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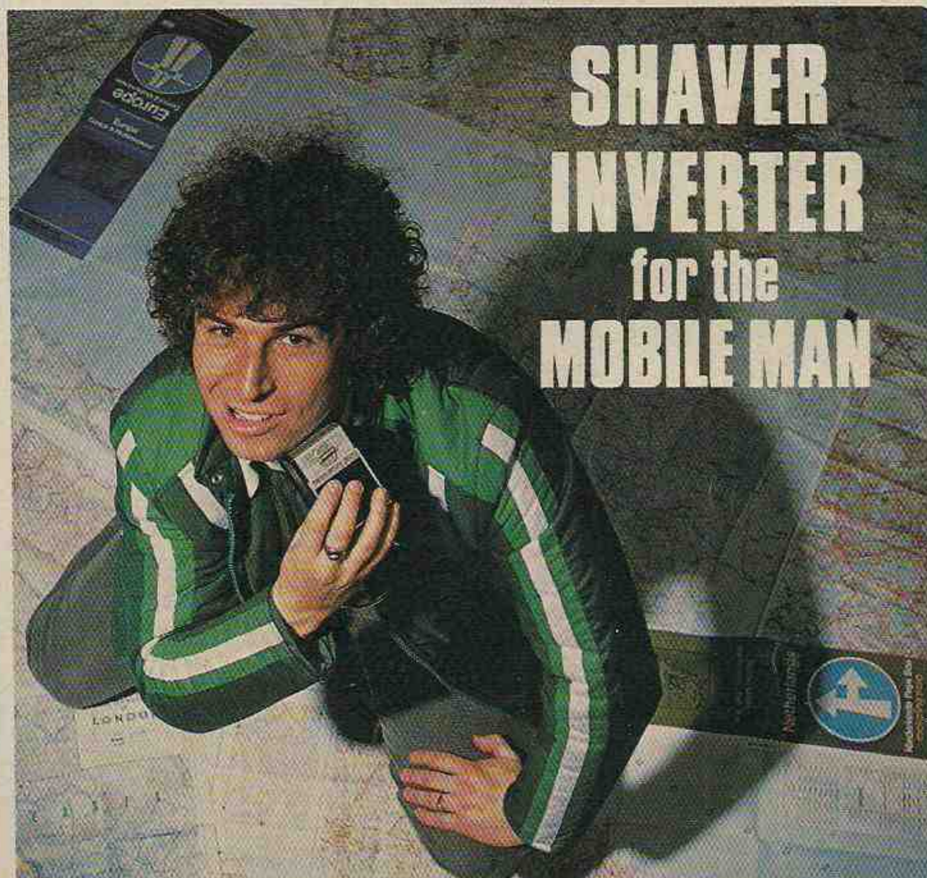

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LM341P-5	0·56	LM1889N	2·50	CA3030	1·50
LM341P-12	0·56	LM1890N	P.O.A.	CA3030A	2·20
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LM379S	4·25	LM78L12CH	0·85	CA3047	2·20
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LM381AN	2·70	LM7805KC	1·56	CA3049	1·98
LM381N	1·69	LM7812KC	1·56	CA3050	2·66
LM382N	1·32	LM7815KC	1·56	CA3051	1·82
LM384N	1·55	LM7824KC	1·56	CA3052	1·78
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LM388N	1·00	LM78L15CZ	0·30	CA3059	2·10
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LM741CH	0·50	MC844P	0·70	CA3090Q	4·40
LM741C-8	0·30	MC846P	0·70	CA3130	1·06
LM741C-14	0·60	MC848P	1·10	CA3140	1·04
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LM1304N	1·52	CA3007	4·15	LM114H	2·75
LM1305N	1·02	CA3008	2·55	LM301AH	0·40
LM1307N	1·22	CA3012	1·65	LM301-8	0·30
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LM1351N	1·30	CA3014	2·20	LM307N	0·50
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LM1496N	0·97	CA3018A	1·10	LM308N	0·55
LM1800N	1·94	CA3020	2·20	LM309KC	1·55
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LM1808N	2·10	CA3021	2·40	LM317MP	1·35
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74C08N	0·24	74C76N	0·54	74C151N	2·47	CD4006	1·25	CD4016	0·52
74C10N	0·24	74C83N	1·30	74C154N	3·68	CD4007	0·18	CD4017B	1·05
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74C32N	0·24	74C90N	0·85	74C162N	1·11	CD4011B	0·20	CD4021	1·05
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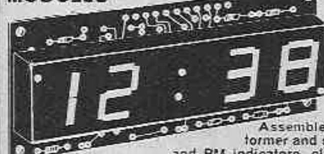

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TIC253D	Plastic TO3	400v	20A	£1·87
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40576				£2·20
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TIC46†	0·6A	100v	TO18	£0·50
TIC47†	0·6A	200v	TO18	£0·60
2N5060	0·5A	25v	TO18	£0·32
2N5061	0·5A	50v	TO18	£0·33
2N5062	0·5A	100v	TO18	£0·40
2N5063	0·5A	150v	TO18	£0·43
2N5064	0·5A	200v	TO18	£0·45
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SN74H10N	0·56	74LS73N	0·42	74LS189N	3·74
SN74H11N	0·55	74LS74N	0·42	74LS190N	1·00
SN74H20N	0·55	74LS75N	0·58	74LS191N	1·00
SN74H21N	0·55	74LS76N	0·42	74LS192N	0·95
SN74H30N	0·55	74LS78N	0·42	74LS193N	0·95
SN75H40N	0·55	74LS83AN	0·90	74LS194N	0·70
SN74H51N	0·55	74LS85N	0·95	74LS195N	0·70
SN74H53N	0·56	74LS86N	0·44	74LS196N	0·80
SN74H54N	0·55	74LS90N	0·64	74LS197N	0·80
SN74H55N	0·55	74LS91N	1·20	74LS221N	0·80
SN74H60N	0·55	74LS92N	0·70	74LS240N	1·50
SN74H62N	0·55	74LS93N	0·64	74LS241N	1·50
SN74L00N	0·55	74LS95AN	0·90	74LS242N	1·25
SN74L02N	0·56	74LS96N	1·35	74LS243N	1·25
SN74L04N	0·60	74LS107N	0·42	74LS244N	1·50
SN74L47N	3·10	74LS109N	0·42	74LS245N	1·65
SN74L74N	0·90	74LS112N	0·42	74LS247N	1·09
SN74L85N	2·62	74LS113N	0·42	74LS248N	1·09
SN74L93N	2·30	74LS114N	0·42	74LS249N	1·09
74LS00N	0·26	74LS122N	0·62	74LS251N	1·00
74LS01N	0·26	74LS123N	0·83	74LS253N	1·00
74LS02N	0·26	74LS124N	1·70	74LS257N	1·00
74LS03N	0·26	74LS125N	0·60	74LS258N	1·00
74LS04N	0·29	74LS126N	0·50	74LS259N	1·55
74LS05N	0·29	74LS132N	0·85	74LS261N	3·25
74LS08N	0·26	74LS136N	0·42	74LS266N	0·44
74LS09N	0·26	74LS138N	0·65	74LS273N	1·30
74LS10N	0·26	74LS139N	0·65	74LS275N	3·20
74LS11N	0·26	74LS145N	1·30	74LS279N	0·58
74LS12N	0·26	74LS147N	1·65	74LS280N	1·65
74LS13N	0·58	74LS148N	1·35	74LS283N	1·20
74LS14N	0·75	74LS151N	0·58	74LS289N	3·74
74LS15N	0·26	74LS153N	0·58	74LS290N	1·00
74LS20N	0·26	74LS154N	1·45	74LS293N	1·00
74LS21N	0·26	74LS155N	0·80	74LS295N	1·35
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74LS30N	0·26	74LS161N	0·85	74LS325N	2·40
74LS32N	0·27	74LS162N	0·80	74LS326N	2·70
74LS33N	0·29	74LS163N	0·85	74LS327N	2·55
74LS37N	0·32	74LS164N	1·10	74LS348N	1·10
74LS38N	0·32	74LS165N	1·15	74LS352N	1·07
74LS40N	0·26	74LS166N	1·65	74LS353N	1·07
74LS42N	0·80	74LS168N	1·45	74LS365N	0·55
74LS47N	1·09	74LS169N	1·45	74LS366N	0·55
74LS48N	1·00	74LS170N	1·90	74LS367N	0·55
74LS49N	1·09	74LS173N	1·10	74LS368N	0·55
74LS51N	0·26	74LS174N	0·75	74LS373N	0·85
74LS54N	0·26	74LS175N	0·75	74LS374N	0·85
74LS55N	0·26	74LS181N	2·75	74LS375N	0·66

