PRACTICAL ELECTRONICS

OCTOBER 1976

40p

PRACTICAL
ELECTRONICS

VOLUME 12 No. 10 OCTOBER 1976

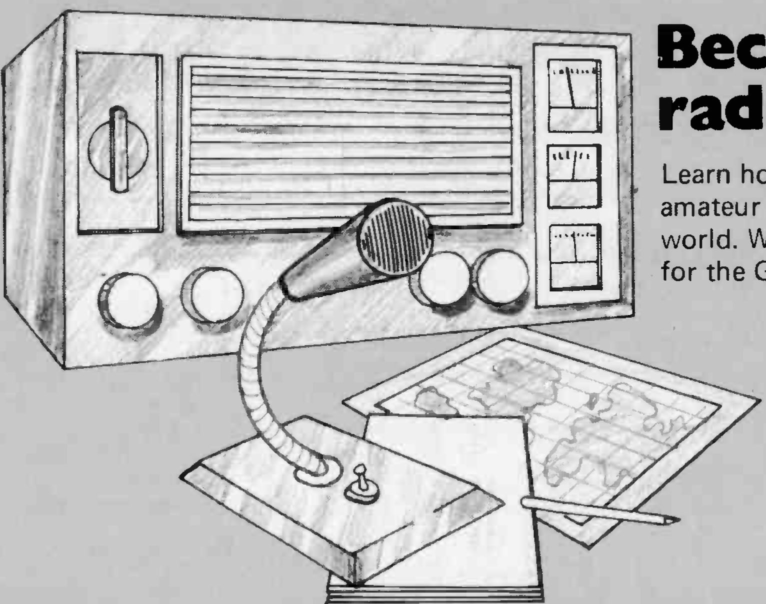
CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

FREE WITH THIS ISSUE

Our November issue will be published on Friday, October 8, 1976
(for details of contents, see page 817)



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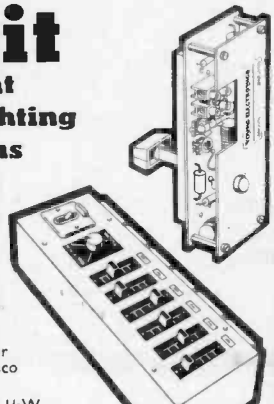
Dimmit

range of light dimmers and lighting control systems



Illustrated is the popular PMSD1000 module. A 1kW slider control dimmer, interference suppressed, 60mm slider range size 4½ × 2 × 1½in. Ideal for low cost stage and disco lighting. Used by schools, theatres, studios, etc. Complete with scale plate, fixing screws and full instructions. **£9·06** inc. VAT and postage and packing.

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Col. (4) Price
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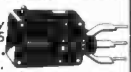

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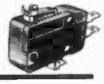

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Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£3·15.** Post 25p.
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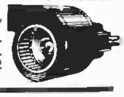

Mfg by Smiths Industries. 230/240V a.c. Miniature Model. Series 5E/200. Size 95mm × 82mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m., **£2·75.** Post 50p.

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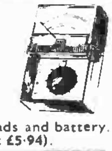

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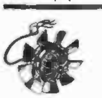

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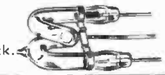
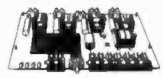


Range available from stock. S.A.E. for details.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES
4ft 40 watt, **£6·00** (callers only).
2ft 20 watt, £4·60. Post 60p. (For use in standard bi-pin). MINI. **12in 8 watt, £1·75.** Post 25p. **9in 6 watt, £1·40.** Post 25p. **6in 4 watt, £1·40.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, **£2·50.** Post 30p. (9in and 12in measures approx.)

SQUAD LIGHT



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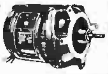
BODINE TYPE N.C.I.



(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. 50Hz. **(Type 2) 28 r.p.m.** torque 20 lb. in. **Reversible** 1/80th h.p. 50Hz.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
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15 R.P.M.

Type SD48 80 lb. in. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. drive shaft 16 mm. Weight 8·5 Kilos. BRAND NEW. Price **£10.** Carr. £1.
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24 R.P.M.

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1 R.P.M. 230/240V A.C. SYNCHRONOUS!

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20 R.P.M.

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230V operation a.c. 15 or 20 r.p.m.
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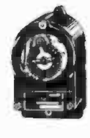
TIME SWITCH



'Horstmann' Type V Mk. II Time switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually preset time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board Spec. individually tested. Price **£7·75.** Post 50p. (Total inc. VAT **£8·91**)

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New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
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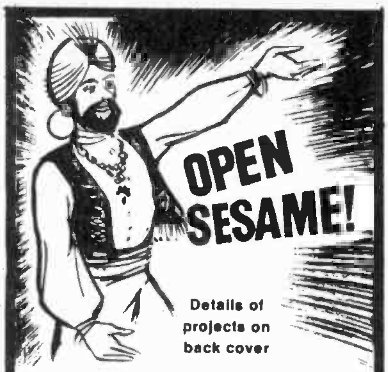

4600 SYNTHESIZER

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PIV	8A (TO92)	1A 3TO5)	3A (C106)	4A (TO220)	6A (TO220)	8A (TO220)	10A (TO220)	15A (TO220)
50	0·20*	0·25	0·35	0·32	0·41	0·42	0·47	0·96
100	0·25*	0·25	0·40	0·37	0·47	0·48	0·54	1·02
200	0·27*	0·35	0·45	0·40	0·58	0·60	0·68	1·14
400	0·30*	0·40	0·50	0·45	0·87	0·88	0·98	1·40
600	—	0·65	0·70	—	1·09	1·19	1·26	1·80

TRIACS (PLASTIC TO—220 PKGE ISOLATED TAB)

	4A (a)	4A (b)	6·5A (a)	6·5A (b)	8·5A (a)	8·5A (b)	10A (a)	10A (b)	15A (a)	15A (b)
100V	0·60	0·60	0·70	0·70	0·78	0·78	0·83	0·83	1·01	1·01
200V	0·64	0·64	0·75	0·75	0·87	0·87	0·87	0·87	1·17	1·17
400V	0·77	0·78	0·80	0·83	0·97	1·01	1·13	1·19	1·70	1·74
600V	0·96	0·99	0·87	1·01	1·21	1·26	1·42	1·50	2·11	2·17

N.B. Trlacs without internal trigger diac are priced under column (a). Triacs with internal trigger diac are priced under column (b). When ordering please indicate clearly the type required.

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7409	0·16
7410	0·16
7413	0·29
7417	0·27
7420	0·16
7427	0·27
7430	0·16
7432	0·27
7437	0·27
7441	0·75
7442	0·65
7445	0·85
7447	0·81
7448	0·75
7447A	0·95
7470	0·30
7472	0·25
7473	0·30
7474	0·32
7475	0·47
7476	0·32
7482	0·75
7485	1·30
7486	0·32
7489	2·92
7490	0·49
7491	0·65
7492	0·57
7493	0·45
7495	0·67
74100	1·08
74107	0·35
74121	0·34
74122	0·47
74141	0·78
74145	0·68
74154	1·62
74174	1·00
74180	1·06
74181	3·20
74192	1·35
74193	1·35
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381	14 Pin Dil	1·60*
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566	8 Pin Dil	1·50*
567	8 Pin Dil	2·00*
709	8/14 Pin Dil	0·35
741	8/14 Pin Dil	0·28
748	8 Pin Dil	0·35
3900	14 Pin Dil	0·70*
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CA3089E		2·14*
CA3090Q		3·22*
CA3130		0·79
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MC1307P		1·17*
MC1310P		1·96*
MC1351P		0·91*
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MC1458P		0·77
MC1496L		1·10
SN75324		2·55
SN75451		0·89*
SN75452		0·89*
TAA263		0·95*
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TAA350A		1·95*
TAA550		0·45*
TAA611B12		1·25*
TAA861		0·65
TAD100		1·95*
TBA480Q		1·30*
TBA530		1·85*
TBA530Q		1·90*
TBA540		2·10*
TBA540Q		2·20*
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										CRS3-10	0·45	TIP32A	0·64	2N3054	0·40
AC126	0·15	BC117	0·19*	BC301	0·32	BDY60	0·60	BT109	1·00	CRS3-20	0·50	TIP34	1·05	2N3055	0·50
AC127	0·16	BC125	0·18*	BC323	0·60	BDY61	0·65	BT116	1·00	CRS3-40	0·60	TIP41A	0·68	2N3440	0·56
AC128	0·13	BC126	0·20*	BC327	0·18*	BDY62	0·55	BU105	1·80*	CRS3-60	0·85	TIP42A	0·72	2N3442	1·20
AC128K	0·25	BC141	0·28	BC328	0·16*	BF178	0·28	BU105/02	1·90*	MJ480	0·80	IN2069	0·14	2N3525	0·50
AC141	0·18	BC142	0·23	BC337	0·17*	BF179	0·30	BU126	1·60*	MJ481	1·05	IN2070	0·16	2N3570	0·80
AC141K	0·28	BC143	0·23	BC338	0·17*	BF194	0·10*	BU204	1·60*	MJ490	0·90	IN4001	0·04*	2N3702	0·10*
AC142	0·18	BC144	0·30	BCY30	0·55	BF195	0·10*	BU208	2·60*	MJ491	1·15	IN4002	0·05*	2N3703	0·10*
AC142K	0·28	BC147	0·09*	BCY31	0·55	BF196	0·12*	BY206	0·15	MJE340	0·40*	IN4003	0·06*	2N3704	0·10*
AC176	0·16	BC148	0·09*	BCY32	0·60	BF197	0·12*	BY207	0·20*	MJE371	0·60	IN4004	0·07*	2N3705	0·10*
AC176K	0·25	BC149	0·09*	BCY33	0·55	BF224J	0·18*	BYX36–		MJE520	0·45	IN4005	0·08*	2N3706	0·10*
AC187	0·18	BC152	0·25*	BCY34	0·55	BF244	0·17*	300	0·12*	MJE521	0·55	IN4006	0·09*	2N3707	0·10*
AC187K	0·25	BC153	0·18*	BCY38	0·50	BF257	0·30*	600	0·15*	OA5	0·50*	IN4007	0·10*	2N3714	1·05
AC188	0·18	BC157	0·09*	BCY39	1·15	BF258	0·35	900	0·18*	OA90	0·08	2N696	0·14	2N3715	1·15
AC188K	0·25	BC158	0·09*	BCY70	0·12	BF337	0·32	1200	0·21*	OA91	0·08	2N697	0·12	2N3716	1·25
AD140	0·50	BC159	0·09*	BCY71	0·18	BFW60	0·17*	BYX38–		OC41	0·15	2N706	0·10	2N3771	1·60
AD142	0·50	BC160	0·32	BCY72	0·12	BFX29	0·26	300	0·50	OC42	0·15	2N929	0·14	2N3772	1·60
AD143	0·46	BC161	0·38	BD115	0·55	BFX30	0·30	600	0·55	OC44	0·12	2N930	0·14	2N3773	2·10
AD149	0·45	BC168B	0·09*	BD131	0·36	BFX84	0·23	900	0·60	OC45	0·10	2N1131	0·15	2N3819	0·28*
AD161	0·35	BC182	0·11*	BD132	0·40	BFX85	0·25	1200	0·65	OC70	0·10	2N1132	0·16	2N3904	0·16*
AD162	0·35	BC182L	0·11*	BD135	0·36	BFX88	0·20	BZX61	Series	OC71	0·10	2N1304	0·20	2N3906	0·11*
AL102	0·95	BC183	0·10*	BD136	0·39	BFY50	0·20	Zeners	0·20	OC72	0·22	2N1305	0·20	2N4124	0·14
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AF114	0·20	BC184	0·11*	BD138	0·48	BFY52	0·19	BZX88 Series		SC40A	0·73	2N2102	0·44	2N4348	1·20
AF115	0·20	BC184L	0·11*	BD139	0·58	BFY64	0·35	Zeners	0·11	SC40B	0·81	2N2369	0·14	2N4870	0·35*
AF116	0·20	BC207B	0·12*	BD181	0·85	BFY90	0·65	C106A	0·40	SC40D	0·98	2N2369A	0·14	2N4871	0·35*
AF117	0·20	BC212	0·11*	BD182	0·92	BR100	0·20	C106B	0·45	SC40F	0·65	2N2484	0·16	2N4919	0·70*
AF118	0·50	BC212L	0·11*	BD183	0·97	BFY39	0·40	C106D	0·50	SC41A	0·65	2N2646	0·50	2N4920	0·50*
AF139	0·35	BC213	0·12*	BD232	0·60*	BSX19	0·16	C106F	0·35	SC41B	0·70	2N2905	0·18	2N4922	0·58*
AF239	0·37	BC213L	0·12*	BD233	0·48*	BSX20	0·18	CRS1/05	0·25	SC41D	0·85	2N2905A	0·22	2N4923	0·46*
BC107	0·09	BC214	0·14*	BD237	0·55*	BSX21	0·20	CRS1/10	0·25	SC41F	0·60	2N2926R	0·10*	2N5060	0·20*
BC107B	0·09	BC214L	0·14*	BD238	0·60*	BSY95A	0·12	CRS1/20	0·35	ST2	0·20	2N2926O	0·09*	2N5061	0·25*
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BC109	0·09	BC238	0·16*	BDY20	0·80	BT107	1·60	CRS1/60	0·65	TIP30A	0·52	2N2926G	0·10*	2N5064	0·30*
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2N3054	0·48
2N3055	0·65
2N3702	0·11
2N3705	0·15
2N3706	0·11
2N3707	0·13
2N3709	0·10
2N3710	0·11
2N3711	0·11
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ACY17	0·75
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ACY19	0·35
ACY20	0·35
ACY21	0·35
ACY22	0·35
ACY27	0·25
ACY28	0·25
ACY39	0·78
ACY40	0·22
ACY41	0·22
ACY44	0·32
AD140	0·50
AD149	0·75
AD161	0·44
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BC149	0·10
BC157	0·14
BC158	0·12
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BCY33	0·38
BCY34	0·45
BCY38	1·00
BCY39	1·50
BCY40	0·80
BCY42	0·30
BCY70	0·18
BCY71	0·22
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BDY11	1·45
BF115	0·20
BF167	0·25
BF173	0·28
BF181	0·35
BF184	0·22
BF185	0·22
BF194	0·10
BF195	0·13
BF196	0·15
BF197	0·15
BFS61	0·25
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BFX13	0·26
BFX29	0·28
BFX30	0·28
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BFX84	0·25
BFX85	0·28
BFX86	0·25
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BFY18	0·45
BFY19	0·55
BFY24	0·45
BFY44	1·00
BFY50	0·21
BFY51	0·20
BFY52	0·20
BFY53	0·17
BFY64	0·36
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BR100	0·40
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BSY27	0·20
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BYZ10	0·45
BYZ11	0·40
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BYZ13	0·42
BYZ15	1·25
BYZ16	0·60
BZY88	0·10
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NKT773	0·25
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OA5	0·72
OA6	0·12
OA47	0·08
OA70	0·10
OA71	0·20
OA73	0·15
OA74	0·15
OA79	0·10
OA81	0·18
OA85	0·15
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OA90	0·07
OA91	0·07
OA95	0·07
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OA211	0·35
OAZ200	0·50
OAZ201	0·45
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OAZ207	0·45
OAZ208	0·40
OAZ209	0·40
OAZ210	0·40
OAZ211	0·40
OAZ222	0·45
OAZ223	0·45
OAZ224	0·45
OAZ241	0·25
OAZ242	0·15
OAZ244	0·25
OAZ246	0·15
OAZ290	0·38
OC16	1·00
OC16T	1·00
OC22	1·00
OC23	1·25
OC24	1·10
OC25	0·40
OC26	0·40
OC28	0·75
OC29	0·65
OC30	0·40
OC35	0·75
OC36	0·60
OC41	0·35
OC42	0·40
OC43	0·70
OC44	0·20
OC44M	0·17
OC45	0·20
OC45M	0·18
OC46	0·27
OC57	0·60
OC58	0·60
OC59	0·60
OC66	0·50
OC70	0·18
OC71	0·25
OC72	0·28
OC73	0·50
OC74	0·30
OC75	0·30
OC76	0·30
OC77	0·54
OC78	0·25
OC79	0·30
OC81	0·29
OC81M	0·20
OC81DM	0·18
OC81Z	0·75
OC82	0·28
OC82D	0·25
OC83	0·60
OC84	0·30
OC114	0·38
OC122	1·00
OC123	1·10
OC139	1·00
OC140	1·14
OC141	0·80
OC169	0·20
OC170	0·30
OC171	0·30
OC200	1·00
OC201	1·50
OC202	1·50
OC203	1·25
OC204	1·50
OC205	1·75
OC206	1·10
OC207	1·00
OC460	0·20
OC470	0·30
OCP71	1·20
ORP12	0·60
ORP60	0·55
ORP61	0·48
SX68	0·20
SX631	0·45
SX635	0·55
SX640	0·75
SX641	0·75
SX642	0·60
SX644	0·85
SX645	0·85
TIC44	0·29
V15/30P	0·75
V30/201P	0·75
V60/201	0·50
V60/201P	0·75
XA101	0·10
XA102	0·18
XA151	0·15
XA152	0·15
XA161	0·25
XA162	0·25
XB101	0·43
XB102	0·30
XB103	0·35
XB113	0·30
XB121	0·43
ZS170	0·12
ZS271	0·20
ZT21	0·25
ZT43	0·25
ZTX107	0·12
ZTX108	0·10
ZTX300	0·13
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7411	0·25
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7413	0·36
7416	0·36
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7428	0·40
7430	0·16
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7438	0·37
7440	0·22
7441AN	0·92
7442	0·79
7450	0·16
7451	0·16
7453	0·16
7454	0·16
7460	0·16
7470	0·36
7472	0·38
7473	0·41
7474	0·42
7475	0·59
7476	0·45
7480	0·60
7482	0·87
7483	1·10
7484	1·00
7486	0·47
7490	0·55
7491AN	1·00
7492	0·70
7493	0·70
7494	0·80
7495	0·80
7496	0·95
7497	3·87
74100	1·89
74107	0·45
74110	0·58
74111	0·86
74118	0·90
74119	1·68
74121	0·50
74122	0·70
74123	1·00
74141	0·90
74145	1·26
74150	1·75
74151	1·00
74154	2·00
74155	1·00
74156	1·00
74157	0·95
74170	2·52
74174	1·57
74175	1·10
74176	1·26
74190	2·00
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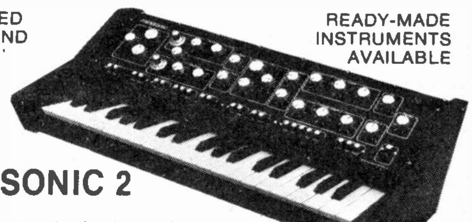

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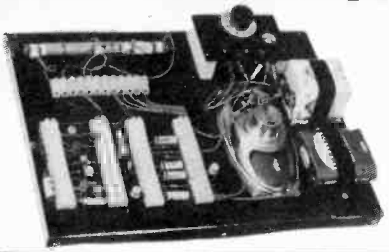

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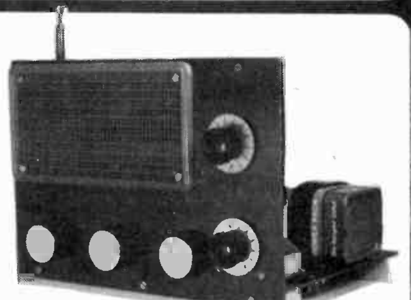

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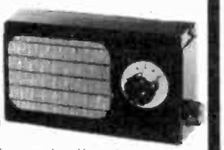

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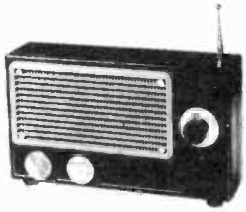

CASE AND LOOKS AS TRANS-EIGHT

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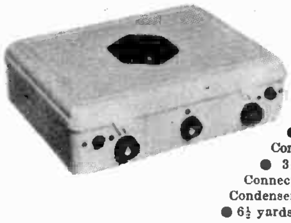

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GOOD MEASURE

HOME constructors have the good fortune to be involved with a technology based essentially upon devices which have tended to become cheaper over the years. Translated into terms of cost per circuit function, the fall in semiconductor prices is quite dramatic. This fact may be overlooked when costs for a project appear to mount up. The real reason is likely to be the inherent, but not always obvious, advanced design features leading to a more versatile and reliable piece of equipment. In real value-for-money terms, item for item there is no doubt that electronics sets a fine example for all other manufacturing businesses.

From the hardware of electronics let us now turn to the important matter of communication between designer and constructor. This is our own particular neck of the woods, nevertheless what we have to say in this regard is strictly objective and will we hope receive a broad measure of agreement from our readers.

If we look back five or more years ago, an average type of design for the home constructor would involve, typically, six active devices, each performing a single function. This circuit diagram would occupy about half a page in this magazine. Today that same area of page is likely to contain a diagram incorporating that same number of i.c.s. And what a magnification of circuitry this indeed represents. For if we consider a simple digital system, this could amount to a sixfold increase in circuit functions; or if linear i.c.s are considered, the function performed by each one if converted to discrete component terms would probably require for itself more space than that occupied by the entire circuit in its contemporary form. The kind of circuit composition we are considering is now commonplace and is accepted without a further thought (although all-discrete circuits continue to flourish alongside). And it does not stop there. Larger and more complex diagrams frequently appear and they may occupy a whole page or several—in the latter event being broken down into convenient sections that usually coincide with practical assemblies.

It is demonstrably clear that overall the wealth of circuit information carried per square inch (or cm^2) of printing area has steadily increased over the years. This brings us to another point which normally escapes attention. Even though much detailed "conventional" circuitry is not revealed, but is represented by i.c. symbols, the work involved in preparing diagrams for publication is greater than in pre i.c. days. And circuit diagrams are only part of the graphics called for in constructional articles. The component layout and wiring diagrams reflect in the practical form the increased complexity of many designs. The high population density of p.c.b.s and circuit boards entails correspondingly greater effort in their detailed illustration.

Productivity-wise we believe there is justification for drawing a parallel between the good value-for-money performance of electronic component manufacturers over past years and a publication such as ours. Within our standard format we have packed an ever-increasing amount of technical information and practical know-how, whether in the discrete or integrated form. We shall continue to do so. It is therefore all the more important to make clear to our readers that the extra 5p on the cover price as from this month has nothing at all to do with electronics. We are caught up in the general problems affecting the publishing world. The most serious being the rising cost of newsprint.

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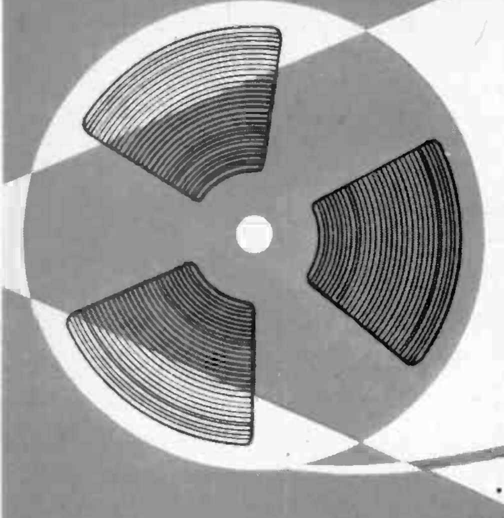


CINE/TAPE SYNCHRONISER

By N.V. DAVIES

. . . featuring a CMOS 12-bit magnitude comparator

Although sound cameras and projectors which allow direct recording of a sound track on magnetic striped film are now available, these are necessarily more expensive and usually offer fewer facilities than their silent counterparts.

The displacement of the sound along the film from the pictures to which it relates causes problems when editing the film. A system where the sound track is recorded separately therefore still has much to recommend it.

USING TAPE RECORDERS

Many cine enthusiasts must have considered using the domestic tape recorder for the purpose of recording film sound tracks, but anyone who has tried this will have discovered that minor variations between the projector and tape recorder speed soon result in the sound and film becoming out of sync.

Various systems have been devised for synchronising the film and tape but these usually either involve some form of mechanical linkage between the projector and tape recorder (which would be difficult for the home constructor to produce) or an electronic system in which the phase of pulses obtained from the projector and tape recorder is compared and the difference signal used to control projector speed. An excellent synchroniser which worked on this principle was described in Practical Electronics, September 1969 (not available).

Synchronisers of the type described suffer from two basic weaknesses: it is necessary to start the projector and tape recorder simultaneously, and a sync error can occur during the run up before the two pulse trains lock into sync; also, if a momentary loss of sync occurs during projection (due, say, to a poor splice slowing the projector) an error of one or more pulses can occur before the trains lock into sync.

CMOS SYNCHRONISER

The CMOS Synchroniser overcomes the problems described above by using the pulses from the projector and tape recorder to clock two binary counters. The numbers in each are continuously compared by a magnitude comparator and any difference is used to correct the projector speed.

Provided both counters are first reset to zero, it is possible to start the tape recorder first followed by the projector. The counter associated with the tape recorder will begin to clock up as soon as the tape recorder starts and will already contain a certain number by the time the projector is started while the projector counter will still be at zero.

The comparator will detect the difference between the two counters and control the projector to run at above synchronous speed until the numbers in the two counters become equal. This will be detected by the comparator which will slow the projector to synchronous speed. Any future loss of sync will result in a difference in the numbers in the two counters which will be detected and an appropriate correction made to the projector speed to restore sync.

COUNTER CAPACITY

In theory, each counter should have sufficient capacity to count the total number of pulses produced during the entire length of the reel of film as, if, due to loss of sync, one counter reaches its terminal count before the other and begins counting again from zero, the comparator will give the opposite correction signal to that required until the second counter also passes its terminal count.

In practice, the sync error at any time should be so small that both counters will reach their terminal count almost simultaneously and the period during which an incorrect speed correction signal will be given will be too short to be of practical significance.

Even so, the counter capacity should be as large as is reasonably practical. The author has found by experiment that a minimum count period of about one minute is necessary. At 54Hz (projector shutter frequency at a projection speed of 18 frames per second) this indicates a minimum counter capacity of 3240 and a twelve-stage binary counter which has a count capacity of 4096 will be the minimum suitable.

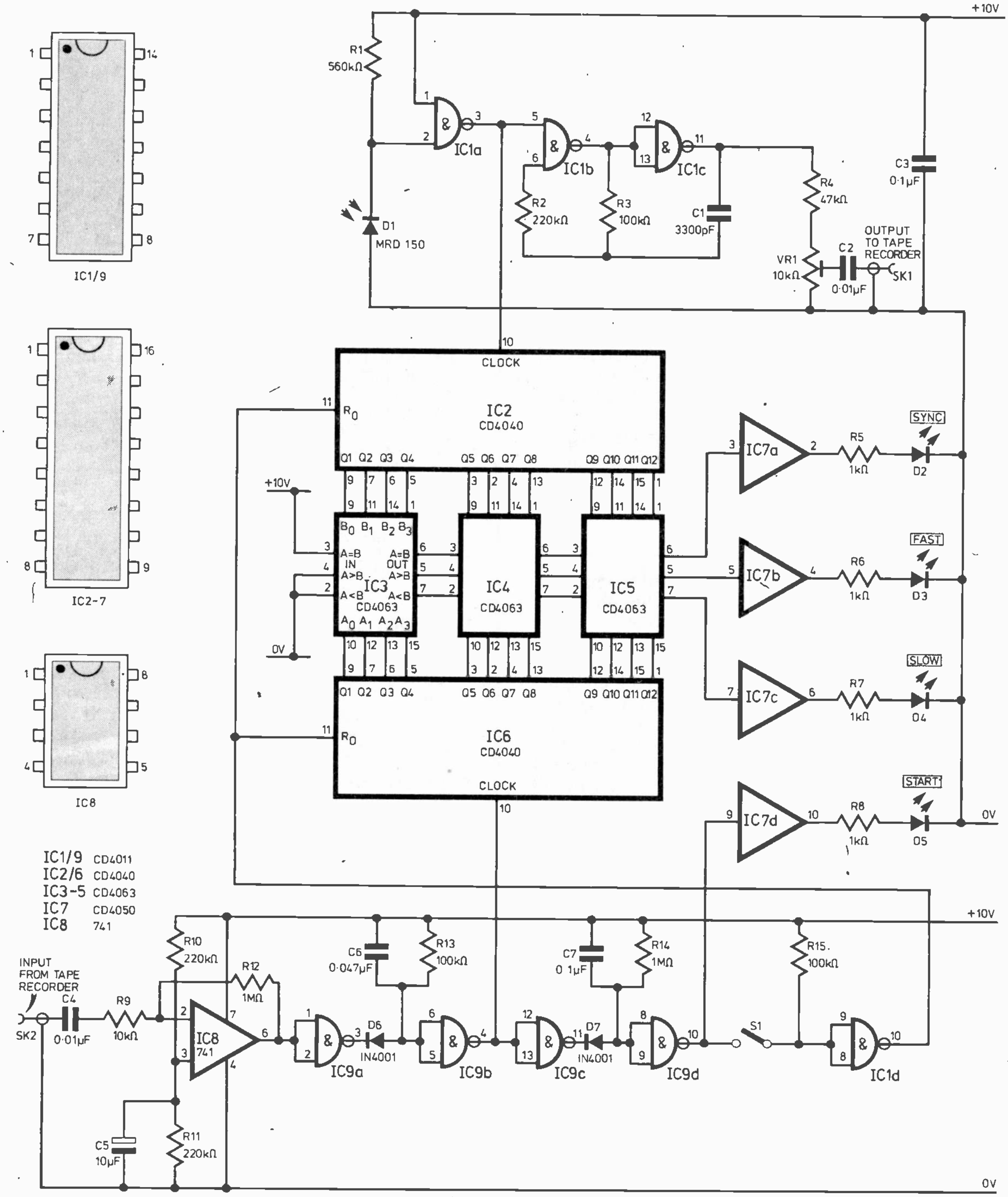


Fig. 1. Complete circuit of the Sync Indicator excluding the power supply

The construction of a twelve-stage binary counter using discrete components would be a formidable task and the cost prohibitive. Even using TTL a number of i.c.s would be required.

