the same time the global temperature added to the phenomena by rising by 1·0 degree Centigrade, the sea level rose and the westward drift of the Earth's magnetic field accelerated.

During the last few years great strides have been made in the science of geophysics. As a result of refined measuring systems, the observations from satellites and probes and the revival of interest in plate tectonics, earthquake predictions have become more accurate.

The spin-off of space technology has had its part in this and we are thus able to learn more about the rather unstable globe on which life exists. Indeed, like so many of the things going on around us the facts are more exciting than fictional stories.

ON THE MOVE

The Earth's upper crust is not stable and solid, but is in fact made up of about a dozen tectonic plates which move in relation to each other. The upper surface of the crust is rather similar to a conveyor belt feeding new crust out at one end and consuming it at the other. Pressure builds up in the interior of the Earth and pushes new molten material out of the sea floor separating the plates and pushing them apart. If this ocurrs with the Pacific Plate and the North American Plate then one passes under the other returning material to the inerior. Earthquakes occur at the lines where the plates meet.

This is but a part of the chain of events. The total energy cycle involves the atmosphere, for energy is transferred from it to the crust, to the core and back out again. For example, when the Earth slows down rotational energy is released and this could be transferred to the atmosphere or the core.

From his examination of the data Dr. Anderson believes that massive earthquakes release enough energy to affect the Chandler wobble and the Earth's rotation. There seems to be evidence of a 40 year cycle of the Chandler effect. The great earthquake of 1911 was near the Chandler maximum and so was the Assam event in 1950 and the Kamchatka event in 1952.

The efficiency of measurements now possible, of the tilt and bulge of the Earth, make predictions of earthquakes a more positive science.

EXPLORING THE MAGNETOSPHERE

Plans for a joint effort by NASA/SRC which would involve three satellites have been discussed in London. The original project involved two satellites. These would have been put into a low circular orbit and the other in an elliptical orbit with an apogee varying between three to six Earth radii. Correlated measurements could thus be made.

Now thoughts are along the lines of three satellites. The third would be a UK vehicle unpropelled. The lower orbiting US satellite would be used to vary their separation.

There is considerable competition for space funds but there can be no doubt about the value of such missions. A great deal of work needs to be done at lower levels and the inter-level correlations have already shown their value.

The sunspot cycle seems to be directly related to tropospheric phenomena such as lightning, verticity rainfall and pressure.

SOVIET ACTIVITIES

The *Salyut 4* vehicle has been an unusually successful project. Apart from the long time occupation by cosmonauts, more than 60 days for the last pair, an enormous amount of data has been acquired.

A new method of spectral sounding was employed in the upper atmosphere using infra red and ultra violet techniques. This enables studies to be made of the distribution of water vapour, ozone and nitrous oxides. The optical observations were carried out by means of the OCT-1 orbital solar telescope. Also aboard were automatic installations for the growth of higher plants. The "beds" were sown with onions and peas. These have shown lavish development a month after launch.

The present parameters of *Salyut 4* are: Orbital period 91·3 min. Perigee 336km Aprogee 362km and orbital inclination 51·6 degrees.

METEOR 2

Launched for meteorological studies, *Meteor 2* on board instruments include infra red experiments, an experimental optical-mechanical television scanning system and some rather complex radiometric equipment. The radiometric equipment is for the study of penetrating radiations in near Earth space.

The satellite has an advanced three axis sysem for the orientation of the satellite to the Earth. In addition there were the usual telemetry and other communications systems.

The parameters are: Orbital period 102·5 min. Perigee 872km. Apogee 903km and the inclination of the orbit 81·3 degrees.

ENVELOPE SHAPER

By E. F. FLINT

Two types of envelope shaper are found in commercial synthesisers: one gives control of attack and release times and is known as an "AR" envelope shaper: the other gives control of attack and release times and also allows, after the end of the attack period, a decay of variable rate to a preset level (sustain level). This type is known as an "ADSR" envelope shaper (Fig. 1) which has a far greater control potential and allows a wider range of effects to be produced.

The circuit comprises two exponential generators, a high impedance buffer stage, a Schmitt trigger and a unity gain differential adder.

CIRCUIT DESCRIPTION

The circuit diagram of the ADSR shaper is given in Fig. 2. When S1 is closed the emitter of TR1 rises to 8·5V, resulting in capacitor C1 charging through D1 and VR1 to approximately 8 volts, since about 0·5V is lost across D1. Half of the voltage on C1 is applied to the inverting input of IC1 via the divider R2 and R3.

F.E.T. BUFFER STAGE

This voltage is also applied to the gate of f.e.t TR2, which has a high impedance and thus does not drain C1. The source of the f.e.t. connects onto VR3 whose slider position determines at what stage in the cycle the Schmitt trigger (TR3 and TR4) fires. This occurs when the base of TR3 reaches approximately 3V. When this happens TR4 is off and TR5 is held on with R8. Zener diode D3 (3·9V), D4 and VR4 provide a charging path for C2, the charging rate being determined by VR4.

A proportion of the voltage on C2, depending on the setting of VR5, is applied to the non-inverting input of IC1 via R11. Any voltage present at this input will result in a proportional reduction of the output voltage of IC1. The rate this reduction occurs is set by the decay control, and the level it reduces to by the sustain control.

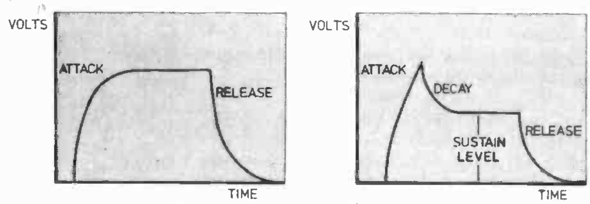


Fig. 1. "AR" and "ADSR" envelopes

COMPONENTS . . .

Resistors

R1	4·7kΩ	R5	270Ω	R8	560Ω
R2	1MΩ	R6	680Ω	R9	4·7kΩ
R3	3·3MΩ	R7	560Ω	R10–13	1MΩ
R4	390Ω				

All ¼W, 5% carbon

Potentiometers

VR1, VR4 100kΩ lin. VR5 1MΩ lin.
VR2 500kΩ dual ganged lin.
VR3 10kΩ vert. mounting skeleton preset

Capacitors

C1–2 10μF 16V elect.

Semiconductors

IC1 741 8 pin dil.
D1, 2, 4, 5 1N914
D3 BZY88 3·9V, 400mW, Zener
TR1, 3, 4, 5 2N3702, BC212 etc (any general purpose silicon or germanium *pnp* type)
TR2 2N3820 (*p*-channel f.e.t.).

Miscellaneous

S1 S.p.s.t. or trigger switch of keyboard
S2 D.p.s.t.
B1–2 PP9
Veroboard 2½ × 4½in. (64 × 115mm)
8 pin dil. holder for IC1 (optional)

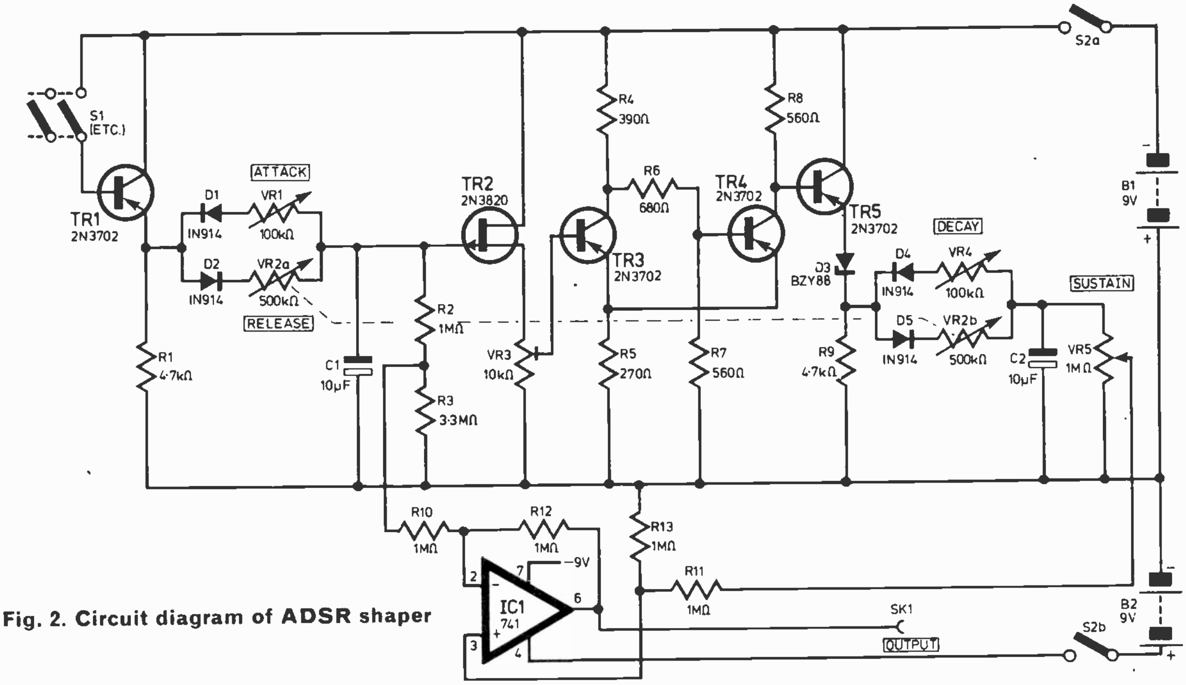


Fig. 2. Circuit diagram of ADSR shaper

RELEASE

When S1 is opened, TR1 switches off, the voltage on C1 falls, the Schmitt trigger switches off resulting in the voltage on C2 also falling. Capacitor C1 discharges through R1, D2 and VR2a: C2 through R9, D5 and VR2b. Thus both discharge with the same time constant.

CONSTRUCTION AND TESTING

A suitable Veroboard layout is given in Fig. 3. Note that pin 5 of the holder for IC1 should be snipped off so that it does not touch the copper strip connecting pin 4 to the negative voltage line. An oscilloscope or high resistance voltmeter is required to set VR3.

First monitor the voltage on C1 and ensure that it rises when S1 is closed. Now monitor the voltage on C2. Start with VR3 wiper at the ground end of its travel; close S1 and advance VR3 wiper until C2 starts to charge. If C2 is not at 0V with S1 open, change D3 for one of a higher Zener voltage. If VR1 and VR4 are both set at minimum resistance the voltages on C1 and C2 will rise quickly.

USE WITH VOLTAGE CONTROLLED AMPLIFIERS

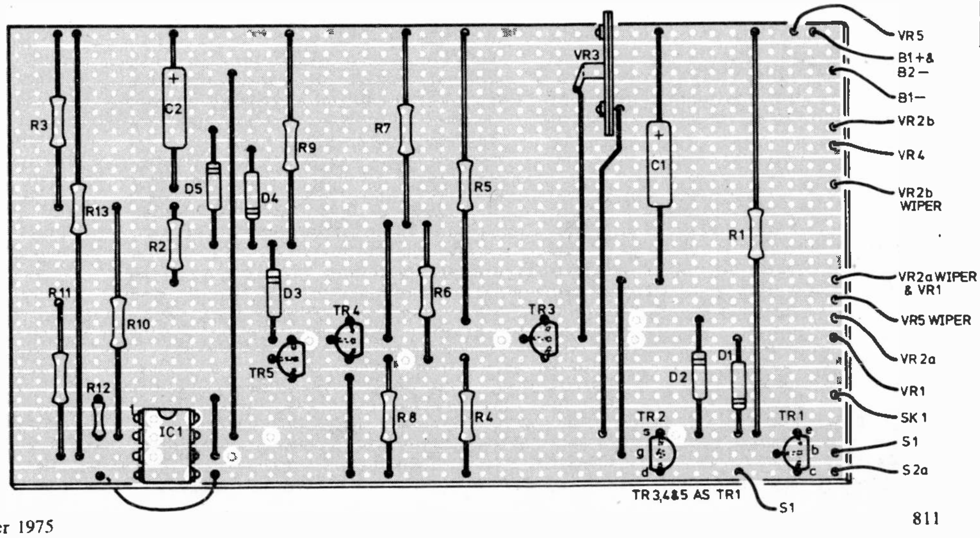
The module can be used with the VCA circuit published in PRACTICAL ELECTRONICS October '73. For this purpose connect a 4·7KΩ resistor between the output and ground, and connect the output to the input of the VCA.

ADSR SHAPER EFFECTS

Generally speaking, short attack and decay times will tend to give short, sharp, percussive sounding effects when used with, for instance, noise sources. With a little experimentation with the various controls, an ADSR shaper can be adjusted to closely simulate the envelopes produced by a wide variety of instruments (e.g. the piano, violin, guitar, etc) and thus adds a new dimension to a monophonic synthesiser.

★

Fig. 3. Veroboard and component layout details



SEMICONDUCTOR UPDATE

By R.W. COLES

2416 MP9100
553 MP9200
554

MISTER SHIFTER

T.T.L. brought us the eight-bit shift register, and m.o.s. stretched this up to 128, and then an incredible 1024, bits per register during the last few years. A shift register 1024 bits long in a single dual in line package seemed pretty indredible to me, or anyway it did until the other day when I saw the preliminary data sheet on the new **Intel 2416**!

The 2416 is a charge-coupled m.o.s. device housed in a diminutive 18 pin package containing no fewer than 64 separate registers each 256 bits long, an amazing 16,384 bits in all! Even those who are numb to the customary excesses of m.o.s. technology will have to agree that getting that number of storage elements together on one piece of silicon is quite a revolution, and a revolution is just what its manufacturers want to start, because the 2416 is aimed at the bulk-storage end of the computer memory market, the traditional territory held by electro-mechanical devices such as magnetic tapes and discs.

If Intel are right, and the 2416 does start to replace its non-solid-state predecessors, it will be continuing a trend which began with the ousting of magnetic cores from computer work stores by the now familiar "Random-Access" m.o.s. chips. Semiconductor storage has already proved that it can be cheaper and more compact than rival magnetic devices at this high speed small capacity end of the market, but at first glance it seems a tall order to think of replacing things like disc-drives whose storage capacity is rated in Megabits. The key to success, as always, lies in the low price of semiconductor devices, and even at its introductory price of £30 each, the 2416 works out at only about 0·2 pence per bit.

The reason why the storage on the new chip is organised as 64 separate recirculating registers instead of one thumping great long one is not hard to find. Since shift register stores can only be accessed via their serial inputs and outputs, it would take an unacceptably long time to rotate the contents of a 16,384 bit device for access to a particular bit, even at high clock speeds. By splitting the store into separate loops of 256 bits each and using an address decoder to get at the separate registers, average access time is reduced to less than 100 microseconds at a clock rate of 1 Mhz.

To prove that the 2416 really is a practical proposition Intel have put together a printed circuit board measuring 9in by 15in which has a storage capacity of 1,048,576 bits, the magic "Megabit" figure, which will have the manufacturers of the magnetic systems losing a lot of sleep if I'm any judge!

TIMELY QUADS

The 555 i.c. timer chip has been with us now for several years, and in that time it has become very popular, and has been used in many amateur projects. The popularity of this chip is well deserved because the 555 combines in one small package all the useful features one needs to build a wide range of ascillators and time delays, coupled with a wide availability and low price.

A dual version of the 555 was introduced, but not a lot was gained because the dual version came in a 14 pin d.i.l. instead of the little 8 pin "Mini-d.i.p." of the 555, but Signetics have now taken the cramming process a step further by putting four 555 type timers in a 16 pin d.i.l. which comes in two versions with type number **553** or **554**.

To get four timers into such a restricted space, some reduction in available facilities has had to be made, the most fundamental being a reduction in the output drive capability. The original 555 can source or sink up to 200ma at its output pin, whereas the new quads come in two versions, one of which, the 553, sinks current, while the other, the 554, sources it, both at a reduced current level of up to 100ma. In addition, the 553/554 quads do not have the reset input which is available on the 555 to terminate an initiated time period, but since in many applications the reset is superfluous this is no loss.

The 553/554 have most of the other traditional timing features, such as good stability and wide range, and the duty cycle of all four timers can be varied by means of a single external control voltage.

The new quads really come into their own where sequential time periods are required, i.e. timer A triggers timer B, timer B triggers timer C and so on, making them ideal for such applications as traffic light controllers, model train sequencers, etc.

DIAL STYLE

Two new i.c.s from Plessey demonstrate the way that large-scale-integration can solve everyday problems as well as the more exotic problems of the mammoth computer industry.

The **MP9100** and the **MP9200** are m.o.s. i.c.s intended for use in push-button telephones, the first being a dial code generator and the second a store to enable a caller to recall previously entered numbers by pressing a single button.

The MP9100 comes in an 18 pin d.i.l. package, and has many novel features which make it attractive for amateur as well as professional applications. A four line binary code from a keyboard is accepted, up to twenty digits at a time, and from this input the MP9100 generates the necessary pulse sequences to drive the uniselectors of standard Post Office Strowger type exchanges. In addition to the digits 0 to 9, "Dial-tone-waits" may be keyed in anywhere in the number sequence, to force a pause in the output pulse sequence.

This unfamiliar-sounding operation is normally carried out by the telephone user himself, and is required, for example, when a private exchange has a dial-out facility. In situations like this it is necessary to dial, say 9, and then wait for the "outside-line" dialling tone before dialling in the normal way.