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2N3404	·21	2N3570	4·50	2N2705	·14	2N4909	4·98	2N5036	1·20	2N5209	·35	2N5307	·30	2N5550	·38	2N6132	·70	BD182	2·20	BFW59	1·75
2N3405	·21	2N3571	1·90	2N3706	·14	2N4910	1·20	2N5086	·30	2N5210	·38	2N5308	·33	2N5551	·44	2N6133	·70	BD183	2·35	BFW87	1·75
2N3414	·18	2N3572	3·00	2N3707	·14	2N4913	1·45	2N5087	·30	2N5219	·16	2N5354	·27	2N5555	·65	2N6134	·70	BD187	·95	BFW90	1·75
2N3415	·18	2N3583	1·25	2N3708	·12	2N4914	1·65	2N5088	·30	2N5220	·15	2N5355	·20	2N5638	·45	2N6179	·77	BD201	1·10	BFX12	·35
2N3416	·21	2N3584	1·35	2N3709	·12	2N4915	2·40	2N5089	·30	2N5221	·16	2N5356	·23	2N5640	·45	2N6180	1·05	BD202	1·25	BFX13	·33
2N3417	·25	2N3605	·18	2N3710	·12	2N4916	·22	2N5126	·44	2N5222	·20	2N5358	1·75	2N5654	·55	2N6181	·88	BD203	1·28	BFX19	·49
2N3420		2N3606	·18	2N3711	·12	2N4917	·27	2N5127	·22	2N5223	·16	2N5365	·24	2N5655	·55	2N6253	1·00	BD204	1·35	BFX29	·34
	12·50	2N3607	·18	2N3712	1·35	2N4918	·65	2N5128	·22	2N5224	·16	2N5400	·33	2N5656	·65	2N6254	1·45	BD220	·66	BFX30	·34
2N3439	·85	2N3632		2N3713	1·50	2N4919	·70	2N5129	·22	2N5225	·16	2N5401	·44	2N5657	·75	2N6288	·50	BD221	·66	BFX34	·66
2N3440	·75		12·75	2N3714	1·55	2N4920	·83	2N5130	·22	2N5226	·16	2N5415	1·05	2N5661		2N6289	·50	BD222	·66	BFX37	·49
2N3441	·92	2N3638	·17	2N3715	1·55	2N4921	·54	2N5131	·22	2N5227	·16	2N5416	1·65		17·00	2N6290	·50	BD223	·75	BFX68	1·10
2N3442	1·45	2N3638A	·17	2N3716	2·29	2N4922	·60	2N5133	·22	2N5232	·22	2N5447	·16	2N5786	·98	2N6292	·50	BD224	·75	BFX84	·30
2N3444	1·35	2N3639	·33	2N3724	·65	2N4923	·75	2N5137	·22	2N5232A		2N5448	·16	2N5813	·55	AF239	·70	BD232	·75	BFX85	·38
2N3445	6·50	2N3640	·25	2N3725	·60	2N4924	1·15	2N5138	·22		·23	2N5449	·20	2N6027	·64	AF240	1·25	BD233	·45	BFX86	·30
2N3446		2N3641	·25	2N3732	2·00	2N4926	1·70	2N5139	·22	2N5239	2·25	2N5450	·16	2N6036	1·39	AF279	·84	BD234	·46	BFX87	·35
	10·00	2N3642	·22	2N3734	·75	2N4927	1·70	2N5140	·22	2N5245	·37	2N5451	·16	2N6039	1·17	AF280	·95	BD235	·46	BFX88	·30
2N3447		2N3643	·38	2N3735	7·00	2N4928	2·20	2N5142	·22	2N5246	·38	2N5457	·35	2N6099	·62	AFY42	1·65	BD538	·77	BFX89	1·37
	10·50	2N3644	·40	2N4871L	·51	2N4944	·30	2N5143	·22	2N5247	·44	2N5458	·38	2N6107	·45	AU110	1·70	BD539	·60	BFY10	1·10
2N3448		2N3645	·38	2N4888	·54	2N4945	·30	2N5172	·24	2N5248	·44	2N5459	·32	2N6108	·55	AU113	1·70	BD540	·60	BFY18	1·10
	12·90	2N3646	·26	2N4889	·75	2N4964	·28	2N5179	·75	2N5249	·38	2N5460	·65	2N6109	·55	BC409	·27	BD581	1·10	BFY19	1·10
2N3468	1·32	2N3662	·25	2N4891	1·30	2N4965	·28	2N5180	·58	2N5266	3·00	2N5461	·53	2N6111	·49	BC413	·16	BD582	1·30	BFY87	1·10
2N3507		2N3663	·29	2N4898	1·55	2N4966	·28	2N5183	1·20	2N5293	·44	2N5462	·65	2N6121	·41	BC414	·17	BD675	·60	BFY89	·38
	10·00	2N3690	·45	2N4901	1·65	2N4967	·28	2N5188	·44	2N5294	·44	2N5484	·37	2N6122	·46	BC415	·16	BD676	·65	BFY41	·88
2N3512	1·10	2N3691	·45	2N4902	2·20	2N4968	·28	2N5189	·49	2N5295	·44	2N5485	·40	2N6123	·48	BD153	1·05	BD677	·70	BFY50	·35
2N3553	3·25	2N3692	·45	2N4903	2·75	2N4969	·28	2N5190	·65	2N5296	·44	2N5486	·40	2N6124	·45	BD155	1·10	BD678	·82	BFY51	·35
2N3563	·25	2N3693	·50	2N4904	1·85	2N5010	5·75	2N5191	·75	2N5298	·44	2N5490	·64	2N6125	·47	BD157	·70	BFS98	·33	BFY52	·35
2N3564	·25	2N3694	·50	2N4905	2·40	2N5011	8·25	2N5192	·80	2N5301	4·00	2N5492	·64	2N6126	·48	BD158	·70	BFW10	·83	BFY53	·40
2N3565	·25	2N3702	·14	2N4906	2·99	2N4030	·22	2N5193	·75	2N5303	5·50	2N5494	·65	2N6129	·60	BD159	·70	BFW11	·83	BFY72	·99
2N3566	·25	2N3703	·14	2N4907	4·90	2N5033	·65	2N5194	·80	2N5305	·26	2N5496	·67	2N6130	·65	BD160	3·40	BFW30	2·45	BFY75	·77

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M2	As M1 but 33mm dia with pointer	£0·31
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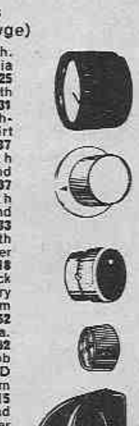

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Projects... Theory...
and Popular Features...

Spring is a curtain raiser. It is the time plans are made for holidays in those long, bright and warm days we confidently anticipate in the months ahead.

Amongst our readers will be many motorists who are already preparing for that touring/camping holiday. They should include in their plans the building of our *Shaver Inverter*. Then no matter where their car may rest, whether here in the UK or abroad, a 240V 50Hz supply will be available at all times to run an electric shaver.

Looking back, one of the advantages of an absorbing indoor hobby is that it does take your mind off unpleasant things like the weather, the last winter especially. Constructors working on the *2020 Tuner Amplifier* will at any rate have had plenty to occupy themselves with, and we imagine the winter passed quite rapidly for them!

This month the penultimate article in the 2020 Series gets to grips with the final and major building operation. Now the fruits of the last few months' labours are gathered together and the task of integrating all into one equipment commences. At this stage the work takes on a greater significance with completion now clearly within sight. The rising expectancy of soon listening and enjoying the results of one's handiwork will inject extra incentive and excitement into the current task.

Now a seasonal message to those interested in electronics but who have not yet taken the plunge into the constructional business. Remember electronics is a hobby for all seasons. Throughout the year the constructor can enjoy this pastime. Most projects featured in EE are of a modest nature, and inexpensive in cost of parts. These designs are often of direct use in other indoor or outdoor activities. The time you spend at the workbench can be the odd half-hour or longer sessions, as you are so disposed. The smaller designs can be built in the course of an evening. A week-end should be sufficient for all but the largest projects.

Spring is the time of awakening and growth. It's a very good time to discover a new exciting and rewarding hobby. So why not give it a try now?

Sorry about this final piece, but I have now to advise readers that the price of EVERYDAY ELECTRONICS will be increased to 45p as from the May issue. Despite this, EE still remains unrivalled in value for money. And be assured we're going to keep it this way!

Fred Bennett.

Our May issue will be published on Friday, April 20. See page 227 for details.

Readers' Enquiries
We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.
Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

Component Supplies
Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 8 NO. 4 APRIL 1979

CONSTRUCTIONALS

GENERAL FEATURES

Back issues of EVERYDAY ELECTRONICS June 1977 onwards (October to December 1977, January to March 1978 NOT available) are available worldwide at a cost of 60p per copy inclusive of postage and packing. Orders and remittance should be sent to: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

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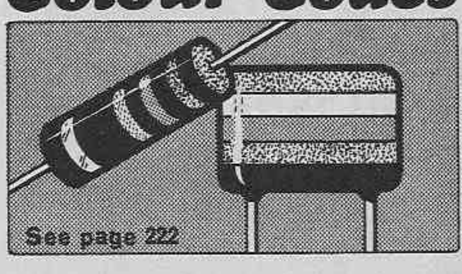


See page 222

● FOR THE SMART MOTORIST/CAMPER

● 12V d.c. to 240V a.c. 20W

By D. S. Gibbs & I. M. Shaw

shaver inverter

ANYONE who has had to use a battery shaver whilst on holiday will know that these devices are a very poor substitute for the real thing. This unit is designed to operate a normal 50Hz mains shaver from a 12 volt car battery and so is ideal for caravan and camping enthusiasts.

When loaded with a shaver it takes just about 1 amp from a 12 volt battery, which is quite acceptable since it is only required for a few minutes per day. If a somewhat heavier drain on the battery can be tolerated the unit will supply a small soldering iron (25 watts maximum). This will enable keen constructors to continue their hobby whilst on holiday.

COMPONENTS approximate cost £10

CIRCUIT CONSIDERATIONS

Many shavers contain a vibrator which is mechanically tuned to 50Hz and so it is important that the inverter should operate at exactly 50Hz or the shaver will not operate at maximum efficiency. This ruled out a simple self oscillating inverter circuit since the frequency would then be a function of the transformer, the supply voltage and the load presented by the shaver. Instead, in this design, the output transistors are driven by a multivibrator which oscillates at 50Hz.

CIRCUIT DESCRIPTION

The circuit diagram of the Shaver Inverter is shown in Fig.1.

Transistors TR2 and TR3 form the heart of the multivibrator. The extra diodes, D2, D3, D4, and D5 make the circuit look more complicated than the usual astable multivibrator but it works in just the same way.

Assume that TR2 has just been turned on. This turns on the output transistor TR1 via R1 and R2 and at the same time diode D3 conducts and takes the top end of R3 to about +10·5 volts. This in turn takes the base of TR3 up to about +21 volts and cuts off TR3.

However C1 now starts to discharge through R4 and as it does so the voltage on TR3 base drops. When the base voltage drops to +10·5 volts TR3 starts to turn on and its collector voltage rises. Diode D4 now conducts and the top end of R7 starts to go positive. This turns off TR2 and the collector voltage of TR2 drops to zero. Diode D3 is cut off and capacitor C1 recharges via R3 and the base of TR3, turning TR3 and its associated output transistor TR4 hard on.

The same sequence then repeats ending with TR2 being turned on and TR3 cuts off.

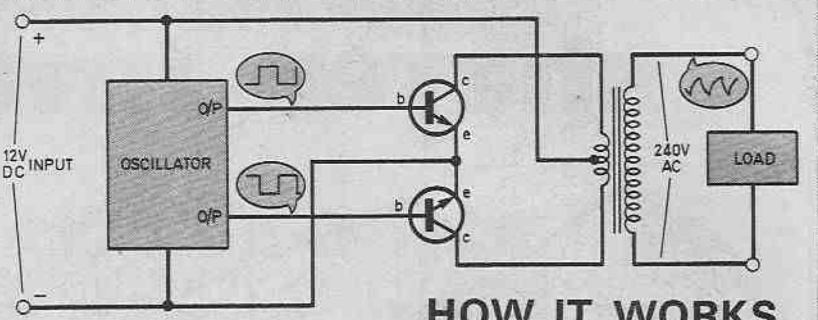
PROTECTION DIODES

Now we come to the functions of diodes D2, D3, D4 and D5. Silicon transistors generally cannot stand a reverse bias on their base of more than about 5 volts. If this is exceeded the base/emitter junction breaks down and a reverse current flows, which upsets the timing of the circuit and may also cause long term damage to the transistor. In this circuit TR2 and TR3 are subjected to a reverse bias of about 10 volts, but the bases are protected from breakdown by D2 and D5 which prevent any reverse current flowing in the base/emitter junctions.