A twelve-stage binary counter with separate outputs from each stage is available in a single 16-pin dual-in-line package in the CMOS range of i.c.s—the CD4040. This, together with the CD4063 four-bit magnitude comparator, enables the heart of the synchroniser to be built with five i.c.s.

PRACTICAL CONSIDERATIONS

Many constructors may be reluctant to risk invalidating manufacturers' guarantees by modifying their projectors or tape recorders. The CMOS Synchroniser has therefore been designed as a basic sync indicator which may be used with any variable speed projector and stereo tape recorder without modification. The projector speed must be adjusted manually as indicated by the sync indicator.

Next month, in Part 2, modifications and additions will be described which cover fully automatic synchronisation, automatic start and stop of the projector controlled by the tape pulses, and use with a mono tape recorder either by fitting an additional pulse head or by using perforated tape.

The use of the unit with cameras fitted with sound sync contacts to record full "lip sync sound" will also be covered. Some modifications to the projector and/or tape recorder may be necessary to incorporate these features.

THE SYNC INDICATOR CIRCUIT

The circuit diagram of the CMOS Synchroniser is shown in Fig. 1 and, as can be seen, this contains rather more than the five i.c.s mentioned earlier. The purpose of the additional components will be explained during the description of the circuit operation.

A photodiode, D1, is positioned so as to pick up light from the projector lens and is used to detect the opening and closing of the projector shutter. This photodiode is connected between one input of a two-input NAND gate IC1a and 0V and the same input is also connected to the 10V line by R1. The other input to the gate is unused and is connected to 10V.

When the projector shutter opens, the photodiode will conduct and the voltage at the input of IC1a will fall, switching its output to logic 1.

When the shutter closes the opposite will occur and the output of IC1a will switch to logic 0. Thus, when the projector is running, the output of IC1a will be a train of pulses at the projector shutter frequency and these pulses are used to clock the projector counter IC2.

MODULATION

Eight millimetre projectors operate at either 16 or 18 frames per second, depending on whether standard or Super 8 films are being used, and are usually fitted with three bladed shutters so the output of IC1a will be 48 or 54Hz.

Unfortunately the response of the average tape recorder to low frequency pulse waveforms leaves a lot to be desired and if these pulses were recorded directly the resulting distortion on playback could cause erratic operation of the tape pulse counter.

The pulses are therefore converted into bursts of about 1kHz square waves by the gated multivibrator IC1b and c and it is this waveform which is recorded, the output level being set by VR1.

COMPONENTS . . .

SYNC INDICATOR

Resistors

R1	560kΩ
R2	220kΩ
R3	100kΩ
R4	47kΩ
R5–R8	1kΩ (4 off)
R9	10kΩ
R10	220kΩ
R11	220kΩ
R12	1MΩ
R13	100kΩ
R14	1MΩ
R15	100kΩ

All ±5% ¼W carbon

Potentiometers

VR1 10kΩ vertical skeleton preset

Capacitors

C1	3300pF
C2	0·01μF
C3	0·1μF
C4	0·01μF
C5	10μF 10V elect.
C6	0·047μF
C7	0·1μF

All polyester or polycarbonate except C5

Diodes

D1	MRD150 photodiode (Motorola)
D2–D5	TIL209 l.e.d.s (4 off)
D6	1N4001
D7	1N4001

Integrated Circuits

IC1	CD4011 (or MC14011)
IC2	CD4040 (or MC14040)
IC3–IC5	CD4063 (or MC14063) (3 off)
IC6	CD4040 (or MC14040)
IC7	CD4050 (or MC14050)
IC8	Type 741 8-pin DIL
IC9	CD4011 (or MC14011)

Miscellaneous

S1 Single pole on/off
SK1, SK2 Sockets to suit (2 off)
8-pin DIL socket, 14-pin DIL socket (2 off), 16-pin DIL socket (6 off)
114 × 165mm DIP Breadboard (Vero)

PLAYBACK

On playback, the output from the tape recorder is amplified by IC8, a 741 operational amplifier connected for single supply operation.

The gain is set at 100 by R9 and R12, giving an input sensitivity of about 50mV which should be suitable for most tape recorders.

The output from IC8 is connected to a monostable, IC9a and b, which converts each burst of square waves back into a single pulse and these pulses are used to clock the tape pulse counter IC6.

The pulses are also applied to a further monostable (IC9c and d) with a longer time constant, the output of which will go to logic 1 and remain in this state so long as the train of pulses is applied to its input, but will revert to logic 0 when the pulses cease.

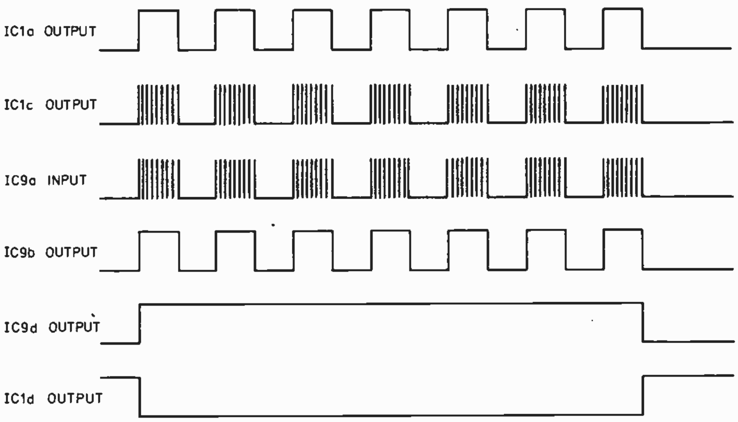


Fig. 2. Waveforms associated with the circuit of Fig. 1

The output from this second monostable is used to drive the START l.e.d. (D5) via the non-inverting buffer driver IC7d and is also used to reset the two counters after being inverted by IC1d. The result of this arrangement is that, with S1 closed, while no pulses are received from the tape recorder, both counters will be reset to zero and disabled, but as soon as pulses are received the counters will be enabled and the START l.e.d. will light.

MAGNITUDE COMPARATORS

The Q1 to Q12 outputs of the two counters are connected to the A and B inputs respectively of a twelve-bit magnitude comparator formed by connecting three CD4063 four-bit magnitude comparators in cascade.

The A=B, A>B and A<B outputs of the comparator are used to drive the SYNC, FAST and SLOW l.e.d.s (D2 to D4) via the non-inverting buffers IC7a, b and c. IC7 is a CD4050 hex non-inverting buffer driver and the two remaining buffers in the package are not used in this circuit so their inputs are tied to 10V to prevent damage due to static build up. IC1 and IC9 are both CD4011 quad two-input NAND gates and the two counters are CD4040 12-stage binary counters.

The purpose of S1 is to disable the automatic counter and its use will be described next month.

COMPONENTS . . .

MAINS POWER SUPPLY

Resistor
R16 100Ω 1W

Capacitors
C8 100μF 35V elect.
C9 100μF 35V elect.

Diodes
D8–D11 1N4001 (4 off)
D12 10V 1·5W Zener

Transformer
T1 Mains primary,
12V 100mA secondary (see text)

Miscellaneous
S2 Double pole mains switch
FS1 1A fuse and holder
LP1 Mains neon indicator

Waveforms at various points in the circuit are shown in Fig. 2.

POWER SUPPLIES

The power consumed by the CMOS i.c.s is extremely small at the frequency involved and the complete Sync Indicator uses only about 20mA. The CMOS i.c.s operate from as little as three volts, but a minimum of about eight volts is needed for the 741 and to obtain adequate brightness for the l.e.d.s. The unit may therefore be powered by a small nine volt battery such as a PP3 or PP9.

The circuit of a suitable mains power supply with a simple Zener stabilised supply for the i c.s is shown in Fig. 3. The supply has sufficient capacity to power the fully automatic version of the synchroniser to be described next month.

If the unit is built into a tape recorder, it may be possible to obtain power supplies from the tape amplifier power supply. The stabiliser circuit from Fig. 3 could then be used, R16 being changed to suit the supply available.

If the unit is built into a projector fitted with a low voltage projection lamp, it may be possible to obtain power supplies from the lamp transformer using this in place of T1 in Fig. 3.

It is **most important** to check that this is an isolated winding and not an auto transformer with one side of the winding connected to the mains. **If there is any doubt whatsoever about this point, then this power source should not, in any circumstances, be used.**

Next Month: Construction, Setting-up and using the Synchroniser.

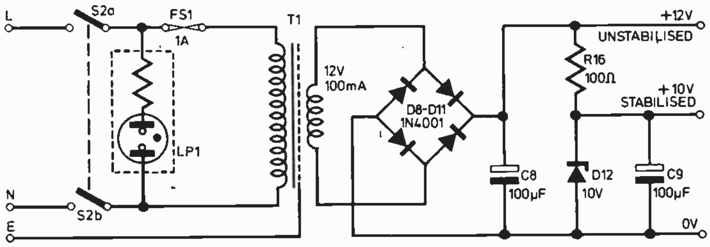
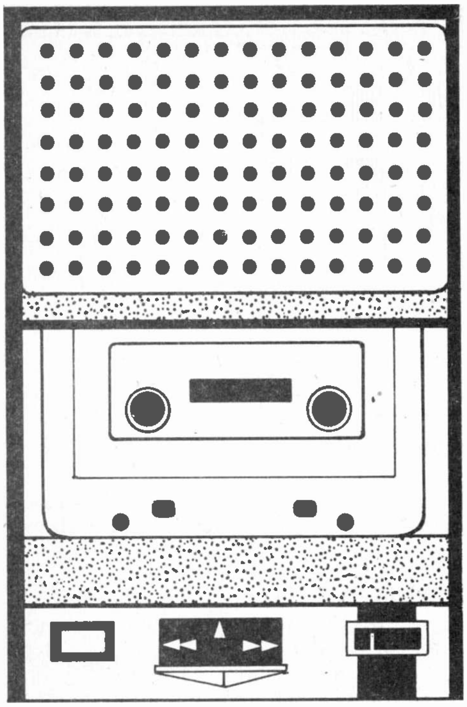


Fig. 3. Circuit diagram of a suitable mains power supply. This supply is capable of driving the automatic synchroniser. The transformer can be that used for the projector lamp if this is suitable



CASSETTE PLAYER POWER SUPPLY

By H.T. KITCHEN

THE power supply to be described was built to enable a battery powered cassette recorder to be mains powered, thereby enabling the internal batteries, which grow increasingly more expensive, to be reserved for outdoor use.

DESIGN REQUIREMENTS

Measurements made on a fresh battery pack, reading precisely 6 volts on load, showed that on replay the current consumption varied between 125mA on quiet passages to 260mA at full blast. The maximum current on rewind or fast forward was 220mA, whilst stall current was 300mA. 300mA was, therefore, the minimum current to be delivered by a mains powered supply. The initial outlay on such a supply is fairly modest, and if the cassette recorder is at all much used—as most are, at full blast—then the initial outlay is speedily recouped in that batteries only have to be purchased infrequently, if at all.

Anticipating future requirements, of various kinds, it was decided that some form of voltage stabilisation was desirable, and since the power supply was intended for use by a young child, who is as careless as most children of her age, protection against short circuits was definitely essential.

CIRCUIT

The circuit is shown in Fig. 1. The mains transformer, T1, has two secondaries of 12-0-12 volts and 2-0-2 volts at ½A, of which only the former is used in this application. The a.c. voltage is rectified by D1 and D2, to provide about 16·8 volts across C1 off-load, this being the peak value of the 12 volts a.c. This voltage is applied to the collector of the series pass transistor, TR2, the base of which is held at a constant 6·8 volts—or what ever the Zener voltage happens to be, the Zener current being provided by R2. The output will therefore be the Zener voltage, minus the V_{be} of TR2, typically 0·7 volts.

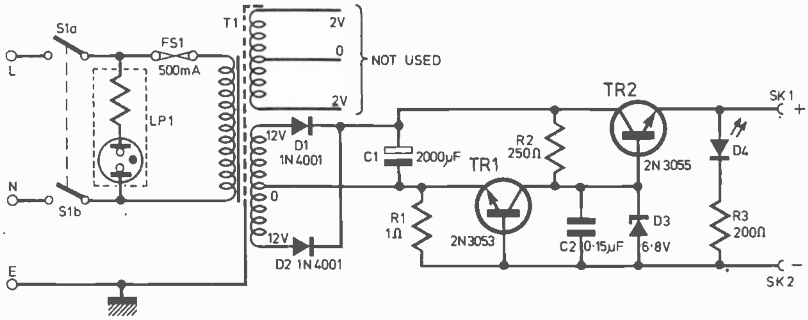
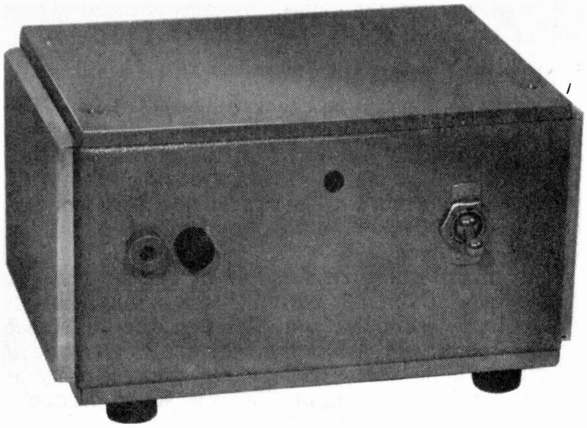


Fig. 1. Circuit of Power Supply



To provide any given voltage, it is only necessary to select a Zener having a voltage exceeding the required voltage by 0·7 volts.

Zeners, like all components, have tolerance spreads, the best being held to a tolerance of ±5 per cent. Cheaper Zeners have tolerances of ±10 per cent. In other words, the actual Zener voltage will lie within the tolerance for that particular device. The output voltage obtained may therefore be above, or below, the nominal Zener voltage, again minus the V_{be} of TR2. If this happens, the constructor has several choices. He can put up with the voltage he has; he can replace the Zener, but he will have no guarantee that the replacement will do the trick, unless he can preselect the actual voltage from a batch of nominally similar Zeners; or he can resort to level shifting.

This is an old trick whereby an ordinary silicon diode is connected in series with the Zener, and since this has a voltage drop of, again, 0·7 volts, the output will be correspondingly raised. This is a useful ploy where, say, a 9 volt output is required from a 9·1 volt Zener, the nearest standard value.

BASE CURRENT

To ensure that the series pass transistor operates correctly, and that the output voltage does not sag excessively under load, it is necessary to provide it with an adequate base current. The simplest way of achieving the required result is to ensure that the Zener is passing more than the current required by the base of TR2, and this is simply calculated by dividing the required maximum emitter current by the h_{FE} of TR2. For the 2N3055 used, this is 13·5mA.

To ensure that the Zener's slope resistance is not adversely affected, we can double the current flowing in the Zener, and this will enable a 250mW Zener to be used.

Capacitor C2 across the Zener serves to suppress Zener noise, and must not be increased in value; to do so is to invite the destruction of TR2, for in the event of a short circuit at the output the capacitor will discharge through the low impedance offered by the base/emitter junction of TR2.

COMPONENTS . . .

Resistors
R1 1Ω wirewound
R2 250Ω wirewound
R3 200Ω ½W

Capacitors
C1 2000µF 25 V elect.
C2 0·15µF

Semiconductors
TR1 2N3053
TR2 2N3055
D1-D2—1N4001, D3-6·8V 1½W Zener, D4-2V 40mA l.e.d.

Transformer
T1 Type 28T05 (Electrovalue)

Miscellaneous
S1—Double pole mains on/off. Mod—2 type A case (West Hyde Developments)
FS1—500mA

CURRENT LIMITING

The total output current flows through R1, and this includes the current consumed by the Zener and by the l.e.d.: these are small in comparison to the load current and can be disregarded.

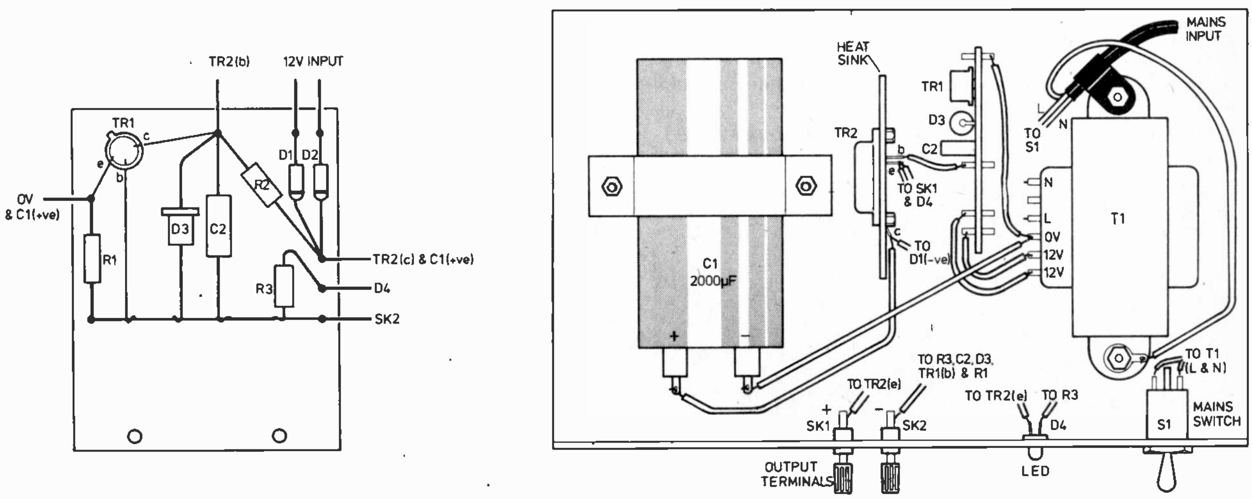


Fig. 2. Small Veroboard layout and general component assembly

The V_{be} necessary for a silicon transistor to turn on is around 0·7 volts, and until the voltage across R1 approaches this value TR1 plays no active part in the proceedings. As soon as the V_{be} is sufficient, TR1 turns on and, since its collector is connected to the junction of D3, R2, and TR2's base, it begins to divert current away from D3, and then from the base of TR2.

The total current that TR2 can pass is therefore directly related to the voltage dropped across R1. In the prototype R1 just allowed 500mA to flow, at which point the supply voltage had dropped by only 200mV. Short circuiting the output increased the current to only 600mA, well within the ratings of the components used.

The heatsink used was a piece of $\frac{1}{16}$in aluminium $2\frac{3}{8} \times 3\frac{1}{2}$in secured to the bottom of the case. Since the collector and case of TR2 are common, a mica washer and insulating bushes must be used.

Indication that the power supply is switched on is by means of an l.e.d. connected across the output. R3 limits the current to the l.e.d. to 20mA. If the output is short circuited, the l.e.d. should extinguish, making the user look for the reason.

CONSTRUCTION

The unit was built into a Mod-2 case from West Hyde Developments. With the exception of T1, C1 and TR2, all the components were accommodated on a piece of plain 0·1in Veroboard 2in × $2\frac{1}{4}$in, with a little room to spare. All interconnections were on the reverse, flying leads being used to connect the board to the other components.

With all wiring completed, a careful check should be made for errors. The supply can then be switched on and the output voltage checked which should be about 6V.

LOAD MEASUREMENTS

The regulation can be checked by applying various resistive loads and checking the fall in output voltage with increasing current; on the prototype a fall in output voltage of 200mV occurred when the maximum rated current was drawn. The ripple voltage, measured on an a.c. millivoltmeter was 440μV at maximum current.

The output short circuit current can be checked by applying a suitable current meter straight across the output terminals, and although the resistance of the meter will mean that the real short circuit current will be somewhat greater, the difference is not worth worrying about. The measured short circuit current was, in fact, 600mA.

CAR USE

The circuit from C1 onwards is an ideal one for running equipment requiring less than the nominal 12 volts of the car battery. The author has built such a regulator straight into an extruded finned heat sink, the components, C1 excluded, being self supporting in the area reserved for the TO3 power transistor, that is, held together by their leads, and then being encapsulated in an epoxy resin.

The encapsulation serves a dual purpose. It prevents the components moving around, and it also serves to prevent the ingress of contaminants thus allowing the complete assembly to be mounted in any convenient position, but not in the vicinity of the exhaust pipe or other heat radiating members of the engine. ★

The PE WIRE BENDING GAUGE

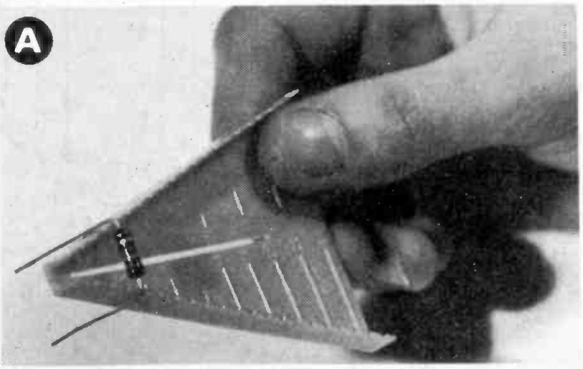
YOUR free *PE* Wire Bending Gauge has been designed mainly for use on 0·1 inch matrix perforated circuit board and Veroboard, but can also be employed on 0·15 inch matrix boards or on printed circuit boards where a similar matrix layout is adopted.

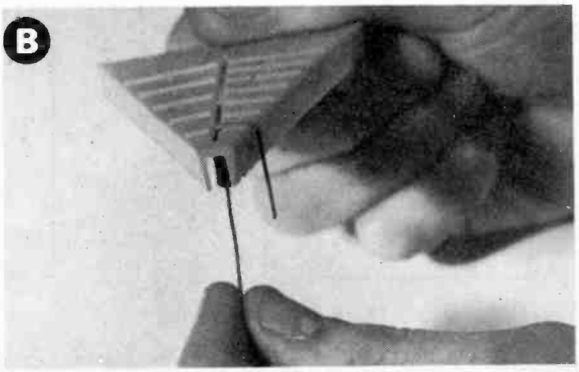
From the component layout diagram decide how many holes each component should span, and whether it should be mounted horizontally or vertically.

For horizontal mounting use the gauge as shown in (A). The number of holes for 0·1 inch matrix are indicated on the left, and for 0·15 inch matrix (odd numbers only) on the right.

Use the flat side for vertically mounted components, as shown in (B). Push one straightened lead of the component up through the slot and align it with the required groove, again 0·1 inch matrix on the left, 0·15 inch on the right.

In both cases, the lead(s) should be bent down at right angles so that they lie parallel before removing the component from the gauge. ★





BY FRANK W. HYDE

THE FRIENDLY PLANET

Mars has pink skies, red soil, rocks that are greyish-green and black and an atmosphere that once could have been very similar to Earth's today. These were the conclusions by scientists at the Jet Propulsion laboratory as the first Viking Surface Data came back to Earth.

"Mars somehow looks much more friendly than the Moon", said Dr. Thomas Mutch of Brown University when looking at the first colour pictures of the surface on July 21. "You see these colours in the Painted Desert" (the Painted Desert is in Arizona in the south western part of the United States).

The atmosphere of Mars, measured as the *Viking* Lander made its way to the surface, has about two per cent argon and three per cent nitrogen, compared with Earth's one per cent argon and 78 per cent nitrogen. "But", said Dr. Michael McElroy of Harvard University, "that amount of nitrogen is enough to support microbial life on Mars today, if at times in the past, when liquid water was abundant at the surface, life got started."

The major constituent of the atmosphere is carbon dioxide, although there is some oxygen. Mars' skies are pink because of dust in the atmosphere that scatters sunlight, the same mechanism that produces blue skies in Earth's much more dense atmosphere. The red soil is produced by oxidation of the surface material, like rust on Earth. It can be produced by weathering. The weathering could have resulted from a reaction with surface water and oxygen in the atmosphere.

MARTIAN BUGS

While the amount of nitrogen on Mars is low compared to Earth, it is sufficient to support any Martian bugs. Dr. McElroy says that "Most nitrogen in Earth's atmosphere is wasted". The atmosphere's nitrogen is mainly in a form useless to plants and animals, the two nitrogen atoms must be broken apart, or fixed by legumes or bacteria before they can be incorporated into the tissue of plants and animals. Dr. McElroy said "Martian bugs would have to be pretty smart to fix nitrogen for themselves."

According to Dr. McElroy's model, the Martian atmosphere could do the "fixing" for the bugs. Sunlight hitting the upper atmosphere could break the nitrogen atoms apart to form nitric oxide (NO) that could rain down on the surface, supplying as much as one million tons of fertilizer a year to the soil. Earth's living systems fix about 100 million tons of nitrogen per year, in addition to that fixed artificially by fertilizer.

The limiting factor in the possibility of Martian life now seems to be the absence of the liquid water that oxidized the red soil and cut the enormous stream channels seen in the *Viking* photographs. *Viking* scientists have thus chosen landing sites in low warm regions in the hope of outwitting cold Mars.

The theory is, that while most of the time the water is frozen, during the day the sun melts the surface ice to water and the dust protects the water from immediately evaporating. Any Martian bugs might have sufficient water to sustain life. The weather station at the *Viking-1* Chryse site will indicate whether or not the ice does turn to temporary water and the cameras will be able to photograph the rising ground fog.

The biology experiments will supply vital answers to these questions. While the first results may not be definitive, scientists will know more about Martian life, or the lack of it, than was known hitherto, but the atmospheric results have already raised hopes.

MARTIAN ATMOSPHERE

The atmospheric measurements verify that Mars probably had an atmosphere of nitrogen like Earth's earlier in its history. The atmosphere was also probably more dense, allowing surface water to remain in that kind of environment. Mars would then have had everything needed to start life: Energy (from the sun); water, nitrogen, carbon and phosphorus.

According to a theory developed by Dr. McElroy and supported now by the first data from Mars, the early nitrogen atmosphere escaped; Earth with its higher gravity, held on to its atmosphere. Argon which is heavier than nitrogen and oxygen did not escape. It is the amount of that inert gas in the atmosphere that gives scientists a means of measuring what has escaped.

The first direct measurements of two per cent argon in the atmosphere contradict earlier measurements made by Soviet scientists who reported as much as thirty per cent on Mars. Nevertheless, even two per cent argon, twice Earth's amount, is a large amount. It says that Mars, like Earth, had a very active volcanic period during its first one billion years when a great deal of gas in the interior was ejected into the atmosphere.