With the MP9100 there is no need to pause during the keying sequence, all that's necessary is to key in a "dial-tone-wait" after the 9, and then the rest of the number, the chip will send out the 9 and then wait until a dial-tone arrives before continuing.

The MP9200 is a sort of optional extra to go with the MP9100 in a telephone system, bringing with it a facility which did not exist at all with traditional instruments, namely the ability to store up to ten, separate, 22 digit telephone numbers, for later recall. Each complete number is recalled and dialled out via the MP9100, by pressing the appropriate single key.

A system using these chips could be the long awaited electronic replacement for the "little-black-book" for space-age batchelors!

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AC188	30p	BAW62	8p	BC177B	19p	*BC321	14p	BC449	16p
ACY19	30p	BAW63	35p	BC178	18p	*BC322	16p	BC485	15p
ACY20	16p	BAX13	8p	BC179	20p	*BC327	15p	BC486	15p
ACY22	8p	BAX16	10p	BC208A	10p	*BC328	15p	BC487	15p
ACY22D	8p	*BB105B	20p	BC214K	10p	*BC337	15p	BC488	17p
AD140	31p	*BB105G	19p	*BC237	11p	*BC338	12p	BC489	17p
AD149	45p	BC107	11p	*BC237A	12p	BC347	11p	BCX25	13p
AD162	36p	BC107A	13p	*BC237B	12p	BC347A	11p	BCX26	15p
AF114	25p	BC107B	13p	*BC238	9p	BC347B	12p	BCX47	17p
AF115	22p	BC108	13p	*BC238A	10p	BC347L	10p	BCX48	18p
AF116	19p	BC108A	13p	*BC238B	10p	BC348	10p	BCY21	62p
AF117	18p	BC108B	13p	*BC238C	13p	BC348A	11p	BCY58	18p
AF118	60p	BC109	15p	*BC239	11p	BC348B	10p	BCY59	20p
		BC109B	17p	*BC239B	12p	BC349A	10p	BCY70	24p
		BC109C	18p	*BC239C	13p	BC349B	10p	BCY71	28p
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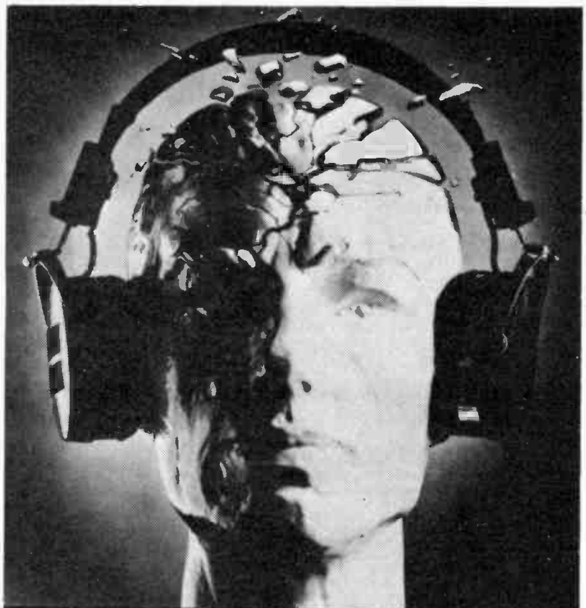


INTER NAVEX 75 REPORT

An exhibition designed to cater for the ever expanding Audio and Visual Aids industry, Inter Navex 75 was held at Olympia from July 8 to 10. Most exhibitors were showing equipment in some way associated with education, but an enormous range of peripheral gear was also displayed.

PROJECTION T.V.

Trying to show a large number of people a t.v. programme, whether taped or live, can be difficult unless one happens to have a large number of monitors available. A new colour t.v. projection system launched by Advent should help solve a few problems from this point of view. Providing a $4\frac{1}{2} \times 5\frac{1}{2}$ ft. screen, the system can give comfortable viewing for as many as 40 people.

The system employs three separate "Light Guide" projection tubes each having its own optical system within the tube (thus eliminating the cleaning and alignment problems usually associated with this sort of equipment). A built-in cross-hatch generator allows for quick and easy convergence adjustment. With the growth of the video-recording industry, the system is sure to find popularity with schools and industrial training courses as a means of showing programmes to classes.

Still on the t.v. front, Grundig were displaying their new television (Color 2252) which features an extremely comprehensive ultrasonic control system, and a 110 degree in-line slot mask tube. The control system allows instantaneous selection of any channel, plus the usual volume, brilliance and colour contrast up-down controls. In addition a button is provided on the unit to allow one to cut the sound. Pressing it again returns the volume to its original level.

The service engineers should like it too, as plugging a gadget called a Diagnostic Adapter into the main printed circuit board, in theory reveals faulty modules in the set under breakdown conditions.

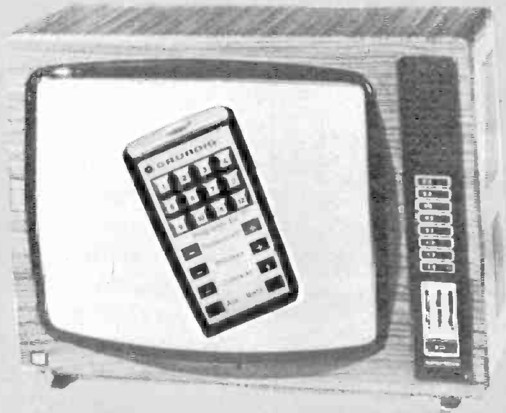
ANIMATED DISPLAYS

Have you ever wondered how those "animated" displays work which depict such things as flows in chemical processing plants, or the movement of fluids round the body? The displays themselves appear to have zones that are actually moving along. The effect is generated by using a special plastic film which, although transparent, is in fact composed of strips which are "sequentially polarized", i.e. the direction of polarisation is sequentially rotated strip after strip. If one views this through a rotating disk on which the angle of rotation of polarisation varies through 360 degrees around it, the dark zones formed when the two polarisations are at right angles to each other, will move down the film due to the sequential polarisation of the film. This causes the effect of apparent motion on the display.

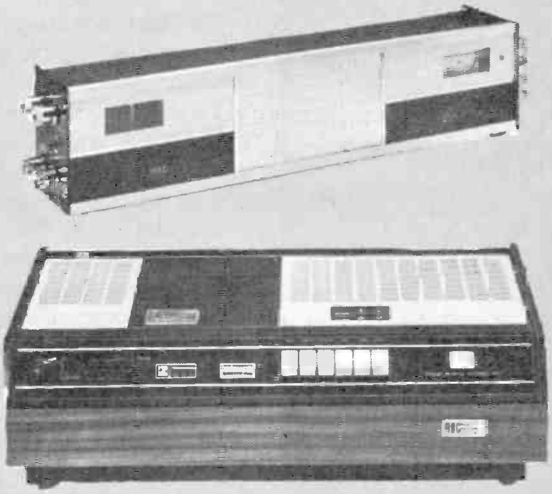
Technamation had some impressive displays of charts of widely differing subject matter using the principle. The charts are easily made up with ordinary coloured self-adhesive plastic film and the special polarised material (also self adhesive). The system is ideal for overhead projectors where the rotating wheel is merely placed between the chart and the projector lens to give the animation effect.

VIDEO CASSETTES

A number of video cassette recorders were on display; amongst others the increasingly popular Phillips model, and surprisingly, an all British recorder with a sophisticated digital clock arrangement to allow accurate time switching (from Radio Rentals Contracts). ★

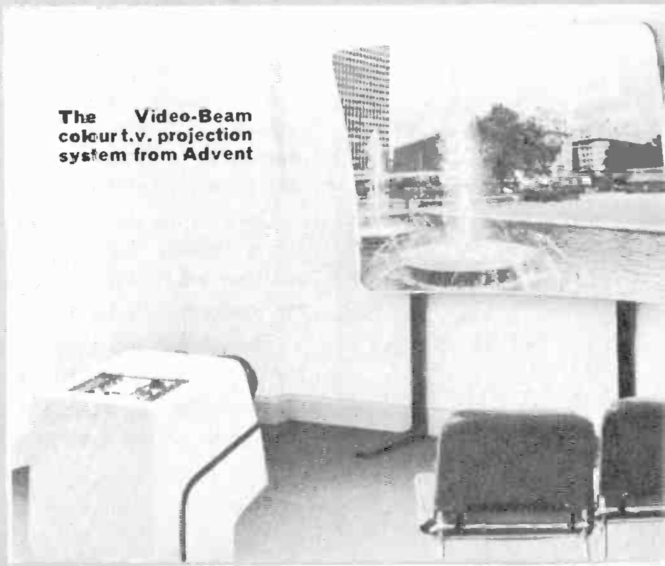


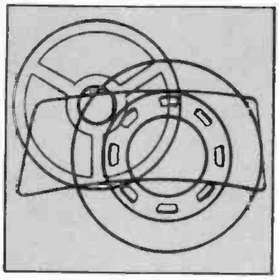
Grundig's new ultrasonically controlled t.v.

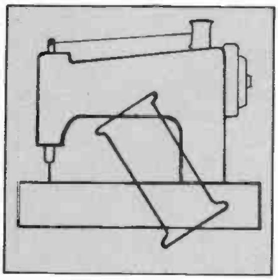


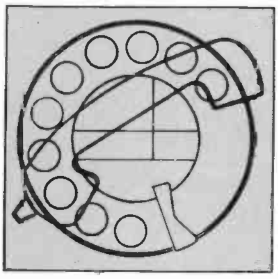
The Radio Rentals Contracts VCR and timer

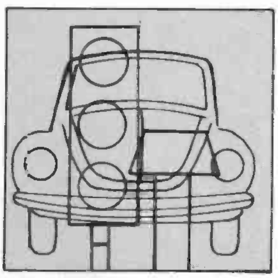
The Video-Beam colour t.v. projection system from Advent

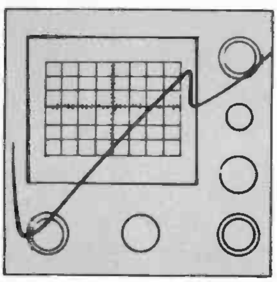


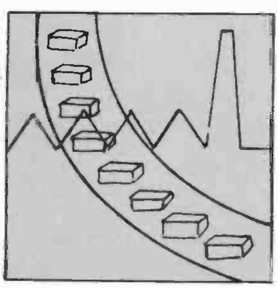












MICROPROCESSORS

PART 1

By V. YATES*

A word heard more and more in electronics today is "microprocessor". Although a comparatively recent innovation, this device is now finding its way into extremely diverse fields of application.

The word "microprocessor" describes a complex integrated circuit package which forms the heart of a digital processing system. The concept has been designed in order to provide a basic, flexible system which can be "programmed" to perform functions normally requiring large numbers of standard TTL devices. The essence of the system is flexibility however, and this is one of the many reasons for their rapid increase in popularity.

The automobile industry, for instance, has turned to microprocessors to cope with the task of optimising engine performance under all conditions, and with the price of fuel soaring, this is obviously a highly favourable feature. Microprocessor on-board diagnostic systems (i.e. letting the driver know where a fault has occurred) and "anti-skid" braking systems are among other applications in this field.

Domestic equipment will benefit by this new technology. Sewing machines and washing machines are examples of consumer products which will make use of microprocessors.

Electronic games will soon be (some already are in fact) incorporating microprocessors, which are bound to greatly increase their sophistication. An electronic bowling-alley exists now which uses a complex microprocessor system not only in scoring, but also in giving the right "feel" to the game as far as the roll of the "ball" and knocking the pins down.

These devices have already entered the field of electronic instrumentation and some of the more advanced types of oscilloscopes and signal generators already incorporate microprocessors.

Industry has been exploiting microprocessors in such fields as factory automation systems, machine tool control, electronic scales, conveyor-line control, robot manipulation of piece parts and component insertion. A microprocessor-based metal stretching machine can monitor operations performed on a piece of metal (via various A-D converters) commit them to a "memory" and then can duplicate the operation as many times as is required.

Traffic control is another area where microprocessors are bound to excel. The complex logic required to control an intricate main road intersection can be relatively easily carried out using a microprocessor.

Telephones and telephone systems will greatly benefit from the use of microprocessors. Research is being carried out at present to reduce the bandwidth necessary to transmit a telephone channel by having an "intelligent" transmitter and receiver system.

On a more practical basis a microprocessor controlled memory arrangement for a 'phone could be envisaged which would not only automatically dial a number when perhaps a name or symbol was entered, but also have facilities for redirecting calls to holiday addresses.

The above examples show how microprocessors can become the heart of intelligent systems, and also indicate their great flexibility.

The following article is concerned with the operation of the device itself and also some of the associated equipment.

THE microprocessor is one of the most exciting new products to be announced by semiconductor manufacturers and, even though microprocessor technology is still in its infancy, a bewildering choice of some 30 different types is now being offered to electronics design engineers. Before examining the microprocessor in depth, it is worth briefly looking at the development of the digital integrated circuit to see exactly how and why the microprocessor evolved.

DEVELOPMENT

In the early days, all digital integrated circuits were integrated copies of the discrete component circuitry they replaced. They were made up of resistors and bipolar transistors diffused into a single chip of silicon and only a very few individual logic elements (gates, flip flops, etc.) could be built into a package. Therefore, a typical digital system employing these circuits consisted of a very large number of separate packages.

As bipolar semiconductor technologists learned how to increase the complexity of the circuit in each package, integrated circuits employing *p*-channel, and more recently *n*-channel, m.o.s.f.e.t.s. were introduced. The mos technologies opened the way to integrating thousands of transistors on a single chip and enabled circuits of an unprecedented complexity to be contained in a single small package.

PROBLEMS

At this stage a very difficult problem arose. A great deal of money is needed to design and produce one complex l.s.i. (large scale integration) circuit, say, several tens of thousands or hundreds of thousands of pounds. If a large number of each particular integrated circuit is ultimately to be produced, the development cost can be spread over a sufficiently large number of units to become insignificant. In addition, it is important to note that semiconductor manufacture is essentially a mass production undertaking as the more integrated circuits of one type that can be produced the lower the production cost per unit.

The potential advantages of large scale integration were in danger of not being fully realised because it was found that as the complexity of an integrated circuit was increased the more specialised became its uses. What was needed was a universal digital integrated circuit that could be used in an unlimited number of different applications. That universal i.c. was developed and was called the microprocessor.

MICROPROCESSOR FUNDAMENTALS

Any conventional digital circuit consists of a number of gates and flip-flops connected in such a way as to perform the required function. Such a circuit accepts digital inputs, performs some kind of processing and provides digital outputs. The function performed by many digital systems is determined by the way in which the various gates and flip-flops are interconnected.

PROGRAMMING

The microprocessor differs from the "hardwired" digital circuit discussed above in that the function performed is determined by a sequence of instructions which are stored in a memory in much the same way as a conventional digital computer. A change in the programme will alter the function carried out by the microprocessor.

PRACTICAL MICROPROCESSORS

To enable readers to more fully grasp the detail involved in microprocessor system design, one microprocessor—the Motorola M6800—will be described in some depth. Following this, basic details will be given on some other microprocessors which are available to industry.

The Motorola M6800 is a family of six integrated circuits that can be interconnected in a variety of different ways. The set comprises the microprocessor itself (MPU), a Random Access Memory (RAM), a Read Only Memory (ROM), a Peripheral Interface Adapter (PIA), an Asynchronous Communications Interface Adapter (ACIA) and a Low-speed Modem (LSM).

SECTIONS

All microprocessors can be divided into four basic sections: a memory, an input/output unit, a control unit and an arithmetic logic unit. The entire operation of such a system can be likened to a man adding up numbers written on a sheet of paper and writing the result on the same piece of paper.

In this analogy the sheet of paper becomes the peripheral device—the source and destination of the data to be processed. The man's eyes are the input system enabling the numbers to be read into the memory. The man's hand forms the output unit enabling the results of a calculation to be written down. The memory of both the man and machine perform the same function—both store the sequence of instructions (algorithm) for performing addition. The part of the brain which performs the addition can be likened to the arithmetic logic unit and the brain's co-ordinationg centre to the machine's control unit.

BYTES

In the Motorola microprocessor, instructions and alphanumeric data are represented by eight-bit

*Director, MOS Marketing, Europe. Motorola Inc.

GLOSSARY OF TERMS...

ACIA	Asynchronous Communications Interface Adapter
ACU	Arithmetic Logic Unit
Byte	8-bit binary word
CCR	Condition Code Register
CROM	Control Read Only Memory
DMA	Direct Memory Access
IRQ	Interrupt Request
MPU	Microprocessor
NMI	Non Maskable Interrupt
PIA	Peripheral Interface Adapter
PROM	Programmable Read Only Memory
RAM	Random Access Memory
RALU	Register, Arithmetic and Logic Unit
ROM	Read Only Memory
RTI	Return from Interrupt

binary words, called bytes, which are stored in the memory. Each location within the memory has a numerical address (in the same way as houses in a street) and each location is capable of holding one byte of information.

With one byte (eight bits) it is possible to count up to the equivalent of 256 in decimal and, therefore, with one byte it is possible to individually address up to 256 memory locations. For the majority of microprocessor applications much greater memory capacity is required, therefore all the registers within the microprocessor concerned with addressing have a length of 16 bits.

This means that up to 65,536 separate locations within memory can be addressed (since a 16-bit binary word can have a value of up to this figure in decimal). Every location within memory will hold one 8-bit binary word, which means that the memory can consist of 65,536 × 8 = 524,288 bits. However, there is no need to have a memory as large as this to make the MPU function.