Now to diodes D3 and D4. If these diodes were not present the circuit would still operate, but when, for example, TR2 turned off its collector voltage would not immediately drop to zero because of the need to recharge C1. This would delay the turn off of TR1 and there would be short periods when both TR1 and TR4 would be conducting at the same time. This would reduce the efficiency of the circuit and result in overheating. Diodes D3 and D4 solve the problem by isolating the collectors of TR2 and TR3 from the timing capacitors.

The only other components whose function might not be obvious are D1 and D6. These diodes are required because a shaver presents a highly inductive load to the inverter. This causes overshoots on the collector voltage waveform which could result in the collectors of TR1 and TR4 being driven negative momentarily, with a risk of damage to the transistors. This is prevented by D1 and D6 which conduct if the collectors are driven negative and hence prevent any reverse current from flowing in TR1 and TR4.

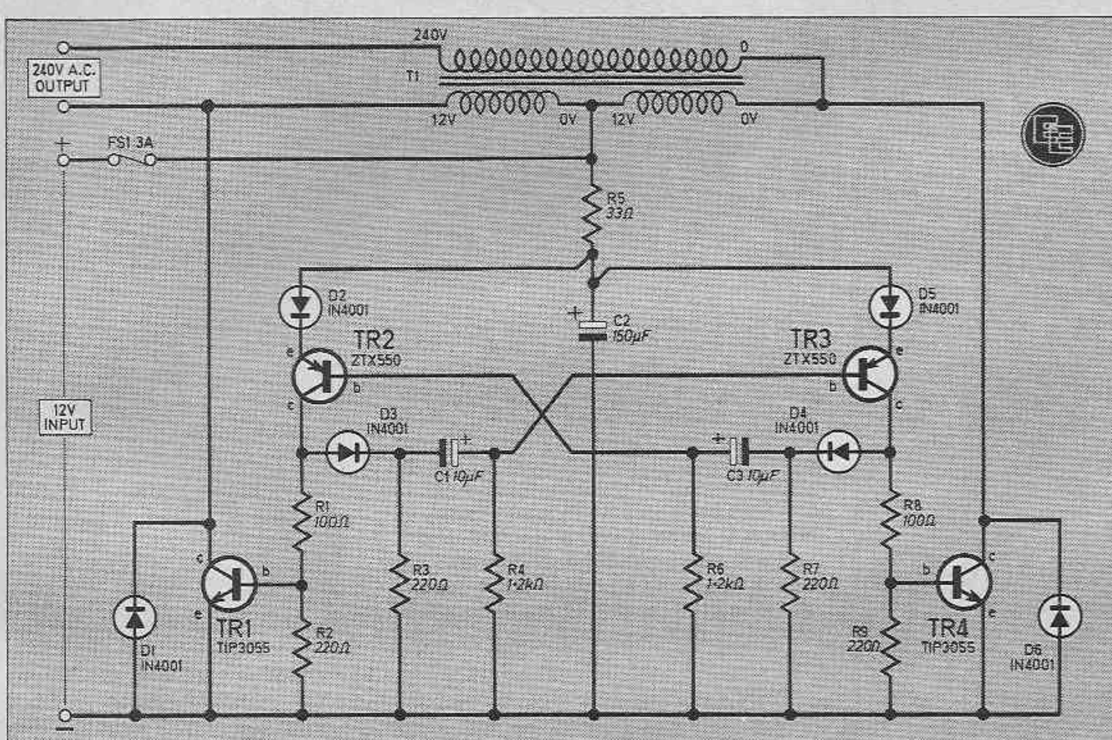
Finally, it will be noted that the transformer secondary is connected in series with the primary. This increases the output voltage by 10 per cent to compensate for voltage drops in the transistors and in the winding resistance of the transformer. If you use a different transformer to the one specified it will be necessary to experiment with the connections to determine the correct phasing, since if the phasing is incorrect the output voltage will be *reduced* by 10 per cent.



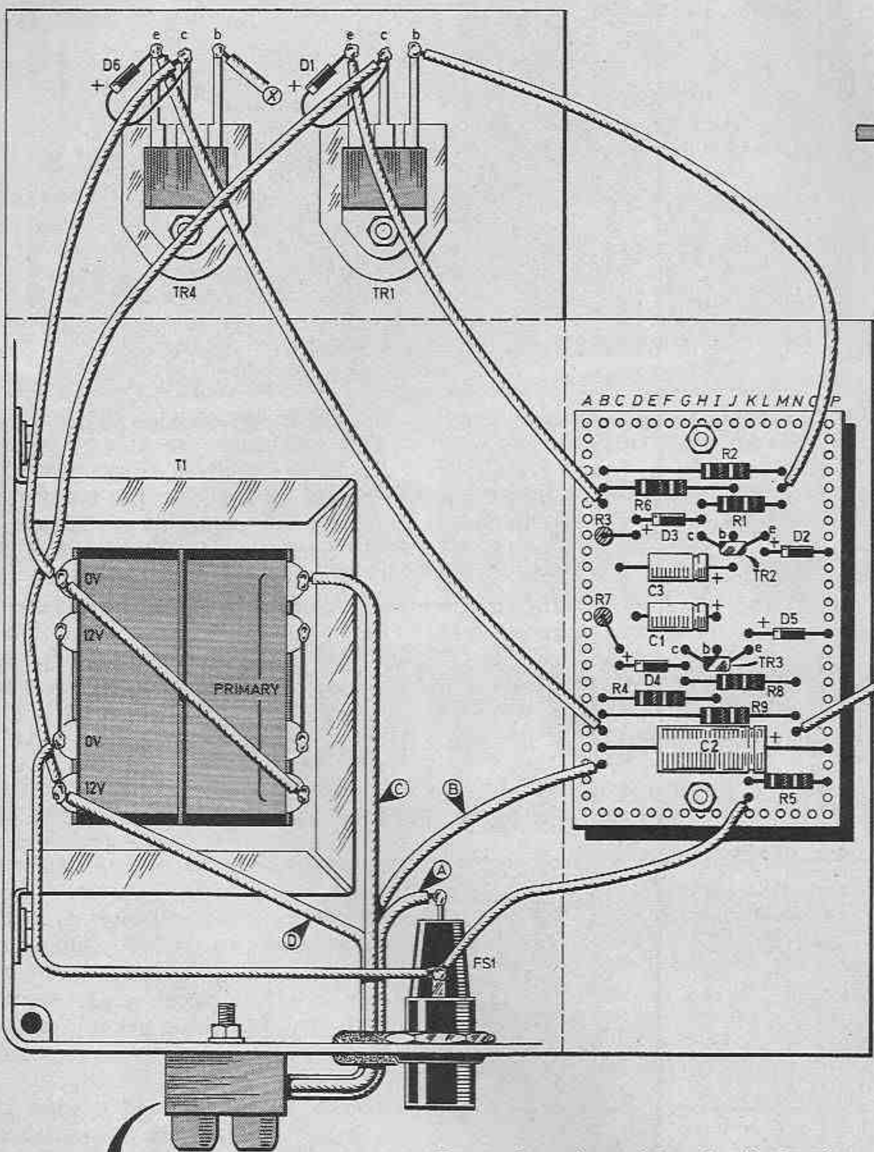
HOW IT WORKS

A squarewave oscillator operating at 50Hz, supplies push-pull (out of phase) waveforms to two output transistors. These transistors switch on and off alternately and generate a 50Hz squarewave across the primary of the transformer. In this application the transformer is used the "wrong way round", hence the voltage is stepped up, and 240V appears at across the secondary and the load. The inductance of the shaver filters the square wave thus producing a close approximation to a sinewave.

Fig. 1. Complete circuit diagram of the Shaver Inverter.



shaver inverter



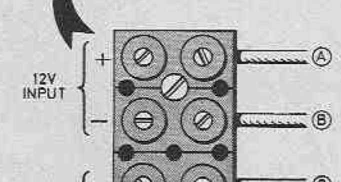


Fig. 3. Complete wiring details for the Shaver Inverter. Also shown is the stripboard layout. The only breaks to be made are those which isolate the mounting screws. Be very careful when mounting the two power transistors to ensure that they do not short to each other or to the side of the case. It would be advisable to place sleeving over the leads also to prevent short circuits. Ensure also that the tags of the transformer are bent down as far as possible otherwise they may touch the lid when this is in place.

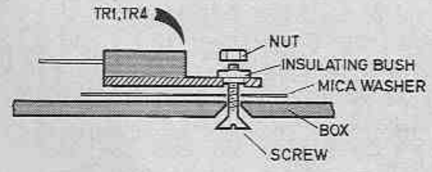
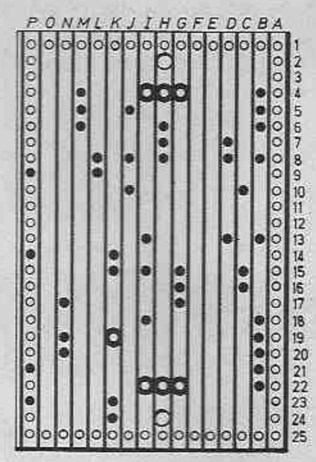
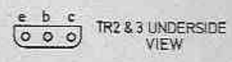
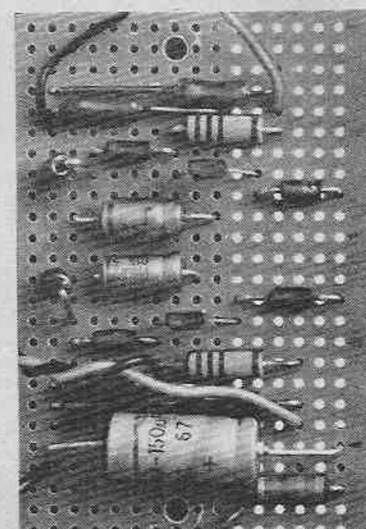


Fig. 4. Power transistor mounting details.







Photograph of the completed circuit board.

CONSTRUCTION starts here

COMPONENTS

See Shop Talk page 236

Resistors

R1 100Ω	R4 1·2kΩ	R7 220Ω
R2 220Ω	R5 33Ω	R8 100Ω
R3 220Ω	R6 1·2kΩ	R9 220Ω

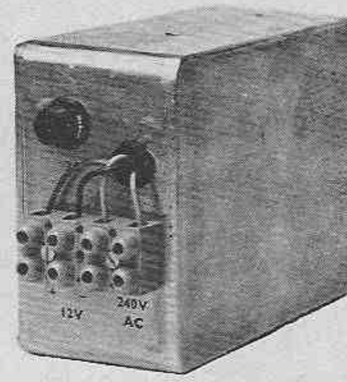
All ¼W carbon film ± 5%

Capacitors

C1 10μF 25V elect.
C2 150μF 16V elect.
C3 10μF 25V elect.