The amount of oxygen and hydrogen that has escaped Mars since would form a 3-metre thick layer of ice all over the Planet, says Dr. McElroy. The reddened surface seems to support the theory that large amounts of oxygen and water have interacted with the surface. Scientists agree that while Mars has lost much of its water, it still has plenty, in frozen form.

Mars is much colder than earth. The average surface temperatures are now below the freezing point of water, although the landing site of *Viking-1* probably gets warm enough during the day to melt that ice. Geologists now think that beneath the dusty surface lie deep layers of frozen water mixed with dust permafrost. This source would continually resupply the atmosphere with water.

QUASAR REDSHIFT

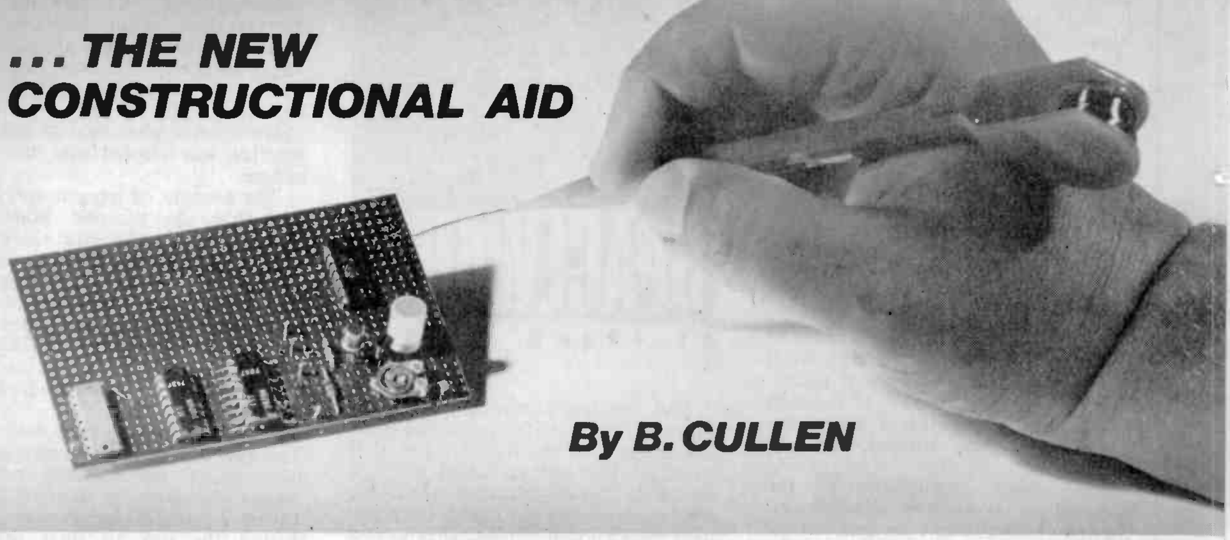
For the first time, large redshifts have been seen in both the visible and radio spectra of one object (AO 0235 + 164). This was an absorbing cloud in front of a quasar.

During 1975 two teams of astronomers in the United States recorded a redshift of $z = 0{\cdot}5240$ in the optical spectrum of a quasar. Now a team of radio astronomers at the National Radio Astronomy Observatory, West Virginia, have looked at the same object, which was a known radio source. They set up their apparatus to scan for the 21 cm line at what could be its redshifted wavelength. Several sets of observations were made with the NRAO 91 metre radio telescope. A careful analysis of the data confirmed that the absorption feature corresponded to the 21 cm line, but shifted by an amount that gave a redshift of $z = 0{\cdot}52385$.

Astronomers interpret the redshift as being due to the Doppler effect (the variation of the perceived frequency of a signal with the motions of emitter and receiver). In that interpretation the relative velocity of Earth and AO 0235 + 164 is over half the speed of light. In the expanding universe, that means that this source is over 2,500 megaparsecs or 8×10^{17}km from the Earth.

INTRODUCING WIRING PENS

... THE NEW CONSTRUCTIONAL AID



By B. CULLEN

WHEN I first learnt of the new constructional aid, the wiring pen, I immediately realised that this would have a great potential for both professional and amateur use, as the pens were primarily designed to simplify and speed up the construction of prototype circuits. Before venturing further—don't let the "prototype" designation put you off. These pens are not strictly for professional use only.

To the reader who has dabbled in the construction of electronic circuits it must be fairly obvious that the bugbear is the tediousness of the hand wired interconnections. Let us take, for example, the construction of a dense logic card, where the enormous number of interconnections needed leads to painfully slow progress. The same is, of course, true for discrete component circuits. The wiring pen system is a way of easing this type of problem.

As the name suggests, the wiring pens are simply pen-type holders for spools of very fine polyurethane insulated wire. This insulation melts when heated with a soldering iron. In theory it is then a simple matter to link up all the required components by threading the wire from the pen around each individual component, soldering each joint and producing a completed circuit, made up in a fraction of the time and without being too tedious an operation. In practice, however, I found that it was not quite so easy as putting pen to board.

Two of the types I was able to test, and that are available at the moment, are the Vero wiring pen and the Vector P173 wiring pencil. These are marketed by Vero Electronics and Vector Electronics.

VERO PEN

The Vero wiring pen comes with one spool of wire, and is also available in a very comprehensive prototype kit form containing pen, spools of wire, magnifying eyepiece, lead forming tool, wiring combs, cutters, various types of terminal pins and a pin insertion tool, also a Eurocard, International Card or American Card, depending upon which kit you purchase, at around £16·00 complete.

I feel it is a little too luxurious for the "one off" amateur, although the manufacturer's claim that the kit contains sufficient materials and basic tools to enable one to assess the system's general application, is more than justified.

All the items mentioned are available separately, and the pen, with a spool of wire, at approximately £2·00 with VAT plus postage, is good value.

For these or the kit you should write Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Hampshire.

VECTOR PENCIL

The Vector wiring pencil comes complete with one spool of wire fitted, plus a spare spool and a wire threading tool. The instructions enclosed do, however, refer to accessories such as lead forming tool and plain Vectorboard.

The cost is around £7·00 and, although it seems rather more expensive than the Vero pen, is of a much more robust design. This pencil is available from J. H. Equipment Ltd., 91, Redbrooke Rd., Timperley, Trafford, Lancs.

COMPARING BOTH

The only similarity between the two pens is their mode of operation. The Vero pen is a slim shape resembling a pencil, with the spool of wire clipped into a holder at the top. The fine wire runs through the centre, and a slide, conveniently placed at the finger tip, allows the wire to run freely, or with tension, as required. Somewhat surprisingly the carrier at the top of the pen does not make it unbalanced or awkward to use.

Only one disadvantage appeared in use, namely that threading the very fine wire into the pencil and slide was not quite so easy as the leaflet led one to believe. Fine wire has a mind of its own when being guided into places, and bends in ways not required. It took a few attempts to succeed.

The Vector pencil is much larger in size, shaped like a torpedo, and again with the spool of wire at the top, but this time the spool is fitted inside the barrel of the pen.

Almost at the top of the pen are two holes on the left and right, from which the wire is fed, depending upon left or right hand operation. At the tip there is a fine metal tube through which the wire is passed and fed to the work. Tensioning the wire is controlled by one's index finger, placing pressure on the wire running out of the hole and through the tube.

For its size the pen is well balanced and easy to use and has the following advantages:

1. Its robustness would be a distinct advantage if the pen were to be put to a good deal of use.
2. The threading tool, much like a giant needle-threader, made child's play of fitting new spools of wire.

For those who are wondering, I reached these conclusions on the advantages and disadvantages of the pens after much practice on both discrete and i.c. component circuits. This enabled me to get the feel of the pen's operation, which is essential if a fair assessment is to be given. At this stage I followed the manufacturers' instructions closely before drawing my own conclusions.

Common to both the Vero, Vector or, for that matter, any type of wiring up system, is the planning and assembly of the components on the type of board in use, whether it be plain matrix board, Veroboard, Vectorboard, or a specialised wiring card.

When hand wiring is used, a lot of thought must be given to the placement of the components to ensure sufficient space is left for the wired runs and routing of wires. The advantages of this new type of wiring system really speak for themselves, in that considerable time is saved at the planning stage as components can now be placed on a board in an orderly flow pattern similar to the circuit diagram of the project being built. Less board space is needed as cabling space can be virtually discounted and, of course, an inherent advantage is the neat appearance of the finished job as there are no unsightly wires on the component side of the board.

VEROWIRE TECHNIQUES

The Verowire instructions recommend planning and assembly in the conventional manner, mounting the components from the ground side of the board—that is the side with less copper—and mounting the i.c.s first to enable the use of the lead deforming tool. This cunning little device is simplicity itself, being made of one piece of aluminium and designed to accommodate 7·62 and 15·24mm pitch i.c.s. The very nature of the design will always ensure correct deformation of i.c. pins as its shape forms an internal built-in stop.

Once the i.c.s have been inserted the board should be turned over onto a clean flat surface, and the deforming tool placed between the i.c. pins. A gentle downward pressure together with a sideways rocking action will bend the pins to a uniform 120 degree angle (Fig. 1).

Discrete components, such as resistors and capacitors, can now be mounted on the board, either by soldering them to terminal pins fitted in place on the board, or, alternatively, the wire ends can be fed through the appropriate holes in the board, bent to the approximate angle on the i.c.s and cut to a suitable length so that they can be wired with the wiring pen. See Fig. 2.

COMB ATTACHMENT

Having attached all i.c.s and components to the board, plastic wiring combs can now be fitted between i.c.s and up or down the entire width of the board. The wiring combs are used to provide a guide and pegs which control and hold the wire ensuring a neat stable layout. Fig. 3 shows a cross section of a comb inserted between an i.c.

The Vero wiring pen comes complete with one spool of wire already threaded to start the point to point wiring, as follows: with approximately 3mm of wire protruding from the tip (Fig. 4a) this is inserted into the hole containing the lead of the first component connection. The wire is kept taut by depressing the slider/clamp.

At least two turns should be wrapped around the i.c. lead ensuring a tight wrap as in Fig. 4b.

Two turns are then wound around the nearest peg on the wiring comb.

The appropriate pins on the components are next wired using the combs and wherever possible routing the wire through a gap in the comb adjacent to the component to be connected. Generally speaking, multiple turns are only required at the start and end of a wiring run.

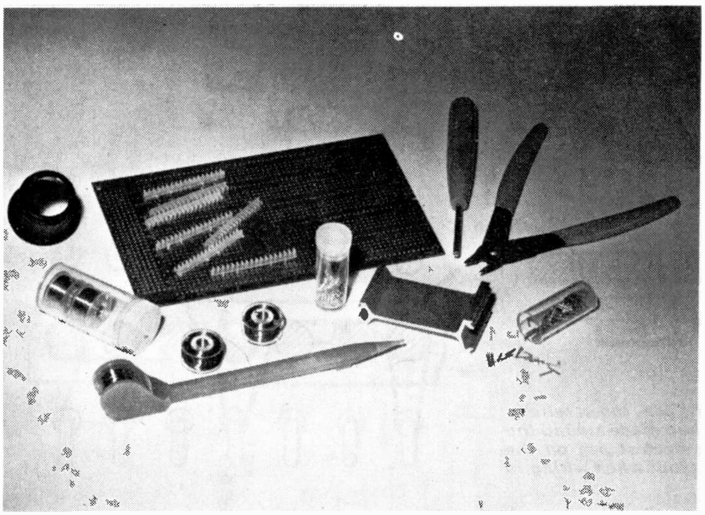
All that now remains is to solder all wrapped joints, using a miniature soldering iron with a hot tip temperature of 380° to 400°C and resin cored solder. It will be found that a reasonable application of the soldering iron together with an appropriate quantity of solder is needed to ensure that the polyurethane insulation melts sufficiently to effect a good soldered joint between wire component lead and, where appropriate, the pad on the board.

VECTOR WIRING TECHNIQUES

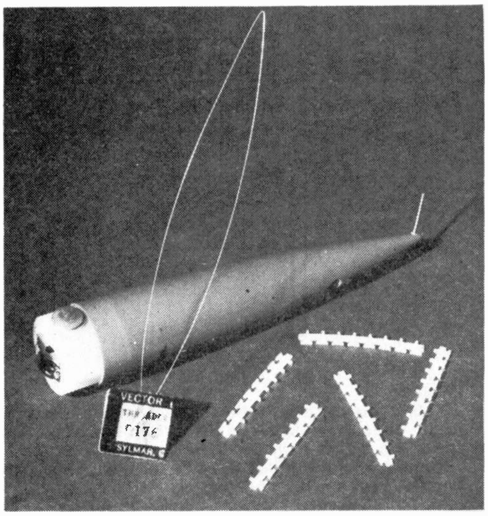
It does not take long to realise that if the operation of the two pens is similar, then the instructions recommending use must be similar. The leaflet accompanying the P173 wiring pencil is brief but adequate and the mounting techniques described for the Vero system also apply. Unfortunately the pencil does not have the same number of accessories as the Vero system, but accessories such as the P133A lead staking tool, and plain Vectorboard, are often referred to, as already mentioned. I think the lead staking tool explains itself, and one can quite easily imagine it will have a similar action to that of the Vero lead forming tool.

The P173 pencil also comes threaded for action, although this time one has the choice of altering the feed of the wire

The Vero Verowire prototyping kit



The Vector wiring pencil with threader and combs



WIRING PENS

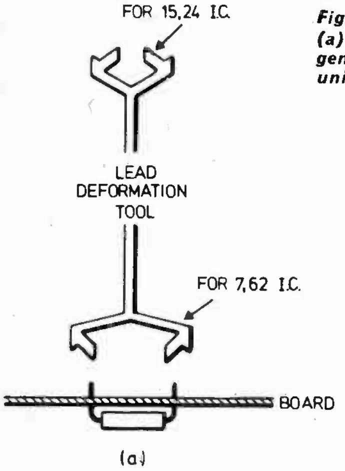
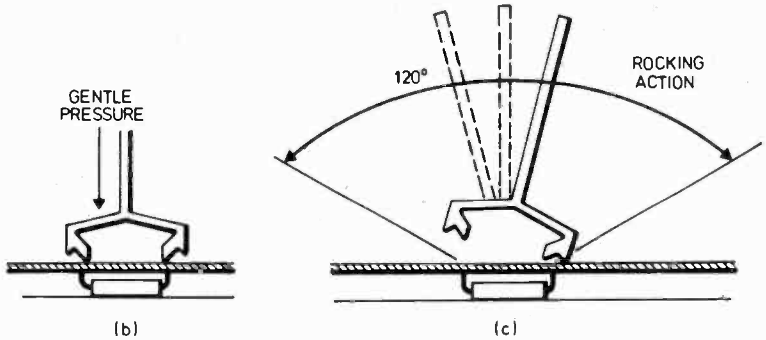


Fig. 1.
(a) Presenting the lead deformation tool to the board mounted i.c. The tool is then pressed gently down on the leads (b) together with a rocking action (c) to splay them to a unifom 120°



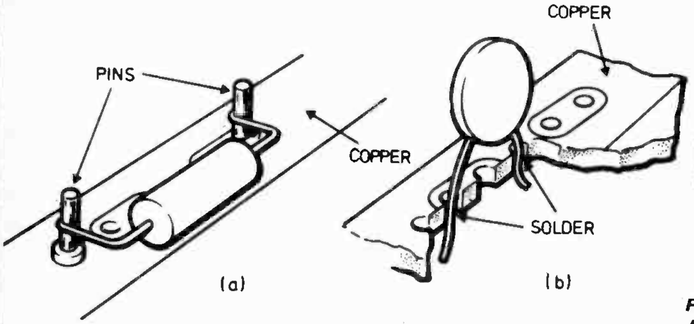


Fig. 2.
Showing alternative assembly methods for discrete components here (a) a resistor is soldered to terminal pins and (b) a capacitor is inserted and leads deformed to 120° prior to pen wiring

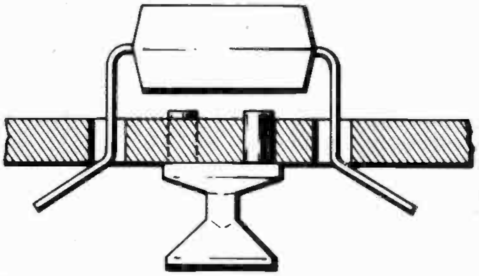
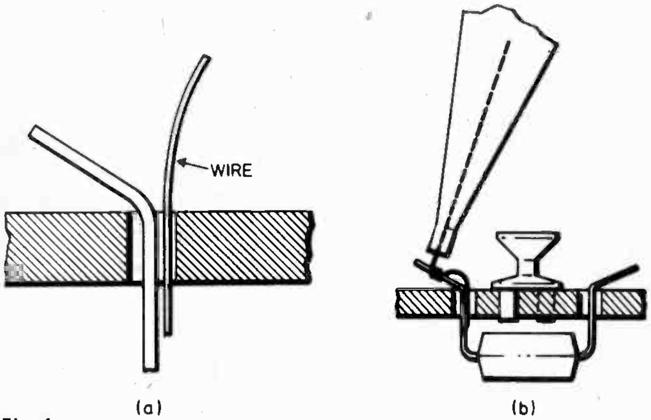


Fig. 3.
After deforming the i.c. lead the combs are inserted. The combs are fitted adjacent to each other



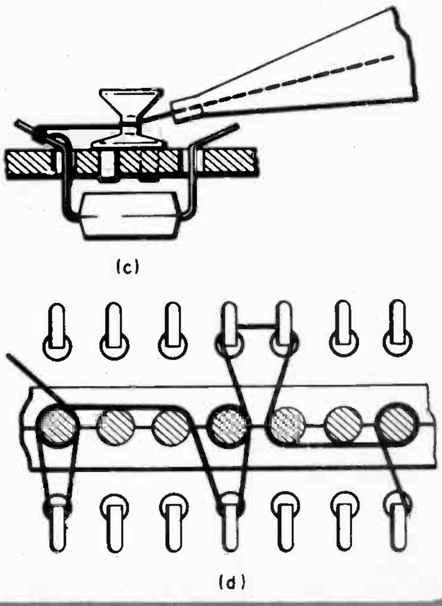


Fig. 4.
With about 3mm of wire protruding from the tip of the pen, insert wire in hole containing i.c. lead (a) a tight wrap of wire is then made around the lead (b) a two turn wrap is then made around the nearest peg on the comb (c) which holds the wire and ensures a neat layout when wiring to other leads on the chip (d)

for right or left hand operation by running the wire through the appropriate hole in the cone of the pencil. When assembling components onto the board no preference is given to which components should be inserted first, and i.c. leads are bent by hand to approximately a 45 degree angle.

Discrete components are fitted and bent first at right angles to the board, then upright to form a terminal point to wrap with wire. Here the use of the lead staking tool is described and its action is simply to insert component wires through the appropriate holes in the board. Place the lead staking tool on the wire, leave a ⅛in gap between the end of the tool and board, press downwards and the tool will first anchor the component lead at right angles and then leave the rest of the lead vertical to form a terminal. Wiring is very similar to the Verowire method.

Vector use a 36 AWG wire as opposed to the 34 and 39 AWG of the Vero system but specify a similar soldering bit temperature requirement.

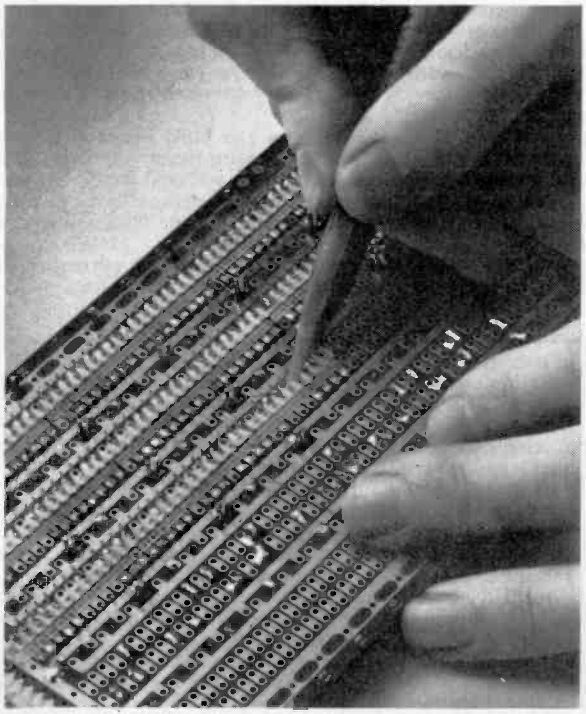
COMPONENT REMOVAL

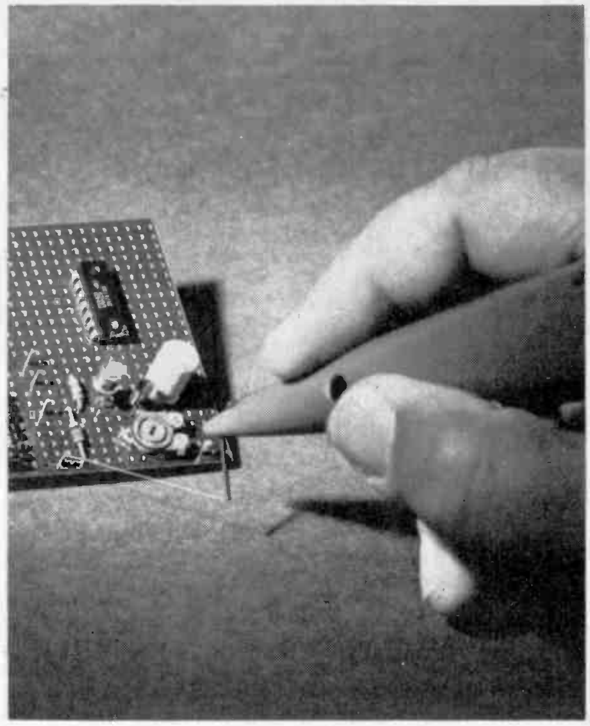
To replace a component for both systems simply snip off the component leads to leave a short length left in the board and soldered to the wire joint. Solder the new component lead to the short length left in the board, and the faulty component has been replaced. To prevent the short leads dropping back through the board when the solder melts, and if space permits, bend the shortened lead at right angles to the board. If a wiring fault has been made snip out the wrong length of wire and replace it with a new run.

EVALUATION

In the test piece attempted it was found that the i.c.s virtually held themselves in place quite rigidly, but a transistor, for instance, will wobble about in the holes in the board if not mounted flush to the board and the leads, bent at right angles on the underside to lock it into place. Considering the large application of heat needed to melt the polyurethane wire, I felt that this method had its drawbacks. Admittedly, soldering discrete components

Demonstrating point-to-point wiring with the Verowire pen. The d.i.p. board enables extremely high packing densities to be achieved





The illustration demonstrates the best hand position when using the Vector pencil. The index finger controls the tension on the wire

to terminal pins leads to easy and fast replacement, but this method too seemed to take up a good deal of valuable time compared to soldering components straight onto a circuit board. It was also strange having to work from the underside of the circuit board and having to virtually count pin numbers backwards.

Both manufacturers refer to plain matrix board. I found stripboard costs very little extra, so I combined the best of both worlds by soldering my components straight into the board, leaving the leads long enough to act as terminal pins with which to wire wrap. It also has an added advantage of cutting down the number of wire runs to the discrete components.

SOLDERING

A few words on soldering will not go amiss here. It is essential that the bit of the soldering iron be kept clean when making a joint and the use of a moist sponge to clean it is highly recommended. With sufficient solder on the tip to help with heat conductivity, the solder must be melted against the joint and not the iron and even if you use the correct tip, don't be surprised if it takes just that little bit longer to melt both the insulation and solder. Finally, it will be noticed that a little char remains at the soldering joint, but this need not give cause for concern as regards the quality of the joint.

To sum up, I would not like to argue as to which pen or system is the better; they both do the same job very effectively, only differing in their physical appearance. It is a matter for the individual to decide which suits him best.

In the first place you either like the idea of this new system or you don't. If you do, you go out and buy one, together with the accessories you think fit. Once committed, however, persevere in the using and developing of your own skills. This type of wiring system gives me the impression that it is the type to which you will commit yourself wholly, or lose interest in quickly. In my opinion it is a very practical system, provided that the owner adapts it to his personal needs. ★

THE CLEAN ROOM

EXPANSION IN U.K. MEMORY PRODUCTION

A NEW clean room of 30,000 square feet, believed to be the largest and most modern in Europe, has been built in eight months flat at the Mullard Southampton semiconductor plant. This is to be used for the manufacture of *n*-channel MOS products, principally memories. This large investment by the parent company Philips follows last years acquisition of the U.S. company Signetics. Philips claim to be the largest manufacturers of semiconductors in the world; now the world's second largest producer of i.c.s, and Europe's largest manufacturer of i.c.s.

The Mullard Southampton works was the first purpose-built semiconductor factory in the United Kingdom (1956). Successive extensions culminating in the new clean room area bring the total plant area to some 375,000 square feet.

HOW CLEAN IS CLEAN?

The unit of measurement of cleanliness is expressed as the number of particles of a size of 0·5 micron or greater per cubic foot of air. A typical factory may have as many as a million such particles per cubic foot and a "clean" factory (in the ordinary sense) 100,000 particles. No part of the new Clean Room at Southampton is worse than Class 10,000 (i.e. 10,000 particles) with more critical areas Class 1,000 and super-critical areas Class 100. These are maximum figures, but in practice Class 100 zones may have a particle count of less than 10.

The basic problem is not airborne dust introduced by the air-conditioning system. This can be eliminated by washing and filtering the air input. The problem is that people, however well bathed and scrubbed are "dirty" inasmuch as they are constantly shedding particles of skin tissue and hair. This can be alleviated to some extent by lint-free clothing. A change of shift causes a noticeable increase in particle count for a short period until external dust introduced by incoming personnel has been eliminated.

The specification for services such as de-ionised water and various gases—oxygen, hydrogen and nitrogen—became more and more critical with each technological innovation. Particular attention has been paid to the purity of gases and a Reverse Osmosis plant (the largest in the U.K.) has been installed for the treatment of the "raw" water used in the de-ionising process.

Production is normally on a two-shift basis, 0600–1400 hours and 1400–2200 hours. A third shift could be introduced if necessary.

The level of automation is continually increasing although very critical operations such as alignment, are still hand-controlled. The loading and unloading of slices is fully automated, not for speed but for cleanliness and care of slices. Speed is not always a necessary characteristic of i.c. and L.S.I. processing. It is more important to obtain maximum yield of good devices. The slice through-put time is sometimes quoted as a measure of efficiency but speed cannot be taken in isolation. The fastest through-put time is not necessarily the most economic.

Production is currently based on a standard 3-inch slice but all the new equipment is capable of conversion to larger slices if justified by advancing process technology. The ultimate capacity of the *clean room* is estimated at approximately 2,500 slices per day.

Perhaps the most impressive item of new equipment is the ion-implantation machine which enables shallow doped regions to be formed with great precision. This single item of equipment costs £100,000. A second machine is to be purchased in the next expansion phase.

THE PRODUCTS . . .

The first main product being manufactured in the new unit—Clean Room No. 6—is the Signetics Type 2680 4k RAM. This is a 22-pin dynamic device already established as an industry standard and is equivalent to the Intel 2107B. Its principal market is computer mainframe manufacture. Final assembly is undertaken in the Far East where the current package is CERDIP. However, Southampton is currently developing a plastic package as a cheaper alternative.

A 16-pin 4k RAM (Signetics 2660—an industry standard) has been under development at Southampton and is now at the sampling stage. The attraction of the 16-pin package is that it is suitable for automatic insertion on printed circuit boards as well as occupying a smaller board area. Its disadvantage is that it needs external multiplexing and is slower in operation, but in its main applications in computers these negative qualities are not of over-riding importance.

Southampton is thus already uniquely equipped to respond rapidly to market demand for 4k RAMs of all types including static versions now scheduled for production. There is also development work going on for the next leap forward, the 16k RAM.