HEXIDECIMAL CODING

In binary, memory location number one would be referred to as location 0000000000000001, location number two would be 0000000000000010 and location 32,769 would be 1000000000000001, which, you will agree, is all rather tedious.

To avoid using such long strings of 1s and 0s, the hexidecimal code is often used when referring to numbers within the MPU, as conversion between binary and hexidecimal is easier to perform and more convenient than conversion between binary and decimal.

The conversion between binary and hexidecimal first involves splitting the binary word up into blocks of 4-bits as follows:

01101101 becomes 0110 1101

Table 1: Hexidecimal Code

Decimal		Binary		Hexidecimal
0	=	0000	=	0
1	=	0001	=	1
2	=	0010	=	2
3	=	0011	=	3
4	=	0100	=	4
5	=	0101	=	5
6	=	0110	=	6
7	=	0111	=	7
8	=	1000	=	8
9	=	1001	=	9
10	=	1010	=	A
11	=	1011	=	B
12	=	1100	=	C
13	=	1101	=	D
14	=	1110	=	E
15	=	1111	=	F

Each block of four bits has 16 possible values. In the decimal system we only have ten symbols to use (0 to 9) so, in the hexidecimal system, counting continues using letters of the alphabet as follows:

Returning to our earlier example, 01101101 in hexidecimal is equal to:

01101101
0110 1101
6 D (from Table 1)

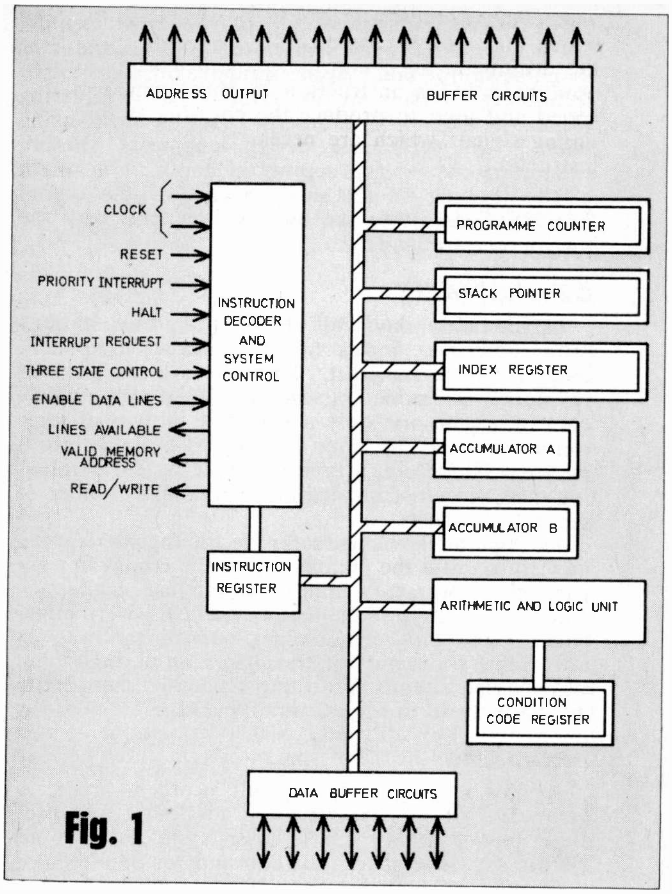


Fig. 1

Fig. 2

0001	86	Load accumulator A with
0002	05	the number 05 (Hex).
0003	B9	Add contents of accumulator
0004	00	A to the contents of the
0005	27	Memory location 0027.
0006	B7	Store the contents of accumulator
0007	00	A at memory
0008	28	location 0028
0027	03	Operand
0028	08	Result

In other words 01101101 is equivalent to 6D in hexidecimal. If you wish to work it out you will find that 6D in hexidecimal is equivalent to 109 in decimal.

Using the hexidecimal system is confusing at first Numbers like CF2C do not seem to make much sense. However, after a little practice working in 16s with the hexidecimal system, it becomes as familiar as working in tens.

SIMPLIFIED VIEW

A much simplified block diagram of the Motorola microprocessor is shown in Fig. 1. The blocks labelled programme counter, stack pointer and index register are all registers capable of holding 2 bytes (16 bits) which are used to hold the addresses of instructions or data stored in the memory.

Accumulators A and B are each 1 byte registers which are primarily used to hold data for and from the arithmetic logic unit. The instruction register is used to hold an instruction (1 byte) which is decoded and used to produce the control, routing and timing signals which are necessary to carry out the instruction.

EXAMPLE SEQUENCE

With the aid of Fig. 1 and Fig. 2 it is possible to trace a complete sequence of events within the microprocessor.

Fig. 2 shows a number of memory locations containing instructions which are to be performed by the microprocessor. For convenience the instructions are shown in hexidecimal instead of binary. To the left of the memory locations are the four digit hexidecimal memory location addresses. On the right of the memory locations are the plain English explanations of the instructions stored in the memory locations.

The programme counter is set to the address of the first instruction in the programme which is situated at memory location 0001. This is done by loading the programme counter with the number 0001.

The address in the programme counter is sent to the memory along the address bus and, as a result, the contents of memory location 0001 are sent to the MPU along the data bus to be stored in the instruction register. The programme counter is now incremented by 1 to 0002.

The content of the instruction register (86—the instruction to load accumulator A with data represented by the byte in the next memory location) is decoded and the control system causes the byte addressed by the programme counter to be transferred along the data bus from memory to accumulator A in the MPU. The programme counter is again incremented (now holds 0003) and accumulator A holds the numerical value 05 (hexidecimal).

NEXT INSTRUCTION

The MPU fetches the next instruction from memory that is addressed by the programme. This is B9—an instruction which causes the numerical value contained in accumulator A to be added to the content of the memory location specified in the following two bytes of the instruction and to place the result of the addition in accumulator A. The programme counter is incremented to 0004.

The MPU fetches the first byte of the second operand address (00) from memory location 0004, increments the programme counter to 0005 and fetches the second byte of the address (27) from location 0005. The programme counter is incremented to 0006.

The MPU now holds the first operand (05) in accumulator A, holds the address 0027, which is the location of the second operand, and has the instruction to add (B9) in the instruction register. The MPU fetches the data at address 0027 (the numerical value 03), adds it to accumulator A and stores the result in accumulator A.

Having completed instruction B9, the MPU fetches the next instruction (B7) addressed by the programme counter and then increments the programme counter. Instruction B7 will cause the

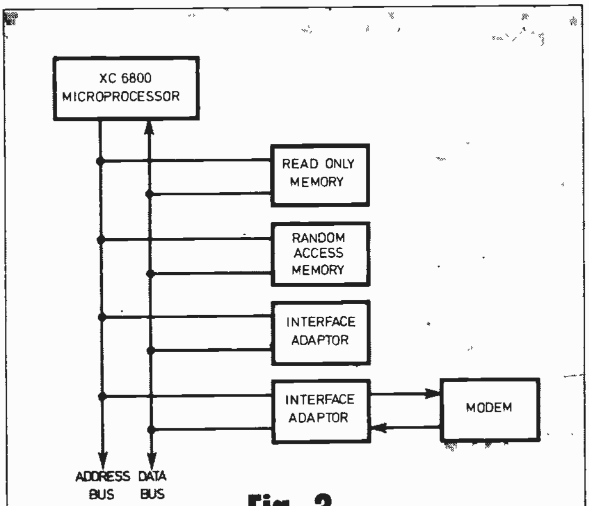


Fig. 3

contents of accumulator A (the result of the addition of 05 and 03) to be transferred to the location specified by the next two bytes. These two bytes 00 and 28 are fetched one at a time by the MPU and the numerical value 08 is transferred to memory location 0028.

The sequence of instructions we have just traced caused the numbers 03 and 05 to be added together and the result to be stored in a known memory location.

The purpose of the various registers and counters in the MPU are summarised below.

Programme counter: The programme counter holds a two byte address and is used by the MPU to proceed through a programme step-by-step.

Stack pointer: A section of the memory is called "the stack". Each new byte to be stored in the stack will be stored at a location which is on top of all the other bytes which have previously been stored in the stack. Reading information from the stack is done one byte at a time starting with the byte that is on the top. Sometimes the stack is described as a "last in first out memory". The stack pointer is a register which contains a two byte address that specifies the vacant location on top of the stack. The use of the stack will be discussed later.

Index register: The index register is also used to store a two byte address and its use will be discussed in a later section of the article.

Accumulators: The two accumulators are used primarily to hold operands for, and results from, the arithmetic logic unit (ALU).

Condition code register: The condition code register (CCR) provides extra information on the results of operation performed by the ALU. It enables the MPU to be programmed to make decisions. When the ALU performs an operation the result of that operation is stored in accumulator A, accumulator B or the memory.

Additionally, various flip-flops (or bits) may be set in the CCR to indicate that, for instance, the result is negative, the result is zero or that overflow occurred. Two bits are set aside to indicate if a carry (or half carry) has occurred and one bit is called the "Interrupt Mask Bit"—more about that later.

It is possible, under programme control, to examine (or test) the state of individual bits within

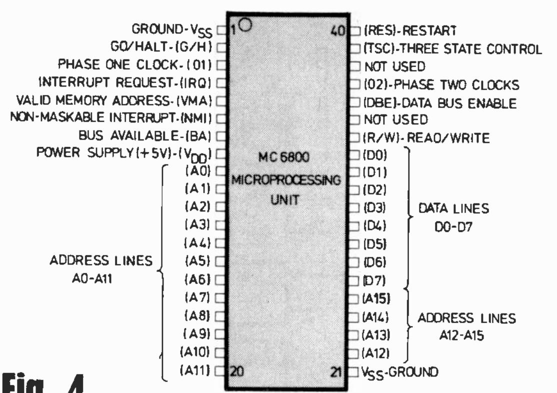


Fig. 4

the CCR following an operation. For example, bit N in the CCR is set to "1" if the result of an operation is negative. A programmer could say:

A. Carry out instructions 1, 2 and 3.
B. Instruction 4. Does bit N = 1? (bit test). If N = 0 return to instruction 1. If N = 1 proceed with instruction 5. In other words, the sequence of instructions being carried out by the machine was made dependent on the sign of the result through the use of a CCR bit test.

Fig.3 shows the main interconnections in a typical MPU system. The address bus is 16-bits wide and provides the means by which the MPU selects a particular memory location or output device. The data bus is 8-bits wide and is bi-directional. That is, the buffers in each integrated circuit connected to the data bus can function as either inputs or outputs.

The MPU itself is housed in a 40-pin dual-in-line package as shown in Fig. 4. In all, 26 of these pins are taken up by the previously discussed address and data highways, and the +5V and common lines of the power supply. Another two are used by the 1MHz two-phase clock generator needed by the system. The functions of the remaining pins are as follows:

Pin 2. $\overline{\text{HALT}}$: When this input is taken to logic "0" all activity in the machine is stopped.

Pin 39. Three-state control: A logic "1" input on this pin will cause all of the address bus buffers and the Read/Write line (pin 34) to go into a high impedance state—in other words turning them off. External equipment can now use the address bus to directly access the memory without involving the MPU in the process (Direct Memory Access—DMA).

Pin 34. Read/Write: The MPU has two basic modes of operation—read and write. In the read mode the MPU is in a condition to accept information from either the memory or from input/output devices. In the write mode the MPU will send out information to either the memory or the input/output circuits. The MPU informs the rest of the system that it is in the read mode by applying logic "1" to the read/write output.

When the MPU is in the write mode the read/write output is at logic "0". Normally, when the MPU is in the standby mode (waiting for work) the read/write output will be logic "1". When either the $\overline{\text{HALT}}$ input is at logic "0" (machine halted) or the three-state control input is high (DMA), the MPU read/write output will be put into a high-impedance state.

Pin 5. Valid memory address (VMA): When the MPU has placed a memory address on the address bus, the VMA output goes to logic "1". This signal is used for control purposes.

Pin 36. Data bus enable: When this input is in the logic "0" state the data bus driver circuits are held in a high impedance state for DMA applications. Normally this input is driven by the clock. Additionally, the data bus drivers within the MPU are also disabled internally every time the MPU goes into the read condition.

Pin 7. Highway available: This output is normally in the logic "0" state unless either the $\overline{\text{HALT}}$ line is at logic "0" (halt machine) or the MPU has just executed an instruction to "wait." In both of these two conditions the Highway available output will go to logic "1"—indicating to other circuits the MPU has stopped and that the address highway is vacant, and all "three-state" output drivers will be put in their high impedance condition. The MPU is removed from the "wait" state when a valid interrupt occurs (see later).

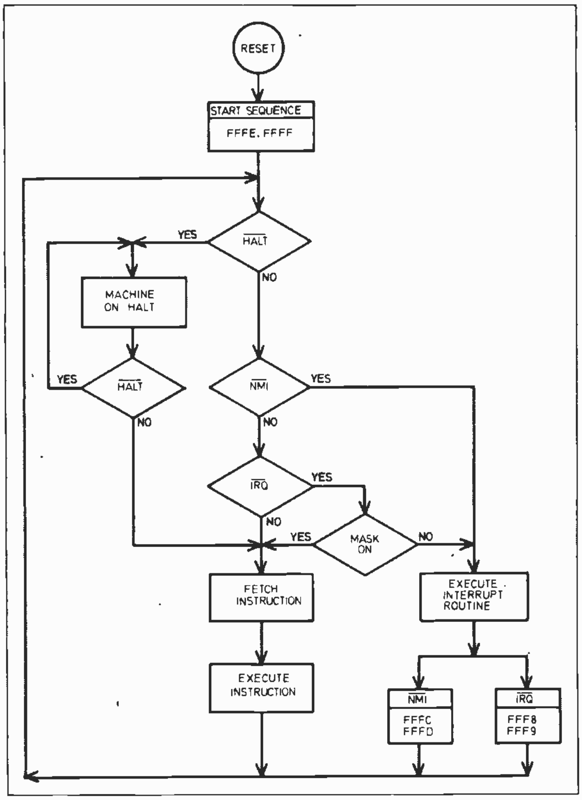


Fig. 5

Pin 4. Interrupt request (IRQ): A logic "0" on the IRQ input will cause the following sequence of events:

1. The MPU will complete the instruction it is currently processing.
2. The Interrupt mask bit in the condition code register is examined. If this bit is "1" it means that the processor is processing a previously requested interrupt and the MPU will, therefore, ignore the new interrupt request until it has completed all the instructions in the interrupt programme it is currently servicing. If the Interrupt mask bit is at logic "0", the MPU enters an interrupt routine.
3. The contents of the index register, programme counter, accumulators and the condition code register are stored in the memory in the previously mentioned stack.
4. The MPU now responds to the interrupt request (having ensured that all the information it was processing has been safely stored away) by setting the mask interrupt bit to logic "1". This ensures that the MPU cannot respond to any new interrupt request.
5. The MPU now addresses a known location in memory where the first instruction for the interrupt service programme will have been previously stored.
6. The last instruction in the interrupt programme will be RTI (Return from Interrupt).
7. On receipt of this instruction—having completed the interrupt programme—the MPU recalls the data it stored away in the stack and continues from where it left off.

Pin 40. Reset: Whenever the MPU is first switched on, or after a power failure, the MPU has to go through an initialisation routine before it can commence operations. A positive going pulse on the Reset input causes the processor to begin its restart sequence. During the sequence the interrupt mask bit in the code condition register is set to "1" to prevent interruption. At the end of the sequence the MPU will output a known address to provide the MPU with the address of the first instruction to be performed.

Pin 6. Non maskable interrupt (NMI): The application of a logic "0" on this input begins a chain of events which is very similar to the interrupt request sequence, but which has one major difference. The NMI input is used to inform the MPU that a task awaits which has the highest possible priority.

The MPU, on receipt of the NMI signal, enters the interrupt routine without regard for the condition of the interrupt mask bit. However, the MPU completes its present instruction and stores the contents of the various registers away in the stack before starting the high priority programme.

At the end of this programme, when it encounters the RTI instruction, the MPU will return to its previous task.

The whole operation of the MPU is summarised in the flow chart of Fig. 5.

Next month:
The language and programming of the MPU

APRS 75

Some of the highlights from the Association of Professional Recording Studios exhibition held recently in London.

THE APRS exhibition offered its usual spectacular display of state-of-the-art professional audio equipment. Although one would expect the general poor economic situation to severely affect development in this field, if it has it was not obvious at the exhibition. With over 70 stands almost every aspect of sound processing was covered.

C.R.T. LEVEL MONITORING

An impressive display of various forms of program level monitoring equipment was given by the Danish firm N.T.P. One such device uses a conventional colour t.v. monitor as a multi-channel display unit. Keeping an eye on a large number of programme meters (as is required in multi-track recording) can be extremely difficult. This unit, however, makes the process much easier by bringing all the channels together on a t.v. screen. Channels may be grouped together and/or colour coded for easy identification. They have even incorporated an overload arrangement which causes the overload portion on the display to go red.

DELAY UNIT

H.H. Electronics, makers of high quality power amplifiers, have recently added a portable echo delay unit to their range. It is capable of single or multiple echoes with the facility of variable time delay. Working on a tape-loop system with a fixed recording and moveable replay head, it can achieve continuously variable delays (or times between echoes) of between 100 and 720ms. The unit also incorporates a compressor to allow a large range of input levels to be accommodated.