Semiconductors

TR1 TIP3055 silicon *npn*
TR2 ZTX550 silicon *pnp*
TR3 ZTX550 silicon *pnp*
TR4 TIP3055 silicon *npn*
D1 to D6 1N4001 silicon rectifier (6 off)



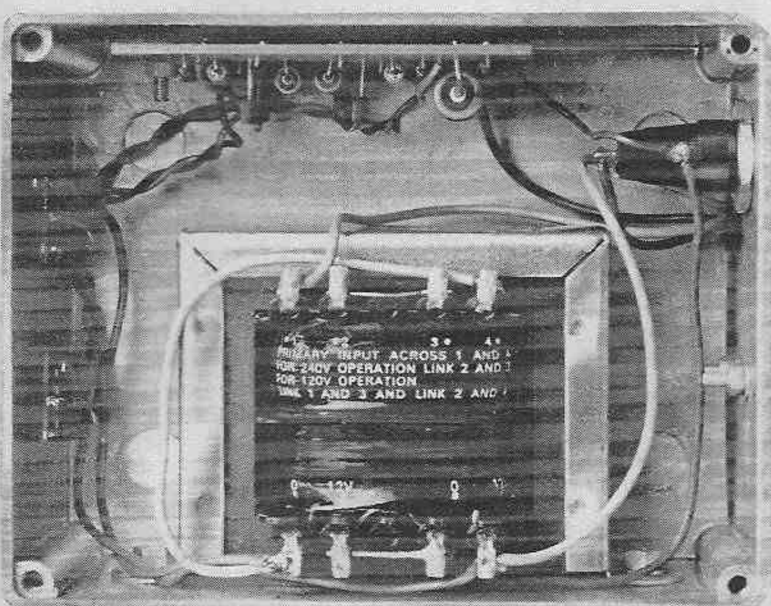
Miscellaneous

T1 Mains transformer, 0-20V, 0-20V 1·6A secondaries (RS type 207 144 or similar).
FS1 3A 20mm fuse.
Stripboard 0·1 inch matrix, 16 strips × 25 holes; diecast box 118 × 90 × 55mm or similar; panel mounting fuseholder for FS1; mica insulating kits for TR1 and TR4 (2 off); four-way 5A plastic connecting block; ¼ inch grommet; 4BA and 6BA hardware as required; connecting wire.

CONSTRUCTION

The unit is constructed in an aluminium diecast box with dimensions of 118×90×55mm, which provides both a rugged "drop proof" enclosure and also a heatsink for the output transistors. The box should be drilled taking particular care to remove any burrs from the transistor mounting holes.

Most of the components are mounted on a piece of 0·1 inch matrix stripboard having 16 strips by 25 holes. Take care to clip off all component leads as close to the board as possible as they may otherwise short to the box. All the components are standard readily available types and should not present any problems.



Internal view of the Shaver Inverter showing the relative positions of the components. Note how the component board is mounted using 6BA hardware. As a further safety measure to that already mentioned, some insulating tape can be stuck to the inside of the lid to prevent the tags of the transformer touching, and possibly causing a short circuit.

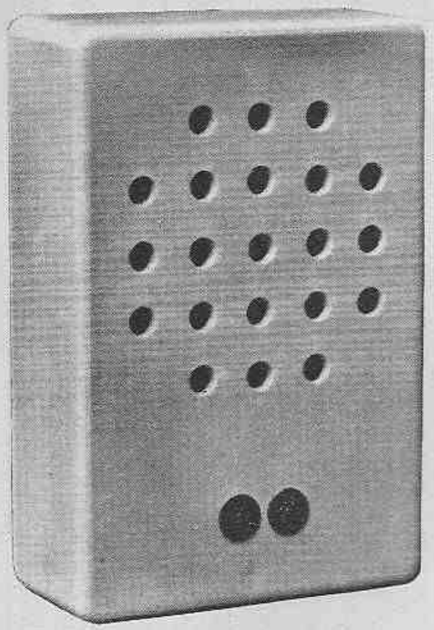
A full wiring diagram is shown in Fig.3. Note that the output transistors should be mounted with insulators and mica washers and that diodes D1 and D6 are connected directly between the collector and emitter of the output transistors. Mounting details for these transistors are shown in Fig.4.

The tags of the transformer come rather close to the lid of the box and so to avoid the possibility of shorts a small piece of insulating material should be glued inside the lid, over the transformer. The tags should also be bent down as far as possible.

IN USE

There is no connection between the circuit and the case, so the unit may be used with either positive or negative earth systems. When testing the unit initially it might be as well to reduce the fuse rating to 1 amp in case there has been a wiring error. If all seems to be in order the fuse can then be increased to 3 amps and the unit installed.

So now you no longer have an excuse to come home from holiday with a beard! ⌑



touch bleeper

BY T. J. HERKLOTS

IF YOU HAVE ever had the problem of trying to work when a child with the irritating habit of playing with and inevitably breaking the equipment on your workbench is present, this is the project for you. The author has found that it keeps most children quiet and occupied, the only problem being to get it back!

The Touch Bleeper is operated by means of a pair of touch contacts, a finger on the contacts produces a loud tone. The tone ceases when the finger is removed from the contacts. The device needs no mechanical on/off switch as the standing current is nearly negligable—a question of microamps—and so batteries should last a long time.

The unit could also be used for, say, a doorbell, or perhaps the audio stage of an alarm system, or even as a rain or moisture sensor. The applications are possibly endless.

CIRCUIT DESCRIPTION

The circuit for the Touch Bleeper is shown in Fig. 1 and can be conveniently separated into two sections: a touch switch and an oscillator.

The touch switch is basically a very high gain amplifier consisting of TR1 and TR2. To achieve very high gain, the Darlington pair configuration has been used. The total gain of this arrangement is approximately equal to the product of the individual gains of TR1 and TR2—a gain of at least 15,000.

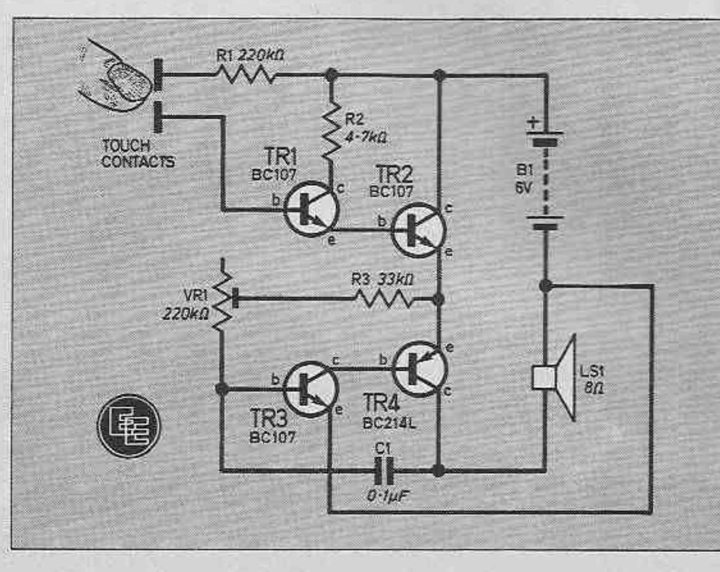
To turn on the device, a finger is placed across the touch contacts. This allows base current for TR1 to flow through the finger. Resistor R1 limits the base current of TR1 to about 21 microamps in the event of a dead short-circuit across the contacts.

The resistance of the finger across the touch contacts controls to an extent the purity of the note, as it controls the amount of base current to TR1. If a moist finger is used, the Darlington pair saturates and the note is clear. A dry finger produces a fuzzier tone.

The oscillator is a complementary pair relaxation oscillator comprising TR3 and TR4, which produces a squarewave at audio frequency. This type of oscillator must drive a low impedance loudspeaker, and if a speaker with a coil impedance above 15 ohms is used, the circuit may become unstable.

The circuit draws about 30 milliamps when the tone is being produced, so if another battery is substituted—the circuit will also work on 9 volts—be sure that it can supply this current.

Fig. 1. Complete circuit diagram for the Touch Bleeper.



COMPONENTS approximate cost £2.50

CONSTRUCTION starts here

The unit is constructed in a plastic case type PB1 with approximate dimensions of 114mm by 76mm by 38mm. It is recommended that this case be used, but another can be substituted providing it is no smaller than the dimensions given.

The case has a lid secured by two self-tapping screws. This is regarded as the base. The top is drilled with a pattern of 5mm holes to form an aperture for the speaker. The speaker can be glued in place behind the aperture with a strong glue such as Araldite.

Two plated drawing pins are used as the touch contacts. Two 1·5mm holes are drilled to accommodate the drawing pins, but the pins are not put in place yet.

STRIPBOARD

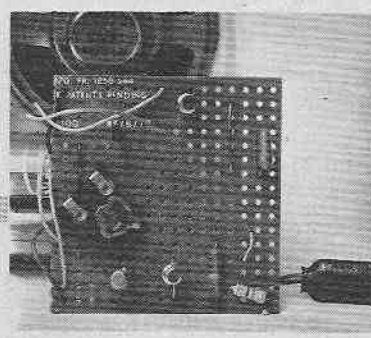
Most of the components, excluding the battery and the speaker, are mounted on a piece of 0·15-inch matrix stripboard 16 strips by 16 holes. This has to be cut from a larger piece of board. There is only one break in the copper strips as indicated in Fig. 2.

The two links should be soldered first, then the resistors, the capacitor and the four transistors. Keep all the components, including the transistors, as close to the circuit board as possible.

The battery leads can now be soldered to the circuit board, and the speaker leads connected similarly.

Next solder one end of each of the leads to the touch contacts (drawing pins) to the circuit board, and pass the other ends through their holes from the inside to the outside of the case. Solder the outside ends of the leads to the shaft of each drawing pin. Now the touch contacts can be pushed into their holes, and their shafts (with leads soldered on) bent flat against the inside of the case. A smear of Araldite can be used to secure them.