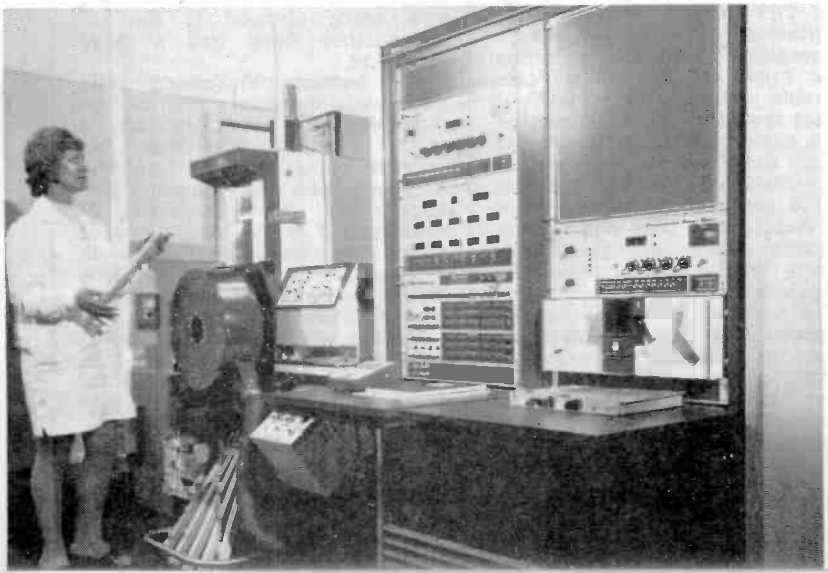
Looking to the future, Southampton will also be a main production unit for microprocessors for both the professional and consumer sectors of the industry and for the MOS products used in electronic telephone exchanges and other professional telecommunications equipment.

Initially, because of the nature of the product, nearly all output will go to third parties with practically no in-house sales. However, as new products are introduced, in-house use will increase, a typical example being devices for Teletext in which Philips will have a strong interest as a leading manufacturer of television sets.

The ion implantation machine (left) with its control console (right)

Loading wafers prior to ion implantation

The final test installation for hot testing of MOS memories



PE Special Offer

SAFETY IN SOLDERING

OUR next issue will contain full details of a special offer exclusive to readers of Practical Electronics of a complete soldering kit, which includes a new soldering instrument designed to conform to the highest international safety standards.

The new soldering instrument—making its public debut, here—has been developed by **Adcola Products Ltd** to conform generally to British Standard BS 3456, 2:14. Known as the Invader "S" 646—the "S" stands for "Safety"—it is flash tested at 2,000V, and the typical leakage current measured by the method set out in CEE 11 (European Standard) is 0·018mA.

It will be available as part of a kit containing all the essentials for simple soldering including a stand, solder wire, alternative soldering bits and an instruction card providing basic hints on successful soldering.

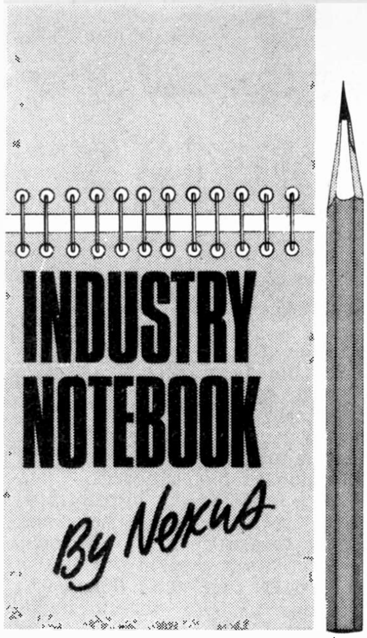
Invader "S" series soldering instruments are thermally controlled to provide a constant level of the correct heat for soldering. They feature a slim handle for easy control and weigh less than 2oz. The standard soldering tip provided is $\frac{3}{16}$in diameter but two alternative bits reduced to $\frac{1}{8}$in and increased to $\frac{1}{4}$in diameter are included to provide complete versatility in use.

The smaller bit is designed to undertake small detailed work and the larger bit for jobs calling for an increased heated area. These bits are merely inserted in the hexagonal shim at the end of the Invader to convert it from one task to another.

An Invader stand is also contained in the kit to provide the user with a mobile and safe receptacle for the hot soldering instrument. The stand features an integral sponge for cleaning excess solder from the soldering bits and two holders to contain the spare bits. A wide angle spring holder is mounted on the base of the stand at an angle of about 45 degrees and the soldering tool is simply inserted into the holder when not in use.

To complete the kit a packet dispenser of Adcola solder wire—which contains its own flux, and a guide to soldering is also included.

Details of this special offer next month



OLYMPIC PAY-OFF

Whether you found the Montreal Olympics thrilling or boring or a little of both, it is worth noting that such events generate powerful business for the electronics industry. The obvious case is a temporary boost in the sales of colour TV receivers. But the behind-the-scenes electronics, to my mind, is more impressive.

In an imperfect world electronics played a big part in the security arrangements. The Racal Electronics Group was involved but to what extent is not revealed.

Protection against fiddling by competitors was provided by Hewlett-Packard with a dozen gas chromatographs to analyze 3,000 urine samples from the top four finishers in each event plus hundreds of samples taken at random from the competitors. The chromatograph complex was computer-controlled and programmed to recognise any of 200 different drugs that may be used. An interesting sidelight on what is still called sport and games.

The control centre in Montreal that assembled the TV programmes for Europe was supplied by EMI Sound and Vision Equipment Ltd under a £400,000 contract. Subcontractors included Mercury Electronics Ltd and Oxley Developments Ltd. The centre enabled TV pictures from 28 different locations and with up to 160 separate sound commentaries to be beamed to Europe by satellite to the European Broadcasting Union (EBU) distribution centre in Liege.

The whole equipment was built in 27 air-transportable containers which can be quickly assembled and commissioned on arrival. The EBU will be using the equipment at a number of big events in the future, flying or trucking it to new locations as required. A great concept.

Even the vexed issue of international TV standards had its pay-off. The most advanced standards converter in the world is DICE designed by the British Independent Broadcasting Authority (IBA) and it is now commercially engineered and marketed by Marconi. The Montreal Olympics provided the first two sales, one to Russia, one to Yugoslavia. The equipment in Russia converted the Canadian NTSC 525-line pictures to SECAM, that in Yugoslavia to PAL.

I understand that the one-off price for DICE is of the order of £250,000. Nice business and likely to continue because DICE, as a completely digital system, is well ahead in technology. It uses computer techniques achieved through the use of 8,000 integrated circuits. The main store is said to contain the equivalent of more than 15 million (yes million) transistors.

UPTURN CONTINUES

"What's good for General Motors is good for the United States" is an old tag. We might paraphrase it to "What's good for GEC is good for British electronics" because the fortunes of GEC, the UK giant, are an excellent barometer of the outlook. Sales are up from £1,400 million to £1,750 million, profits up from £165 million to £207 million.

Then we see Ultra, not a record performer in the past, turning in a profit of £0·9 million on sales of £11·3 million. Hardly a shattering performance but still 26·5 per cent up on sales and 62·8 per cent up on profits. Electrocomponents, the component distributors (I still think of them by their old name Radiospares), have zipped up to £15·8 million turnover and £2·85 million profit. Membrain, in the automatic testing business, and still small with £1·5 million turnover, has nevertheless grown 36 per cent in a recession year, has a strong order book and reports a "considerable upturn in the market".

Best results of all in percentage terms came from Racal Electronics Group. Sales up 48 per cent at £80 million and, wait for it, profits up 105 per cent at £19·6 million. The Racal sales force commandos attacking world markets surely deserve to be called "The Unstoppables".

The only sour note is in the consumer electronics business. When the managing director of Mullard, Jack Ackerman, calls for import quotas on equipment and components from the Far East, things must be really bad.

QUIET AMERICAN

It's not every day that you meet a man who, at a stroke, has boosted his business turnover from a substantial 0·8 billion to a whacking 1·3 billion dollars, his biggest single jump in the past ten years. That is what happened when Gould Inc. notched up I-T-E Imperial as the latest acquisition to the Gould empire, putting Gould up to number three in size of the American electrical/electronic giants. Well, this still leaves Gould some way behind US General Electric and Westinghouse but William T. Ylvisaker, Gould's chairman and chief executive is clearly working at it.

When Ylvisaker joined Gould in 1967 the company was primarily a battery manufacturer with a turnover of 115 million dollars. Today Gould is a multinational conglomerate more than ten times as big. So when I was invited to meet Ylvisaker I looked forward to meeting a tough operator, a fast talker, a whizz-kid, a hirer and firer, who would be sure to be wearing a bow tie and have a cigar butt jutting from his lip.

The reality came as a shock. Could this soberly dressed, quiet spoken, modest character be the great Ylvisaker? It was. Totally relaxed, he answered questions with a shy smile, almost apologetic in manner and, for an American, incredibly low-key in approach.

Ylvisaker was in London as part of a world tour visiting newly acquired companies such as Advance Electronics, bought in September 1974 and since renamed Gould Advance. Was he pleased with Advance? No, he wasn't. It wasn't as profitable as he had hoped. But Advance had just introduced some new products and these would go well. He also revealed that Advance-designed switching power supplies for the OEM market would be made in the United States for sale there and in Canada, and lots of standard catalogue items from Advance are now being shipped to the US where they have had a good reception.

But beneath Ylvisaker's quiet demeanour there is a man of iron determination. He is, in fact, a tough operator who has few scruples about ditching companies or people who don't or won't perform and his yardstick of performance is the simple one of profit. Commenting on the growth of Gould, Ylvisaker considers size as merely incidental. It is just one way to achieve his goals.

Gould's private venture R and D is now running at the rate of 35 million dollars a year but the corporation is "not looking for great scientific breakthroughs—we are a profit making company".

MARKET PLACE

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

WATCHES AND CALCULATORS

Seven new calculators and a range of 12 low-cost digital watches have recently been announced by **Texas Instruments.** There are two slimline pocket calculators, the TI–1600 at £17·95 and the TI–1650 (with memory) at £19·95. The rechargeable TI–41 at £34·95 includes special preprogrammed functions for business and finance use. The TI–30, a "students' scientific" offers 48 functions for £19·95. Two new printing calculators make their appearance, both with dual memories—the TI–5040 at £109·95 is a desktop model with automatic constant, while the portable TI–5050 costs £99·95.

Top of the range is the SR–60, a prompting programmable desktop calculator with a suggested retail price of £1,506·60. Basic capability is 480 program steps and 40 data memories, with an option to expand to 1,920 steps and 100 memories. Programs can be keyed in as required or recorded on magnetic cards for future use.

The watches all use the same basic five-function module based on a single I^2L chip and an l.e.d. display. Cases are in metal or plastics and there is a choice of colours and strap styles. Prices start at £15·95. All prices quoted include VAT. Further details can be obtained from **Texas Instruments Ltd., European Calculator Division, Dept P.E., 165 Bath Road, Slough SL1 4AD.**

STICK-ON WIRING

Some of our older readers may remember Cir-Kit stick-on copper strips for making your own printed circuit boards. Another company, **Print-A-Kit,** have now introduced a similar product which comes in sheets of self-adhesive plain copper, group board pads and sheets of dual-in-line strips.

Known as P.A.K. Strip, the large d.i.l. Type A sheets are useful in that they can be used for in-line pin i.c.s and also for the staggered pin type of packages. The pins mate directly to the soldering pads, as do miniature and standard p.c. mounting preset potentiometers.

To make a printed circuit using Type A strip to mount d.i.l. i.c.s., the complete circuit is drawn on the board using the strip as a pattern guide to align the pin pads with those on the board. Etch board in the usual way and then stick the strip in position to the underside of the board. The adhesive used is such that the board can be drilled in one operation, drilling through both the strip and board.

An obvious advantage with this flexible type of stick-on wiring is that it can be used on plastic sheet, wood or even cardboard and mounting holes pierced with a sharp pointed instrument.

Further information and complete price list for the various ranges of P.A.K. Strip can be obtained from **Print-A-Kit, Electronics Supplies, Dept. P.E., 408 Sharrowvale Road, Sheffield, S11 8ZP.**

CATALOGUES

Just in time for the new season of Electronics Courses at the evening institutes, which start at this time of the year, are three new components catalogues.

The 20-page 1976 **Chromasonic** catalogue contains, apart from a fairly large stock of i.c.s., a new range of Chèkit audio amplifier modules with outputs up to 10W. Included in the range is a "Poor Man's Digital Tuner" kit.

The catalogue costs 35p, but includes redeemable vouchers, and is available from **Chromasonics, Dept P.E., 56 Fortis Green Road, London, N10 3HN.**

The new **Maplin** catalogue, published at the end of next month (October), should please our organ constructor readers. Listed amongst the new items is a complete two-manual organ kit. This organ is a "progressive" kit in that the constructor can stop at a single-manual version and add the extra manual and other tone colours at a later date.

Listed separately are keyboards, special organ integrated circuits, keying contact sets and complete kits of parts for articles published in various magazines, including PRACTICAL ELECTRONICS.

Of course, there are the usual large lists of stock items such as transistors, integrated circuits, resistors/capacitors, loudspeakers, control knobs, transformers and equipment cases. Listed amongst these sections are numerous "new lines".

For the organ constructor, the Maplin and the **Elvins** catalogues, who specialise in keyboards and complete organs and pianos, should cater for all their needs.

Copies of the Maplin catalogue will cost 50p and can be ordered from **Maplin Electronic Supplies, P.O. Box 3, Rayleigh, Essex SS6 8LR,** and the Elvins catalogue (not new), price 60p, from **Elvins Electronic Musical Instruments, 12 Brett Road, Hackney, London E8 1JP.**

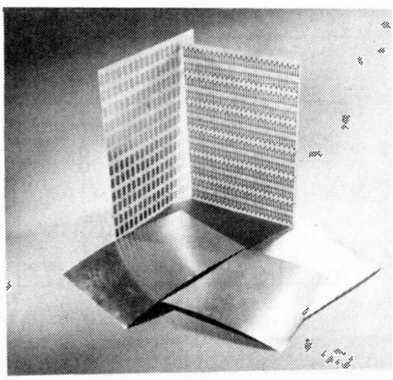
The new **Marshall's** catalogue seems excellent value for money at 40p. With over 150 pages the catalogue is broken down into seven sections; Transistors; Integrated Circuits; Diodes and Rectifiers; Opto Electronics; Resistors; Capacitors and Accessories.

There are 22 pages devoted to transistors and 34 pages on integrated circuits. Included in the optical section are l.e.d.s and opto couplers. The accessories section includes such items as switches, DIL sockets, technical books, soldering irons and stands, transformers, heatsinks, cases, knobs and test meters.

The catalogue is nicely laid out and easy to use, but the Japanese transistor equivalents list could be expanded to include general transistor types as well as Marshall's own reference type numbers. Also, it would seem that an error has crept into the transistor leadout data on page 21. The tabulated information on the left of the page lists a drawing reference letter and pin connection numbers from 1 to 6, but the case outline drawings have omitted these pin numberings which makes it difficult, in some cases, to work out the correct connections.

Copies of the Marshall's catalogue can be obtained from any of their branches or direct from **A. Marshall (London) Ltd., 42 Cricklewood Broadway, NW2 3ET.** Price 40p by post and 30p to callers.

Sheets of P.A.K. Strip from Print-A-Kit



One of the new digital watches (TI 401-3) from Texas using I^2L techniques

PATENTS REVIEW...

OVERLOAD PROTECTION

The Hungarian company, Elektroakusztai Gyar, in BP 1 407 824, give full details, including component values, for a circuit intended to offer better protection for loudspeakers against overload. The system is claimed to be able to distinguish between, on the one hand, signals with occasional peaks and, on the other hand, signals with a high average energy content.

The invention is based on the belief that the latter condition is more dangerous; i.e. that the long-term average of the programme signal is more important than its peak content because it dictates the extent to which the drive unit coil is likely to overheat and burn out.

In one form of conventional circuit (Fig. 1) D1 rectifies the audio input applied across A, B, and applies it to the coil of relay RLA in parallel with capacitor C2. When the current in the coil exceeds a selected threshold value, the relay contacts open to put resistor R_s in series with the loudspeaker LS1. Because the circuit functions essentially as a peak rectifier loaded with the resistance of the relay coil, the operational time constant of the circuit depends on an average of momentary peak values.

In Fig. 2, however, the Zener diode D2 stabilises the d.c. voltage from D1. The relay coil and an indirectly heated thermistor R3 are wired in parallel with D2, the thermistor filament being in series with R2 across the input A, B. The Zener voltage is selected to be 10 per cent lower than that which causes RLA to operate.

Apart from a constant factor, the heating power is proportional to the square of the r.m.s. value, so the temperature of the thermistor is proportional to the square of the r.m.s. value across AB. It follows that when the voltage across AB exceeds a predetermined danger level the thermistor heats up, its resistance drops, and the voltage stabilised by the Zener drives a current through RLA coil sufficient to operate the relay. This switches the loudspeaker LS1 out of circuit.

Because the resistance of the thermistor is dependent also on ambient temperature, the time period for trip operation will decrease as ambient temperature increases.

UNDERWATER BEACON LOCATOR

A clever idea for helping divers home in on a submerged beacon emitting sounds is patented by Graseby Instruments Ltd, in BP 1 432 774. The idea could well be modified to meet other audio direction-finding requirements.

A submarine sound beacon emits audio pulses of frequency around 9kHz. The diver carries a battery-powered locator which resembles a torch having a crossbeam with a piezoelectric hydrophone at each end. The hydrophones are spaced apart by a distance which is much greater than one wavelength of the beacon sound in water.

The block diagram, Fig. 1, shows the left-hand hydrophone and the right-hand hydrophone connected to the inputs of the left- and right-hand amplifiers. When sound is received by one hydrophone, it is amplified to illuminate an associated light-emitting diode, D1, D2. At the same time an inhibit signal is sent, via a delay network, to the input of the other amplifier.

The delay imparted is significantly less than the time taken for sound to travel in water between the left and right hydrophones. Thus, if the beacon is to the left of the locator the left hydrophone will receive sound before the right and the diode D1 will be illuminated, while an inhibit signal prevents illumination of diode D2. Similarly, D2 is illuminated and D1 inhibited when the beacon is to the right of the locator.

When the beacon is straight ahead both diodes are illuminated. The diver thus need only swim in the direction which lights both diodes.

BP 1 432 774

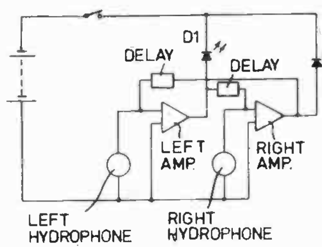


Fig. 1

BP 1 407 824

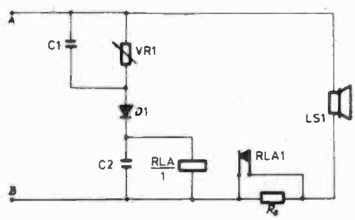


Fig. 1

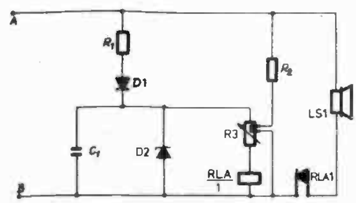


Fig. 2

IN BRIEF

BP 1 435 954, V E Tesler of Moscow: *Compatible Stereoscopic Colour Television System.* This Russian patent gives details of a mono-compatible stereo colour TV system which uses phase quadrature modulation of the colour sub-carrier to convey the necessary extra information.

BP 1 438 063, Motoh Industry Ltd, of Japan: *Drawing apparatus.* An electronically controlled automatic drawing board which draws lines at predetermined angles with respect to imaginary lines on the board, using as a base reference position lines of the earth's magnetic field.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 75p each

RETURN OF POST MAIL ORDER SERVICE

R.C.S. 10 WATT AMPLIFIER KIT

This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s, input 100M.V. high imp. Size 9½in × 3in × 2in.

Mono kit **£11·25** Stereo kit **£18** post 45p

Easy to build. Full instructions supplied.

ELAC 10 inch

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 c/s. Bass resonance 55 c/s. 8 ohm impedance. 10W. **£4·95**
9 × 5in. model £3·25.

MAINS TRANSFORMERS

ALL POST 50p each.

250–0–250V 80mA, 6·3, 2A £2·95
250–0–250 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A £4·60
350–0–350 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A £5·80
300–0–300 120mA, 6·3V 4A C.T., 6·3V 2A £7·00
MIDGET 220V 45mA, 6·3V 2A, 2½ × 2½ × 2in £1·75p
HEATER TRANS, 6·3V 3A, £1·45 ½ amp. 95p
GENERAL PURPOSE LOW VOLTAGE.
Tapped outputs at 2A 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £4·60
1A 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·60
2A, 6, 8, 12, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7·00
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8·70
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11·25
5, 8, 10, 16V ½A £2. 6–0–6V 500mA £1. 9V 1A £1
12V 300mA £1. 12V 500mA £1. 12V 750mA £1.
40V 2A tapped 10V or 30V £2·50. 20V 3A £2.
40V 3A £2·50. 30V 5A + 34V 2A ct. £3·75.
20–0–20V 1A £2. 30V 1½A £1·75. 20V 1A £1·80.
60V tapped 40V, 20V, 1A £3·50.
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FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs 1½A 40p; 2A 55p; 4A 85p.

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All parts including printed circuit and instructions to build this unit. Voltages available: 6V, 7·5V, 9V, 12V. Up to 100mA output. Please state voltage required. **£2·95** Post 45p.

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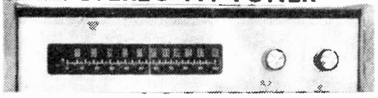

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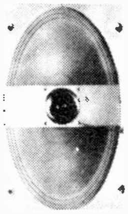

With tweeter. And crossover. 10W. State 3 or 8 ohm. As illustrated. **£5·25** Post 45p

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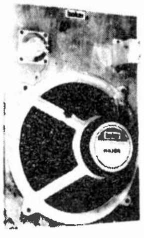

30–14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 3 or 8 or 15 ohms must be stated.

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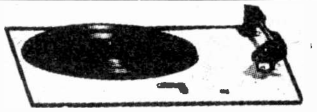

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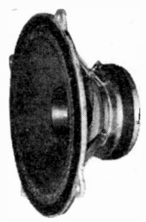

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Useful response 20–17,000 c/s
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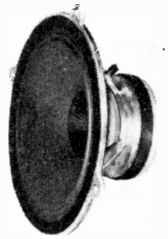

A full range reproducer for high power. Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.
Bass Resonance 35 c/s
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Readout—
A SELECTION FROM OUR POSTBAG

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.

On-course

Sir—In a recent issue of PRACTICAL ELECTRONICS (May 1976) you published details for the construction of an "Audio Compass" which could be used as an off-course alarm for yachtsmen.

I was a competitor in the single-handed transatlantic yacht race and was able to try out and evaluate your prototype unit and think that your readers may be interested in my observations. Unfortunately, I had to retire from the race when I was about one third of the way across, after my self-steering was broken when I hit a submerged object of some sort.

I was at sea for twenty days and for all that time, despite the instrument being wet for a good part of the time and getting soaked on several occasions as well as receiving the battering one might expect in a North Atlantic gale, it operated very well. My main comments are on one or two details and on the use of the instrument.

When sailing singlehanded for any length of time sleep becomes of major importance and very often one is only able to snatch cat-naps of a few minutes for several days. Because of this, when one gets the chance of a few hours at a stretch, sleep is of prime consideration. Hence, when I first used the off-course alarm on the third night of the race after 48 hours without sleep and it woke me up minutes after I had fallen asleep I felt like throwing the whole thing overboard! I had set it to go off with a course change of about 15 degrees, forgetting that in the open sea a temporary wind shift of that magnitude is quite common.

The first important lesson I learnt from this was that one needs to set the alarm on a fairly broad band, i.e. so it will only sound when a change of course of about more than 35 degrees occurs. In this way, the minor meanders off course will not wake the exhausted sailor, but if he strays far enough off his course the alarm will sound and prevent him sailing back the way he has come or sailing toward a danger. Later in the race I set the alarm so that it would only sound if the course altered more than 45 degrees and this proved most satisfactory for both progress in the right direction and sleep.

The alarm itself is very strident, especially when connected to the ship's supply of 12V. In fact, I considered it to be far too noisy and think that a far gentler tone would have been just as effective and considerably less wearing on my nerves.

I believe that in the construction of the sensor ring housing the Hall Effect probes you used a piece of "Conti-Strip" so that it could slide easily round the compass bowl. I found that after this had been wetted it was very difficult to slide, probably because it swelled. Some sort of plastics strip might have been more satisfactory.

Apart from these two minor comments I found the instrument generally most satisfactory and had I been able to finish the race think that it would have saved me a good number of miles.

Andrew Bray,
Assistant Editor,
YACHTING MONTHLY

Missed Point

At this late stage, due to the fact that as a New Zealand reader, I do not receive P.E. until about three months after publication, I would like to enter the fray started by your reader Mr B. Timson who in *Readout*, February issue, deplored the appearance of what he felt were "unnecessary" projects in P.E.

I feel that he has missed the point behind magazines such as P.E. and I wonder that he even bothers to read it. These "useless" projects he refers to are so important because of what they teach people who read them, and more, what they teach people who build the projects and even who fail in the attempt and have to find out why they don't work. As one who has had all this sort of thing happen, I think that your correspondent may have missed out on the pleasure of discovering mere principles which seem to be fairly dry at the time of learning them, but which often quite unexpectedly open up to be something most interesting and rewarding.

He reminds me a bit of a man who wrote to "Electronics Australia" a few years ago to air his impatience with all the new integrated circuits which were flooding the market. He regarded it as laziness on the part of a constructor to use an i.c. instead of using discrete components. I wonder why he ever stopped using valves. I wonder what he would say now we have l.s.i.

Although, as I said, I entered this argument late, might I suggest that if you think it would do any good, you might see fit to publish an edited version of my letter. I have never written to the editor of any publication outside New Zealand before, but I felt that Mr Timson should realise that even people as far away as N.Z. may disagree with him.

D. A. Arthur,
New Zealand

Project Boxes

Sir—Perhaps some of your readers may be interested in my idea for a simple projects box.

A length of plastic downpipe of the section shown in Fig. 1 can be made into a whole range of project boxes by cutting as shown in the diagrams. They can be any length, since the downpipe can be bought at any good builders, suppliers in anything up to 12ft lengths, so the cost per box would be quite small.

I hope this idea will help your younger readers who cannot afford those expensive boxes just to case up a cheap experiment.

F. W. Camping,
Hoddesdon.

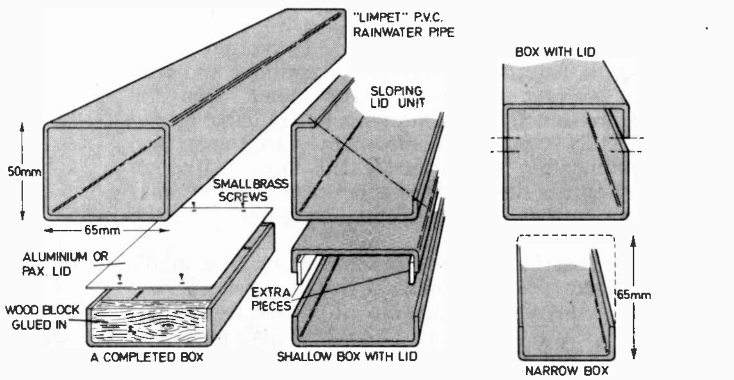
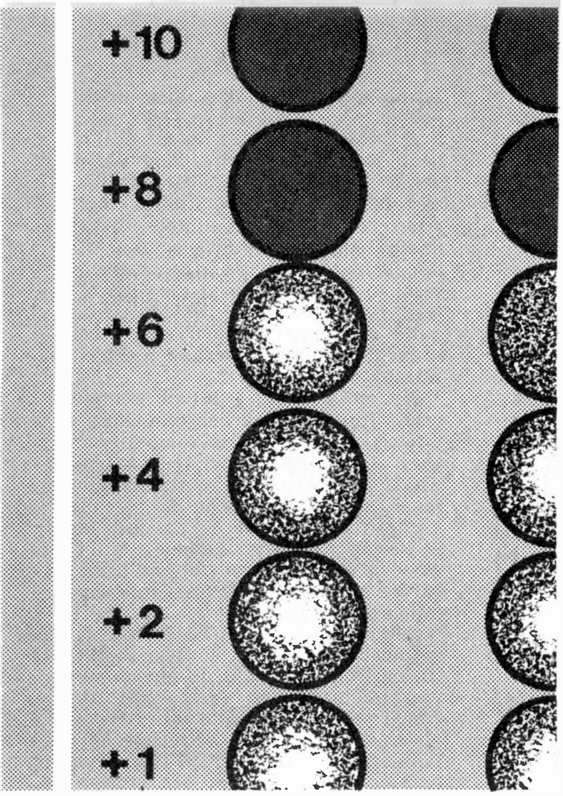


Fig. 1.