AUDIO PROCESSING

Audio & Design were demonstrating their range of audio processing equipment. An interesting new product in this line is a band-selective compressor. A normal compressor attenuates the whole programme signal when operating. With this unit, however, one can select a particular frequency band and only operate on that. It can, for instance, act as an extremely effective "de-esser" (a device which removes high level sibilants thus reducing the possibility of associated distortion). It will no doubt find popularity in the disc-cutting field.

TAPE RECORDERS

The new Studio 8 tape recorder from Ferrograph (Wayne Kerr were responsible for most of the development work) was on display. It has been well received by the professional recording field and such features as state-of-the-art logic systems, fibre optics, and choice of editing facilities no doubt help it along in this respect.

Leevers-Rich have introduced a new $\frac{1}{4}$ inch tape recorder known as the Proline 2000. Servo controls in its capstan and tape tensioning systems as well as optoelectronic techniques are a few of its prominent features. Also from Leevers-Rich is a cassette transport system aimed at Broadcasting, Studio, and Educational use.

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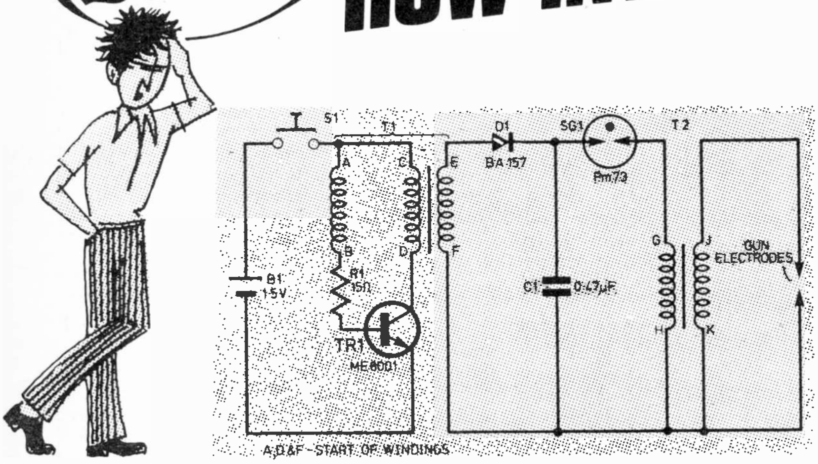

PRIZES

★ **1st Prize £250**

★ **2nd Prize £100**

★ **3rd Prize £50**

Fifty Other Prizes for Runners Up

★ **25 Magispark Gas Ignitors**

★ **25 One-Year Subscriptions to Practical Electronics**

When you saw the Portable Gas Ignitor in the July issue of *Practical Electronics* did you immediately think of other applications for this particular circuit? Can you suggest any ways in which the device could be put to other uses in industry or in the home? If so, here's an opportunity to put your ideas to good advantage. And if you missed the July issue, not to worry—the circuit and the essentials of its operation are given on this page.

In association with the Plessey Company, we present this fascinating challenge and offer prizes totalling over £500 in value for really practicable and ingenious ideas. And a chance, possibly, to see your idea in production! So get that grey matter plus your know-now of electronics working, and meet our challenge right away!

HOW TO ENTER

The contest is for practical applications of the Portable Gas Ignitor Circuit—either utilising the original circuitry or including design modifications to increase its scope.

To remind you, the operation of the Ignitor is:

The application of a high voltage across a pair of electrodes produces an electric field in the gas between them, this leads to ionisation and breakdown of the gas producing a spark across the gap. When the circuit of the ignitor is completed current flows from a battery into a transistor oscillator circuit and the resultant pulses of energy charge a capacitor to approximately 300 volts The capacitor is then discharged by an electronic switch into the primary of an H.T. transformer which produces the necessary voltage to cause the sparks at the electrode. The design enables a steady stream of sparks at 10,000 V to be generated with complete safety and employing only a single 1·5V dry cell as the power source.

Entries must be written/drawn clearly on one side of plain paper with the entrant's full name and address at the top of every sheet. Each entry to comprise:

(a) a brief summary of the idea (about 25 words)

(b) any such further lucid description, drawings, sketches or circuit diagrams you consider the judges may need to form the best appraisal of your idea. DO NOT send actual models.

Each entry must have a properly completed entry coupon firmly affixed to the BACK of the summary.

SECOND CHANCE!

The closing date is Monday October 13, 1975, to allow plenty of time for you to obtain the second entry coupon from our next issue and post two different ideas in one envelope if you wish.

RULES AND CONDITIONS

There is no entry fee nor limit to the number of entries a reader may submit but each entry must be accompanied by a proper printed entry coupon, cut from PRACTICAL ELECTRONICS, and must bear the entrant's own full name and address. Entries will also be accepted from groups—in which case the entry coupon must be completed by one of the group and the names and addresses of all the other members listed on a separate piece of paper affixed, with the entry coupon, to the back of the summary.

All accepted entries will be examined by a panel of expert judges, including Plessey engineers and the Editor of *Practical Electronics*, and asssesed on (a) originality of the idea, (b) technical merit, (c) practicability, (d) economic viability, (e) market potential. The prizes will be awarded for the best entries in order of merit. No entrant may win more than one award. In the event of the same idea being submitted by two or more entrants, presentation of the entry (clarity, best expression, etc) will decide such winner(s) or winning order.

In the event that the judges consider there are not enough entries of a sufficiently high standard, the Editor reserves the right not to award any prize(s) at his discretion.

Entries arriving after closing date will not be considered, nor will any received that are illegible, not wholly understandable, are not accompanied by a properly completed entry coupon or in any other way do not comply exactly with the instructions and rules.

No responsibility can be accepted for entries lost or delayed in the post or otherwise; proof of posting will not be accepted as proof of receipt. No entries can be returned.

Copyright of all entries shall become the property of IPC Magazines Ltd., publishers of *Practical Electronics*. Ideas submitted may be used or adapted by the competition sponsors for production or other commercial use. Where appropriate, additional payment will be automatically negotiated with the entrant. Entries will not be published prior to evaluation in order to comply with legal safeguards.

Decisions of the judges, and of the Editor in all other matters affecting the competition, will be final and legally binding. No correspondence will be entered into nor interviews granted.

Winners will be notified by post and brief details of winning entries published later in *Practical Electronics*. The Editor reserves the right to amend and/or re-draw any sketches or diagrams of prizewinning entries for publication purposes.

The contest is open to all readers in Great Britain, Northern Ireland, Eire, Channel Isles and Isle of Man except employees of IPC Magazines Ltd., the Printers of Practical Electronics, and the Plessey Co. Ltd. and its subsidiary companies; and the families of all such employees.

Post your entry in a sealed envelope to: Ignitor Application Contest, PRACTICAL ELECTRONICS, 136 LONG ACRE, LONDON, WC2E 9QP, to arrive not later than October 13, 1975 the closing date.

FREE ENTRY COUPON

NAME (Mr/Mrs/Miss) ....
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I certify that
*** delete clause NOT applicable**

*** (a) this entry is of my own original idea and has not been copied from any other source.**

*** (b) this entry is made on behalf of the group members listed, and is our own original idea not copied from any other source.**

(c) this idea has not been published—or offered for publication elsewhere.

I/We agree to abide by the rules and conditions, and to accept the published result as final and legally binding.

SIGNED ....

BOOK REVIEWS

HI-FI FOR THE ENTHUSIAST

By M. L. Gayford
Published by Pitman
235 pages, 222 m.m. × 140 m.m. Price £5.00

This is the second edition of a work first published in 1971 and the contents have been expanded to take in developments such as quadraphonic sound.

This book ranges over the whole gamut of equipment from input to output. But first it deals with the *end*—to which all these items are but the *means*. The first chapter explains simply the nature of human speech and hearing; the human vocal and auditory systems are examined; psycho-acoustical factors such as perception of pitch and sound pressure, the need for two or more channels for exercise of our full psycho-acoustical powers, stereophonic and quadraphonic systems, room acoustics and placement of loudspeakers are discussed.

The bulk of the book is concerned with hardware, and sets out to serve the needs of would-be purchasers of audio equipment who lack any extensive technical knowledge by indicating the features and performance that should be looked for when selecting complete units or kits for home construction, to form a sound reproduction system.

The description of f.m. broadcasting and reception and the typical f.m. tuner specification given are more suited to the technically knowledgeable; to the non-technical person the terms and expressions will be largely meaningless, although a nodding acquaintance as gained through a study of this book will possibly help when reading manufacturers' sales literature or listening to salesmen.

This point also applies to the sections dealing with other programme input sources and with amplifiers. A few typical circuits for commercial tuners and amplifiers are included, but component values are omitted—at the instance of the proprietors, no doubt.

The two chapters dealing with loudspeakers and enclosures are likely to be particularly valuable to the lay reader and merit close study. This final link is perhaps the most important, and choice and selection of loudspeakers must be based very considerably on personal preferences.

Recommendations are included on planning a complete high-quality system. There are diagrams of commonly used audio connectors and cables. A Glossary of Hi Fi and radio terms, lists of recommended books, and a list of gramophone test records are useful appendages to this book.

J.V.

A GUIDE TO AMATEUR RADIO (16th Ed)

By Pat Hawker, G3VA
Published by Radio Society of Great Britain.
112 pages, 248 m.m. × 182 m.m. Price 90p.

This latest edition is as welcome as all its forerunners. Those who are not addicts of amateur radio will find this an illuminating read. It could convert them before the final page is reached.

No one is better able to "sell" home radio than Pat Hawker—an ardent activist in the game and an acknowledged authority in the related technical matters.

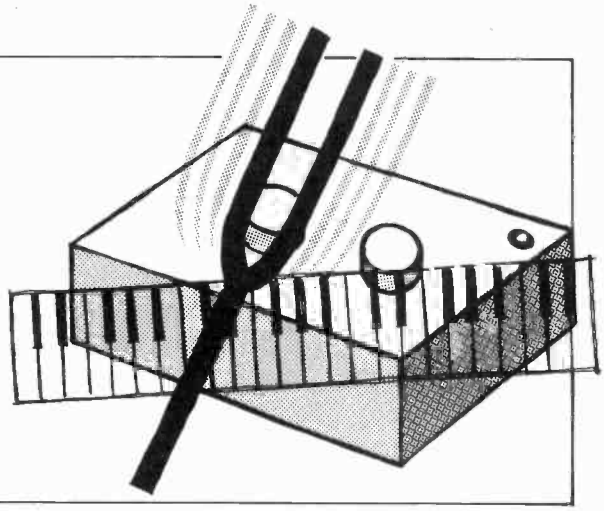
Those who already have a hankering after radio communication will find the answers to all their immediate queries in this publication.

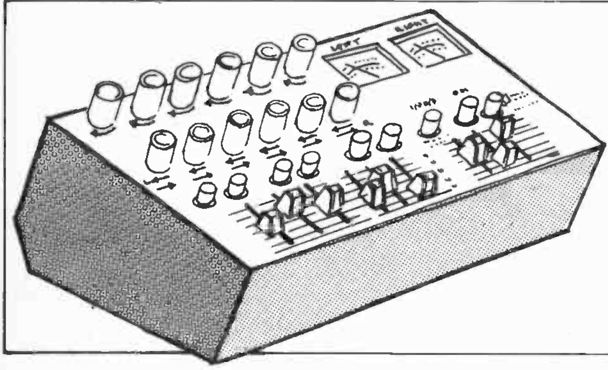
The recent changes in UK amateur regulations are covered. Guidance on the latest developments in technique and equipment is given, and a new chapter on popular amateur radio equipment is incorporated.

PE NEXT MONTH...

ELECTRONIC TUNING FORK

Completely simplifies the tuning of musical instrument by providing 84 frequency-accurate tones which can be instantly switch selected. All beat note adjustments are clearly visible on a l.e.d. monitor





MINIMIX 6

A compact low cost, battery operated, six-channel stereo mixer with such features as: panning controls, comprehensive headphone monitoring facilities, twin VU meters, and prefade monitoring on all channels. Although designed with synthesisers (such as the P.E. Minisonic) in mind, the unit is nevertheless capable of a much wider range of applications

ENGINE ANALYSER

This month's article contains full constructional details for building the dwell/tachometer unit complete with calibration procedures

Ensure YOUR future issues

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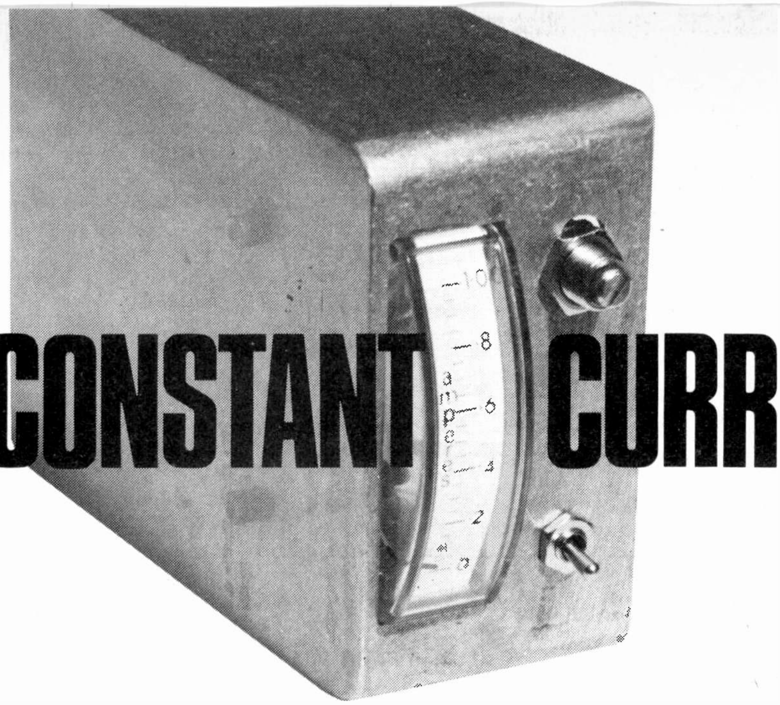


CONSTANT CURRENT LOAD

By D. W. LLOYD

An easily adjusted load for p.s.u.s and amplifiers

WHEN experimenting, particularly with power units and amplifiers, a constant current load is often required. The unit described here was designed to serve just that purpose being easily adjusted by a potentiometer to give the required loading effect.

The load is constant for a.c. as well as d.c. inputs within the range of 4–30V. As the unit is not polarity conscious it may be used with d.c. circuits either way round, that is, the positive and negative terminals on the circuit being loaded may be reversed and the constant current load will still work correctly. The a.c. loading capability of the unit makes it ideal for checking transformers by simply connecting the load across the secondaries and adjusting the unit to draw from the required current.

REFERENCE LEVEL

To enable a constant current to be generated a reference level must be obtained which should be very stable, this can be obtained from across a Zener diode fed with a series resistor from the supply being loaded. For good constant current stability this method will not produce the best results, because as the input voltage varies so the current through the Zener will vary which will in turn vary the Zener level very slightly. So for the best results the supply to the Zener should be stabilised. This starts to increase the cost of the unit so to overcome this problem it was decided that the only way to ensure a constant voltage to supply the reference Zener was to use an internal battery.

The battery chosen to do the job was a 9V type which fed a 3·3V Zener diode which meant dropping 6V across a resistor. As batteries are being used it is essential that the current to the reference Zener is kept to a minimum so a current of 2·5mA was chosen. This gave a low drain on the battery.

A switch is incorporated into the unit to switch the battery out, this will save the battery and a life of 12 months can be reckoned on.

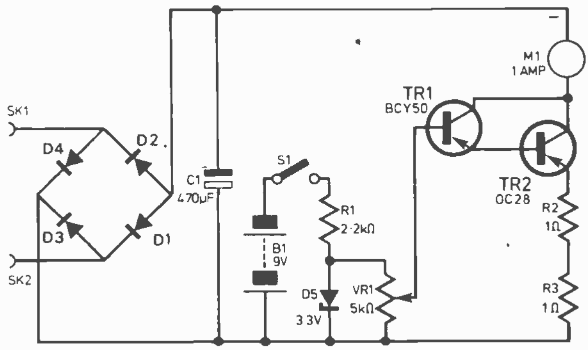


Fig. 1. Circuit of Constant Current Load

COMPONENTS . . .

Resistors
R1 2·2kΩ ½W
R2–R3 1Ω 2·5W vitreous wirewound (2 off)

Capacitor
C1 470µF elect. 100V

Rectifiers
D1–D4 Bridge Rectifier (1A)

Potentiometer
VR1 5kΩ

Transistors
TR1 BCY50
TR2 OC28

Meter
M1 1A d.c.