The battery, which consists simply of four HP7 cells in a battery holder, can now be connected to the battery clip, and the circuit tested by placing a finger on the touch contacts. A loud tone, which can be varied to some extent by turning VR1, should be heard. If this does not happen, check the wiring, or adjacent copper strips on the board which may be bridged by a blob of solder. If all is well however, the battery can now be put in place beside the speaker. A large blob of Blu-Tack is used to secure the battery in place. Another blob is put on the speaker magnet, and the circuit board with the components facing the front of the case, pushed firmly in place on top. The lid can now be secured with the screws supplied after which the unit is ready for use. ⌑



touch bleeper

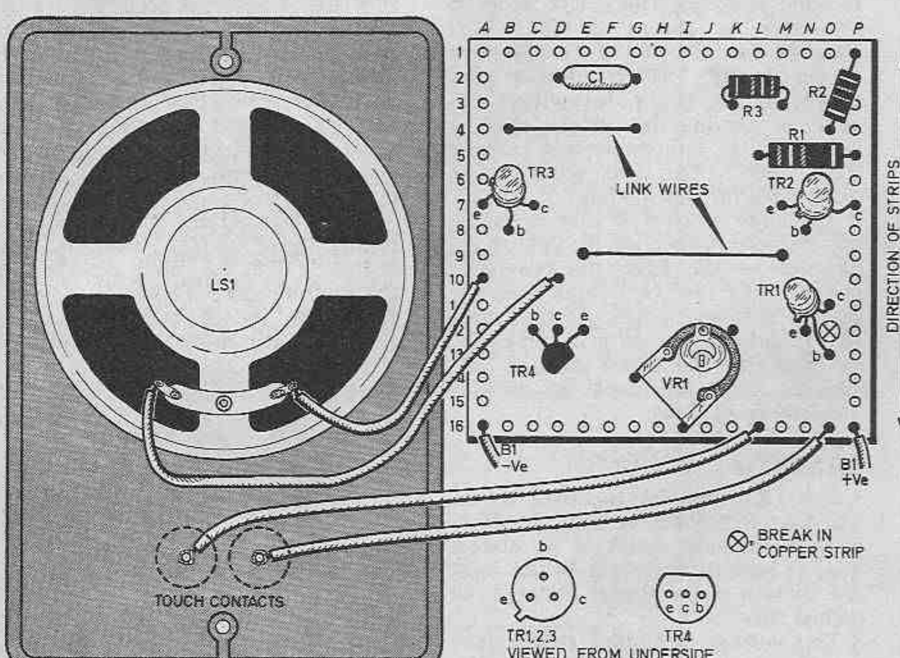


Fig. 2. Complete wiring details for the unit. There is only one break to be made, and is at O12. Resistor R3 is a vertically mounted component.

COMPONENTS

See Shop Talk page 236

Resistors
R1 220kΩ
R2 4·7kΩ
R3 33kΩ
All ¼W carbon ± 10%

Potentiometer
VR1 220kΩ standard horizontal preset

Capacitor
C1 0·1μF polyester

Semiconductors
TR1 BC107 silicon *npn*
TR2 BC107 silicon *npn*
TR3 BC107 silicon *npn*
TR4 BC214L silicon *pnp*

Miscellaneous
LS1 8 ohm 66mm diameter speaker
B1 6V battery (4 off HP7)
Stripboard, 0·15 inch matrix 16 strips by 16 holes; battery holder to suit four HP7 batteries; battery clip to suit holder; small plastic box type PB1, 114 × 76 × 38mm or similar (Maplin); two drawing pins for touch contacts; connecting wire.

DOING IT DIGITALLY

PART 7

By O. N. Bishop

Last month we showed a system for displaying the numbers 0 to 99. It counted pulses produced by the in-built clock. We can think of this system as being made up from a number of sub-systems, or *modules* connected together, see Fig. 7.1. Some of the modules (clock, latch) are built up from several logic gates and additional components. Other modules are complete and ready-assembled on a single i.c.

The switch and the display modules are different from the others because they connect the system to the outside world—we can call them *interface* modules. By means of these, information or data can enter or leave the system. If we look at digital systems in this way, it is much easier to understand what they do and how they operate *as systems,* even though we may not be entirely clear about how some of the individual modules work.

For example, we know that the 7447 receives four BCD inputs and gives seven outputs for driving the display, but we have never gone into any detail about the internal circuitry of this i.c. We have treated it as a *black box,* and this is all we need to do when designing digital systems.

From a few different kinds of module it is easy to design and build scores of different digital systems. The Test-Bed already has several useful built-in modules—clock, latch, bistable, counters, decoders, displays—and also now a keyboard module. With these and a few extra gates we can already build quite a number of digital systems. But before we go on to do this, we need a few more modules—particularly interfaces. Let us look at the circuits for these, and test them on the Test-Bed before building them into more elaborate systems.

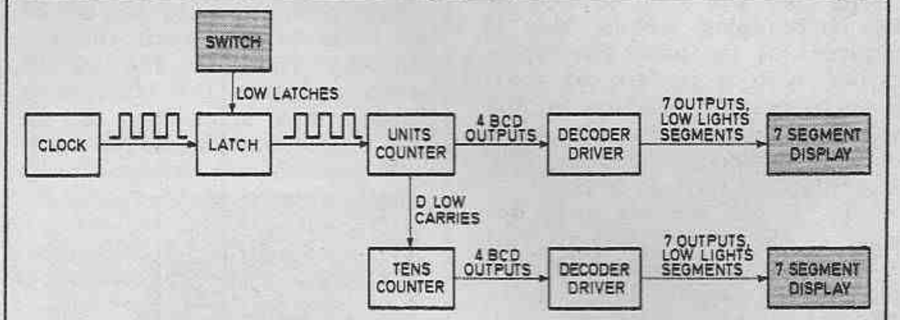


Fig. 7.1. System for counting numbers 0 to 99. Can be used as a random number generator. The tinted areas represent interface modules (see text).

LIGHT SENSOR

A light sensor interface module allows information about light intensity to be fed into a logical system. It detects whether light intensity is above or below a predetermined level and accordingly produces a high or low digital output that can be fed to other modules. The circuit for such a sensor is shown in Fig. 7.2a. Assembly details on the Test-Bed are shown in Fig. 7.2b. Its output goes to one of the l.e.d.s. Investigate the effect of varying the amount of light falling on the light-dependent resistor (l.d.r.) PCC1. Can you write out a truth table for this module?

The l.d.r. consists of a semiconductor material, cadmium disulphide. In darkness or low light, the resistance of the l.d.r. is very high, usually several thousand ohms. As the intensity of light falling on it is increased, its resistance decreases until, in full daylight, its resistance is only a hundred or so ohms.

POTENTIAL DIVIDER

The l.d.r. and R1 together act as a potential divider so that, in darkness, voltage at point *A* is almost V_{CC}, or logical "high". In bright light the voltage falls almost to zero, or logical "low".

This voltage is applied to the four inputs of a special type of NAND gate. Since all inputs are connected, it is acting as a NOT or INVERT gate in this circuit. This gate has the special feature that its output does not go high until the input has fallen below a certain level, called the *lower threshold level* see Fig. 7.3. Once this change-over has occurred, a slight *increase* of input voltage does not cause output to change back to its former state. Input voltage must rise as high as the *upper threshold level* before the output changes back to low again. The difference between upper and lower threshold levels is approximately 0·8 volts.

Small fluctuations in the rising or falling input voltage, such as those shown in Fig. 7.3, have no effect on the output. The result is a single clean-cut switch-over instead of several erratic changes of output.

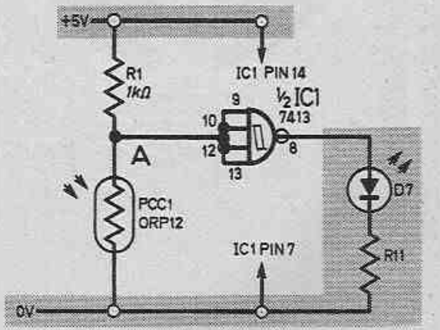


Fig. 7.2 (a). The circuit diagram for a Light Sensor.

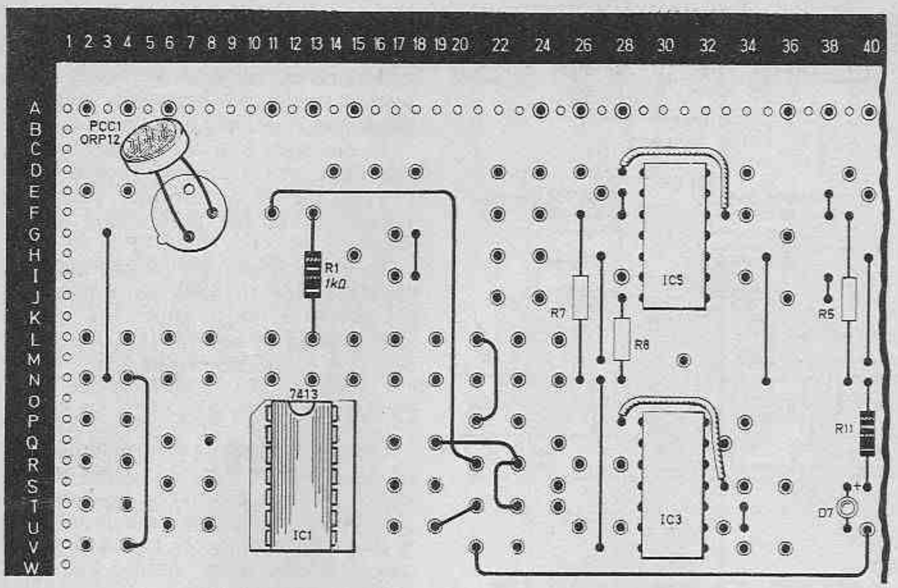


Fig. 7.2 (b). The circuit of Fig. 7.2 (a) wired up on the Test-Bed.

For example, imagine a cloud drifting across the Sun, causing an overall fall of light intensity followed by a rise. The ragged edge of the cloud would produce small fluctuations superimposed on the overall fall and rise; the corresponding voltage changes would be much like those in the figure. The output however would change sharply to high when the input voltage first reached the lower threshold, and would remain high until it eventually rose above the upper threshold level. A single, well-defined output pulse is the result. In general, this Schmitt trigger NAND gate (7413, pinning details in Fig. 7.4) is useful for producing clean-cut outputs from slowly-changing and irregularly shaped input waveforms.

The sensor circuit can be modified to suit requirements. As drawn, it produces low output with low light intensity. To reverse this action, the l.d.r. and resistor are interchanged. To alter the level at which triggering occurs, alter the value of R1. To allow triggering level to be set to a range of values, substitute a variable resistor for R1. Modified versions should be set up on the Test-Bed, tested and modified again if necessary until they perform in the required way.

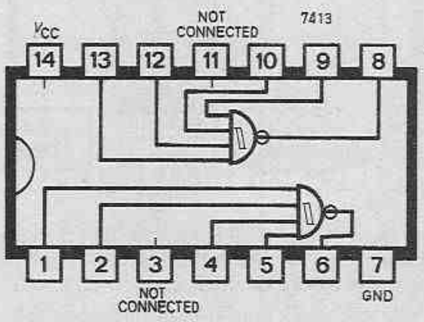


Fig. 7.4. Pinning details for the 7413 dual 4-input NAND Schmitt i.c.