STEREO DIGITAL PPM

with l.e.d. display

By R.W. LAWRENCE B.Sc.

For many years the Peak Programme Meter has been in this country the most popular and widely used level monitoring device in professional sound engineering circles. Its tight technical specifications allow precise and repeatable level measurements—so important when trying to achieve high quality sound recording and reproduction.

The rigorous performance specifications of the device cover not only the electronics, but also extend to the ballistics of the meter movement (rise-time, overshoot, etc.).

Being mechanical the movement is therefore the most costly single item in the whole unit, and if one considers a high quality stereo PPM movement (with two needles sharing the same axis), the cost of the necessary drive electronics may well only be a fraction of the cost of the movement itself.

This article describes an all-electronic alternative to the standard PPM which does away with the need for the costly meter movement, and, although having one or two disadvantages, does have several advantages over its traditional forerunner.

THE NEED FOR A PPM

Considering for the moment tape recording; if one attempts to record any normal programme material with an average responding type meter, then the chances are that short duration peaks are liable to slip through this type of monitoring arrangement and cause momentary saturation of the tape. Although this only occurs during these short peaks, the effect is to reduce the fidelity and general "brightness" of the recording.

It is for this reason that a peak detecting level monitoring system was eventually arrived at, whose rise-time was fast enough to capture all but the fastest and shortest duration transients, and which also possessed a relatively long decay time to allow these to be easily seen.

The necessity for this becomes obvious if one considers the following test. If a standard recording level meter is adjusted to read a certain value with a square wave input of, say, 100Hz, and then the mark/space ratio of the square wave is altered (the amplitude remaining the same) then the meter reading will change despite the fact that the peak level of the input has not changed. With a PPM monitoring system the measured level will remain substantially the same, even down to a low mark/space ratio.

Although these types of waveforms are very unnatural and unlikely to occur, the test does serve to demonstrate the PPM's superior peak detecting abilities, and its advantages over standard monitoring from this point of view.

Also, the final output of the PPM appears on a meter with a logarithmic scale allowing a good relation to the human ear's sensation of loudness.

PPM SCALING

The scale of the standard PPM consists of seven equidistant divisions (Fig. 1) numbered 1–7. The

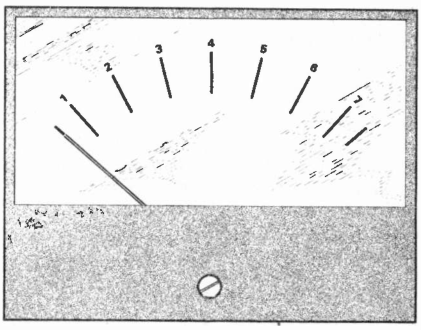
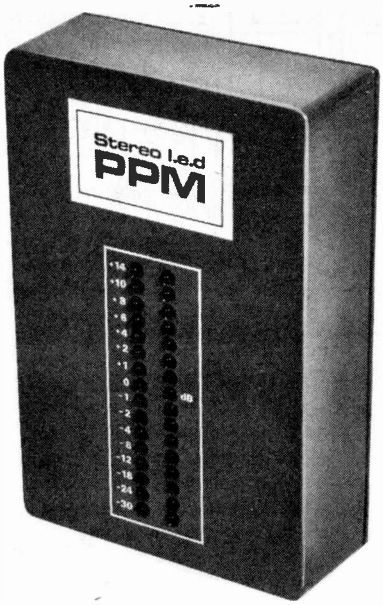


Fig. 1. The scale of the standard PPM. The separation between graduations is 4dB, the whole scale therefore covering a dynamic range of 24dB



fourth division appears in the centre of the scale and represents 0dB (the reference level from which measurements are made on the logarithmic scale). This is the BBC system and the one most universally accepted.

The level difference between each interval is 4dB, which therefore allows a dynamic range of 24dB to be displayed on the meter.

Since the scale is logarithmic there is of course, no zero; the meter needle coming to rest a little below the first division. The scale's 4dB/interval no longer applies beneath this first interval.

LOGARITHMIC GENERATION

One of the most important characteristics of the PPM other than its peak detecting capabilities then, is logarithmic scale. In the first valve PPMs, the logarithmic scale was derived by exploiting the logarithmic properties of the "variable μ" pentode.

The advent of the transistor allowed the log. effect to be generated more easily by using its inherent and very accurate relationship between the base-emitter voltage and the current through it. This relationship unfortunately has a temperature dependent term in it which, although possible to reduce, does lead to a further degree of circuit complexity.

A more popular approach has been the use of non-linear feedback networks around operational amplifiers. These use diodes or transistors to progressively switch in greater and greater amounts of feedback as the output level increases, thus achieving the logarithmic generation by the so-called "piecewise linear approximation" method. The logarithmic curve is usually split into several linear sections to accomplish this (see Fig. 2).

ATTACK AND DECAY TIME CONSTANTS

Earlier it was mentioned that the PPM's attack and decay times were rigidly defined. This allows the meter to be used on any sort of programme material with the sure knowledge that any other PPM will respond in exactly the same fashion.

The actual standard set for the attack time is 2·5ms, and for the decay time: 1s. The effect of these widely differing values is to enable the device not only to respond to short impulses or bursts of high level signal, but also to hold them long enough for one to see them. If the decay time was as short as the attack time, it would be virtually impossible to obtain a sensible reading from the meter since the needle would at almost all times be a blur, and high level, short duration transients would escape unnoticed. The relatively large release time therefore makes reading the meter far easier.

The ballistics of the meter are important here as if, for instance, its overshoot is excessive, then one may be led to believe when monitoring a programme full of short abrupt changes (e.g. percussive instruments) that the programme level is higher than it really is. At the same time, should the meter be excessively sluggish in its response, then the reverse may occur, i.e. that the programme level appears lower than it is.

Here, then lie the main reasons for the tight mechanical specifications laid down for the PPM movement and therefore its relatively high cost.

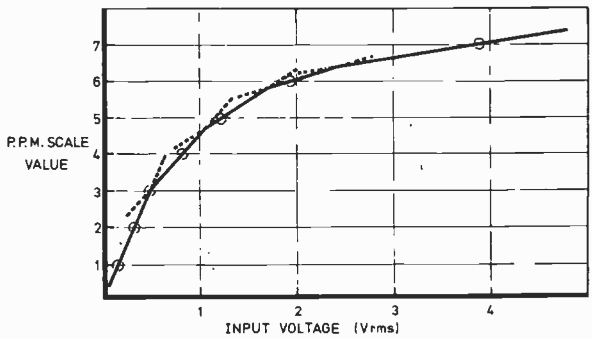


Fig. 2. The "Piecewise linear approximation method" of generating the logarithmic scale

ALTERNATIVE DISPLAYS

An alternative to the meter as the final display device is therefore a reasonable proposition.

The "bar-graph" type display with a large number of individual segments is an obvious choice, since although the resolution may be reduced, the problems associated with ballistics are dispensed with, and the attack and decay characteristics can be set by the electronics.

Typical bar-type displays include those entirely constructed from individual l.e.d.s, and also a gas variety possessing a large number of electrodes arranged in a linear or circular format. In this system every third electrode is connected together, the system operating on the principle that the triggering voltage required to initiate ionisation (thus forming the glow) in neon is greater than that required to sustain it. It is therefore possible for only one of the large number of electrodes to be illuminated whilst the rest—which are connected to the same potential—remain off.

With sequential switching the ionisation can be arranged to jump from one electrode to the next, and with appropriate logic and scanning, display a desired length of illuminated column.

This system, however, requires the use of a special display tube and fairly complex drive logic. For simplicity, then, and to a certain extent economy, an l.e.d. system is described.

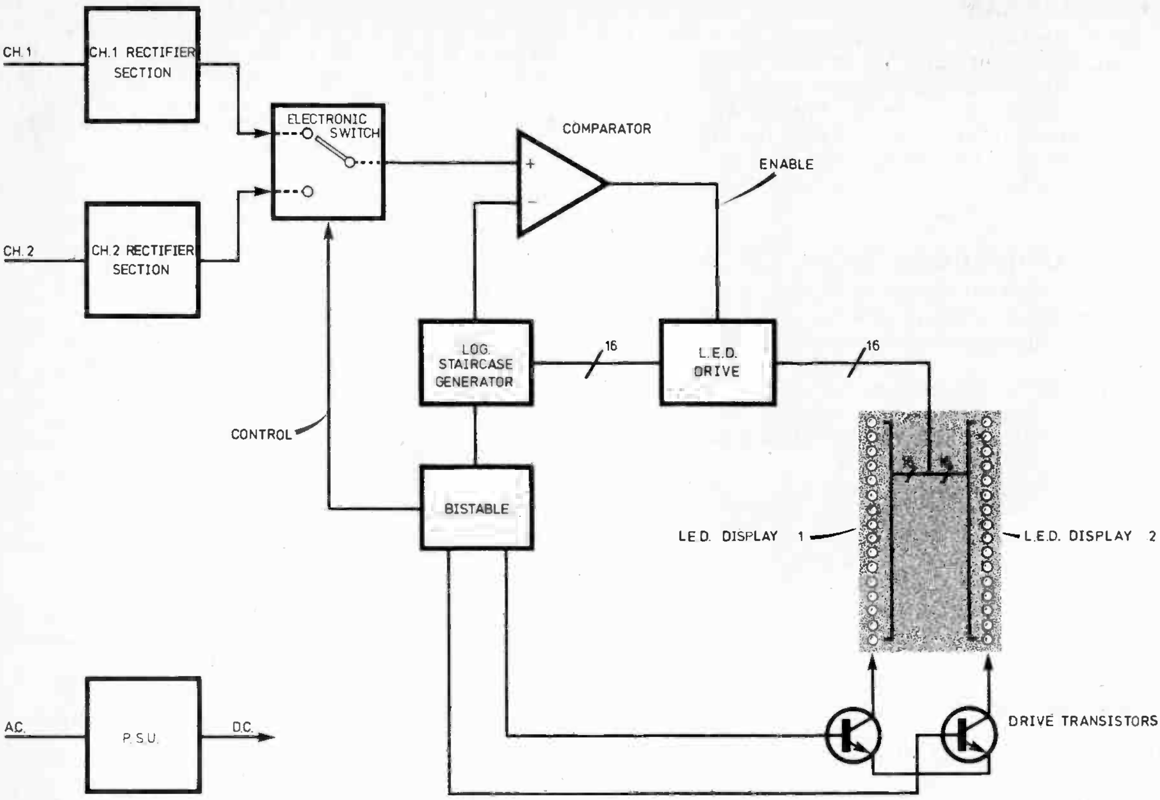


Fig. 3. Block diagram of the system using two separate l.e.d. displays, each of 16 levels, for a stereo PPM which does not use a meter as the display element

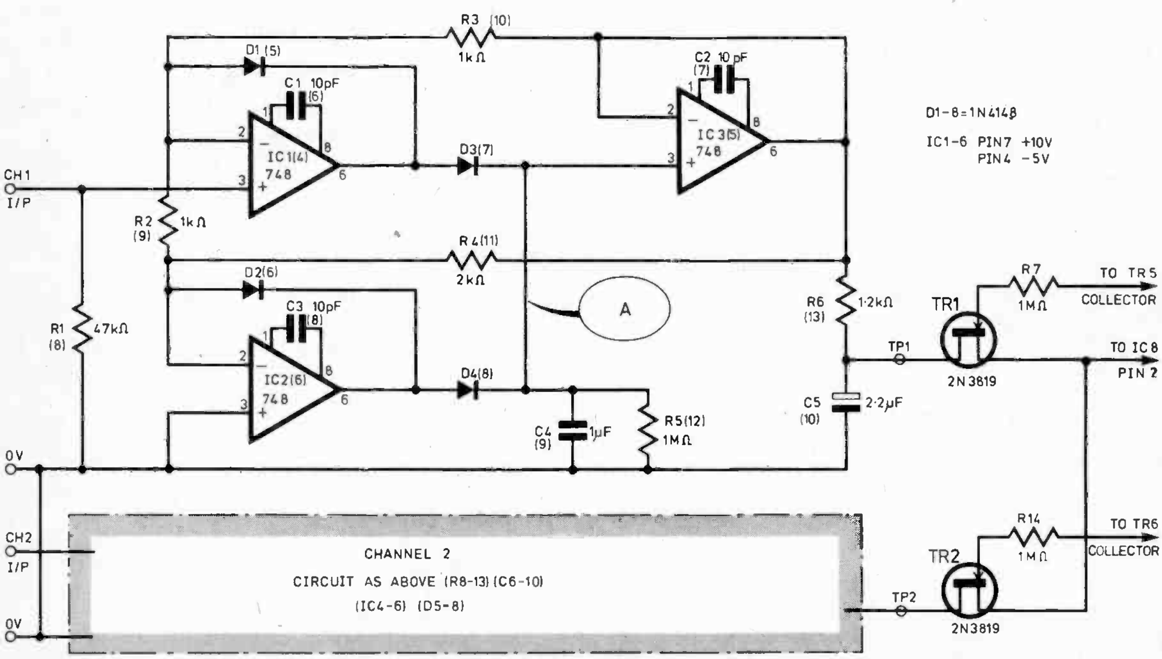


Fig. 4. The portion of the circuitry which full-wave rectifies the signal, and provides the required rise and fall time constants

BLOCK DIAGRAM

A block diagram of the system is shown in Fig. 3. An advantage of this particular method of generating a bar-type display is that it can easily be "multiplexed" for stereo operation (as this in fact is) and since the same control circuitry is used for both channels, there are no channel matching problems.

We will now look at the various sections of the unit individually.

RECTIFIER/TIME-CONSTANTS SECTION

First we consider that portion of the circuitry which derives the peak value of the incoming signal and provides the appropriate rise and fall time constants (Fig. 4).

IC1 and IC2 perform the full-wave rectification function with diodes D1–4 and resistors R2–4, whilst IC3 acts as a voltage follower providing a low output impedance.

The full wave rectification circuitry used here has the advantage over other types having virtual earth inputs in that no impedance buffering amplifier is required between it and the input, since it has an inherently high input impedance.

The circuit works as follows: on positive-going input half cycles D3 conducts, the amplifier adjusting the voltage at point A (and thus the output of the voltage follower, IC3) to cause the junction of R2 and R3 (IC1 inverting input) to be the same as the non-inverting input.

Since IC2 is working with its non-inverting input grounded, current flowing into the R2, R4, D2 junction from R2 or R4 will be conducted away by D2 which will become forward biased.

The voltage at this junction is therefore held at the potential of the non-inverting input, i.e. ground.

Since one end of R2 is effectively grounded and the other at input potential, it follows that the potential of the output (the end of R3 not connected to R2) is at twice the input potential. Diodes D1 and D4 meanwhile remain non-conductive.

NEGATIVE HALF CYCLES

Considering now negative-going half cycles: D1 will be caused to conduct allowing IC1 to adjust its output to maintain the potential between its inverting and non-inverting inputs at zero.

IC1 can be considered to be operating as a voltage follower whose input is taken from the R2, R3, D1 junction. IC2, however, is operating in a virtual earth configuration with D4 being brought into conduction and the feedback loop closed via IC3 and R4. The gain for negative half cycles is therefore determined by the ratio R4/R2, which, as for positive half cycles, equals two. Diodes D2 and D3 this time remain non-conductive.

C4 can only charge via D3 and D4 and the rate is limited only by the maximum current that can be supplied by the 748 (20mA approx.). This allows an output rise time which is considerably smaller than the attack time constant set by R6 and C5, which therefore dominates the response at the output.

LOGARITHMIC STAIRCASE GENERATOR

The logarithmic staircase generator determines the characteristics of the logarithmic scale of the PPM and at the same time provides the l.e.d. drive via buffer transistors (Fig. 5).

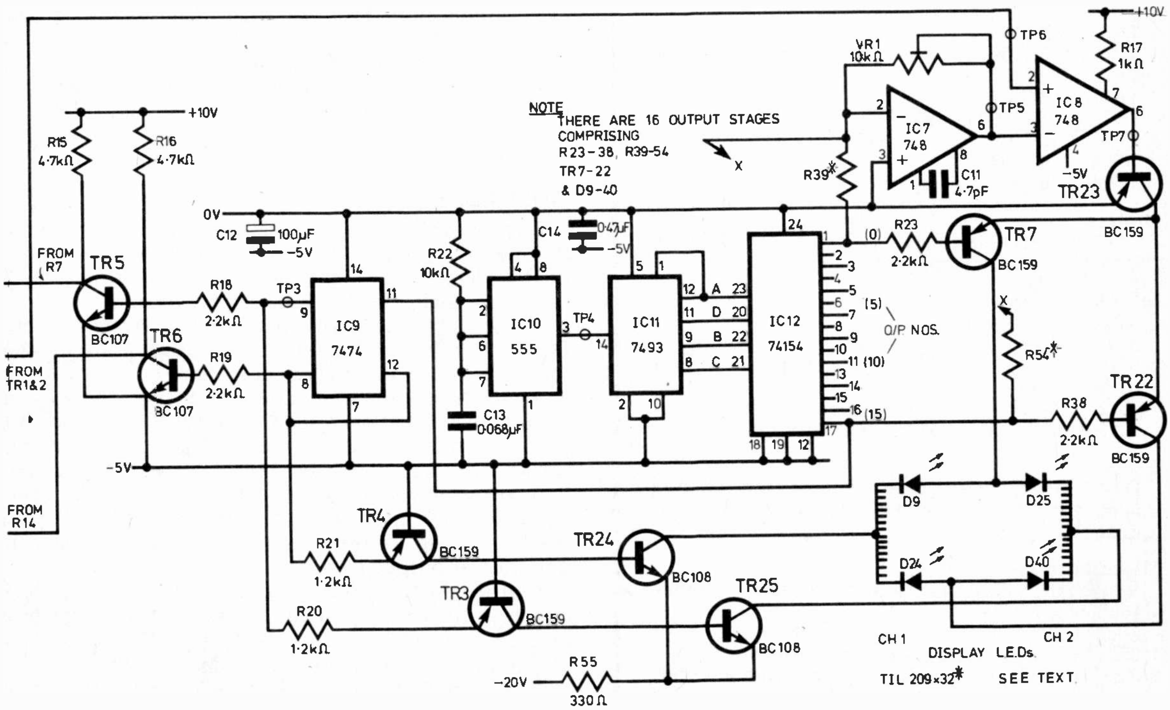


Fig. 5. Circuit diagram of the rest of the PPM. The values of resistors marked with an asterisk (R39 to R54) are given in Table 1. See text for more details (these resistors determine the scale characteristics). IC7 supply connections are: Pin 7, + 10V; Pin 4, – 5V.

COMPONENTS . . .

Resistors

R1	47kΩ	R13	1·2kΩ
R2	1kΩ	R14	1MΩ
R3	1kΩ	R15	4·7kΩ
R4	2kΩ	R16	4·7kΩ
R5	1MΩ	R17	1kΩ
R6	1·2kΩ	R18	2·2kΩ
R7	1MΩ	R19	2·2kΩ
R8	47kΩ	R20	1·2kΩ
R9	1kΩ	R21	1·2kΩ
R10	1kΩ	R22	10kΩ
R11	2kΩ	R23–R38	(16 off) 2·2kΩ
R12	1MΩ	R39–R54	See Table 1 and text
		R55	330Ω 1W

All resistors $\frac{1}{8}$W 5% carbon unless otherwise stated

Potentiometers

VR1 10kΩ Helical trimpot

Capacitors

C1	10pF plastic or ceramic
C2	10pF plastic or ceramic
C3	10pF plastic or ceramic
C4	1μF 20V polycarbonate
C5	2·2μF 16V tantalum
C6	10pF plastic or ceramic
C7	10pF plastic or ceramic
C8	10pF plastic or ceramic
C9	1μF 20V polycarbonate
C10	2·2μF 16V tantalum
C11	4·7pF plastic or ceramic
C12	100μF 16V tantalum
C13	0·068μF plastic or ceramic
C14	0·47μF plastic or ceramic
C15	1000μF 25V elect.
C16	1000μF 25V elect.

Transistors

TR1	2N3819 (f.e.t.)
TR2	2N3819 (f.e.t.)
TR3	BC159
TR4	BC159
TR5	BC107
TR6	BC107
TR7–22	BC159 (16 off)
TR23	BC159
TR24	BC108
TR25	BC108

Diodes

D1–8	1N4148 (8 off)
D41–44	1A bridge rectifier

Integrated circuits

IC1–8	748 (8 off)
IC9	7474
IC10	555
IC11	7493
IC12	74154
IC13	LM309 (5V voltage regulator i.c.)

L.e.d.s

D9–40 TIL209, or any other suitable l.e.d. (32 off). Note that the l.e.d.s may be red or green as desired

Miscellaneous

Veroboard 210mm × 65mm, 100mm × 100mm, 160mm × 30mm
2 feet (approx.) 10-way rainbow cable
6BA nuts and bolts, spacers etc. to suit
Box to suit (if necessary), the prototype box measured 220mm × 145mm × 30mm
Transformer 12–0–12V 500mA
Heatsink (3,300 sq. mm. approx) and insulating kit for IC13.

The staircase is generated by a 4-bit counter (7493) and a 4 to 16 line decoder (74154) which switches one by one a series of resistors between the virtual earth point of an operational amplifier, and a reference voltage.

The smaller the resistor between the reference voltage and the virtual earth point, the greater the current through the resistor and thus the greater the output of the operational amplifier. The values of the resistors are arranged to yield the negative going logarithmic staircase.

This system has the advantage over similar bar-type display systems of allowing the interval between adjacent l.e.d.s to be set at any desired value, which therefore allows the scale to be expanded or compressed to suit. This is a useful feature as it allows a large dynamic range to be displayed on the scale whilst enabling reasonable precision to be maintained around the centre of the scale. In the author's case, the scale has been expanded at the centre and compressed at the extremities although, of course, any format may be adopted.

COMPARATOR

The output from the staircase generator is then fed into one input of a comparator (IC8). This compares the incoming signal with the log staircase and provides a negative output when the staircase voltage is more negative than the input.

When negative the comparator output switches a transistor (TR23) on which then enables the transistors TR7–TR22 to pass current to the display l.e.d.s when required. The output of IC8 drives the base of TR23 direct, current being limited by the resistor R17 in its positive supply line.

The transistors TR7–22 derive their switching commands from the 4–16 line decoder IC12, which provides a logical 0 at each output pin in turn. At all other times they are in the logical 1 state, therefore leaving the l.e.d. drive transistors off.

BISTABLE

The bistable section contains the circuitry which switches the input to the comparator from the output of one channel's rectifier stage to the other, and at the same time switches the l.e.d. display channels over.

The bistable section consists of half of a 7474 dual D-type flip-flop and suitable interface circuitry drives the displays and input channel switches.

A 0–1 transition is required to change the bistable state at the end of each scan, and this is obtained from the sixteenth output of the 74154. As mentioned earlier, the outputs of the 74154 are at logic 1 unless they are selected by the 4-bit binary input code which causes them to go to logic 0. The required 0–1 transition occurring at the end of each scan is therefore obtained at output 16.

The bistable's outputs Q and $\overline{Q}$ feed TR5 and TR6, one therefore being on whilst the other is off. These in turn control the f.e.t. switches TR1 and TR2, resulting also in only one being on at any one time.

TR3 and TR4 are arranged in common base configuration such that current flow into the emitter is transmitted via the collectors to the bases of TR24 and TR25. Hence the bistable determines which input channel and which l.e.d. display are selected.

Table 1: Scale details and values of the resistors associated with the individual levels. These can be altered to suit individual requirements

74154 Output Number	Level dB	Resistor Value kΩ
0	+14	3·125
1	+10	5
2	+8	6·25
3	+6	7·813
4	+4	10
5	+2	12·5
6	+1	14·03
7	0	15·625
8	−1	17·53
9	−2	20
10	−4	25
11	−8	40
12	−12	62·5
13	−18	125
14	−24	250
15	−30	500

THE SCALE

As explained previously, the scale characteristics are determined by the values of the resistors between the virtual earth input of IC7 and the outputs of IC12.

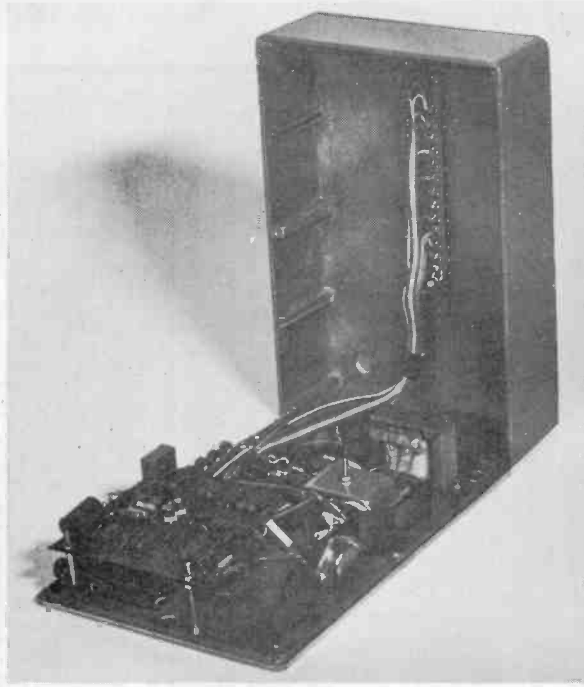
The sixteen selected input levels at which an on or off transition occurs (depending on whether the input is increasing or decreasing) are shown in Table 1. As can be seen a dynamic range of 44dB is covered—14dB above the 0dB reference level, and 30dB below it (0dB being the standard reference level; i.e. the voltage across 600Ω when 1mW is being dissipated in it—775mV). This is limited only by the performance of the operational amplifiers—offset voltage, noise, etc.—at the lower end, and by the necessary voltage excursion required at the upper end.

RESISTOR SERIES

The resistors marked R39 to R54 are those which, as explained above determine the scale characteristics. As can be seen (Table 1) they are mostly of non-standard values. In the prototype PPM the values were either arrived at by using a potentiometer alone or a potentiometer plus a fixed resistor. It is recommended that fixed resistors be used ultimately for stability.

The series was computed by first selecting the largest reasonable value that was to be used (500kΩ) and then working the rest of the series out relative to this. This value is not necessarily the limiting one, but it does allow for larger resistors to be used and thus the possibility of lower levels being displayed.

Due to the basic properties of a logarithmic scale, when one voltage is twice another, there are 6dB between them, and when one is ten times another there are 20dB between them. Thus, in this case if 500kΩ is used for the −30dB l.e.d. then it follows that the −24dB level will be generated by 250kΩ, the −18dB: 125kΩ, −12dB: 62·5kΩ. Similarly the −20dB level (not used in this particular scale) will be generated by 50kΩ, and the +10dB by 5kΩ. A combination of these simple manipulations gives almost all of the rest of the resistor series, log. tables only needing to be used to calculate some of the 1dB increments. The relationships provide an easy method of calculating other resistor values should operation at levels other than those specified be required.



CONSTRUCTION

The actual construction of the l.e.d. PPM will be determined by its application. This may be a "stand-alone" unit or perhaps built into a mixer or other system. Veroboard was chosen for the prototype as it allowed modification to be carried out more easily than on p.c.b.