Diode
D5 3·3V 400mW Zener

Sockets
2mm terminal sockets (2 off)

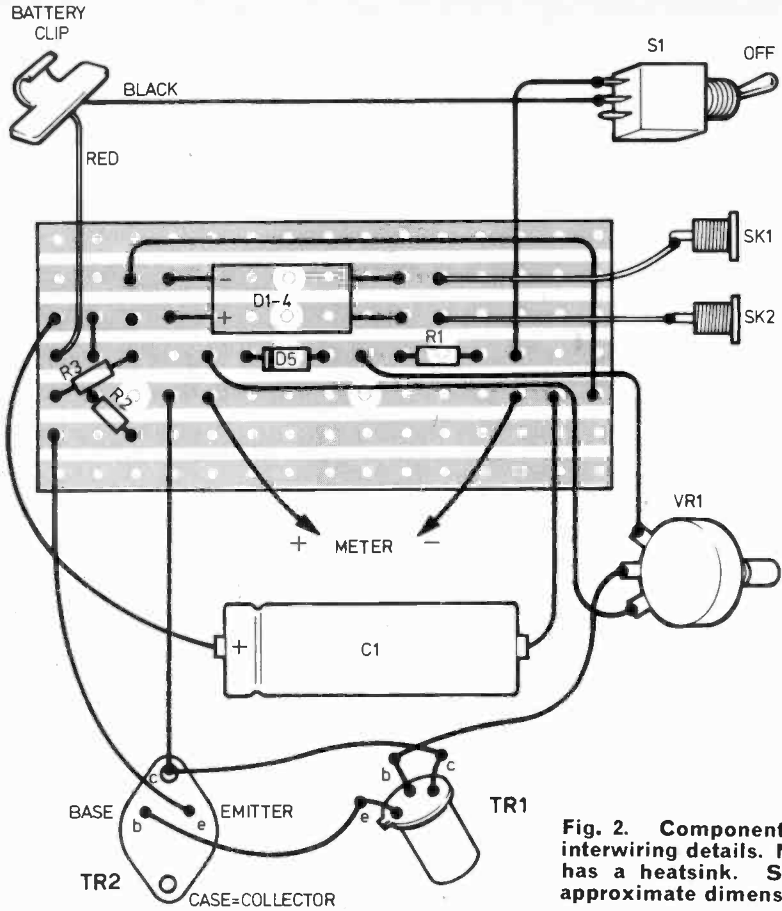
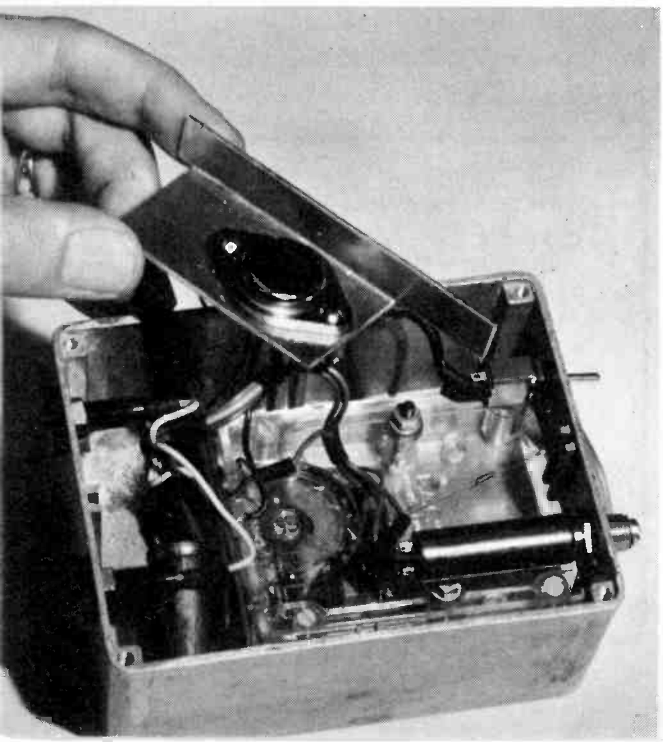


Fig. 2. Component layout and interwiring details. Note that TR2 has a heatsink. See photo for approximate dimensions

The circuit operation is very simple and with the transistor specified a constant current of 1A can be drawn from a circuit of 25V this can be increased by paralleling another power transistor with the one already in circuit, this will enable the voltage to be doubled at the same current or the voltage can remain at a maximum of 25V and the current may be doubled, see Fig. 1.



Keeping to the very basics in this design has enabled the price of the unit to be very low and if all of the components were to be purchased new then the total cost will not exceed £5.

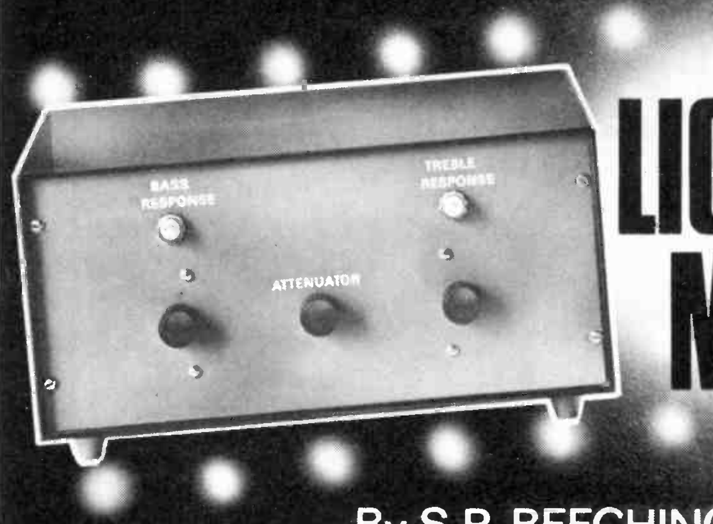
ZENER RESISTOR VALUE

The Zener resistor value is calculated to draw from the battery a current of only 2·5mA. Which can be switched off when the unit is not in use. To enable the unit to be fairly universal the load is formed by arranging TR2 to take a constant current of 1A maximum. With a gain of only 20 for the transistor used, a base current of 50mA would be required which is far too much current for B1 to supply. A further transistor connected to form a super-alpha pair gave an overall gain equal to the gain of TR1 times the gain of TR2 that is, 50 × 20 so that an input of only 1mA will give 1A which is well within the capabilites of the small battery.

EMITTER LOAD

As the unit represents a load which draws 1A resistance is necessary in the emitter of TR2 to enable the circuit to function properly. R2 and R3 are each 1ohm, which will develop an emitter voltage drop of 2V. With 2V at the emitter of TR2 a base

continued on page 831



LIGHT MODULATION UNIT

By S.R. BEECHING

A Two-channel Sound to Light Converter

THE main features of this Light Modulation Unit are its simplicity, reliability and accurate transformation of audio input to audio modulated 50Hz 240V mains current. Before any description of the circuit it is felt that the choice of a two-channel unit as opposed to three should be defended. The two-channel light unit described provides good separation of the bass and treble frequencies without the use of complex filters, which may require high stability low tolerance components.

With a larger number of three-channel systems it is often difficult to discern which channel is which, as they all appear to be behaving similarly. With the middle channel removed the difference between the two channels can be readily seen with the added advantage of the electronics being simpler.

ISOLATING TRANSFORMER

The circuit is shown in Fig. 1. The input is isolated by a speaker isolating transformer rated at 5W with a series resistor incorporated to prevent damage both from and to high powered amplifiers. (This can be increased in case of doubt).

The input sensitivity is about 1V r.m.s. and a suitable signal can be obtained from the speaker outputs of the power amplifier.

The common line of the electronics is mains neutral, and it must be borne in mind that since the live side of the supply can easily be made common by a simple mistake in the wiring extreme care must be taken. The signal is taken from T2 secondary to VR1 which acts as an input attenuator. Attenuators VR2 and VR3 then adjust the treble and bass light levels respectively.

CIRCUIT DESCRIPTION

TR1 and TR2 and associated components from the filter stages. The bass filter operates in the "Miller Integrator" fashion with C7 connected between the collector and base of TR2.

Capacitor C2 and the input impedance of the stage comprising TR1, R3 and R4 form the high pass

COMPONENTS . . .

Resistors

R1 75Ω	R7 2·2kΩ	R13 1kΩ
R2 68Ω	R8 22kΩ	R14 470Ω
R3 22kΩ	R9 2·2kΩ	R15 470Ω
R4 2·2kΩ	R10 1kΩ	R16 220kΩ
R5 1kΩ	R11 68Ω	R17 220kΩ
R6 68Ω	R12 1kΩ	

All resistors ½W 10% carbon

Potentiometers

VR1–VR3 10kΩ 1in. plastic slider controls—see text (R.S. Components)

Capacitors

C1 1000μF 25V elect.
C2 4·7nF plastic or ceramic
C3 4·7nF plastic or ceramic
C4 0·1μF plastic or ceramic
C5 10μF 6V elect.
C6 22μF elect.
C7 0·1μF plastic or ceramic
C8 0·1μF plastic or ceramic
C9 470μF 10V elect.
C10 22μF 25V elect.
C11 22μF 25V elect.
C12 0·1μF 400V polyester
C13 0·1μF 400V polyester

Semiconductors

TR1–TR2 BC107
D1–D4 IN4001 (or bridge rect.)
D5–D6 IN4148
CSR1–CSR2 BRY39
CSR3–CSR4 40430

Miscellaneous

T1 240V to 12V 100mA (R.S. Components)
T2 Universal speaker isolating transformer (R.S. Components)
L1–L2 3A t.v. chokes (R.S. Components)
Case—see text, wire and solder etc.

filter for the treble channel. Capacitor C3 causes the response of the filter to fall off at higher frequencies to prevent spurious responses to spikes generated in the triac circuitry.

If it is found that instruments with predominantly h.f. output are not causing the treble channel to respond, C3 may be reduced; but the above point must be borne in mind.

SILICON CONTROLLED SWITCHES

The filter outputs pass via C4 and C8 to the triac drive circuitry. This consists of two BRY39 silicon controlled switches (CSR 1 and 2) which conduct giving a pulse of current to the triac gate when their anode (pin 4) is driven more positive than their anode gate (pin 3). Resistors R14 and R15 load the BRY39 and hold the triac gate to the common line to prevent spurious triggering.

During continuous switching, the voltage across C10 and C11 will reduce. Gate current to the triacs will then be determined by the value of R12 and R13. These are therefore chosen to be able to provide this current since if they are too large the triacs may fail to trigger under conditions of continuous firing.

DIODES

Diodes D5 and D6 prevent C4 and C8 from charging up with the firing current of the SCS's. On negative signals the diodes conduct so that positive signals can be passed through the capacitors into the gates of the SCS's.

R.F. CHOKES

The r.f. chokes have been incorporated in the circuit to reduce any r.f.i. from the triacs. Three amp types were used in the prototype but if the full current capacity of the triacs is to be exploited these should be uprated to 6A.

MONITORING

Each channel drives a neon bulb to allow monitoring of the state of the display bulbs if they are remote from the unit. The neons also provide a means of checking that the displays are connected, since they will glow dimly without the displays due to the small current passed through C12 and C13. As soon as the displays are in circuit the neons will no longer glow as the small leakage current will then be shunted via the displays to neutral.

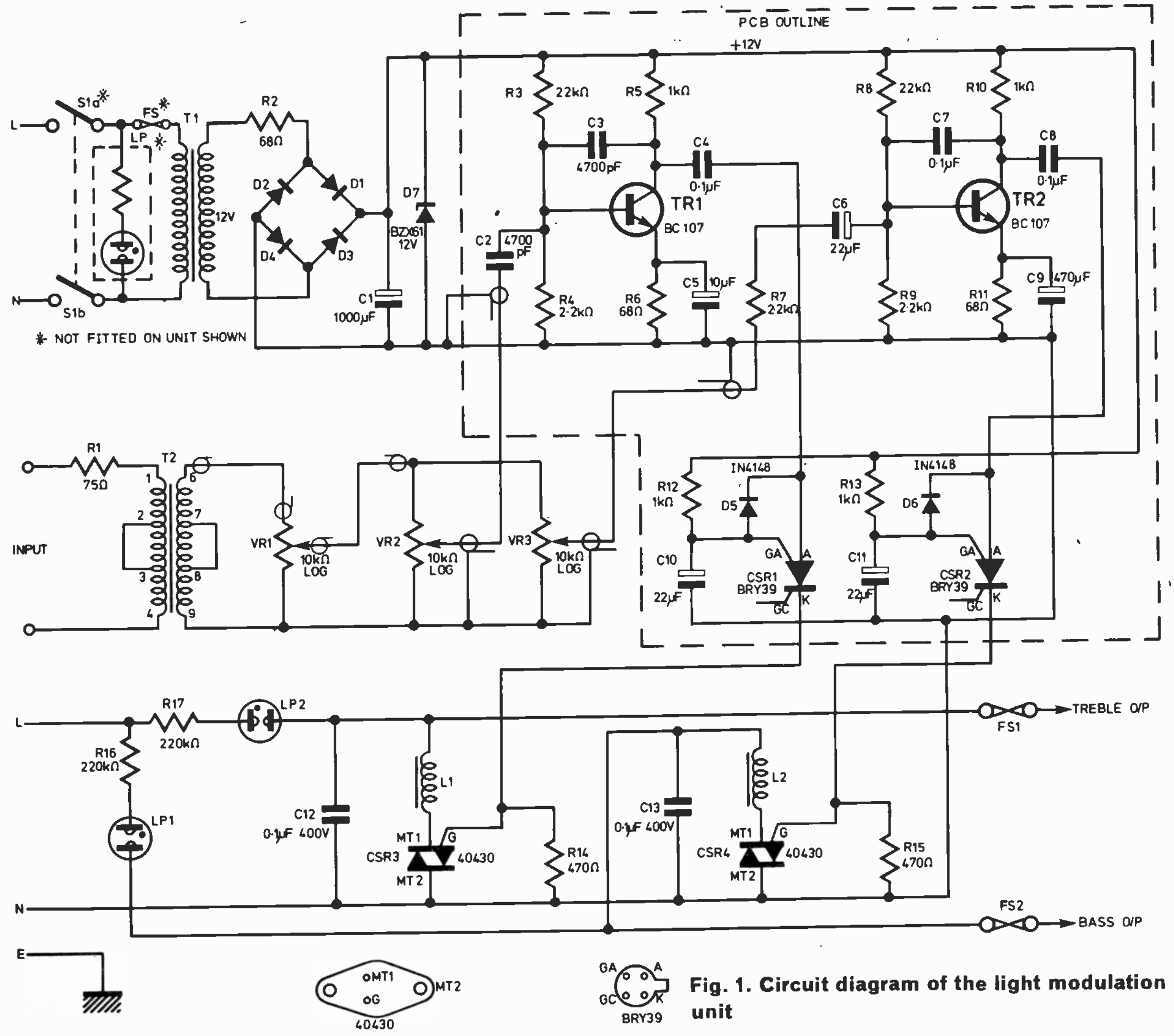
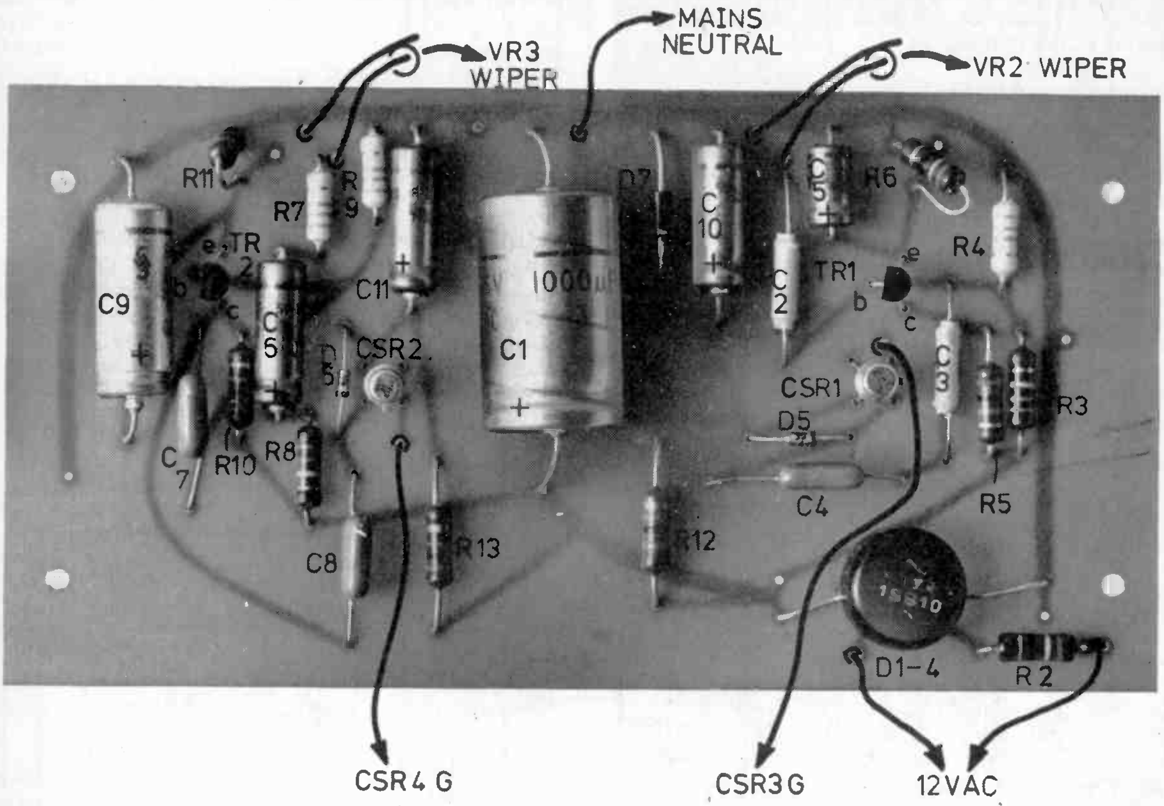


Fig. 1. Circuit diagram of the light modulation unit

CIRCUIT BOARD DETAILS



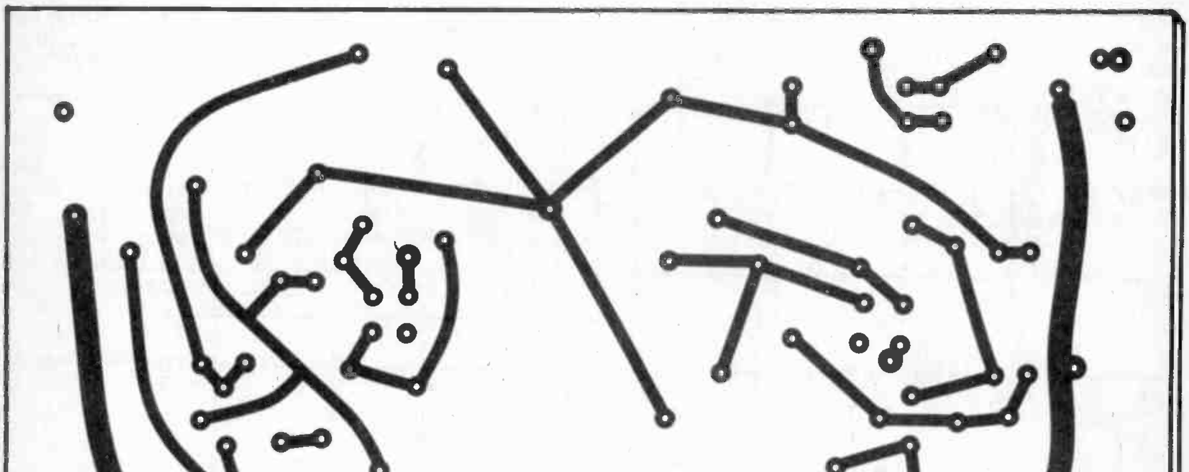
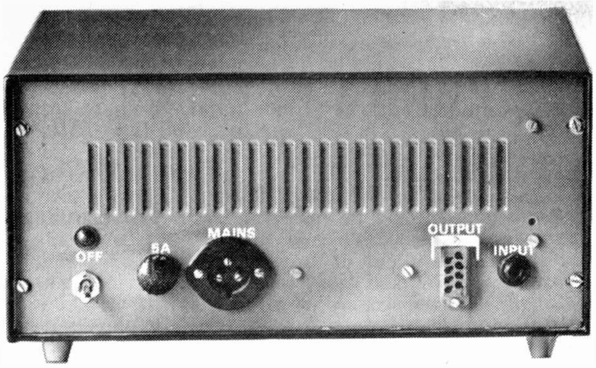


Fig. 2. Component layout and printed circuit board master (full-size)



CONSTRUCTION

The printed circuit board master and component layout is given in Fig. 2.