LOUDSPEAKER MODULE

To obtain a louder sound than you get from the crystal earphone used earlier in this series for listening to audio-frequency trains of pulses, such as those obtained from the clock operating at high frequency, a loudspeaker module, Fig. 7.5a is required.

A loudspeaker module has obvious applications in warning and alarm systems. The input, taken from any TTL output, turns TR1 on or off as it goes high or low. This causes larger and intermittent current to flow through the loudspeaker, energising the coil intermittently, and so giving rise to an audible sound. Connect up this circuit on the Test-Bed and connect its input to one clock output, see Fig. 7.5b.

With the clock at low or medium frequency, a regular series of clicks will be heard as the clock output changes from low to high, and from high to low. When the clock is at high frequency the clicks come closer together, merging to give an audible note of approximately 450Hz.

Another interesting experiment is to feed the clock output to the input of one of the 7490 counters and then listen to the notes obtained when the loudspeaker module is wired to each of the counter output terminals in turn. In this instance the counter is acting as a frequency divider.

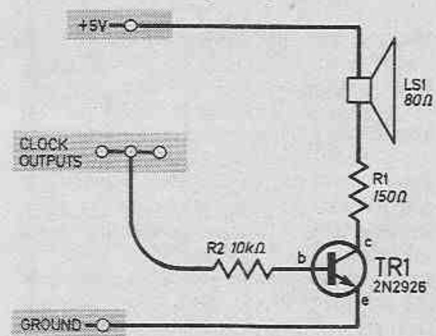


Fig. 7.5 (a). Circuit diagram of a Loudspeaker Module for increasing volume output when listening to a.f. pulse trains.

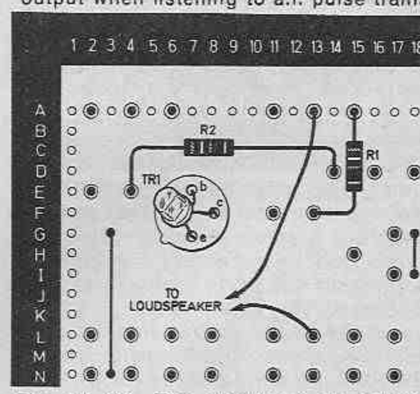


Fig. 7.5 (b). The circuit of Fig. 7.5 (a) wired up on the Test-Bed.

SOME USEFUL DIGITAL SYSTEMS

A few of the many systems that can be built up on the Test-Bed are shown in Fig. 7.6.

Study the diagrams and try to see how they work. Then connect the circuits on the Test-Bed—mainly a matter of joining together the modules already built-in to the Test-Bed—and study their action at first hand. You may think of ways of improving a system, of modifying it to suit your needs more exactly. If so, try it out on the Test-Bed until you get it right. When you have done this, you may prefer to build your system into a more permanent form.

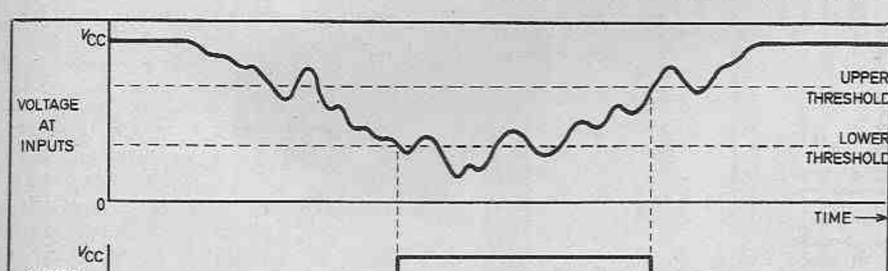


Fig. 7.3. Input (upper graph) and output (lower graph) of a Schmitt trigger NAND gate such as in the 7413.

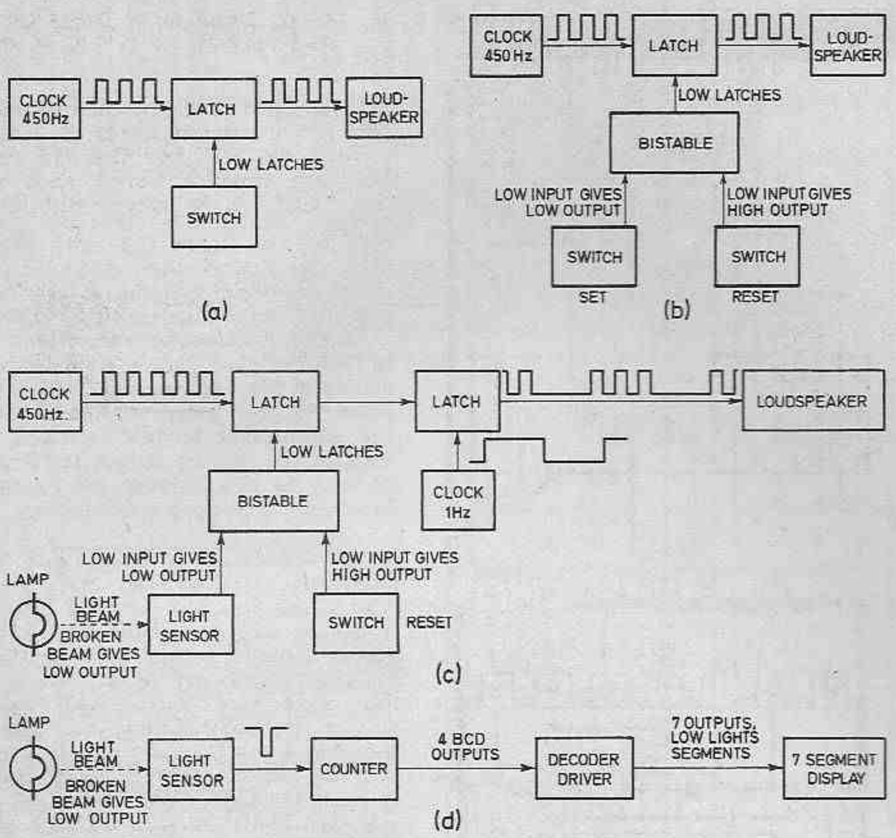


Fig. 7.6. Logical systems. (a) Morse practice buzzer (b) Alarm activated by SET switch (c) Light activated intruder alarm with intermittent tone (d) system for counting goods on a conveyer belt, or people passing thorough a doorway.

PERMANENT UNITS

If there are certain modules that you need to use often, it is worth while to assemble each of these on a separate piece of circuit board. Then you have convenient units which may quickly be connected with each other and to the Test-Bed when you are building logical systems. Also you have greater reliability for there is less chance of loose connections causing faulty operation.

Finally, by assembling some modules off-board, you clear space on the Test-Bed, allowing more room there for the more complicated systems that you may want to build.

Similarly, when you have worked out a complete system you may wish to keep this for future use; the whole system can be built up permanently on a separate circuit board, as described later.

The light sensor can be made into a self-contained module, in a case as shown in Fig. 7.7. If you are thinking of making several different modules it is a good idea to buy enough small cases to match. Each can then bear terminals in standard colours, for example red for V_{CC}, black for ground, green for inputs and yellow for outputs.

Connecting modules together, using leads terminated by 4mm plugs, is quick and relatively error-free.

To cut costs you may dispense with the case and terminal sockets, and use double-sided terminal pins, the lower half of the pins acting as leg stands.

To make it simpler to join modules together, try to keep to a standard layout of terminal pins: V_{CC} at top left, ground at bottom left, inputs on left side, outputs on right side.

COMPLETE SYSTEMS

Complete systems will usually best be built up on a single large circuit board. It is a good idea to make up the system in stages, one module at a time. Each stage is tested and put into working order before the next stage is tackled.

For example, in building a clock-driven numerical display (Fig. 7.1) for use in various games of chance or as a random-number generator, the first stage is to assemble the clock module on the Test-Bed. This is tested, particularly to check that the chosen capacitors produce the desired frequency of operation. The clock components are then transferred to their locations on the new circuit board, soldered in place with flying leads if required. This permanently wired module is then checked for correct functioning.

Next the switch and latch are connected on the Test-Bed, but fed by output from the permanently wired clock (remember to connect V_{CC} and ground terminals on the circuit board to the corresponding terminals on the Test-Bed. The latch is tested, then transferred to its location on the circuit board, permanently soldered, and permanently wired to clock.

Working in this way, each module is first assembled and tested on the Test-Bed, then transferred to the circuit board. Ultimately the complete

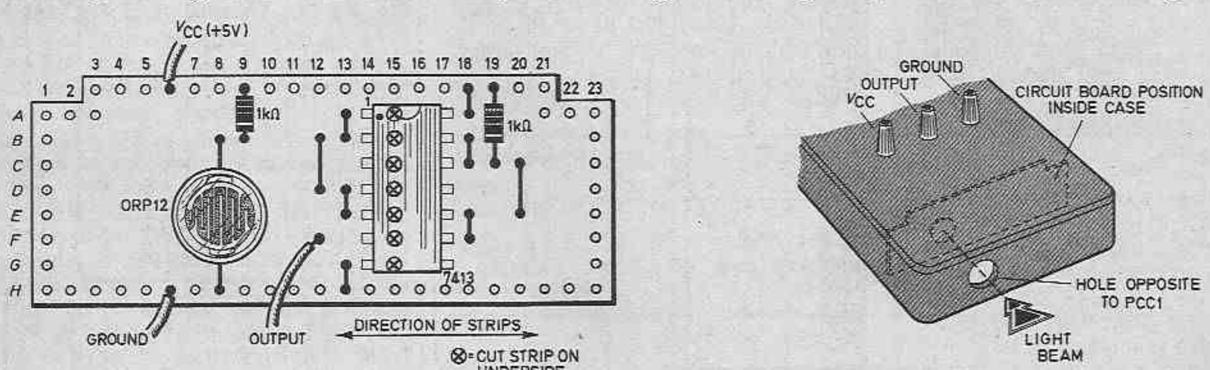


Fig. 7.7. Permanent version of the Light Sensor appearing in Fig. 7.2 (a) except that the first NAND gate is used instead (see Fig. 7.4). A pull-up resistor is connected between positive rail and gate 2 input to reduce power consumption of the unused gate. Instead, this gate could be wired to the output of the other gate (F13 to C19, omitting the 1 kilohm resistor at this point) giving an inverted output—high in darkness. Also shown is the board mounted in a plastic case with cut-out for incident light beam and fitted with screw terminals. The board is shaped and sized to fit in a Bimbox type 2003/13.

system is ready on the circuit board and in full working order. The board can then be cased, with control switches mounted on a panel.