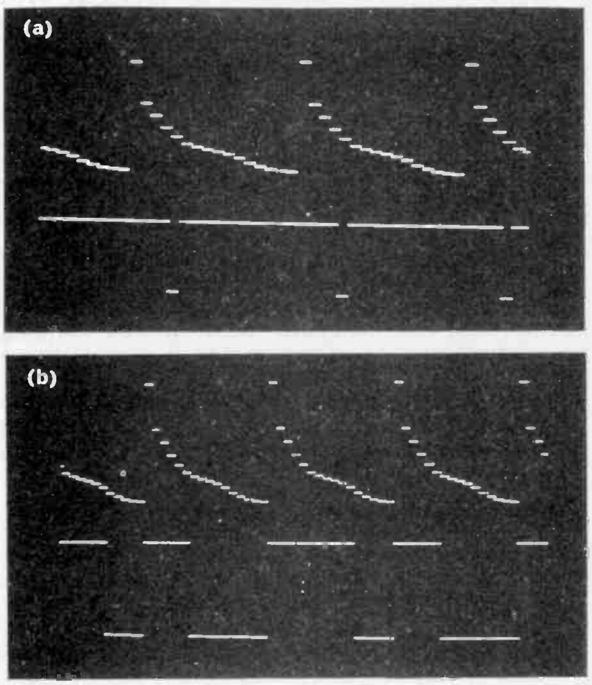


Fig. 6. Some waveforms generated in the l.e.d. PPM. (a) Log staircase plus one IC12 output. (b) Staircase plus IC8 output with both channels operated. Note the 1dB increments in the middle of the staircase

(a) INPUT BOARD

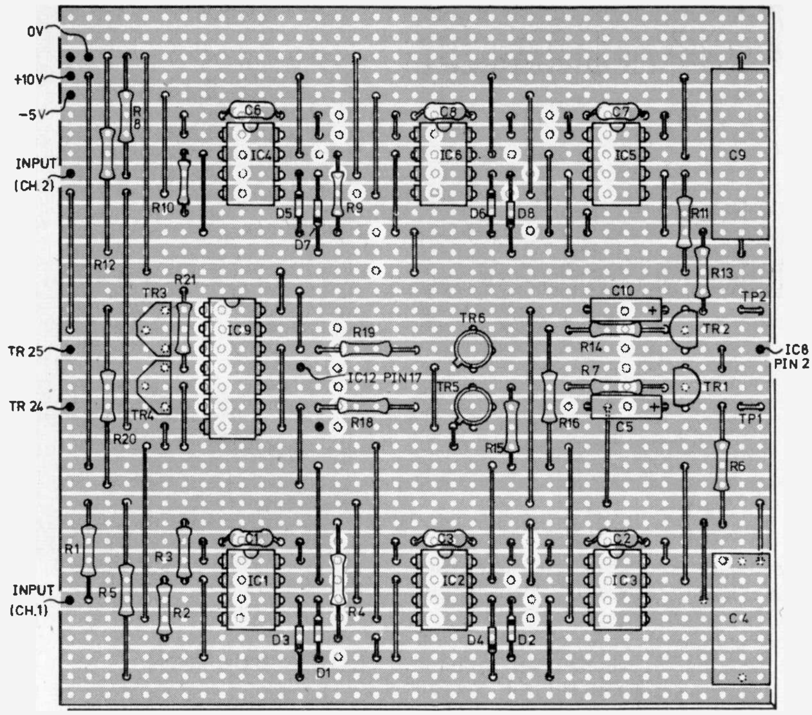


Fig. 7. The component layout, Veroboard cutting details and board interwiring for the PPM

(a) Input board (b) Main board (c) Display board

The bulk of the electronics in the prototype PPM was constructed on two boards with the l.e.d. columns and two drive transistors on a third. Veroboard of 0·1in pitch was found to provide a very convenient method of mounting for the l.e.d.s and unless a proper p.c.b. is to be made up, this technique is recommended as being both simple and effective.

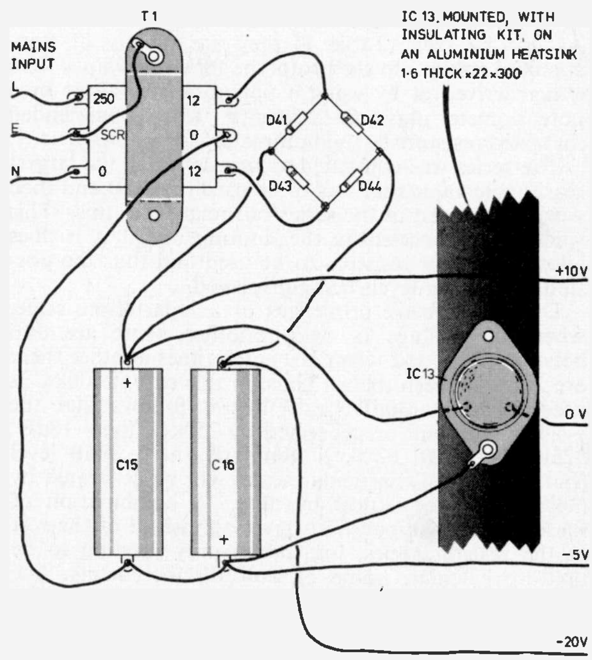
The component layouts and Veroboard cutting details are given in Fig. 7. This requires little comment except perhaps to stress that small resistors ($\frac{1}{8}$W) should be used as recommended as the layout is fairly compact.

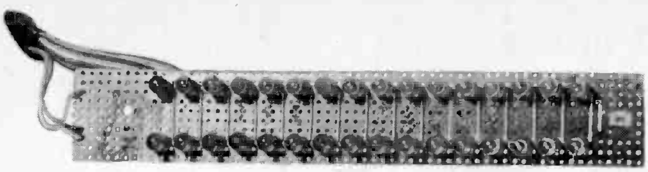
The actual layout of the boards is not critical with the exception possibly of that associated with the open loop 748 (IC8), where oscillation may result if track lengths are not kept to a minimum. Rainbow wire was used for connecting the l.e.d. columns to their appropriate driver transistors and Veropins (or p.c.b. pins) for connecting the rainbow wire to the Veroboard. The use of pins reduces the possibility of the track lifting underneath the board where wires are to be connected to it.

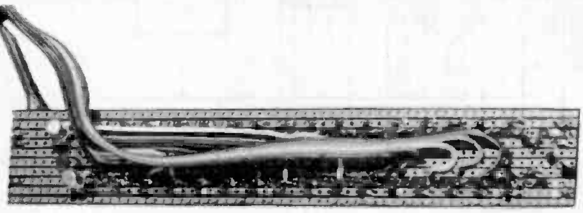
TEST POINTS

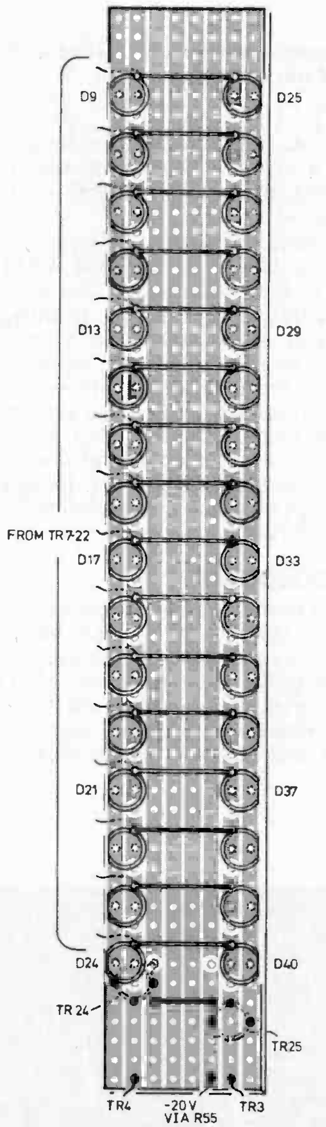
To aid in the testing of the unit and possible fault finding, it is a good idea to put test points around the circuit. Small loops of wire were found to be ideal for this purpose (22 s.w.g., say). Test points were inserted in the following positions on the prototype: the output of both of the rectifier/time constant sections, the inverting input to IC8 (Pin 2), the output of IC7 (Pin 6) to monitor the logarithmic staircase, the 555 output (Pin 3), the 7474 clock input (Pin 11) and Q and $\overline{Q}$ (Pins 9 and 8).

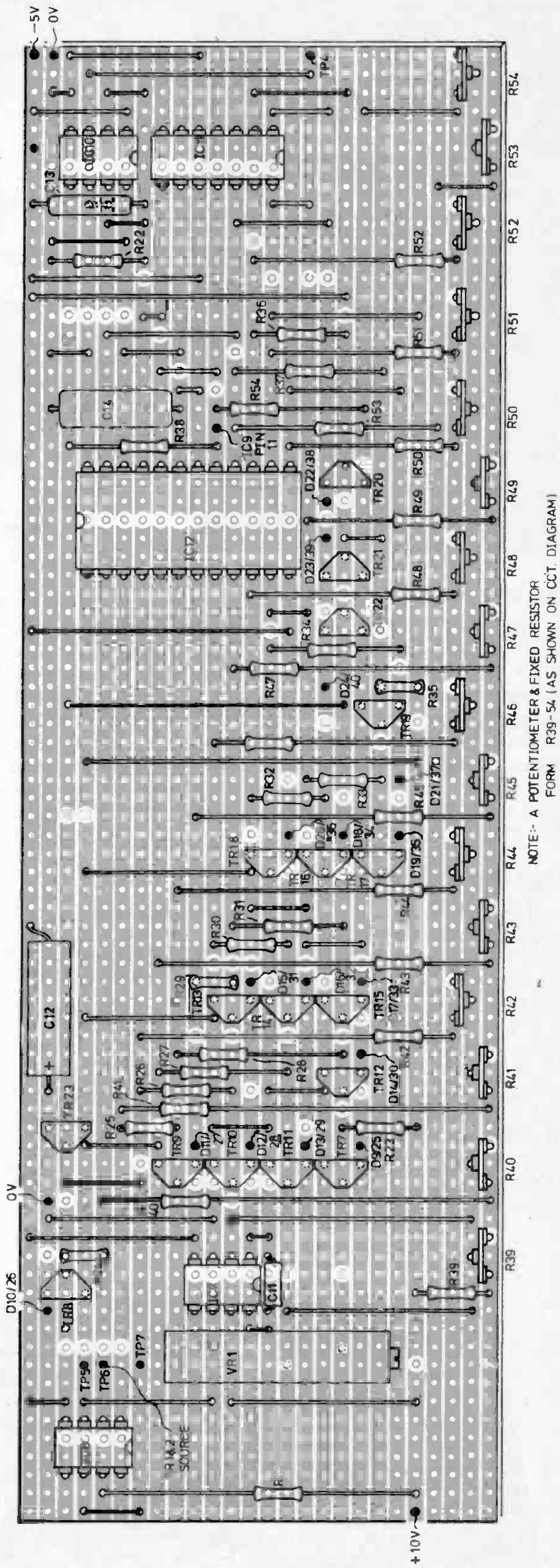
POWER SUPPLY



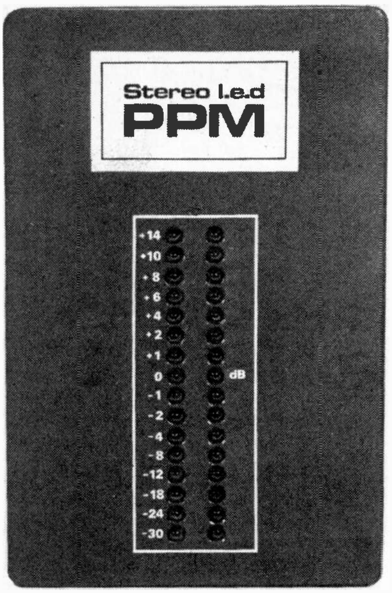








(c) DISPLAY BOARD (above)
(b) MAIN BOARD (right)



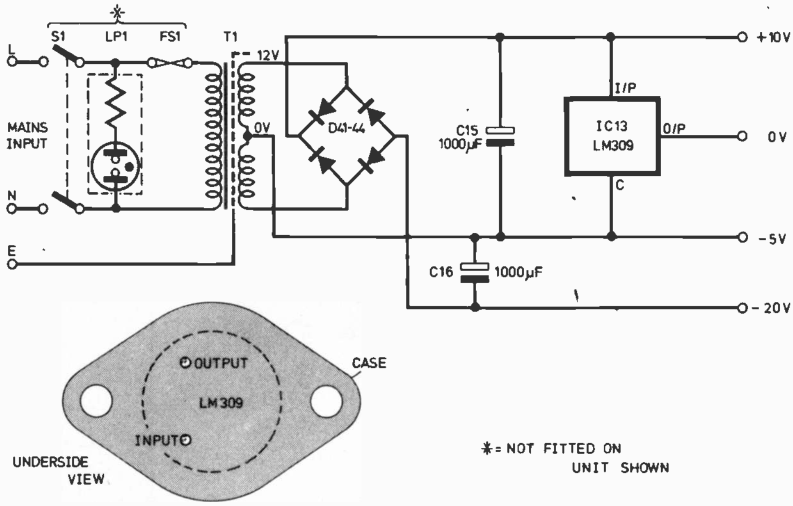


Fig. 8. Power supply arrangement for the unit. N.B. IC13 case is not earthed.

POWER SUPPLIES

The power supplies required by the PPM are −5V, +10 to 15V, and a negative rail of −15 to 20V. The −5V rail should be of high stability since it acts as a voltage reference for the staircase generator. This is obtained very simply by using a 309 5V precision i.c. voltage regulator. Details of the power supply are given in Fig. 8. If possible a lower value of negative rail should be used as this would decrease the dissipation in R55. The arrangement shown was chosen for its simplicity however.

CALIBRATION

Calibration of the PPM basically depends on the values of the scale resistors R39–54. This can be done with reference to Table 1 and the use of a digital multimeter (or some other accurate means of ohms measurement).

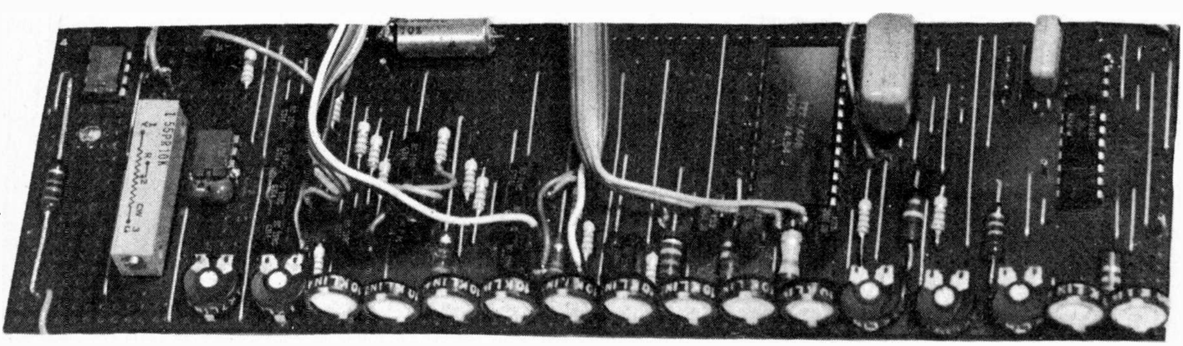
The only other adjustment to be made is that of the 10kΩ helical pot. VR1. The effect of adjusting this is to alter the amplitude of the logarithmic staircase which in turn sets the sensitivity of the unit. Perhaps not as one would first expect, reducing the amplitude of the staircase increases the sensitivity and increasing the amplitude reduces it. This is best explained by considering what happens if one maintains a constant input level to the PPM whilst the staircase amplitude is varied. As it is increased, the comparator will switch at earlier and earlier times in the scan resulting in fewer l.e.d.s (and thus an indication of less level) being activated.

If the popular voltage reference of 0·775V r.m.s. (1mW into 600Ω) is used the PPM can easily be adjusted to this by arranging that the 0dB l.e.d. is just on, with a 0dB tone present at the input.

Individual adjustment of each level can be carried out at this stage by setting the input tone source to the selected known accurate signal levels and adjusting the presets (if these are used) of the scale resistors until the respective l.e.d. indicating that particular level just lights. This is only recommended as a fine adjustment however; they should be set to approximately the correct value obtained by calculation (as outlined under "Resistor Series").

L.E.D. COLOURS

In order to obtain an enhanced indication of overload rather than simply that an l.e.d. above a certain level has lit, one can exploit the fact that there are both red and green l.e.d.s available. Green l.e.d.s can be chosen for levels up to, say, +8dB and red (to indicate overload) for levels above this. The level chosen for the red-green transition is of course up to the individual constructor. ★



NEWS BRIEFS

Marine Electronics Symposium

Some 110 delegates attended a symposium on Marine Electronics, organised by the Society of Electronic and Radio Technicians, at Southampton University in July. Eighteen papers were presented, covering a wide range of topics of concern to all involved in electronics at sea, whether in yachts and small craft, the fishing industry or coastal and deep-sea vessels.

Of outstanding interest were contributions on satellite navigation and communications, computer-backed navigation systems, speech processing for h.f communications, and applications of surface acoustic wave devices.

Reprints of all the papers are available, priced £7 including postage and packing, from SERT, Faraday House, 8-10 Charing Cross Road, London WC2H 0HP.

Tape Cassettes

Although well known in the professional recording industry, to whom they supply more than 15 million cassettes each year, HCL are unheard of in the domestic field. They plan to change this with a range of professional quality, unrecorded High Energy tape cassettes called HCL Super. With recommended prices ranging from 98p for a C60, to £1·73 for a C120, these tapes are at present available only in London and the South East, but should be on sale in the rest of the U.K. at the end of 1976.

Name Change for Novus

As from June 1976 National Semiconductor's Novus division changed its name to "National Semiconductor Corporation, Consumer Products Division". The name National Semiconductor was little known to consumers when the company produced its first calculator in 1973—hence the choice of the more easily remembered name "Novus". Since then National Semiconductor, through its Consumer Products Division, has become one of the world's biggest producers of calculators, and digital watches and clocks.

New high-end calculators, such as the 4640 Scientific, will be introduced carrying the National Semiconductor name and symbol, although the Novus brand name will be retained in some product areas.

National's headquarters are in Sunnyvale, California, but their products are made in locations as diverse as Salt Lake City and Penang, Malaysia. The Consumer Products Division has sales offices in major countries throughout the world. U.K. operations are based at Bedford.

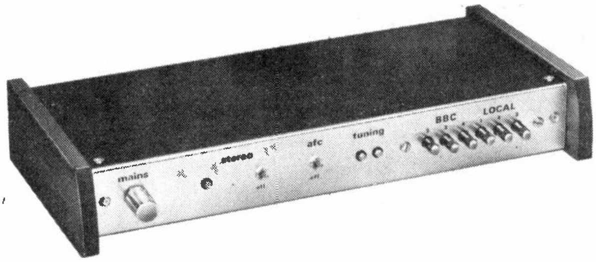
Two distinct ranges of digital watches are being launched onto the U.K. market during 1976. Traditionally cased models will be available at prices from £19·95 to £32·95. A cheaper "plastic" model, using the normal module but house in a glass fibre case with leather-type grain finish, will be marketed at £17·50.

WANT TO BRUSH UP ON YOUR LOGIC?

A new theory and practice series entitled Doing It Digitally starts in the October issue of *Everyday Electronics*—on sale Friday, September 17.

NEXT MONTH

ORION TUNER



This stereo tuner has been designed to complement the Orion Amplifier providing the same low profile styling and high standard of performance at low cost. Construction is easy and no instruments are required for alignment.

SPECIAL OFFER...
EXCLUSIVE TO PE READERS
The Latest SOLDERING IRON FROM ADCOLA

ALSO INSIDE...

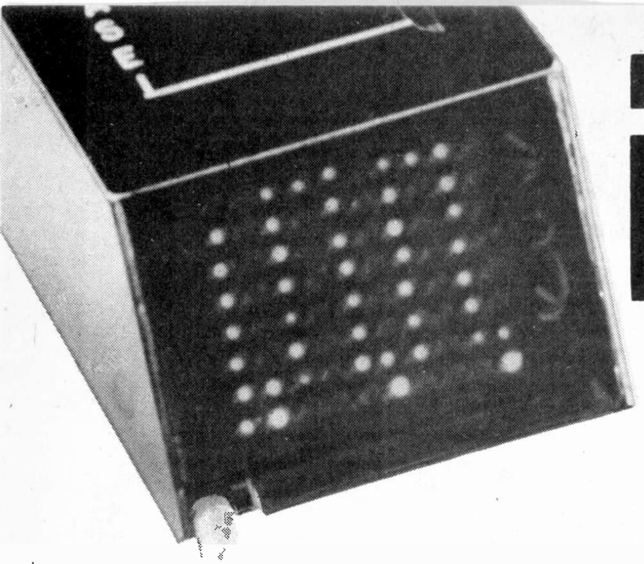
DISCOSTROBE

A four-channel light show controller giving a choice of sequential, random or full strobe modes of operation.

HAZARD FLASHER

This simple design, based on a 555 timer i.c., is suitable for fitting to any car to flash all direction indicators simultaneously in an emergency.

PRACTICAL ELECTRONICS
NOVEMBER 1976 ISSUE
ON SALE OCTOBER 8, 1976



PE DIGISCOPE

By R. W. Coles and B. Cullen

PART 4

THIS concluding article covers the construction of the Display Matrix and case, the interconnection of the individual circuit boards, and calibration and use of the completed instrument.

DISPLAY MATRIX

A good deal of thought was invested in the design of the Digiscope Display Matrix to make for simple assembly, accurate alignment and above all, low cost. The purchase of 80 l.e.d. devices is obviously something of an investment, and efforts were made to find the cheapest suitable l.e.d. which could meet the performance and size criteria dictated by the circuitry and layout. The final choice was the Litronix Red-Lit 50-01 which is a GaAsP device with a diffused lens emitting red light and utilising an extremely compact "pill" package.

The light rise and fall times from the RL50 are typically 1 nanosecond which is quite fast enough for our purposes, and the maximum forward current rating of 40 mA ensures that there is no danger of overdriving, even with very slow timebase speeds. The data sheet on this device claims "high reliability" but a small number of the 80 l.e.d.s in the prototype Matrix were either dead-on-arrival or failed in the first few hours of use.

Once these duds were weeded out, however, the rest lived up to the data sheet claim, but the experience did show the advisability of testing the RL50s before incorporating them in the Matrix. Fortunately the l.e.d.s are easy to check with the aid of a 6 volt battery and a 150 ohm resistor, and this precaution is highly recommended since while it is possible to replace defunct devices in the Matrix, the exercise is rather tedious.

MATRIX CONSTRUCTION

The physical construction of the Matrix is based on the use of 0·15in Veroboards arranged in an X-Y configuration. The X lines Veroboard forms the main support and provides the eight horizontal row drive lines to which the l.e.d. anodes are connected. The Y lines Veroboard is mounted behind the X lines board and is arranged with ten vertical copper strips for the l.e.d. cathode column lines.

Getting the l.e.d. cathodes through the X lines without actually touching them is, of course, the main problem, but this was solved by drilling rows of new holes between the copper strips forming the X lines. The diagonal spacing between the original X line holes and the new Y line holes is about 0·17in, which is just enough to accommodate the RL50 with bent leads while keeping a tight 0·15in matrix-element spacing. The Y lines Veroboard could be formed as a single piece but in the prototype it was split into five separate strips each of two tracks for the simple reason that this makes it much easier to replace any defective l.e.d.s should this ever be necessary.

Details of the Matrix assembly are shown in Fig. 4.1 and the photograph, where it can be seen that once the Veroboards have been prepared and the diodes tested, assembly is quite straightforward.

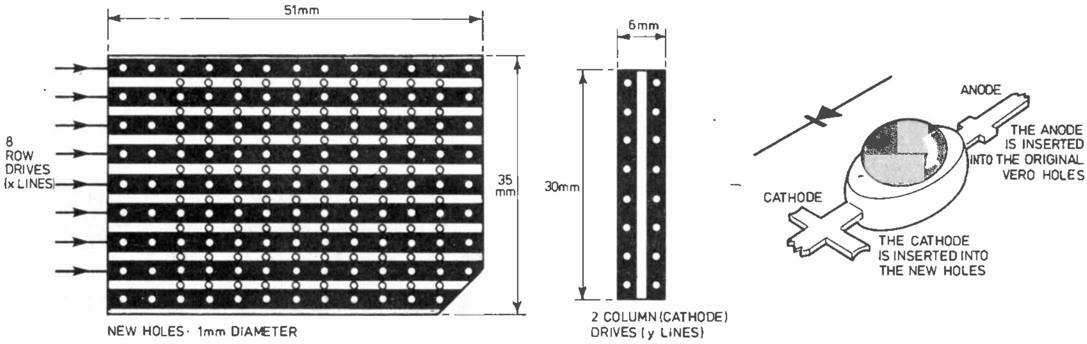


Fig. 4.1. Board assembly details for Display Matrix. The adjacent photograph shows final assembly of the Y line Veroboard strips, the fifth strip not yet being soldered

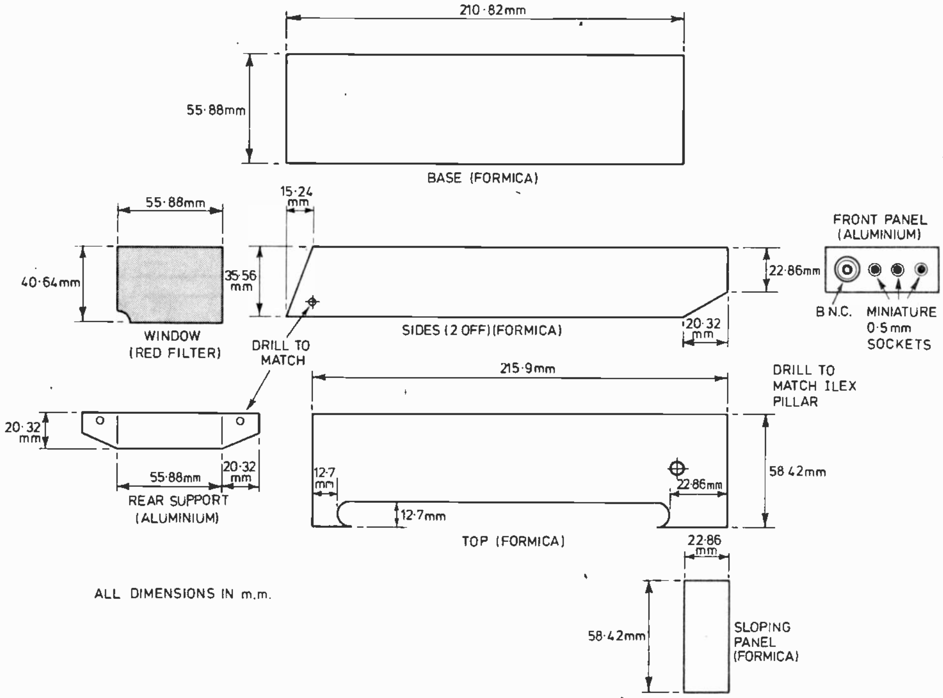
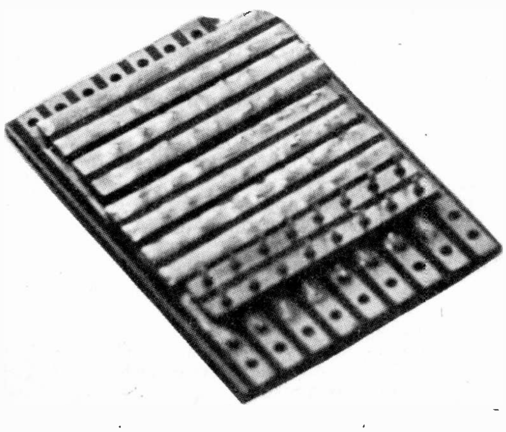


Fig. 4.2. Case assembly details

CASE CONSTRUCTION

The case is intended to be a snug fit on the main electronic assembly and to achieve this, Formica cladding material was chosen for its thinness and rigidity. The case components were joined with Araldite epoxy resin which formed a strong bond but suffered from the usual slow setting problem which it may be possible to avoid by using the new cyano-acrylate adhesives, which are now freely available.

The case is formed in two sections (Fig. 4.2), the base, on which is mounted the two circuit boards and the l.e.d. Matrix, and the cover, which comprises the top, sides, front panel and viewing window. The circuit boards are attached to the Formica base by means of 4BA bolts which do not actually penetrate the cladding but have their heads cemented to the base with epoxy. At the rear of the base an aluminium bracket is mounted to provide a rear anchor point for the cover, and also to provide some lateral protection for the l.e.d. Matrix.