During construction remember that a *live* chassis technique is used and so extreme care must be taken. A wooden or metal case may be used but the metal case must be earthed and the electronics and wiring insulated from it. The output sockets should be 5A or 13A and insulated from the case. For the input attenuators R.S. slider controls are recommended as they are plastic. If rotary potentiometers are used however, they should have nylon shafts. Care must be taken with the wiring of these components as screened cable is used; ***the screening is live and must be insulated from the metal case.***

Wiring details of the unit are shown in Fig. 3. The common (neutral) line is wired from the input to the triacs which are mounted on a heatsink. The cable used should be able to withstand the current (6A) and be adequately insulated. The live mains is wired straight to the output sockets and to the bulbs; it is also wired to the neons and transformer. Both triacs are mounted on the same heatsink. They are insulated by mica washers and as a further precaution it is recommended that the heatsink is insulated from the chassis by pillars or nylon nuts and bolts.

Resistors R14 and R15 are mounted across the triac pins. If wiring to the pins is difficult then insulated mounting tags can be used. The chokes can be mounted between the triac cases and the fuseholders.

DISPLAYS

Finally a word about the displays that have been used. Small wattage bulbs (15W–60W) produce a very rapid 'flashy' effect, whilst the higher wattage bulbs (100W–500W) are much slower due to filament heating time (thermal inertia). Two 500W spots with colour change wheels focussed on the same white wall will produce an ever-changing colour, which varies according to the colour wheel, and the amount of colour mix dependent on the quantities of bass and treble.

At the other end of the scale large numbers of 15W pygmy bulbs in a matrix can produce an exciting display. An enhanced effect can be obtained by wiring the bulbs in fixed patterns which can be switched by relays as well as driven by the light unit. One similar to this was built into an old t.v. cabinet with frosted glass and used as a mobile discotheque. There are no limitations to the display technique and the constructor will be able to spend many hours devising his own. ★

CONSTANT CURRENT LOAD

continued from page 826

voltage of 2V + V_{be} of TR2 + V_{be} of TR1 must be present at TR1 base. The V_{be} of an average transistor is around the 0·3V level so the base voltage of TR1=2V ±0·3V + 0·3V=2·6V. This determines the Zener level which must not fall below this level and so a Zener of 3·3V was used to ensure adequate forward bias at a loading of 1A.

To allow the level to be adjusted the voltage to the base of TR1 is obtained from the wiper of VR1 which is connected across the Zener diode thus as the potentiometer is rotated anticlockwise the voltage at the base of TR1 decreases until zero is reached. At this point the transistor is reverse biased and so cut off and represents no load. As VR1 is rotated the transistors become forward biased and will conduct more and more until the full load of 1A is reached. The dissipation of TR2 must be kept to around the 30W region and so the maximum voltage applied must be limited to 30V. It is connected to a heat sink in direct contact with the diecast box.

BRIDGE CIRCUIT

How does the unit act as a constant load for both a.c. and d.c. circuits. If we consider the unit being used with a d.c. supply first of all it can be seen that with a positive supply at socket SK1 and negative at SK2 then conduction will be via D4 and D1. If the d.c. supply was reversed that is with the negative line at SK1 and the positive at point SK2 then the negative supply to the transistors will be provided by D2 conducting and the positive will be supplied via D3 once again ensuring that the polarity of the supply is correct for the load circuit.

Diodes arranged in this form are said to be in a bridge network and they will provide a rectifying circuit for an a.c. supply that may be connected across the input sockets. After some smoothing from C1 a d.c. signal is obtained and supplied to the transistors as described before. The ammeter connected in series with the super-alpha circuit so that the load current is displayed continuously.

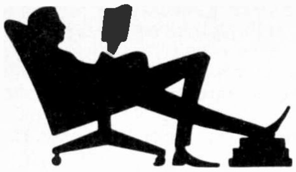
CONSTRUCTION

Constructional layout is determined by the meter used. In the prototype unit an edge meter was used. Of course terminals can be arranged so that an external meter may be used or an Avometer. The transistor TR2 is mounted onto a heatsink, using insulators to ensure that there is no electrical connection to the case. This can be checked by connecting an ohmmeter across the transistor and the heatsink the reading obtained should be infinity.

Vero board has been used for the circuit assembly and requires cutting in the places indicated in Fig. 2.

TESTING

With the reference voltage switched on check with a voltmeter that the voltage across the Zener diode is greater than 2·6V. With an ammeter in series with the unit connect it to a d.c. supply of approximately 15V and adjust VR1. Both meters should coincide over the full range of the unit. Now reverse the leads from the power supply and check that the meters still track togther. Remove the test meter and the unit is now ready for use. ★



BOOK REVIEWS

THE STORY OF RADIO (8 Volumes)

By W. M. Dalton
Published by Adam Hilger
Each Vol.: 150 pages, 215 mm × 150 mm
Price £4·50

THE STORY OF RADIO is intended to extend to eight volumes in all. To date Volumes 1, 2 and 3 have been published.

Each volume is a first-class hardback production, with many line diagrams and photographs of technical and historical interest. The price of each volume makes this add up to a formidable total for the complete work. One is inclined to question the publishing policy: few readers are likely to be interested only in *part* of the overall story, so there seems little justification for separating the work into so many volumes. Fewer volumes with more pages should have resulted in some economy in binding materials resulting therefore, one would expect, in a lower selling price.

What *kind* of story? Well this certainly is no romanticised tale, nor is it a ponderous exposition of scientific and technical development. The author has settled very successfully it seems (judging from these first three volumes) on a mid course and has produced a well researched account of pertinent scientific and technical discovery and invention before and since the advent of radio, or wireless telegraphy to use the more meaningful term.

In this story personalities are treated in a formal fashion, being introduced summarily (by surname alone) as their contributions to knowledge or invention are described. The objective and crisp style of presentation adopted undoubtedly avoids unnecessary distractions to and flow of the essential story. Yet the lack of a bibliography or an appendix giving key facts or source references for the work of these pioneers—some are very well-known figures, some lesser known—will be rather a disappointment to the more inquisitive student of technical history wishing to explore in more detail some of these discoveries, experiments, or inventions. This apart, this work should prove to be popular and provides a useful record of the technical landmarks in the history of radio. Those old enough will certainly relish wallowing in nostalgia, which will be further enlivened by the excellent photographs of equipment of bygone days and once-familiar circuits which are reproduced, together with many other line diagrams, in these volumes.

Vol. 1. How Radio Began

The first chapter retells concisely the principal known events in the long history of magnetism and electricity, the second describes the first practical and commercial uses of electricity—for signalling and for power. These two chapters are a prelude to the real story: this opens with accounts of the earliest investigations into electromagnetic radiation and first experiments in wireless telegraphy, the subsequent successes, and the kind of apparatus used. The final chapter covers the thermionic valve and the earliest valve circuits in the period up to the outbreak of the First World War.

Vol. 2. Everyone An Amateur

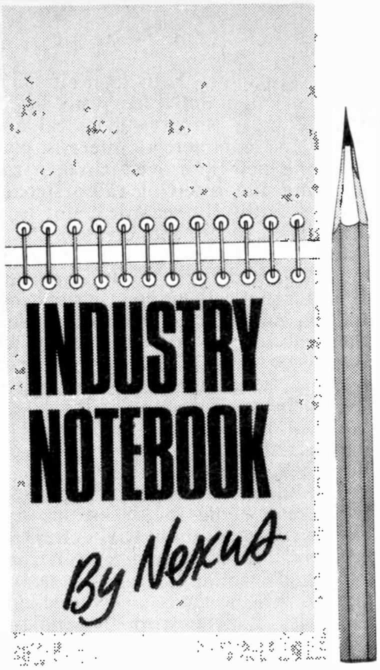
The story is taken up from the post World War 1 years. There are details of wartime uses and developments: especially noteable—radiotelephony in aircraft and directional finding. Amateurs had to wait until 1920 before restrictions on *their* activities were lifted. Then followed a period of great activity—technical and political. Both amateurs and commercial interests play their part in spurring along new improved circuits and new devices for transmitting and receiving radio signals. The amateurs' vital part is faithfully recorded, not least the agitation which finally lead to the creation of a broadcasting service, then to be followed by an epidemic of home construction of receiving sets. The important distinction between the large host of set constructors and the smaller band of transmitting and experimenting amateurs is made clear in the final chapter which deals with the rediscovery of short waves by amateurs and the ultimate usurping of these waves by government and commercial bodies.

Vol. 3. The World Starts To Listen

This volume is chiefly devoted to the rapid and extensive technical advances in commercial receivers during the period 1925-1930. The coming of mass-production, the emergence of many new types of valves and new circuit designs based on them. Developments in broadcasting techniques; the loudspeaker and the gramophone pickup.

The final chapter entitled "Telephones, Talkies and Television" introduces these and other new fields (as distinct from radio) where "radio-techniques" were also being applied at this time. What is outlined is in fact the dawn of "electronics" but that word has yet to enter *The Story of Radio*. Doubtless it will though, in some later volume of this immensely enjoyable, technically informative and (no doubt to the majority of present-day readers) quite revealing account of those past years of brilliant and exciting endeavour and achievement, which include a period when the amateur held a proud position as a pioneer and frequently set the pace for the professionals.

F.E.B.



BOOM OR BUST?

There has never been a more confusing time for industry watchers like myself. From all sides one hears gloom and doom and there is some truth in these stories. But not the whole truth. Consumer electronics has taken its biggest knock for years as forecast by myself and others earlier this year. Deliveries of colour t.v. sets have dropped severely following the imposition of higher taxes. But for the same reason monochrome sales have had a boost. Hi-fi and radio sales were also down.

But what is the norm? Might it not be the case that this year's sales are normal and last year's exceptional? Growth is bound to slow down once the market is saturated.

Well managed companies are not suffering. Those in professional electronics who also have a good export business are at their wits end to recruit staff and maintain deliveries. I have often stated in this column that in times of stress the little company with a flexible response to market changes has a better chance of survival. The big companies are, however, still performing not only well but admirably.

Plessey reports almost £320 million in sales, £27·3 million pre-tax profits, £40 million export. Not bad. Chairman Sir John Clark also commented on Britain's membership of the EEC and how it affected Plessey. In 1972 exports to EEC countries were £3 million. They are now £9 million.

With a courageous look in his crystal ball, Sir John suggests they may well be £40 million by 1979. Consumer components and Garrard record players have been hit by the consumer market slump but with overall trade figures so healthy, every Plessey business will survive and most are clearly prospering.

With sales of £1,500 million, profits up by £23 million to a record £174 million GEC is flourishing. Capital investment for the year was £78 million and this might have been more but for £85 million snatched in taxes by the Government.

With heavy dependence on the consumer market, Thorn Electrical pushed sales up to £807 million but all the headlines concentrated on the profit slump. Profit tumbled by £8·7 million. Sounds an awful lot until you realise that the "huge" drop still left Thorn with £65·4 million profit in what is officially described as "difficult market conditions".

SOLDIERING ON

Then there's Racal, soldiering on through boom, depression, recession. This company has again made record profits and has thus successfully achieved 20 consecutive years of record growth and record profits.

With still only £50 million turnover and 6,000 people employed Racal remains a medium sized company but is world leader in what it does best. The formation of Racal-Tacticom Ltd. in July brought together Racal-Mobilcal and Racal-BCC to form easily the strongest military manpack and mobile radio supplier in the world with a customer list of well over 100 armies.

More than 70 per cent of all Racal sales were overseas last year and in ground radio equipment Racal exported more than all its UK competitors added together. In 1970 Racal turned over £14·3 million with £1·7 million profit. Latest figures are £50·2 million with £9·5 million profit.

Look at British Aircraft Corporation with its record breaking Rapier missile and other aerospace interests. Turnover up from £174 million to £271 million and profits up from £13·7 million to £24·2 million. And the forward order book stands at a record £815 million.

An indifferent performer for a number of years, Ultra Electronics reports a £13 million forward order book. An all-time record. With £9 million turnover profits were £550,000, £142,000 up on the previous year.

The main British subsidiary of ITT, Standard Telephones and Cable, reports record sales of £333 million which included a sharp rise in export business. Profit was £33·8 million.

Naturally these figures, mostly a reflection of trading in 1974, need treating with some reserve because the effects of inflation tend to show "growth" where none exists. But the picture can hardly be regarded as gloomy.

The really dull spot is the instrument industry. The 60 leading companies, according to a recent analysis, after allowing for inflation are showing zero growth or even a loss in sales figures and many are only on the margins of profitability.

LADIES' YEAR

Mrs Mary Griffin has become president of the Scientific Instrument Manufacturers' Association (SIMA). She has served for several years as a SIMA council member and has been the association's spokesman on statistics and economic affairs.

Professionally she is a special director of Smiths Industries Ltd. and was awarded the MBE for services in export in 1970. With a background as a chemist and mathematician perhaps she will prepare an elixir to revive the fortunes of Britain's instrument makers followed by more heartening statistics during her period in office.

Dr Elizabeth Laverick has been appointed to serve on the Engineering Design Advisory Committee of the Design Council. After a distinguished academic start in life she was in industry for 20 years as a radar and microware expert, rising to be technical director of Elliott Automation Radar Systems Ltd. In 1971 she left industry to become deputy secretary to the Institution of Electrical Engineers.

It seems extraordinary that so few ladies enter electronics on the engineering side. I know of two qualified lady engineers at the M-OV division of the GEC Electronic Tube Co. Ltd., and a lady scientist at English Electric Valve Co. In Sweden recently I met the general manager of a semiconductor plant who was a she.

Here and there one comes across a lady craft apprentice but they are always demonstrated to visitors as being something of a novelty. At a recent international conference in Holland there were 200 engineer delegates of whom only one was a lady, French and slightly embarrassed at the preponderence of males.

And yet, of the total workforce in electronics, the majority are women but generally only engaged on the more menial tasks of assembly, although a few do emerge climbing the ladder of promotion in inspection and test departments.

How about it, girls? Unless you improve your performance in electronic engineering we shall have to conclude you are not as equal as you would have us believe.

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. Any idea published will be awarded payment according to its merits. Why not submit **YOUR IDEA?**

CAR ANTI-THEFT DEVICE

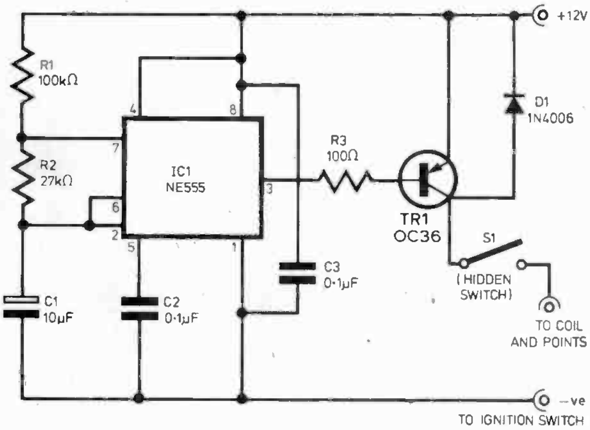


Fig. 1

Most car anti-theft devices use one or both of the following two principles:

(1) The ignition circuit is completely disabled, usually by means of a hidden switch.