DIGITAL DICE

We have used the 7490 counters to give BCD digits from 0 to 9, but for a dice we need digits from 1 to 6. The counter must be made to reset itself immediately it reaches the count of 7. Then it must reset to 1, and here is the problem, for the 7490 is designed to reset to 0 or to 9, but not to 1.

One solution to the problem is shown in Fig. 7.8a and wired up on the Test-Bed in Fig. 7.8b. It uses an i.c. we have not met before, the 7410, which contains three 3-input NAND gates, see Fig. 7.9 for pinning details.

If you are not sure what a 3-input NAND gate should do, investigate the action of one of these gates on the Test-Bed, before building the dice circuit. Work out its truth table.

As the clock runs, the flip-flop output Q alternates between high (1) and low (0). Whenever Q changes from high to low, the 7490 counter is advanced by one stage. The result is shown in table 7.1.

Table 7.1. Truth table for a digital dice.

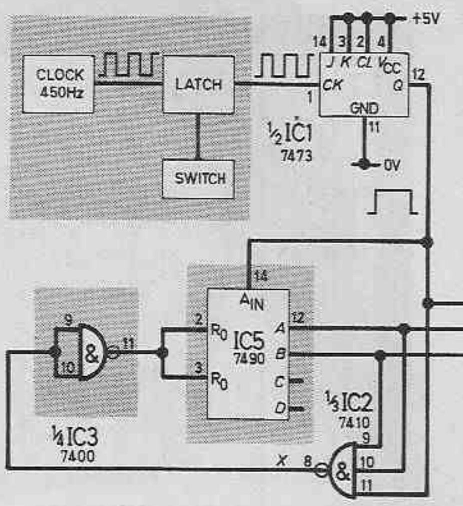
Counter outputs / Decoder inputs	7490 B ↓ C	7490 A ↓ B	7473 Q ↓ A	Equivalent decimal unit
	0	0	1	1
	0	1	0	2
	0	1	1	3
	1	0	0	4
	1	0	1	5
	1	1	0	6
Transitional stage, very short	1	1	1	7
	reset to 00			(not seen)
	0	0	1	1
	0	1	0	2
	. . . and so on			

When all three outputs are high, the NAND output goes low; this is inverted to high by the NOT gate, and so the counter is reset to zero. The 7473 output is *not* reset, but remains high, giving the decimal digit 1, as required.

If the clock is set to run at high frequency the display changes so rapidly that it is impossible to follow. By pressing the latch switch counting is in effect stopped at random. We have the digital equivalent of an unloaded cheat-proof dice.

This circuit is suitable for building into permanent form, powered by a 6 volt battery.

For clock and latch you need seven 2-input NAND gates, so two 7400s will provide these, with one gate to spare.



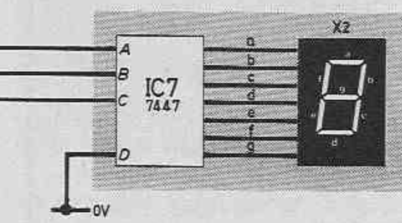


Fig. 7.8 (a). Circuit for a Digital Dice. The tinted systems are built-in on the Test-Bed.

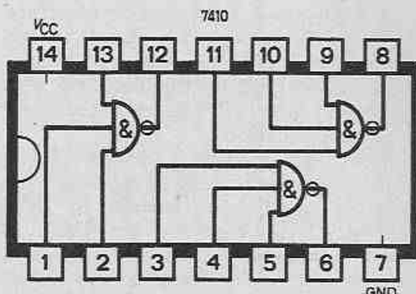


Fig. 7.9. Pinning details for the 7410, triple 3-input NAND gate i.c.

The spare gate can have its inputs wired together to make the required NOT gate. Yet there are still two spare gates in the 7410 and a spare flip-flop so why not extend the system and build a dual digital dice system, with two numerical displays? Many board games need two dice and also there are two-dice games, such as Craps, that can be played with this system.

It is essential that the two dice be independent (otherwise we shall "throw" nothing but doubles) but it is not necessary to build two completely separate systems. The second counting system can be driven from the output of the triple-input NAND gate of the first system. Its output goes low every time the first counter is reset, causing the second flip-flop to change state. The result is a sequence like this: 11, 12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26, 31, 32 . . . . . 64, 65, 66, 11, 12, and so on.

There are 36 steps in this sequence and all combinations of the numbers 1 to 6 occur once each. If the clock runs at 450Hz the sequence is repeated about 12 times each second, so that pressing the latch button is

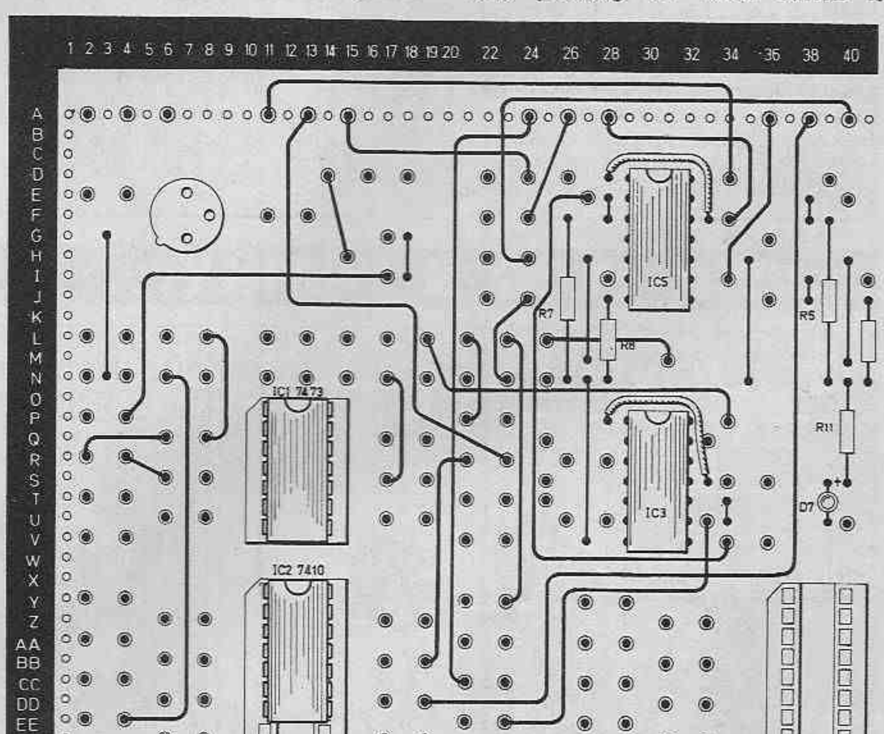


Fig. 7.8 (b). The circuit of Fig. 7.8 (a) wired up on the Test-Bed.

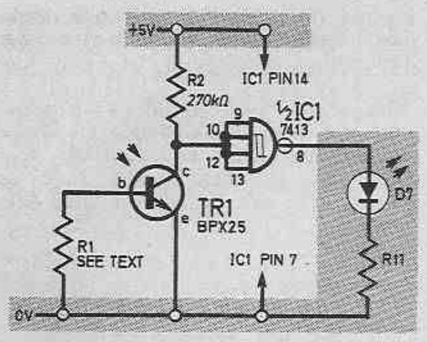


Fig. 7.10 (a). The circuit of a High Speed Light Sensor using a phototransistor which can respond rapidly to light intensity variations.

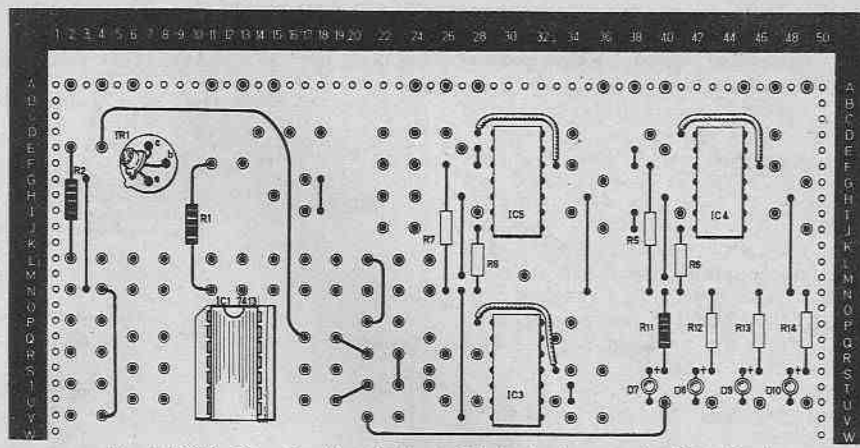


Fig. 7.10 (b). The circuitry of Fig. 7.10 (a) wired up on the Test-Bed.

equivalent to throwing two dice independently.

The Double Digital Dice system can be built on the Test-Bed, and if desired transferred to a circuit board as a permanently wired unit. Table 7.2 lists the i.c.s required for each version, and the allocation of gates.

Thus the permanent version needs only two 7400s, a 7410, a 7473 and the counters and decoders—a total of eight i.c.s.

The system diagram is like that of Fig. 7.8 with a second complete counting module (7473 + 7490 + 3-input NAND gate + NOT gate) and display module, wired as in Fig. 7.8 and joined to point *X*.

HIGH-SPEED LIGHT SENSOR

A high-speed light sensor interface module completes this month's collection of modules, see Fig. 7.10a. This can be built on the Test-Bed, Fig. 7.10b and later, if required, made into a permanent unit.

The light-sensitive device is a phototransistor. This responds extremely rapidly to changes in light intensity. By contrast an l.d.r. is slow; it takes several seconds or even minutes to *fully* respond to large changes of intensity and while its response rate is adequate for many purposes it will fail to respond when a small object passes rapidly through a light beam—even though the object may be just large enough to obscure the whole beam for an instant.

The light level at which the output of the module changes state can be set by choosing an appropriate value for R1. If R1 is 10 megohms the module is triggered by twilight levels. For triggering in daylight or bright indoor light, make R1 100 kilohms. Alternatively, a 2 megohm variable resistor can be used and allows adjustment of triggering level over a wide range.

In the version of Fig. 7.10 the output goes low as light intensity falls below the triggering level. Because the phototransistor has a rapid response and provided that the objects to be detected are reasonably sharp in outline, the Schmitt gate *can* be omitted; the output then comes directly from the collector terminal of TR1, and goes low as light intensity rises above the triggering level. Test both versions on the Test-Bed to see which meets your requirements.