This bracket is cemented to the base with contact adhesive.

The cover is box-like in shape and some care is needed in the assembly of the six separate components to minimise distortion. A wood-block former makes a useful assembly jig for this part of the construction and with the aid of stout elastic bands the job is soon accomplished.

INTERCONNECTIONS

When the two circuit boards and the Display Matrix have been built, the electrical interconnections between these sub-assemblies can be made (Fig. 4.3). The inter-deck wiring should be done with fine p.v.c. insulated stranded wire which can be loomed if desired. It makes good sense to take all the wiring over one long edge of the upper deck because this allows the completed assembly to be opened like a book, with the wiring forming the hinge, when access to the underside of the top deck or the upper surface of the lower deck is required. When the decks have been interconnected the Display Matrix can be wired in using fine single core wire for extra stiffness. The stiffness of the solid wire is very useful because it makes any rigid mounting for the Display Matrix unnecessary.

It is important that fine wire should be used since a total of 18 connections have to be made to the display and thick wire would make display positioning very unwieldy. The power for Digiscope comes from external supplies, and this is connected via a four-core cable terminated in a seven-pin DIN plug. Connections at the Digiscope end are made to the terminal pins on the front left-hand side of the lower deck. The four-core cable runs alongside the lower deck, on the base, and runs out through the cut-out in the viewing screen. The cable can be anchored to the base with contact adhesive.

The front panel carries the input/output sockets for external connections and these can be connected up

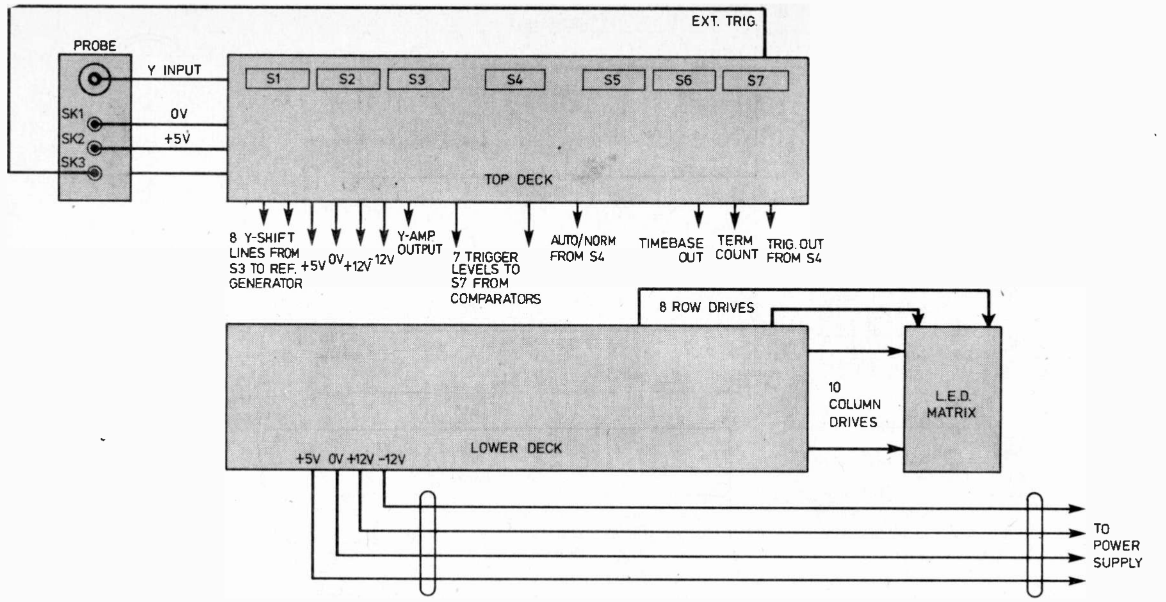
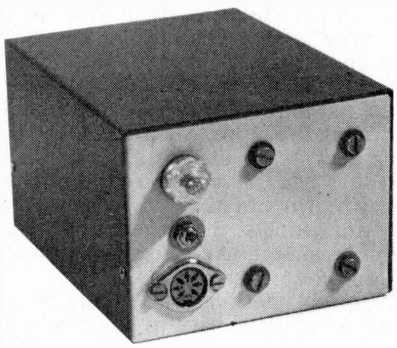


Fig. 4.3. Showing electrical connections between sub-assemblies

at this stage. The BNC socket is for the main Y Amplifier input, and a standard (large) BNC connection is used in this position because it fits in with current oscilloscope practice and allows the connection of standard probes and accessories when the probe-tip is removed. The three 0·5mm sockets can be used for a variety of purposes although a good combination is: *SK*1—Signal ground; *SK*2—+5 volt output (can be used as a Y amp calibration signal, or to power external low drain circuitry); *SK*3—External trigger input (a direct coupled logic type input which accepts TTL edges).

Screened cable is not required for the connection of any of these inputs to the circuit boards, although wiring should be kept as short as possible, and carried out with durable, stranded wire.



POWER SUPPLIES

As previously mentioned, Digiscope requires three separate d.c. supplies, plus 5 volt at 350 mA., plus 12 volt at 60 mA. and minus 12 volt at 60 mA. Each of these should be well regulated and free of mains ripple, but providing these conditions are met the exact nature of the supply source is not important and many constructors may wish to utilise existing supplies or even batteries. The Digiscope prototype had its own special mains Power Supply Unit, and this is described here for those who wish to make a dedicated unit especially for their own Digiscope. The circuit for this supply is shown in Fig. 4.4 and as you can see it is quite a simple arrangement with no frills.

The 5 volts are stabilised by one of the TO3 case integrated circuit regulators now freely available, and this choice guarantees a good performance even at high currents with the minimum of ancillary components. An added advantage of these regulators is that they are short-circuit proof and cannot be destroyed by overloading.

The lower current 12 volt supplies are derived from the same transformer as the +5 volt supply although instead of a full wave bridge rectifier, two simple half wave rectifier circuits are employed. Regulation for the 12 volt supplies is provided by Zener diode shunt regulators which have an adequate performance at these low currents, and are of course, like all shunt regulators,

COMPONENTS . . .

POWER SUPPLY UNIT

Resistors
R1–R2 82Ω 1W (2 off)

Capacitors
C1 2,200µF 20V
C2–C3 1,000µF 25V (2 off)
C4 22µF 12V (tantalum bead)

Semiconductors
D1–D4 2A or 4A 50V Bridge Rectifier
D5–D6 IN4001
D7–D8 12V 1W Zener (2 off)
IC1 L005T1 5V 1A regulator (A. Marshall)

Transformer
T1 TRC type (West Hyde Developments)

Miscellaneous
LP1—mains neon, FS1–1A with holder, 0·1 in. matrix Veroboard, West Hyde 'SAMOS' style 55.
SK4 7-pin DIN socket

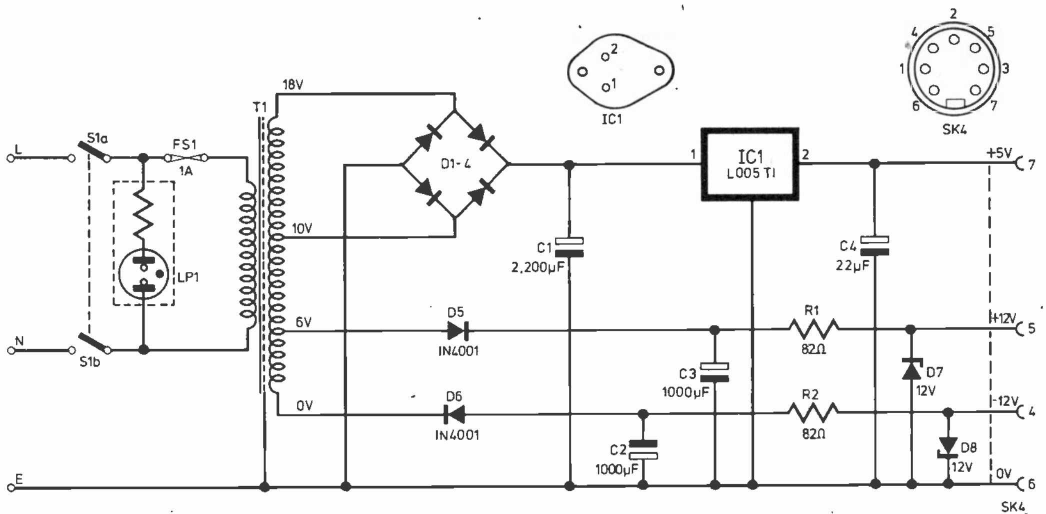


Fig. 4.4. Mains Power Supply Unit. A single Veroboard carries the majority of components with the diode bridge and regulator case attached with adhesive (see photograph)

inherently short-circuit proof, provided the short circuit does not last long enough to overheat the series dropper resistors.

POWER SUPPLY CONSTRUCTION

A West-Hyde Developments SAMOS case was chosen to house the mains supply because it is a cheap but sturdy and attractive housing of compact dimensions. The SAMOS case comes complete with plastic guides for mounting circuit boards, and it was found convenient to mount the smoothing capacitors and other components of the 12 volt supplies on a piece of 0·1in matrix Veroboard resting in these guides at the rear of the case. The transformer fits snugly in the front of the case, alongside the output socket, on-off switch and mains neon, while the mains lead and the mains fuse holder project through the rear.

The current drawn from the 5 volt supply does not justify extensive heat sink arrangements for the 5 volt regulator and the diode bridge, so these components were attached to the bottom of the case with contact adhesive.

SETTING UP DIGISCOPE

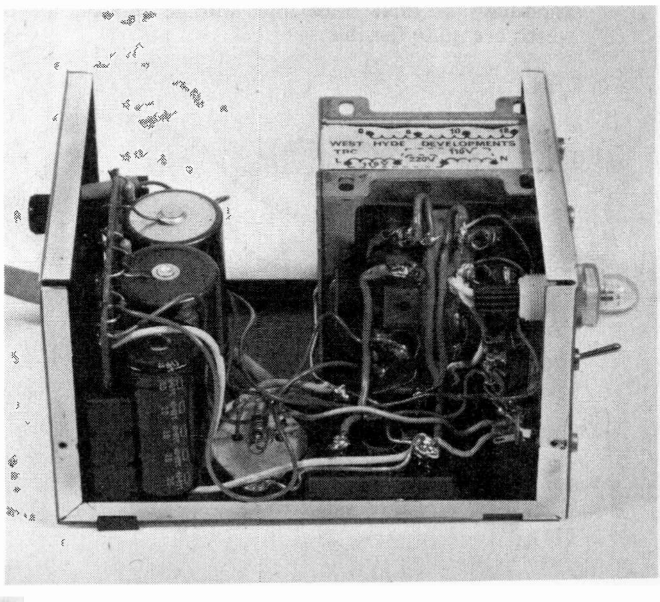
If the wiring up and interconnections have been correctly carried out, there should be little difficulty in getting the display and other circuitry operating to specification. The only essential test equipment required is a calibrated variable frequency generator of some kind, preferably with a square wave output, although other items of test gear might prove useful if available. Set the controls as follows:

1. Y GAIN to 1 volt per division
2. Y SHIFT to half travel
3. AC/DC/GND to GND
4. TRIGGER to AUTO
5. TRIG. SLOPE to POSITIVE
6. TIMEBASE to 1ms per division
7. TRIG LEVEL to half travel

(The first check is to get a trace on the screen, and this will require a functioning timebase oscillator, so if you did not calibrate the timebase after building the top deck it will now be necessary to connect a 10 kilohm potentiometer in place of the 1ms per division select-on-test (s.o.t.) resistor.)

Connect up the Power Supply and switch on. What we want to see now is a straight line trace somewhere on the display, but it is more than likely that the trace will be off screen and will have to be brought to centre screen with VR1. If the trace is not visible or some l.e.d.s are on continuously, switch off and check the Timebase and l.e.d. Driver circuit wiring.

With a centre screen trace visible, it is now necessary to try to display waveforms from the signal generator, so the AC/DC/GND switch should be set to AC, and the output of the generator should be connected to the Y Amplifier input socket, with the output signal set to give an 8V peak-to-peak 100Hz square wave. This signal should just fill the screen from top to bottom and side to side, but adjustment will probably be necessary to the Y gain pot VR2, and to the timebase pot connected in place of the s.o.t. resistor in the Timebase Oscillator. If this procedure is successful then the other three timebase ranges can be calibrated by substituting the pot for each of the s.o.t. resistors in turn and by setting the signal generator to 1MHz, 10kHz and 1Hz as appropriate. The value of the potentiometer when it has been adjusted for a full screen signal should be measured with a multimeter set to the ohms range, and an appropriate fixed resistor substituted.



Since the timebase division ratios are rigidly fixed, there is no need for calibration of these, and it may be helpful to calibrate the Timebase Oscillator at some other division ratio than the X1 range mentioned, depending on the characteristics of the square wave generator used.

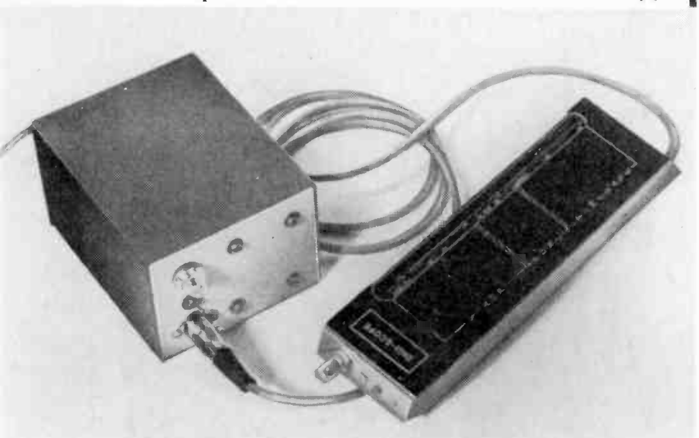
When you are happy with the timebase calibration the Y Attenuator can be checked by ensuring that square waves of 80 millivolt, 800 millivolt, 8 volt and 80 volt just fill the screen with the appropriate attenuator setting selected. The X1 to X8 Y gain settings can also be checked, but don't try to check the 10V × 8 range with a 640 volt signal because although this is the f.s.d. of this range, it is wise to restrict the input voltages to Digiscope to 200 volts or less to avoid the possibility of flash-overs between tracks!

With these essential preliminaries over, it is now possible to check all the other control settings and permutations using the signal generator set to different frequencies, levels, and waveshapes, and perhaps using a variable d.c. supply to examine the d.c. performance. This exercise is important in that it allows one to gain familiarity with the effect of various control settings on the displayed waveform, a task which is difficult to co-ordinate at first, particularly if one is not already familiar with the operation of a conventional scope.

USING DIGISCOPE

Obviously, the definition provided by the 80 point Digiscope Matrix is not as good as that of a cathode ray tube, and this necessitates a slightly different approach when using it to examine a.c. waveforms. It is important to use the ample Timebase and Y Amplifier control settings to get the signal waveform to fill the display, so that all the available definition is utilised. This means, for example, that when looking at a sinusoid, the aim should be to display a single cycle, or at most two cycles, on the screen. Fortunately, the very good trigger performance enables one to select control settings to optimise the display without the need to adjust the trigger after each change.

Digiscope is a prototype design which could form the basis for a new family of l.e.d. display scopes with larger matrices and perhaps improved performance. As the price of semiconductor technology falls there seems to be no real reason why larger displays and, of course, fully integrated drive logic could not be produced, perhaps as an l.s.i. chip set incorporating such "goodies" as dual trace and storage modes, all of which are quite feasible. ★



NEWS BRIEFS

Amateur Convention

The 1976 Welsh Amateur Radio Convention will be held on Sunday September 26, at the Oakdale Community College, Blackwood in Gwent, South Wales.

This year's programme will enable visitors to attend both the technical lectures and film/slide shows. Further details can be obtained from Mr. R. B. Davies, GW3KYA, Blackwood & District Amateur Radio Society, 16, Vancouver Drive, Penmain, Blackwood, Gwent. NP2 0UQ. (SAE required).

Courses

The Bridgnorth College of Further Education will be running a RAE course for the 1976/77 session.

Comm: Monday September 20, time: 7.30 p.m. at the Bridgnorth College of Further Education, Stourbridge Road, Bridgnorth, Shropshire.

The Gosforth Adult Association Classes are starting a new RAE course for the 1976/77 session.

Enrol: Monday September 6, time: 7.00 p.m. at the Gosforth Secondary School, Gosforth, Newcastle upon Tyne.

Two courses, each of nine lectures, are being run by the South London College, Knights Hill, SE27, on *Teletext Systems* and *Integrated Circuits*.

Comm: Thursday October 14, time: 6.30 p.m.
Title: Integrated Circuits, Fee: £3.00
Comm: Tuesday October 12, time: 6.30 p.m.
Title: Teletext Systems (Ceefax, Oracle Viewdata), Fee: £4.80.

POINTS ARISING

RADIO CONTROL SYSTEM RECEIVERS *(July 1976)*

Some readers have experienced difficulty with the receiver's local oscillator failing to oscillate. The author has informed us that the problem can be cured by increasing the values of L3 and L4 to 30μH and 1mH respectively. The 1mH r.f. choke can be obtained from most suppliers, whilst the 30μH is constructed by winding 20 turns of 30 s.w.g. enamelled copper wire on an i.f. core (4mm in diameter, 10mm long) and using glue to secure the ends of the winding only.

Also please note that the value of C7 should be as shown in the components list—47pF—and not 22pF as shown in Fig. 7.

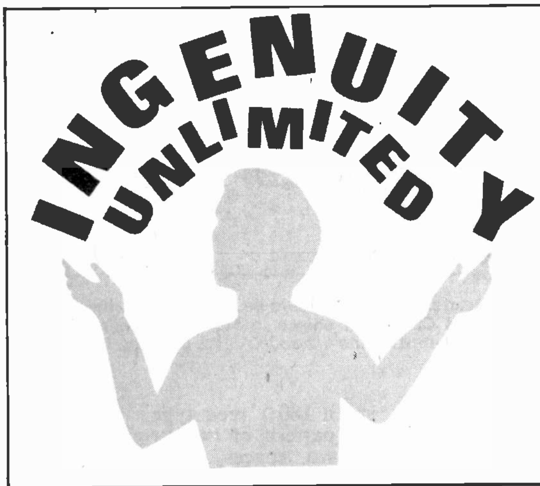
LIGHT-UP ALARM *(September 1976)*

The National LM747 cannot be used for IC1 in this design, since pins 9 and 13 are internally strapped.

SOUND TO LIGHT SYSTEM
(Ingenuity Unlimited, July 1976)

In the circuit diagram Fig. 1, the Live terminal should only be connected to the lamp (LP) and not as shown.

It is most important that the positive 9V line and the Live terminal are not connected together.



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?

Please Note
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

SIMPLE SIREN

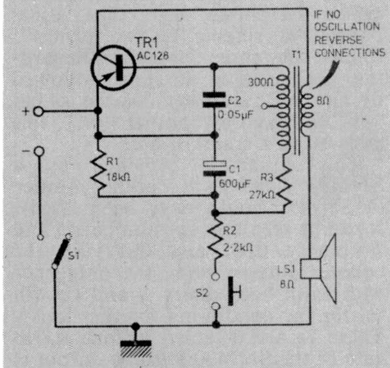


Fig. 1

THE circuit (Fig. 1) uses one transistor and a transistor portable radio output transformer to develop feedback from collector to base. When S2 is pressed C1 charges up at a rate determined by R2. The siren oscillates at a steadily increasing frequency determined by C2 and R3. When S2 is released the oscillations continue decreasing at a rate determined by C2 and R1. An ON/OFF switch prevents battery leakage through the transistor (9V).

The larger the speaker the better the effect. If you plan to use an amplifier omit the speaker and ground that transformer lead. Couple the output from the collector via a capacitor of 0·1–10µF depending on the input impedance. Use 0·1µF for 100kΩ or higher, increase for lower impedances. If there is no oscillation, reverse the transformer secondary connections.

K. Bennett,
Middlesbrough.

CMOS MAGNETIC CARTRIDGE PRE-AMPLIFIER

THE circuit shown in Fig. 1 is a simple pre-amplifier for a magnetic gramophone pick-up based on the now readily-available 74C04 CMOS hex inverter.

Each inverter is operated as a linear amplifier by the application of d.c. negative feedback and has an open loop voltage gain of approximately 50. The first stage of the circuit is arranged to have a voltage gain of about ten to bring the signal from the pick-up to a workable level. The output of this is coupled by a 1µF capacitor to the second stage which provides RIAA equalisation by means of an RC filter connected in the feedback loop and this reduces the stage gain from 10 at 50Hz to 0·1 at 20kHz.

The equalised output of this stage which is about 50mV in amplitude is fed through a coupling capacitor to the tone control stage. The amplification for the tone controls is provided by three cascaded inverters to give a high open-loop gain, but otherwise it is of the conventional Baxandall type. The gain of the tone control stage is close to unity with the bass and treble controls set for flat response. The output of the tone control circuit is then passed to a single inverter output amplifier with a voltage gain of about nine.

The output is provided through a 4·7kΩ volume control. With an input of 5mV at 1kHz the maximum output is about 500mV into a 10kΩ load which is suitable for most commercial power amplifiers.

The power supply for the circuit is not critical provided that it can supply 25mA at a voltage between five and 15 volts. However, it should be well decoupled to prevent noise being introduced into the amplifier stages.

R. Heaton, Christchurch.

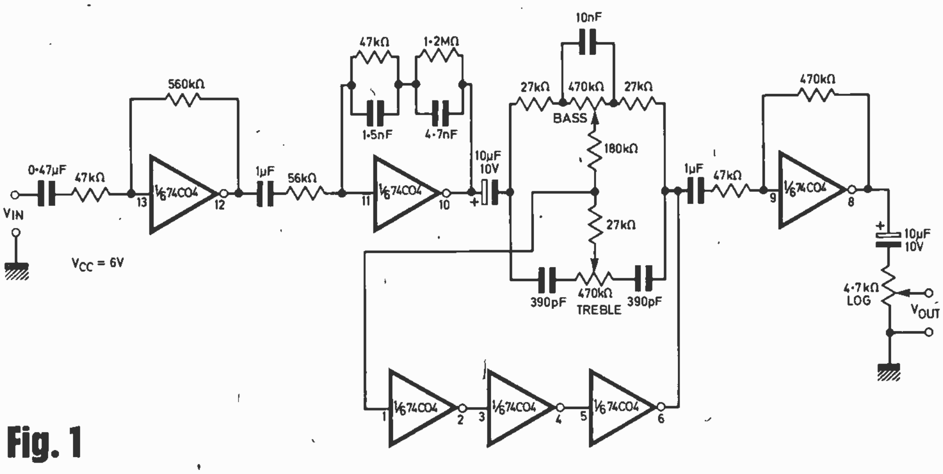


Fig. 1

TELEPHONE BELL SIMULATOR

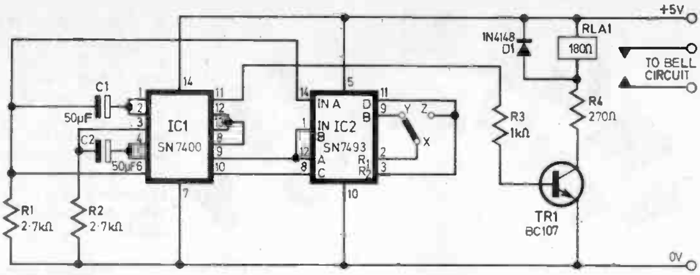


Fig. 1

NOTE: Resistors R1 and R2 should be connected to the opposite side of C1 and C2 to that shown in Fig. 1. In other words, R1 should be between IC1 pins 1/2 and OV, R2 between IC1 pins 4/5 and OV.

It is occasionally desirable to ring a bell in the same pattern as a Post Office telephone bell. The usual pattern of ringing is two "rings", followed by three "spaces". Regarding each ring as an "on" followed by an "off", and each space as an "off" followed by another "off", this adds up to a count of ten.

This count is provided by a SN7493 wired as a decade counter (a SN7490 could have been used). It can be seen that the numbers 5 and 7 (binary 0101 and 0111) in the counter output, being the only ones with 1s in both digits A and C, will satisfy the conditions for the "ons". These 1s are detected by one NAND gate of the SN7400 and the output is inverted by a second, the other two gates being connected as an astable multivibrator supplying the count input to the SN7493. The optimum values of R1, R2, C1 and C2 are best found by experiment. The BC107 drives the relay operating the bell circuit, the relay used being a small 180Ω reed type. To simulate the pattern of two "rings" followed by two "spaces" found in some areas connect X to Z instead of to Y.

K. D. Hooper, B.Sc.
Gillingham, Dorset.

SIMPLE DIGITAL LEAF

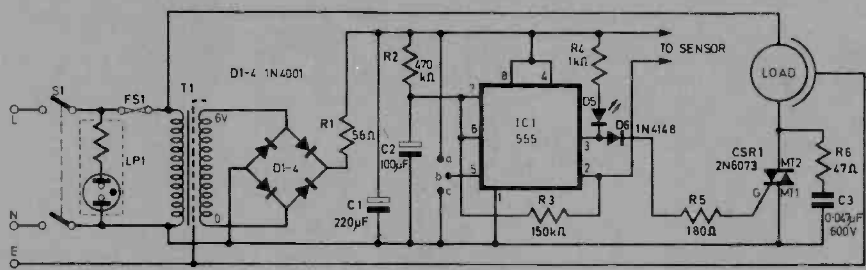


Fig. 1

In Practical Electronics, January 1975, a design was published for a "Digital Leaf" for use in greenhouses. Here is a simplified version which achieves the same ends and also incorporates an l.e.d. to allow testing on a 9V battery, which is less hazardous than with mains connected (Fig. 1).

The NE555 timer can be triggered quite happily by a slowly changing potential at pin 2, the arrangement shown working well and without chatter. The supply is not stabilised, and the original zener diode is omitted to put less load on the miniature transformer and give about 9V. The sensor is built as in the original article—two carbon rods connected to a twin lead and set in Araldite epoxy resin along with a supporting spike, the ends being exposed on a flat upward face. When the sensor is dry, pin 3 of the NE555 goes positive for a period depending upon the values of R2 and C2. This gates the triac and will allow water to flow through the mains operated water valve. Remember to earth the water valve body as shown—if in doubt seek professional advice on this matter.

Water sprays on to the sensor and when the timer has completed one cycle the potential at pin 2 has been lifted and inhibits the timer from starting the next cycle until the water on the sensor evaporates. During the "water off" period, pin 3 goes negative and the l.e.d., D5 is lit. Some increase in the values of R4 and R5 may be needed to limit the current through the l.e.d. during the "water on" period and to ensure that the triac is not gated on if it happens to require a very low current. No such problems were encountered in the prototype.

If variation in the duration of the "water on" time is required, two alternatives are possible. The first method is to connect point "b" in the circuit to "a" or "c" via a 500Ω resistor and a switch. The second alternative is to replace R2 by a switched series of ten timing resistors and an 11-way switch in series with a 10kΩ resistor to make up a total value of about 500kΩ.

During construction do not connect R1. Testing can proceed without the mains connected but with a 9V battery wired temporarily across C1. Check polarity carefully before connecting the battery. With damp blotting paper across the sensor the circuit will complete a cycle and then the l.e.d. will remain lit until the blotting paper is removed. It can be replaced at any time before or after a cycle to start the whole procedure again.

D. Polak,
Middlesbrough.

DIGITAL CIRCUIT TESTER

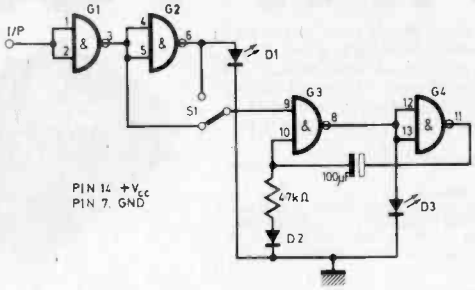


Fig. 1

IN addition to showing the state (positive or negative) at a point in a digital circuit, this device will also show the presence of brief pulses which would not otherwise be seen. Two l.e.d.s are used as indicators.