(2) Any attempt to break into the car sounds the horn, flashes the headlamps, etc.

The first of these two approaches suffers from the disadvantage that the ignition circuit can usually be remade under the bonnet, using a piece of wire. The second approach leaves the car owner with the possibility of returning to his vehicle to find a flat battery and a group of disturbed local residents.

The device described here works by upsetting the timing of the car engine, causing it to run extremely roughly. It is assumed that any car thief would soon abandon a vehicle which refused to accelerate properly, performed kangaroo motions and generally appeared to be in need of some serious repair.

The circuit shown in Fig. 1 works as follows: IC1 is connected as an astable multivibrator, driving TR1. TR1 is turned on for about 0·25S then off for a further 0·95S repeatedly. If the points open when TR1 is on, no spark is generated and the engine does not fire. Due to the parallel connection of the points and TR1 there is no danger of the engine firing in the middle of a compression stroke or inlet stroke.

The circuit still operates even if a piece of wire is used to connect the battery negative to the ignition coil. The wire from S1 to the coil is best made as inconspicuous as possible.

For a negative earth car TR1 could be replaced by an *npn* device (2N3055). TR1 needs no heat sink as it is either fully on or cut off and dissipates little power.

P. J. Tyrell,
Ilford.

SIMPLE TIMER

The 741 and C1 form an operational integrator, the integration current being determined by the current flowing through TR1, see Fig. 1.

This in turn is determined by the setting of VR1 (R1 limiting the maximum base drive to a safe value). The integrator output is fed to R3 and R4 which turns TR2 on when the output reaches about 5 volts.

The circuitry around TR2 can be altered to suit the constructor's needs. For example, a relay could be operated instead of the l.e.d.

The timing range of the circuit as it stands is from less than a second to about 12 minutes.

A. MacNeil,
Great Bookham.

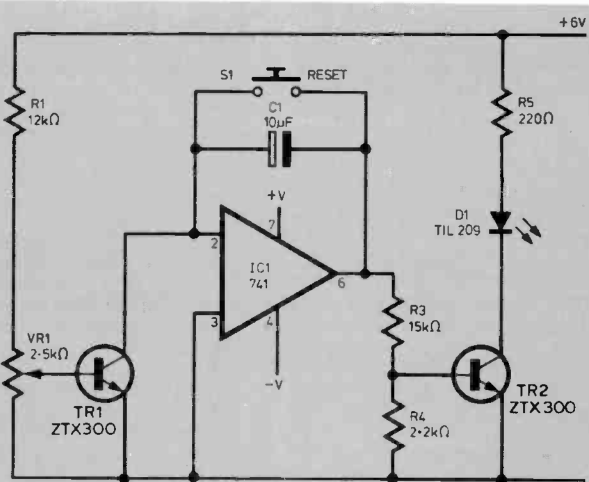


Fig. 1

LOW VOLTAGE PULSE GENERATOR

The circuit (Fig. 1) generates pulses in the audio range with very fast rise and fall times even when the supply voltage is as low as 0·8 volts, thus making it ideal for signal injector purposes.

In commercial injectors an unbalanced multivibrator is often employed which results in slower transitions. Typical wave forms are shown in Fig. 2.

Transistors TR2, 3 and 4 form an oscillator whose frequency largely depends on C and R4. With the values shown the frequency is about 300Hz. This can be altered so that the output is in the range 0·1Hz to 5kHz, with an almost constant mark space ratio of 1:28. At the collector of TR2 negative going pulses are available, while after inversion at TR1 positive going pulses are also available.

The output from the circuit was fed into a u.h.f. television resulting in an audible tone from the loudspeaker and a dot pattern on the screen, thus showing that very high frequency harmonics must be present. Current consumption is only 0·3mA at 1·5 volts.

D. C. Dyer,
Coventry.

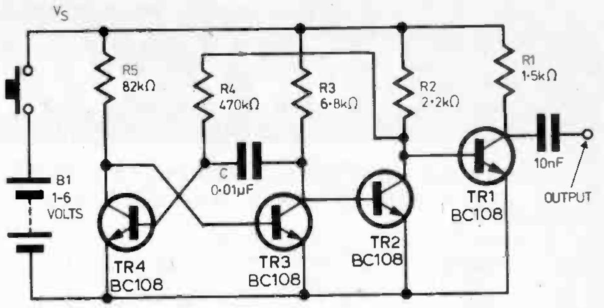


Fig. 1

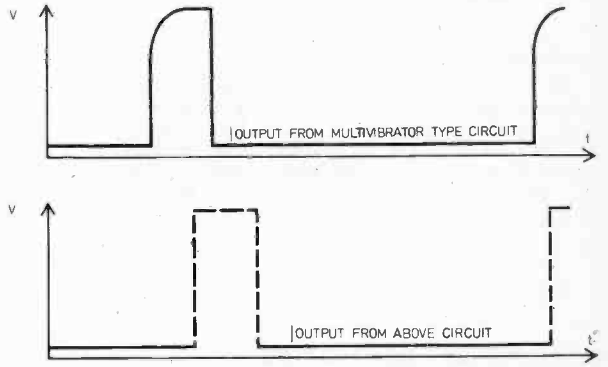


Fig. 2

FREQUENCY DOUBLER

This circuit in Fig. 1 was devised to demonstrate the frequency-doubling of sine-wave voltages over a wide frequency range. The output voltage waveform is sufficiently sinusoidal to suggest its use, after a stage of amplification, as the input to a similar frequency doubling circuit. The circuit may find application in electronic musical instruments as a means of extending the upper frequency range of any instrument which uses sine-wave oscillators.

The circuit (Fig. 1) comprises a phase-splitter amplifier, TR1, driving two point-contact diodes, D1 and D2, which are connected to give full-wave rectification of the anti-phase voltages from the emitter and collector of TR1. The potentiometer VR1, initially set at its midpoint, is adjusted to give an output which is free of the input frequency. VR2 controls the output voltage and the symmetry of the output waveforms, though a fixed resistor of 470 ohms will give satisfactory results. With VR2 at its midpoint, and an input of 700mV pk-pk, the output voltage at double the input frequency is 100mV pk-pk within 1dB over the input frequency range 35Hz to 100kHz. The upper limit of input frequency was set by the available test oscillator.

Transient distortion associated with changes in d.c. level of the output voltage waveform implies that the circuit is best used with inputs of amplitude, but the duration of transient distortion will be reduced if the capacitors C1, C2, and C3 are reduced for operation at frequencies above 35Hz.

This circuit is readily adapted for use with other transistors, provided that R1 is selected to give a collector current in TR1 of 5 to 10mA.

D. Letts,
Camberwell.

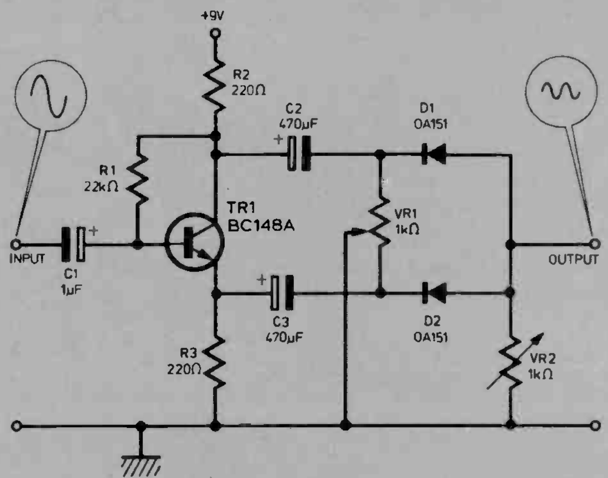


Fig. 1

VOLTAGE CONTROLLED OSCILLATOR

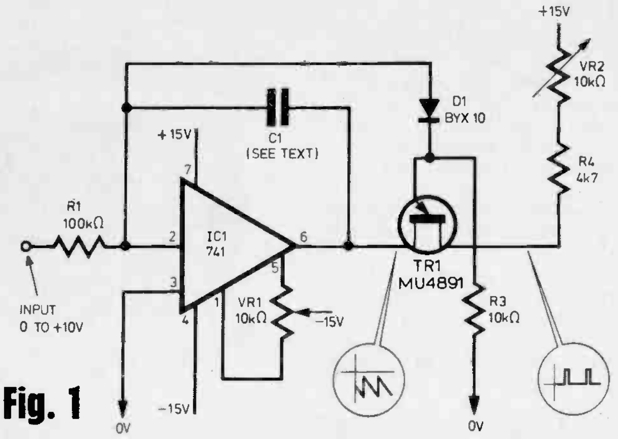


Fig. 1

THE v.c.o. circuit has a dynamic range of 4 decades, for inputs of 10V down to 1mV, and with care, down to 0·1mV. The timing is reliable, and the ramp output is very linear.

A positive voltage applied to the input causes the amplifier to start integrating. When the trigger voltage of TR1 is reached (this is an avalanche device) the capacitor is discharged and the process starts again.

R3 and D1 ensure that the amplifier cannot integrate "backwards" and destroy TR1.

The trigger voltage of TR1 is dependent on the interbase voltage, and R4, VR2 are thus used as a control for setting the frequency range initially.

The outputs are thus obviously effected by loading, and this must be taken into account.

C1 has been tried with values from 0·01μF to 10μF, the latter giving a reliable period of about 1½ hours. Obviously C1 must be very low leakage.

To compensate for offset errors in the 741 earth the input and adjust the offset control at VR1 for minimum voltage drift at pin 6.

A. W. Diverall, Ashtead.

SHORT CIRCUIT PROTECTION

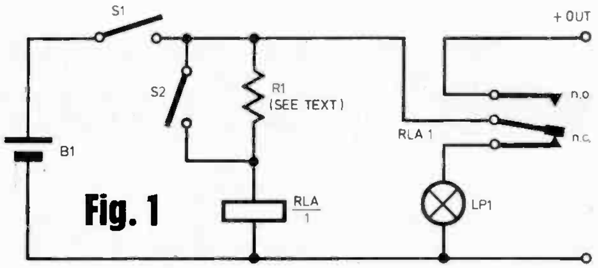


Fig. 1

A SHORT circuit protection device for fixed voltage d.c. power supplies like rechargeable batteries is shown in Fig. 1.

The relay is used to cut out the power supply. When a short circuit occurs no current flows through the relay and thus it falls off to the normal closed position. R1 is chosen experimentally such that enough current flows through the relay to hold the normal open contacts closed, but *not* enough current to operate the relay when S1 is closed. If R1 were not used the relay would chatter in the short circuit condition. S2 serves to reset the relay, and LP is a lamp to indicate when the relay has cut out.

S. Bygraves, Norwich.

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R. Bratby, Headington.

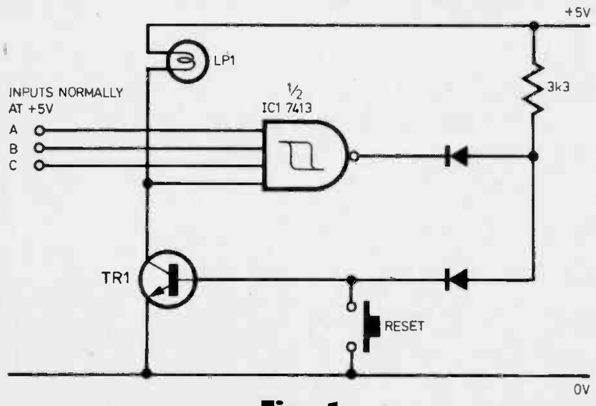
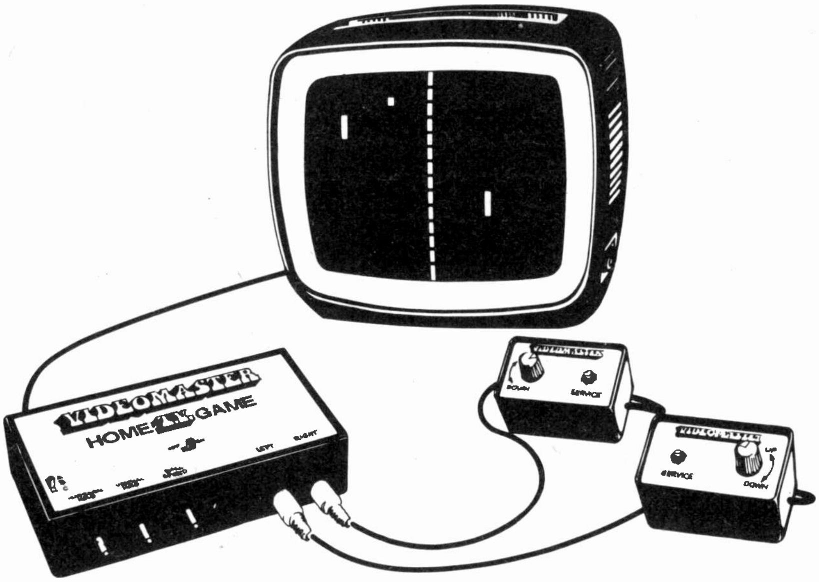


Fig. 1



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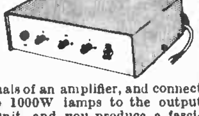

Three Channel: Bass, Middle, Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed.)
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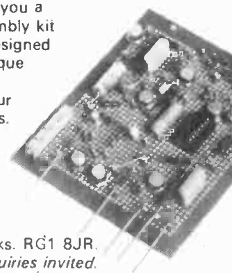

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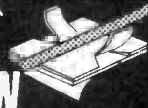

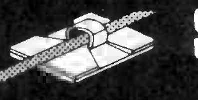

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PATENTS REVIEW...

RESCUE TRANSMITTER/RECEIVER

In BP 1 382 732, Autophon AG, of Switzerland, describes an electronic system to facilitate the rescue of people buried or trapped, for instance by a landslide or avalanche.

The system requires that both the searcher and the searched be equipped (in advance of course) with matching equipment. It is suggested that where this has been previously tried difficulties have arisen because of the very wide range of field strength intensities that must be handled. The receiver must pull in a strong signal from a remote transmitter but must also accurately process a strong signal from the same source when local.

The circuit diagram for the transmitter/receiver is shown in Fig. 1. The ferrite aerial forms with C1 an input circuit tuned approximately to the same transmitter and receiver frequency. The multivibrator intermittently switches the transmitter primary input stage on and off to save battery power.

A manually operated switch S1 has ganged segments, each with nine positions. The oscillator crystal X1 is connected to earth by R5 and C6 and to the primary input stage via switch contacts S1, 1K. TR1 functions as the output stage of the transmitter when under the control of primary input stage.

The input amplifier is connected to a tap on aerial coil and, as long as the amplifier is powered, the base of switching transistor TR3 receives a voltage which causes it to conduct. The circuit elements between TR2 and R8 act as a symmetrical crystal filter, of which the output leads to adjustable attenuation or damping resistors R8, R9, R10.

Signals of three different intensities are delivered to R8, R9 and R10 at their three junction points and each point is connected to two terminals of S1b. Thus the output of the symmetrical crystal filter reaches the input of the mixer after being damped to a degree dependent on the switch position. The mixer also receives a signal from the receiver oscillator, which differs only slightly from the receiver frequency. The resultant signal is filtered, passed to the control element, a.f. amplifier and finally to the earphone.

The circuit gives the following function option with the single switch, S1. Unit on and off, switching between a transmitting function and a receiving function (switch positions S and E). Adjustment of the receiver to the best suited sensitivity range (switch positions E with varying damping effect). Overal performance check (position K with voltage supply to the transmitter and receiver stages with the signal processed as a low frequency signal under normal conditions so that the earphone produces a sound signal). Thus the same unit is carried by anyone feeling themselves to be at risk (e.g. climbing potholing or skiing) and by a searcher subsequently on a rescue operation if the risk is realised.

BP 1 382 732

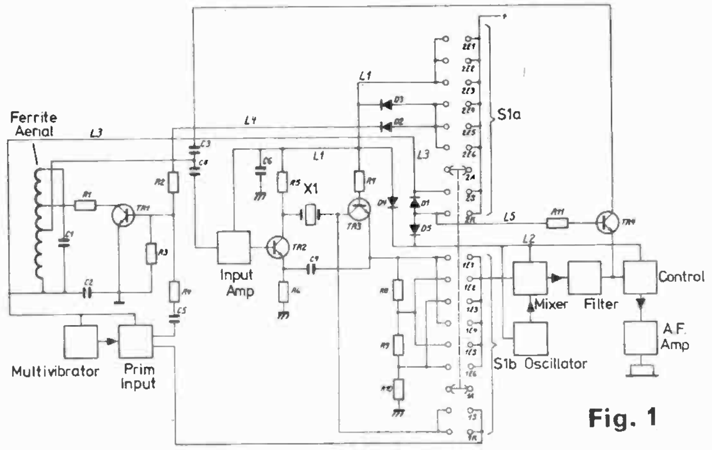


Fig. 1

CAR MIRROR DEFROSTING BP 1 387 436

A technique for electrically defrosting or demisting car wing mirrors is described by the Sprague Electric Co. of Massachusetts in BP 1 387 436.

Whereas it is necessary to embed a heating element in a car window to provide for defrosting or demisting, a mirror of necessity incorporates a conductive element at its reflective backing.