The circuit is as shown in Fig. 1. The gates are DTL 946. A TTL 7400 package could be used, with the addition of a resistor of 470Ω or 1kΩ in series with each of the l.e.d.s.

Gates 1 and 2 form an input amplifier and inverter. Gates 3 and 4 are connected to operate as a monostable which latches on to any negative pulse at the input to gate 3, causing l.e.d. D3 to light up for about a second. A two-way switch is included, so that the device can latch on to positive or negative pulses.

G. G. R. Rutter,
Woking, Surrey

50MHz COUNTER INPUT STAGE

THE first two stages of a digital frequency meter capable of operating at frequencies up to at least 50MHz are shown in Fig. 1. This employs a 74196 (8290) for the first divider stage, IC6. At these frequencies it is necessary to use a Schottky barrier gate (G2) for the mixing of the input from an amplifier, and the timebase control from a crystal oscillator and divider chain. This is often a deterrent to would-be constructors, not because of the increased cost of the gates, but because of the lack of availability.

To overcome this necessity for Schottky devices, the broadside loading facility of the 74196 is utilized as in Fig. 2. The input signal is fed directly to the clock 1 input (pin 8), and the timebase is fed directly to the load control (pin 1). When the timebase is at logical 1 the counter is enabled, but placing a logical 0 onto this control inhibits the count, and loads the counter with data at the inputs. Thus if the inputs are unused, this action effectively resets the display.

This unwanted action is overcome by connecting the outputs of the counter back to their corresponding inputs. Now these inputs are inhibited whilst counting, but at the end of the counting period, the clock is disabled, and the outputs at that instant are fed back to the inputs and reloaded into the device. The count is thus self sustaining until the device is reset by application of a zero logic level pulse at the clear line (pin 13). The necessity for the Schottky devices is eliminated, and control logic for the whole display is simple.

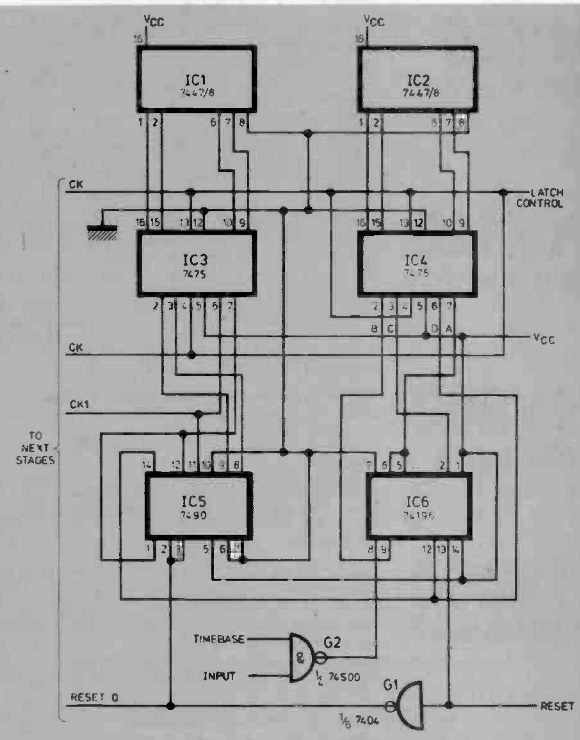


Fig. 1

The timebase is also fed to the trigger input of a monostable, such that a high to low transition will cause it to trigger. The Q output of this monostable controls the latch clocks, and also triggers another monostable, the $\bar{Q}$ output of which gives the reset pulse. The sum of their pulse durations must be less than the timebase off period.

D. Welbourn (G8KRH),
Brighouse, Yorks.

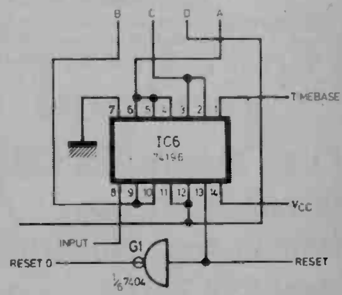
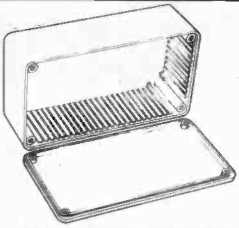


Fig. 2



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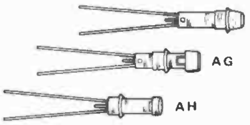

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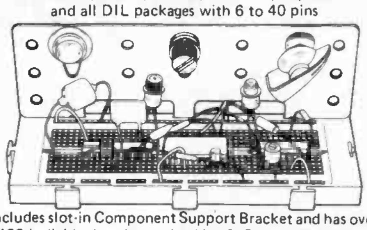

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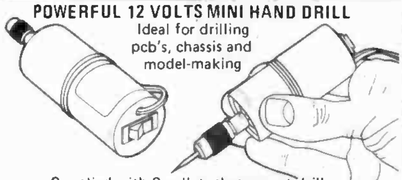

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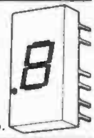

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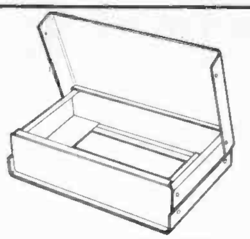

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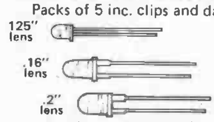

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TTL LOGIC PROBE

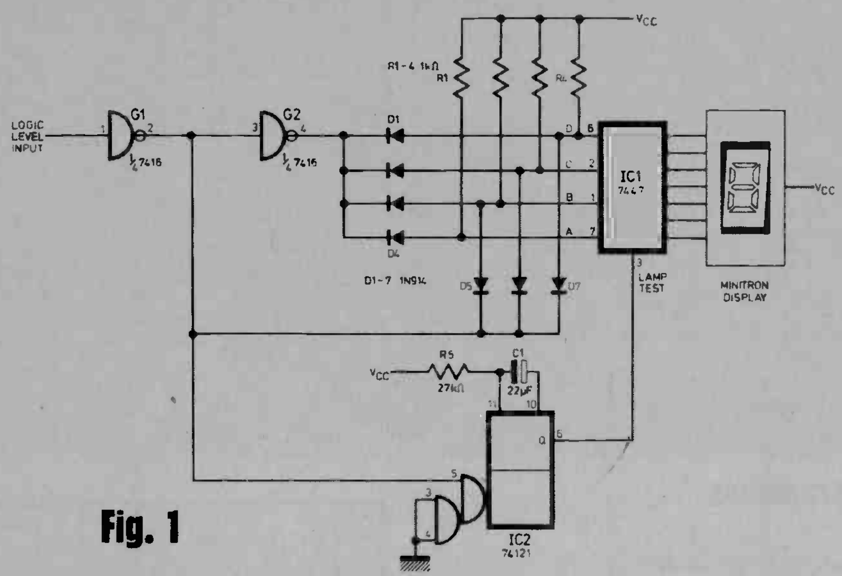

Fig. 1

A HANDY logic probe can be made from a minimum of components such as you might find in a "spares" box, see Fig. 1.

The first gate of the circuit ensures that the logic level being tested is only loaded by one extra gate. A high level on the input of G1 gives a low output, thus the A input of the 7447 stays high while the rest go low. The Minitron therefore displays 1. Similarly a low level on the input gives a low level on the output of the second gate thus grounding all the inputs to the 7447. A zero is thus displayed on the Minitron.

If, however, the input is being pulsed, the 74121 will stretch the pulse to about 0·5s, giving a low on the lamp test of the 7447 and bringing on all the segments of the Minitron thus displaying 8. The 8 may flash or not depending on the frequency, width and sense of the pulses. TTL components are used here, but a very similar device could be constructed from CMOS components for use with CMOS circuitry.

Power can be derived from the circuit being tested; alternatively, three 1½V batteries would probably do for TTL.

R. A. Jones,
Worcham, Dorset

PRESENCE BOOSTER FOR ELECTRIC GUITARS

THIS simple but effective circuit is designed for use with electric guitars to give a variable, even boost to the middle and upper frequencies without the excessive "treble" of some similar devices.

The boost control VR1 adjusts the frequency-selective negative feedback in the emitter circuit of TR1. With the control fully anticlockwise, the response of the amplifier is level and the gain is approximately 1·3. As the control is advanced, frequencies above about 250Hz are progressively boosted. The gain levels off at about 3kHz where the maximum available voltage gain is approximately 131, or about 42dB.

Although a BC109C was used because of its low noise properties, almost any small-signal silicon *npn* transistor could be used.

The prototype is housed in a small aluminium box and arranged such that the battery is switched on when a guitar lead is inserted. The connection to the amplifier is via a short length of screened lead "wired" into the unit and terminated by a jack plug.

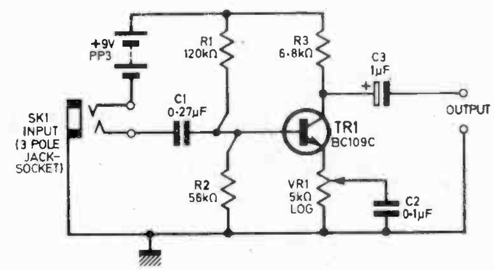

Fig. 1

Under full boost conditions, r.f. interference can be caused at certain settings of the guitar and main amplifier controls. This trouble can be eliminated by connecting a 820pF capacitor across the Presence Booster input.

Although this device could be used to advantage with any guitar or bass (or even organ), it works best in combination with guitars having humbucking pick-ups.

N. P. Stevens,
Brighton.

HEADS AND TAILS

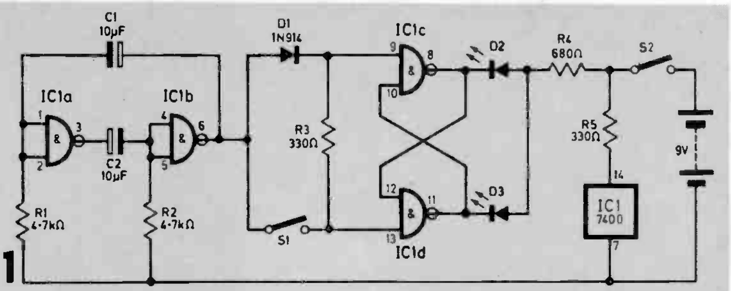

Fig. 1

WITH reference to the Ingenuity in the August 1975 issue by D. Manoharan on a "Head or Tails" circuit, the arrangement as shown would seem only to be suitable for the particular i.c. that the author was using. 7400s do tend to be slightly variable: I have three by different manufacturers, none of which worked in that circuit. All three however worked perfectly in the circuit shown in Fig. 1.

The oscillator formed by IC1a and b is reliable and well known, and the remaining two gates are connected in the familiar flip-flop fashion, alternately driving the two l.e.d.s. D1 serves two purposes: with a fresh battery and S1 (SPIN) on, the two l.e.d.s light alternately, simulating a coin throw. When S1 is released, the flip-flop remains in one of its two stable states, indicating "Head" or "Tail". When the battery voltage drops to about 6V, only D3 lights during the spin period thus providing low battery indication although the circuit works down to a battery voltage of 5V or below. R4 and R5 must be included to drop the voltage to that recommended by the i.c. manufacturers, i.e. 5·25V nominal. Current consumption is low, about 20mA.

D. W. Bickley,
Wolverhampton.

WIDE RANGE STAIRCASE GENERATOR

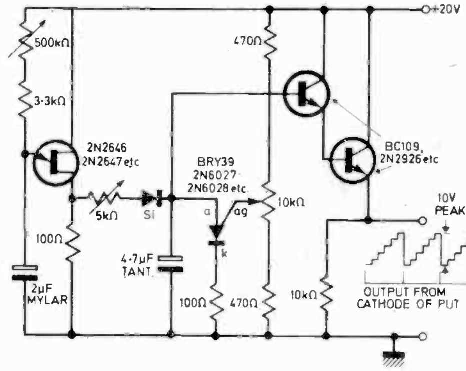

Fig. 1

THE pulse output from B1 of the 2N2646 u.j.t. Fig. 1 is coupled via the diode and this pumps the 4·7μF tantalum capacitor up in steps until the p.u.t. fires. The firing point is adjusted by altering the position of the 10kΩ potentiometer wiper. The output is taken via a Darlington pair to maintain the high impedance necessary at the anode of the p.u.t. If the output is taken to an impedance less than about 500kΩ, a further emitter follower may be necessary to prevent droop at low frequencies.

The capacitor values shown produce an output timing range ideal for playing scales if fed into a v.c.o. However, the values may be altered considerably so as to produce good waveforms up to 50kHz–100kHz. The linearity of the staircase is good at low anode-gate p.u.t. voltage which can be set by the 10kΩ pot. This may be improved if desired by adding a single transistor constant current source in place of the diode. The 500kΩ and 5kΩ pots adjust frequency and number of steps respectively. The big advantage of this circuit is the ability to vary the trigger level of the p.u.t., thus increasing the frequency range and division ratio by at least a decade over the conventional dual u.j.t. circuits. With the use of a d.c. 'scope the peak voltage and step voltage can be set very accurately, making it an ideal programming source for v.c.o.s or for use in curve tracers. The u.j.t. could be replaced by another p.u.t. thus further increasing the range.

J. A. Oliver, Maunbarki,
New Zealand.

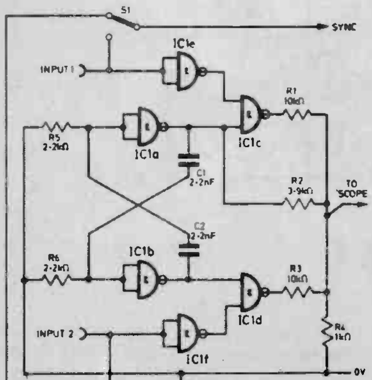

Fig. 1

CHEAP LOGIC TRACE MULTIPLIER

WHILE the 8 channel logic trace multiplier (P.E. Aug. (1975) is an excellent instrument, it is also rather costly and thus may be beyond the means of some, who like myself, have limited funds.

The circuit is shown in Fig. 1. The active components are six 2-input NAND gates. The first two gates IC1a and IC1b are wired as inverters and make up an oscillator with two complementary outputs which alternately enable the NAND gates IC1c and IC1d, thus displaying first one channel then the other.

Resistors R1–R4 form a summer (R2 provides a d.c. potential on top of which input 1 is added). Sync is provided for either channel by S1. The NAND gates wired as inverters (IC1e and IC1f) invert the inputs so that after passing through gates IC1c and IC1d the output presented to the 'scope is the same as the inputs: if these inverters were not used the output would be inverted. However, it would mean that the unit could be built with only one 7400.

C. J. E. Durrant, Norwich.

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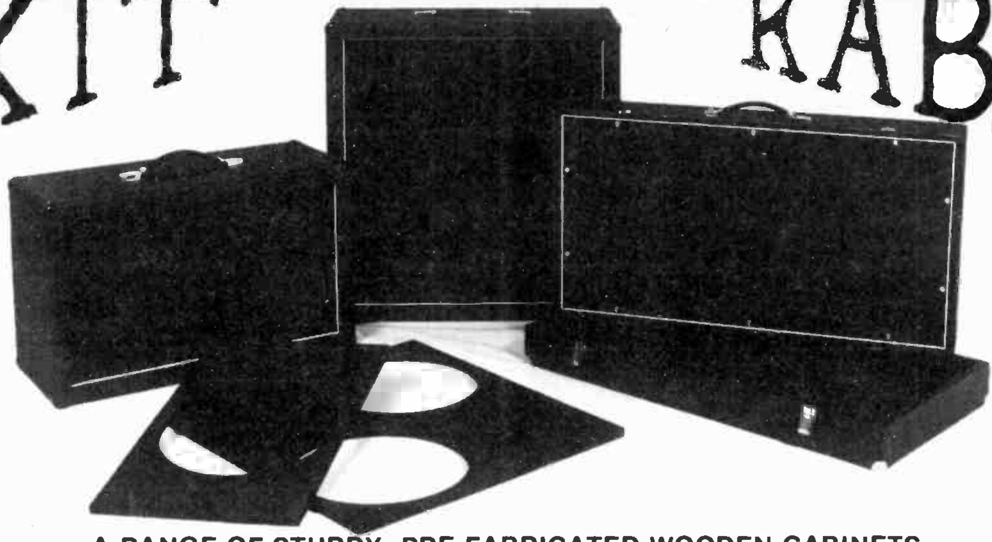

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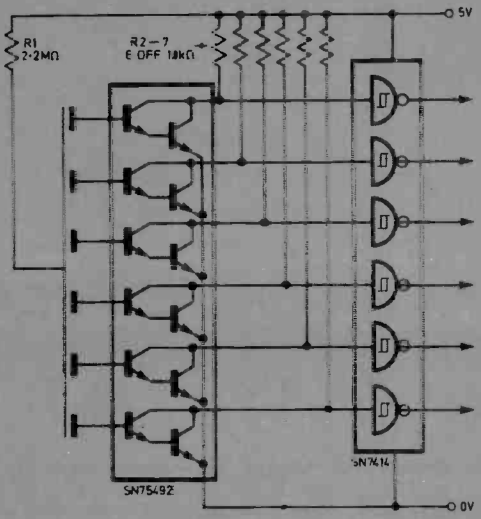

Fig. 1

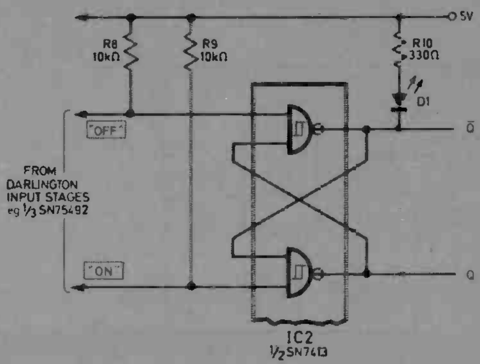

Fig. 2

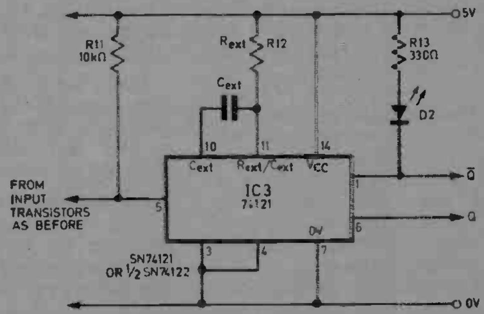

Fig. 3

TTL TOUCH CIRCUITS

THE following circuits form useful building blocks for the implementation of touch-controlled inputs to TTL circuits, with simple circuitry and high reliability of operation.

Fig. 1 shows a simple arrangement for six touch-to-operate switches. The operation of one will be described all being identical. When the input electrode is bridged to the common "live" electrode a current of typically 2μA is fed into the base of a Darlington pair of high-gain transistors (either discrete or a monolithic array as indicated). The second transistor saturates and pulls down the potential at the input to the inverter gate to below its threshold thus switching on the gate output which is fed to the circuit to be controlled. Normal TTL gates can be damaged by operation with inputs at or around their threshold level, and will often oscillate causing false outputs. In this application, the input to the gate may well be around the threshold if the input is touched very slowly or very lightly, and also the finger may tremble against the touch plate before firm contact is made. To overcome these difficulties, gates with Schmitt trigger inputs are used (7414 in this case). On falling inputs these have a threshold of about 0·9V and on a rising input about 1·7V and are unaffected by the maintenance of inputs around these threshold levels. The difference between rising and falling trigger levels, or hysteresis, means that small variations of input, even near the threshold, do not cause similar variations in output level. This hysteresis prevents false double operation due to finger tremble as pressure is being applied.

Many variations on this basic scheme are possible using the other TTL gates available with Schmitt inputs. Fig. 2 shows two of the gates in a 7413 used to form a latch (RS flip-flop) to give a touch-on/touch-off action (normal toggle switch action). When an input is touched, the associated NAND gate output goes high. This output is connected back to an input of the other NAND gate which causes its output to go low and the circuit to rest in this state even when the touch inputs are removed. This diagram also shows a simple means of indicating which output is low that can be used with any of the gates described. When the output goes low the l.e.d. is biased on at a forward current limited by the 330Ω resistor, (giving a current of about 10mA). If much more current is required a buffer must be used. Low current relays (e.g. reed relays) capable of operation on 5V and with coils of greater than 300Ω resistance may also be used provided a reverse biased diode is connected in parallel to remove switching transients.

Fig. 3 shows how an input may be used to produce a single, fixed-length pulse (e.g. for clocking of counters). The B input of the 74121 TTL monostable has a Schmitt action similar to the gates previously mentioned. The A inputs may be permanently wired as shown or used as enabling inputs from other circuitry. The pulse produced has a length proportional to the product of C_{ext} and R_{ext}. The l.e.d. shown lights during the pulse period.

These circuits have shown possible uses with all the currently available one- and two-input Schmitt triggered gates. The Darlington input transistor pairs may be SN75492 as shown or may be discrete or wired from monolithic arrays of individual transistors. Of course the circuits may be extended to controlling a wide variety of other systems by the use of buffer amplifiers, thyristors, triacs etc. The l.e.d.s shown may also be the input l.e.d.s of optical isolators allowing safe isolation from high-voltage circuits.

A. Gray,
London

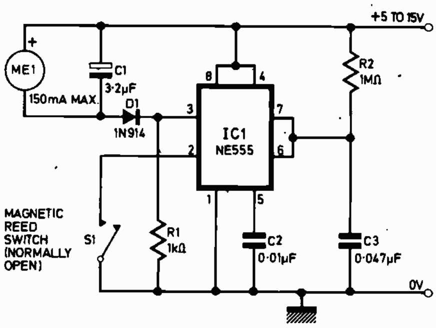

Fig. 1

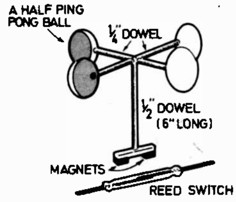

Fig. 2

THE anemometer circuit in Fig. 1 uses a NE555 timer i.c. in the monostable mode to give a pulse of fixed length (·047 sec) regardless of what length the input pulse is.

A wind driven assembly of cups has at its base a pair of diametrically opposite magnets arranged on a disc. Obviously with varying wind speeds the switching rate will be a function of this. The meter ME1 integrates the output pulses and provides an indication with suitable calibration of the meter scale.

A four cup assembly is made up of four short lengths of ¼in dowelling and one 6in length of ½in. The ½in piece is drilled with ¼in holes at right angles to each other (Fig. 2).

Insert ½in of the shorter ¼in pieces into each of the holes and glue if necessary. Cut two ping-pong balls in half and stick the ends of the short pieces through them.

On the end of the ½in length fix a disc of approximately the same diameter as the length of one of the short pieces of dowelling. On this mount the two magnets.

Mount the whole assembly so that it can spin freely, fix the reed switch underneath the disc and check that the 555 triggers twice for every revolution of the disc. There is bound to be someone in the neighbourhood who already has one and he will probably let you calibrate the markings on your meter with his. An alternative is to calibrate against a car speedometer.

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Helensburgh.

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101			5·0	0·65
102	D.C. values		6·0	0·55
103	are obtained		9·0	0·35
104	with a		10·0	0·33
105	Bridge Rect.		12·0	0·275
106	and a 1,000mF		12–0–12	0·14
107	capacitor		15–0–15	0·11
108			24	0·14
109	6	1·0	—	—
110	12	0·5	—	—
111	24	0·25	—	—
201			5	2·0
202	D.C. values		6	1·5
203	are obtained		9	1·1
204	with a		10	1·0
205	Bridge Rect.		12	0·8
206	and a 1,000mF		12–0–12	0·4
207	capacitor		15–0–15	0·3
208			24	0·4
209	6	2·0	—	—
210	12	1·0	—	—
211	24	0·5	—	—
501			5	7·0
502			6	6·0

(Rating)

PRICE LIST (all prices include P. & P. and 8% VAT. Discounts: 1–24 list price; 24–100 less 5%):

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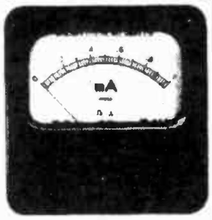
1-0-1mA	10V DC	50mV DC
5mA	15V DC	100mV DC
10mA	20V DC	
50mA	50V DC	
100mA	150V DC	
500mA	300V DC	
1A DC	30V AC*	
2A DC	50V AC*	

* Moving iron (all others are moving coil).



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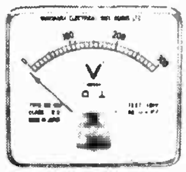

Dimensions: Front 110mm x 120mm wide
Panel Hole: 85mm
Accuracy ±2·5%

RANGES

50μA	10mA	50V DC
200μA	50mA	150V DC
500μA	100mA	300V DC
50-0-50μA	500mA	300V AC
100-0-100μA	1A DC	1A AC*
500-0-500μA	5A DC	5A AC*
1mA	15A DC	10A AC*
1-0-1mA	30A DC	20A AC*
5mA	10V DC	30A AC*
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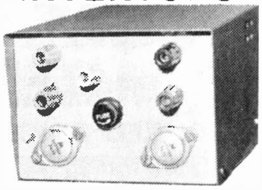

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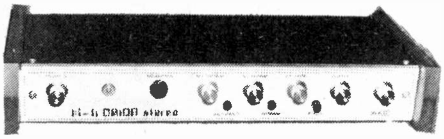

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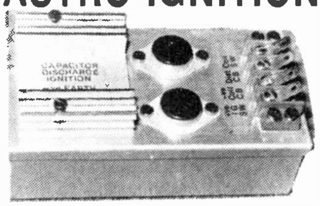

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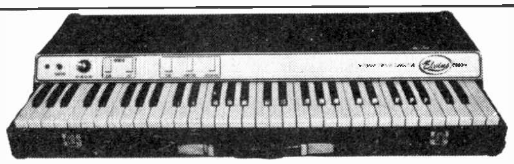

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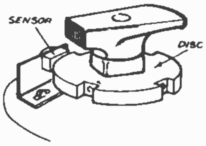

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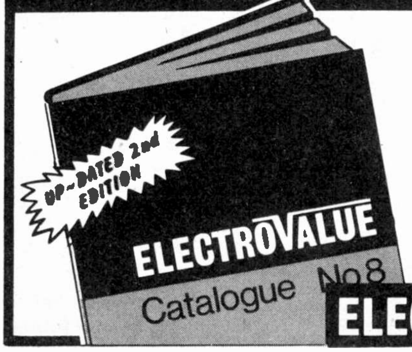

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72	10	5	6·97
116	12	6	7·45
17	16	8	9·27
115	20	10	13·65
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207	500, 500	0-8-9, 0-8-9	2·82
208	1A, 1A	0-8-9, 0-8-9	4·02
236	200, 200	0-15, 0-15	2·03
214	300, 300	0-20, 0-20	2·89
221	700 (DC)	20-12-0-12-20	3·27
206	1A, 1A	0-15-20, 0-15-20	4·78
203	500, 500	0-15-27, 0-15-27	4·27
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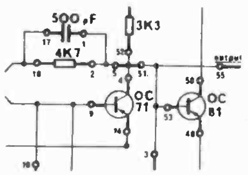

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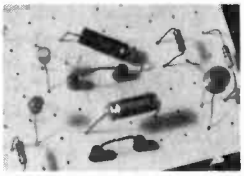

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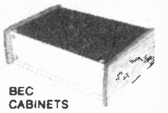

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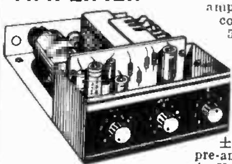

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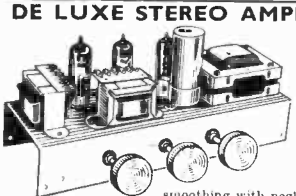

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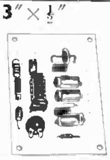

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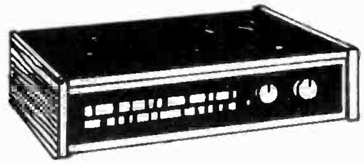

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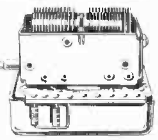

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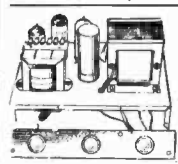

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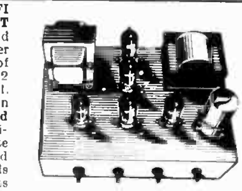

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Subscriptions not available at home or overseas.
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