In accordance with the invention, a glass surface has a reflective nickel-chromium alloy resistance film evaporated or sputtered on the back. In practice approximately 25 or 30W of power is obtained with a coating 300-400 Å thick having a resistance of about 4 to 6 ohms and fed from a 12V battery supply. A thermostat can be used to provide automatic control of the heating dependent on ambient temperature.

One suggestion is that an alloy of 80 per cent nickel and 20 per cent chromium be applied and the electrical supply connected via contacts formed from conductive epoxy resin attached directly to the alloy coating. A small piece of ceramic material with a positive temperature coefficient of resistivity (PTCR) is incorporated in one resin contact to serve as a thermostat. As a suitable PCTR it is suggested that a material composed of 65 per cent $BaTiO_3$ (including 0.15 per cent Nz_3O_5) and 35 per cent $SrTiO_3$.

Readers with enquiring minds may wish to experiment on the effects of connecting conventional wing mirror coatings to the 12V supply.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 33p each

Readout—

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Touch tuning

Sir,—Further to my article titled "Touch Tuning Unit", published in the May 1975 issue, I have made some simple modifications to the circuit which may be of interest to your readers. These modifications improve the sensitivity of the unit, since in the orginal circuit, when the person operating the touch buttons was earthed, the unit could not switch channels correctly.

The modification requires there to be a negative supply voltage of approximately 5V to the unit, as well as the positive supply. The modification is as follows:

1. Remove C3, D9, and D10: replace by short-circuit.
2. Connect pin 4 of IC2 to negative rail.
3. Connect emitters of TR2, TR4, TR6, TR8, TR10 and TR12 to negative rail.

In addition, I would like to point out some printing errors in the article. These are: Component List—D17 should be BZY88C6V8. Component List and Fig. 2—IC4 to be DL707. Page 394, column 2, line 2—R12 to read R11.

R. J. Bonfield,
Hampton, Middx

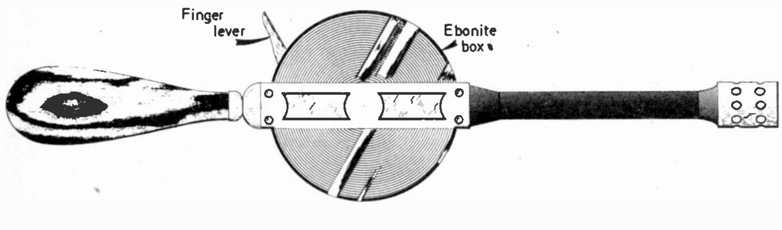
Matchless!

Sir,—I read with interest your article by Mr Bullen, on the "P.E. Portable Gas Lighter". As Mr Bullen says, it would have been rather difficult to light the gas with flint and steel. However, about 50 years ago, when a young man, I was given an old non-working gas lighter. This was operated by frictional electricity. It so happens that this year I decided to recondition and repair it and had only finished it about 8 weeks before your article appeared.

A sketch is enclosed (see Fig. 1) and shows a finger lever near the handle. It takes three depressions of the lever to energise to sparking condition. The spark is about 0·020in and quite brilliant. Internally the ebonite circular box contains one 3in diameter Wimshurst type revolving disc with six metal foil plates stuck upon it. This is driven by the finger lever via a quadrant and a small free wheeling pinion. In the base of the ebonite box is the "Leyden Jar" (capacitor today); this comprises two semi-circular lead foil plates cemented to the bottom of the box.

I do not have gas so I am unable to try it, but feel doubtful if it would be very successful on town gas. A very gentle squeeze of the tripper is sufficient to produce maximum sparking. Its overall length is 12½in, the ebonite box being 4⅞in dia. by $\frac{13}{16}$in high. The name of the machine is "The Matchless Electric Gas Lighter" (I assume no pun intended!) Molisons Patents, and I guess the date circum 1900.

E. J. Bright,
Weybridge, Surrey



Mr Bright's 50 year old "Matchless Electric Gas Lighter"

Sound track

Sir,—I would like to back up Mr Scargill's statement (Readout, June) and add that Mr Lenton-Smith should listen to the following pieces:

"Dark Side of the Moon" by Pink Floyd (Harvest SHVL 804)
Side 1, track 2 "On The Run"
Side 2, track 3 "Any Colour You Like"

"The Two Sides of Tony (T.S.) McPhee" by Tony McPhee (W.W.A. 001)
Side 2 "The Hunt"

The Pink Floyd tracks are played on E.M.S. Sythesisers (V.C.S.3's and a Synthi Hi Fli guitar model), and Mr McPhee's suite is played on two ARP2600's, an electric piano and a "Rhythm Ace" drum sythesiser.

It may be of interest that Mr McPhee's work was recorded in a studio which he built himself in his garage and until 3 years ago he only played the guitar professionally.

Further examples of good sythesiser work can be found on the recordings of the following groups and musicians:

Gentle Giant (Vertigo/W.W.A.), Peter Hammill (Charisma), Rick Wakeman (A&M), Van Der Graff Generator (Fontana/Charisma), Genesis (Charisma), Manfred Mann's Earthband (Vertigo), Yes (Atlantic), Groundhogs (United Artists/W.W.A.) and Jethro Tull (Chrysalis).

Incidentally, how about a reprint of the P.E. Sound Synthesiser as there must be many people who missed this series as I did.

Steven F. J. Smith,
Coatbridge, Lanarkshire

Eaton Audio can supply reprints (see advertisers index).

SS Convention

Sir,—I think your readers may be interested in the special "Slow-Scan TV Convention" being organised by the British Amateur Television Club.

The convention will take place at Aston University, Birmingham on Saturday, October 11, from 1000 to 1800 hrs. This convention is open to all who are interested in this fascinating topic, whether they belong to the B.A.T.C. or not. There will be lectures and display of equipment and plenty of opportunity for the exchange of ideas.

There is a small charge of 50p to cover expenses, and tickets may be obtained from Mr M. Crampton, G8DLX, 16, Percival Road, Rugby, CV22 5JS.

C. G. Dixon,
Ross-on-Wye, Herefordshire

NEWS BRIEFS

Solar Cells Becoming Popular

At long last interest is being shown more actively in solar power. The Government has made moves to support Ferranti in their research on the subject and another active company, Lucas, have been releasing information on applications in Australia for their range of solar energy systems.

The latter includes railway signalling, fire protection, radio repeater stations, a pipeline cathodic protection set-up and a Ham transmitter on Mt. Sugarloaf near Melbourne.

Now that Lucas have proved solar cells in use in the Western Isles, Scotland for transmitter/receiver use it is to be hoped that a lowering of price and increase in availability for the many obvious uses in the U.K. will occur.

British Instrumentation

North Sea Oil is all the rage these days so it is not surprising that electronic companies are fast becoming involved in this market area.

The latest is Transducers (CEL) of Reading who is now offering a specialist service to companies in the offshore oil fields in conjunction with Banchory Instruments of Scotland.

The two companies are jointly offering a comprehensive pressure and load/tension measuring, X monitoring and control facility. They are able to either simply supply the equipment or provide all follow-up facilities including servicing and maintenance.

Inspectors Talk To Computers

Quality assurance inspectors probably spend as much time noting their observations as they use in carrying out the observations in the first instance. Now EMI Threshold Ltd have come up with a computer solution to this problem in which the computer is able to recognise a vocabulary of selected words.

In this way an inspector can instruct the computer to effect various functions whilst his hands are free to manipulate the object under inspection.

The vocabulary used is normal factory terminology and not only does the system display the inspector's findings as he speaks them but it also shows the correct values for any specific parameter. In addition, a record is kept of all operations for future use.

MAIL BAG

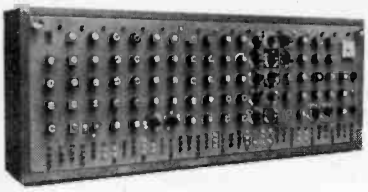
The on-going increase in postal and telephone charges does not seem to have made any difference to our post bag or our telephone bell. Enquiries continue to flood in.

We find that there are two points we are constantly mentioning. In the first place we just cannot afford to reply to any *readers' letters*, particularly those not associated with projects we have pubished, unless they are accompanied by a *stamped addressed envelope*. Were we to undertake to do so our post bill would become astronomic.

We cannot deal with *technical enquiries by telephone*. Readers should write in, giving details of symptoms and perhaps some test point readings, when requesting technical help so that we can at least give the relevant author some idea of the problems involved.

Finally, whilst we normally supply details as to source of components in each project we do assume that the constructor refers to advertisements and has an awareness of general sources. Thus, where goods are generally available we do not specify a source. You could save the cost of a letter by reading the advertisement pages first.

SYNTHESISERS AND KEYBOARDS



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(P.E. Feb. 1973 to Feb. 1974)

The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. All function circuits may be used independently, or interconnected. The greater the number of circuits, the greater the versatility. Other circuits in our lists may be used with the Synthesiser to good advantage.

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Stabilised Power Supply £12·05
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Tone Control, £2·43; **PCB, 72p**
Reverberation Amplifier £6·26
Sprine Line unit for Reverb Amp £4·95
Ring Modulator £3·44
Peak Level Meter Circuit £1·50
100µA Panel Meter £3·75
PCB for Rev., R-Mod. & Meter Ccts., £1·86
Envelope Shaper, £5·24; PCB, £1·42
Voltage Controlled Amp. and Diff. Amp. £6·70
PCB (holds both circuits) £1·26

THE SYNTHESISER KEYBOARD CIRCUITS

Can be used without the Main Synthesiser to make an independent musical instrument)
2 Log. Voltage Controlled Oscillators
PCB for both log VCO's £2·32
Divider, 2 Hold Circuits, 2 Modulation Amplifiers, Mixer and 2 Envelope Shapers £19·46
PCB (Holds the first 6 circuits) £1·80
PCB for both Envelope Shapers £1·50
Keyboard Stabilised Power Supply £7·30
Printed Circuit Board 94p

P.E. JOANNA

(P.E. May to Aug. 1975)

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12 sets (full requirement) £32·16
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Voicing and Pre-Amplifier Circuits £7·99
PCB for above circuits £1·80

Remaining circuits: prices in lists.

KEYBOARDS

Kimber-Allen Keyboards as required for many published circuits, including the P.E. Joanna, P.E. Minisonic and P.E. Synthesiser. The manufacturers claim that these are the finest moulded plastic keyboards made.

3 Octave Keyboard (37 notes C to C) £20·50
4 Octave Keyboard (49 notes C to C) £23·50
5 Octave Keyboard (61 notes C to C) £27·00

Contact Assemblies for use with above keyboards: Single-pole change-over (SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally-open make-break (2P) as for P.E. Synthesiser. Special contact assembly (4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables the same keyboard to be used with the P.E. Synthesiser, P.E. Minisonic, and P.E. Synthesiser simultaneously thus avoiding the cost of more than one keyboard.

Contact	Each	3 Octave Set	4 Octave Set	5 Octave Set
SP	20p	£7·40	£9·80	£12·20
2P	24p	£8·88	£11·76	£14·64
4PS	48p	£17·76	£23·52	£29·28

Printed Circuit Boards for use with the above contacts and thus eliminating most of the inter-wiring required, are available—details in our lists.

PHONOSONICS

P.E. MINISONIC

(P.E. Nov. 1974 to March 1975)

A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility.

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H.F. Oscillator and Detector £1·66
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PCB to hold 2 Power Amps, Noise Gen, Envelope-Inverter, HF Osc. and Detector £1·32
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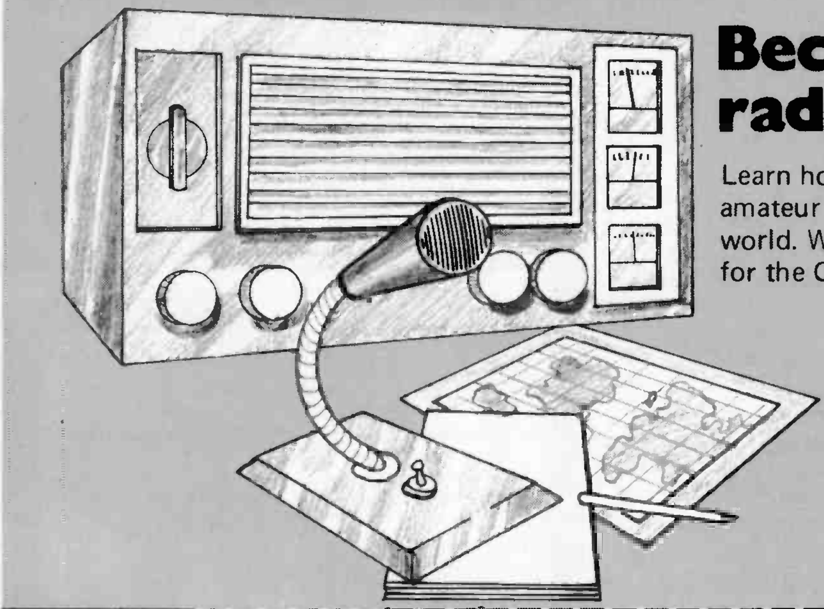
FOR ADDRESS, INFORMATION REGARDING POST AND PACKING, VAT, LISTS, AND EXPORT TERMS SEE OUR OTHER ADVERTISEMENT ON OPPOSITE PAGE

Photos: 2 of our units containing some of the P.E. projects built from our kits and PCBs. (The cases were built by ourselves and are not for sale.)



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SA608

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* 30W rms into 15Ω
* Circuit basically identical to SA1208
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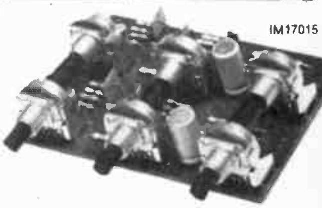

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SAXON SUPERFECT

(illustrated)

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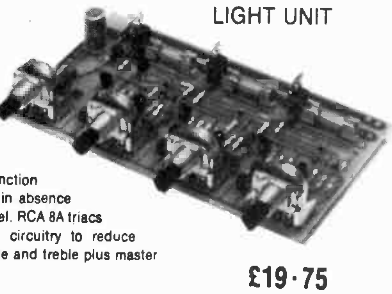

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No other commercially available module to our knowledge, offers all these facilities in one complete unit.

Sequential display with variable speed, frequency dependent channels—individually fused, and continuously variable function control to give uninterrupted light display in absence of signal. Electronic override on each channel. RCA 8A triacs handling 1,000W per channel, plus timer circuitry to reduce "flicker". Individually controlled bass middle and treble plus master audio control for ease of adjustment.

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Gives individual control of bass middle and treble plus master control for ease of adjustment. 1,000W per channel—individually fused. Negligible load on amplifier. RCA 8 AMP triacs for reliability.

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SAXON MONO AND STEREO DISCOTHEQUE MIXERS WITH AUTO FADE

MONO VERSION £18·50
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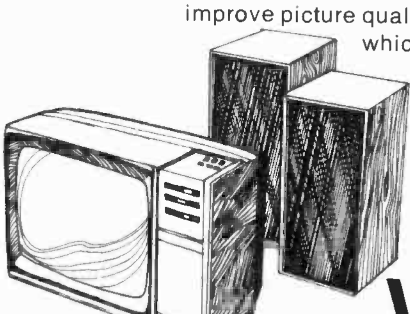

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Green	0·12
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2N3054	0·60
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SN74145	0·90
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SN74157	0·95
SN74160	1·10
SN74161	1·10
SN74162	1·10
SN74163	1·10
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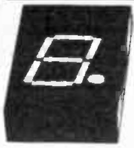

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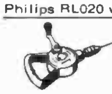
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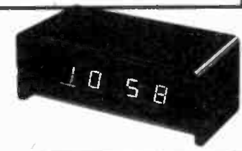

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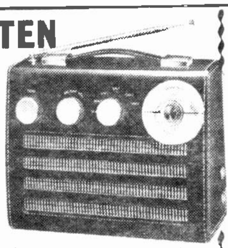

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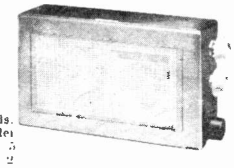

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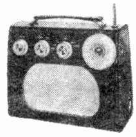

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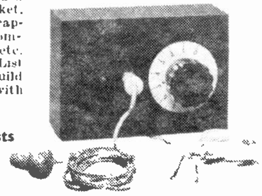

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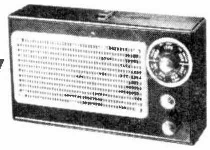

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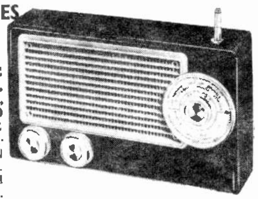

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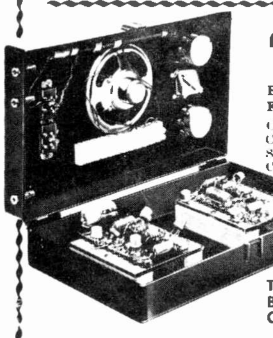

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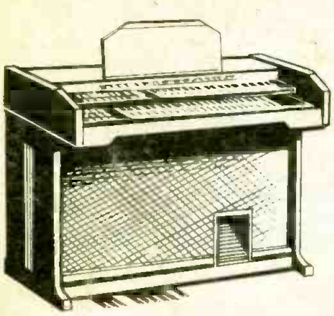

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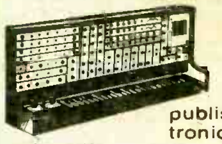

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