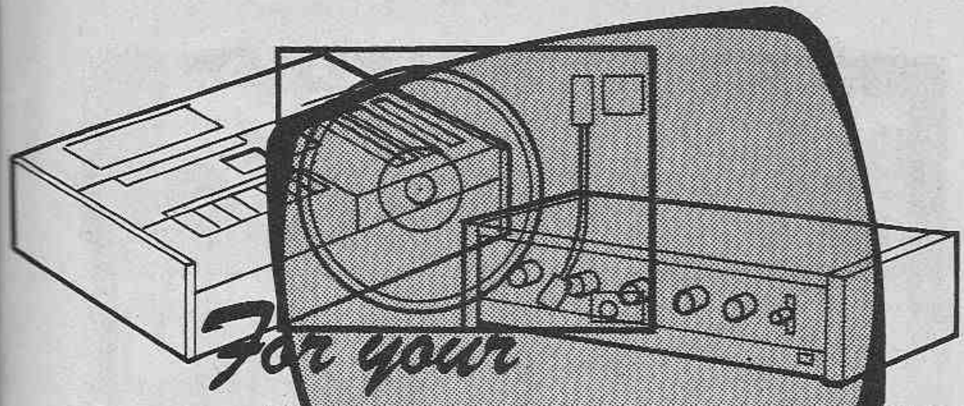
To be continued

Table 7.2. Requirements for the Double Dice on the Test-Bed and in permanent form on circuit board.

		Gate and i.c.	
Function	Requirements	Test-Bed	Permanent version
Clock	2 NAND gates	Built in clock	½ 7400
Latch	5 NAND gates	Built in latch	1 7400 plus one gate from 7410
Flip-flops	2 flip-flops	1 7473	1 7473
3-input NAND	2 gates	1 7410	⅔ 7410
NOT	2 gates	Built in NOT and NAND	½ 7400
Counters	2 7490	Built-in 7490s	2 7490
Decoder/drivers	2 7447	Built-in 7447s	2 7447
Displays	2 displays	Built-in displays	2 displays

JACK PLUG & FAMILY...

BY DOUG BAKER



For your ENTERTAINMENT

By ADRIAN HOPE

Magnetic Coding

Within a few years, keys, as we now know them, could be obsolete. Our future keys will look like credit cards.

The secret lies in magnetic coding. Already some banks are coating cash cards with magnetic material, into which there is permanently encoded an identifying word which "belongs" to the user. When the card is fed into a machine it "unlocks" circuitry which enables the release of ready cash per the customer's instructions.

To ensure that a lost card cannot be used without authority, the rightful owner must key into the cash machine a secret number which matches the number coded magnetically onto the card.

Just The Ticket

Many stations on the London underground already issue tickets which carry a magnetic code and so enable the owner to pass through a magnetically triggered entry turnstyle. This system will only offer a real advantage when, as planned for the future, machines are installed which can read the code on a ticket when it is presented by a passenger *leaving* the station. The turnstyle will only open if the ticket carries a code denoting the correct fare for the journey which the passenger has made.

The Paris Metro is already highly automated in this respect but has the advantage that all journeys cost the same. There is thus no need for the French turnstyles to read the value of the ticket at the end of a journey and compare the fare paid with the distance travelled.

The French have built a very clever facility into their ticket system. It is possible now to buy a so-called "orange card" ticket which for a once and for all cost gives unlimited travel on the Metro for one month. The ticket is magnetically coded with an instruction which renders it useless after one month has expired. Also, the magnetic decoder in the turnstyle is programmed to reject the same ticket if it is presented twice within six minutes. This prevents the owner of an orange card going through the turnstyle and handing the ticket over to a friend for free access.

I asked London Transport whether the system adopted for the London Underground had the facility to upgrade in this fashion. In fact, I asked London Transport twice, and in each case they stalled and never came back with a reply. The inference is that the British magnetic tube ticket system can't be upgraded to such sophistication.

Indeed, recently London Transport were reported as having finally found a way of defeating ticket cheats who pass the same magnetic yellow ticket through the turnstyle more than once. To prevent this LT are now fitting magnetic rollers to the turnstyles which prevent the re-use of a ticket by wiping off its magnetic coding after one use.

The plan is to equip all automatic turnstyles with this solution to the fare dodging problem. But once the turnstyles have been fitted with magnetic "bulk" erase rollers there will presumably be no possibility of LT adopting a season ticket system similar to the French, because, of course, such a season ticket must by definition remain permanently magnetized with fare dodging blocked by code recognition and timer circuits inside the turnstyle.

What a pity London Transport didn't think things through more carefully before starting to install the present system, with which London tube goers are now stuck for many years to come.

Combination Key

The use of a magnetic card as a key is, of course, a logical extension of the use of a magnetic card to trigger the supply of cash or let people on or off a transport system. The British company Tann Synchronome Ltd. has made some enterprising steps in this logical direction.

The basic Tann system (which costs less than £500) centres round a door lock which can be opened only when the correct magnetically coded card is pushed through a letter box slot. The advantage is that you can't pick a magnetic lock like an ordinary key lock and there is no way that a potential burglar can get a duplicate magnetic card key cut at the hardware store.

A more sophisticated system has a calculator style keyboard on the lock and requires the user to punch in a memorised code number that matches the number invisibly coded on the card. This obviously increases security even further. With such systems the individual locks can all be hooked to a central computer and give an instant readout of who has passed through which lock position with their card and so on.

Perhaps one day, if all the obvious bureaucratic obstacles don't prove insuperable, we shall carry around just one card in our pocket that can be used as a door key, a cash card, a credit card and an identification card carrying coded information on name, address, blood group and allergies.

Government Warning

Although it didn't attract much publicity the government recently put out a sobering safety warning on some of the exotic domestic lighting gadgetry which is now in many shops and homes.

One visually impressive beast is a liquid filled lamp which contains fragments of metal foil; these circulate in the liquid and glitter when the lamp is switched on and gets hot. The fluid used in these lamps is a chlorinated hydrocarbon, for instance trichloroethylene, trichloromethane or perchlorethylene.

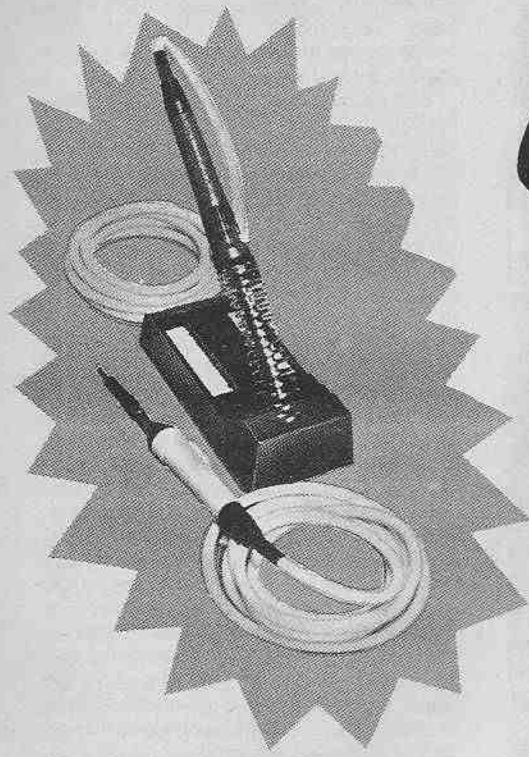
These liquids, similar to dry cleaning fluids, evaporate very quickly on exposure to air. Indeed it's this characteristic that makes a sealed volume of the liquid so active. But the fumes, like those that sometimes leak out of faulty dry cleaning machines, are decidedly unpleasant and can quite literally anaesthetize someone who inhales them.

The Government is thus warning that anyone who uses a lamp of this type should be ready to open all doors and windows and clear the room if ever it is shattered. Users could also be in danger from using too strong a bulb because anything other than a 40 watt bulb may produce enough heat to drive some of the liquid out of the screw-cap vapour seal.

Anyone tempted to make a DIY exotic lamp of this type should be very well aware of these dangers.

FREE ENTRY Competition

25 ANTEX SOLDERING KITS & IRONS TO BE WON



★ **FIRST PRIZE**—A special soldering kit containing TWO soldering irons, TWO stands, SIX iron-coated bits, solder and a heatsink.

PLUS

★ **SIX**—CX or X25 soldering irons plus stands.

★ **EIGHTEEN**—CX or X25 soldering irons.

The most ESSENTIAL tool for the constructor of electronic circuits is undoubtedly a soldering iron, since the majority of electrical connections are made by means of a soldered joint.

In view of this, we have arranged with **Antex Limited**, the well known manufacturers of soldering irons, a FREE entry competition in which a grand total of TWENTY-FIVE prizes may be won which feature two mains powered irons from the Antex range, the miniature 17 watt CX and the general purpose 25 watt X25.

HOW TO ENTER

Listed below are 8 aspects of soldering any or all of which are important in getting good results. How do you rate them for getting the very best results?

Write the key letters of the eight aspects—in ink, pen or ballpen—in order of choice in the spaces on your entry coupon. For example if you consider that "Correct bit size" is of paramount importance put D in the first space, the letter of your next choice goes against 2nd, and so for all eight. Complete the coupon with your own full name and address and post in a sealed envelope to EVERYDAY ELECTRONICS, ANTEX COMPETITION, 55 EWER STREET, LONDON SE99 6YP, to arrive not later than Monday, 30th April, 1979, the closing date. Don't forget to indicate your choice of iron on coupon.

HOW DO YOU RATE THESE ASPECTS OF SOLDERING?

- **A** Adequate iron wattage
- **B** Good mechanical joint
- **C** Well-tinned bit
- **D** Correct bit size
- **E** Clean contact surfaces
- **J** Flux-cored solder
- **K** Correct bit temperature
- **L** Execution time

FREE ENTRY COUPON

Please post to:
EVERYDAY ELECTRONICS, ANTEX COMPETITION,
55 EWER STREET, LONDON SE99 6YP

My order of importance for the eight aspects of soldering is listed on the right. In entering the competition, I agree to the rules as final and legally binding.

NAME ....
(Mr/Mrs/Miss)

ADDRESS ....
(Block letters)

....

....

Closing date for entries: Monday, April 30, 1979.

1st	
2nd	
3rd	
4th	
5th	
6th	
7th	
8th	

MY CHOICE
CX ☐ X25 ☐

CUT ALONG THIS LINE

IMPORTANT

Before sealing, copy out—on the outside back of the envelope—the key letters of the eight aspects in exactly the same order as they appear on your completed coupon. Do not enclose any correspondence or matter other than the coupon.

RULES

There is no entry fee but each attempt must be on a proper entry coupon cut from EVERYDAY ELECTRONICS and must bear the entrant's own name and address.

All accepted entries will be examined and the judges will award the first prize to the entrant they consider has shown the most skill and judgement in placing the eight aspects of soldering in their best order of importance. Remaining prizes will be awarded for next best entries in order of merit, and no entrant may win more than one award.

In the event of a tie for any prize(s) those tying will take part in an eliminating contest, to be held by post, to determine such winner(s) or winning order.

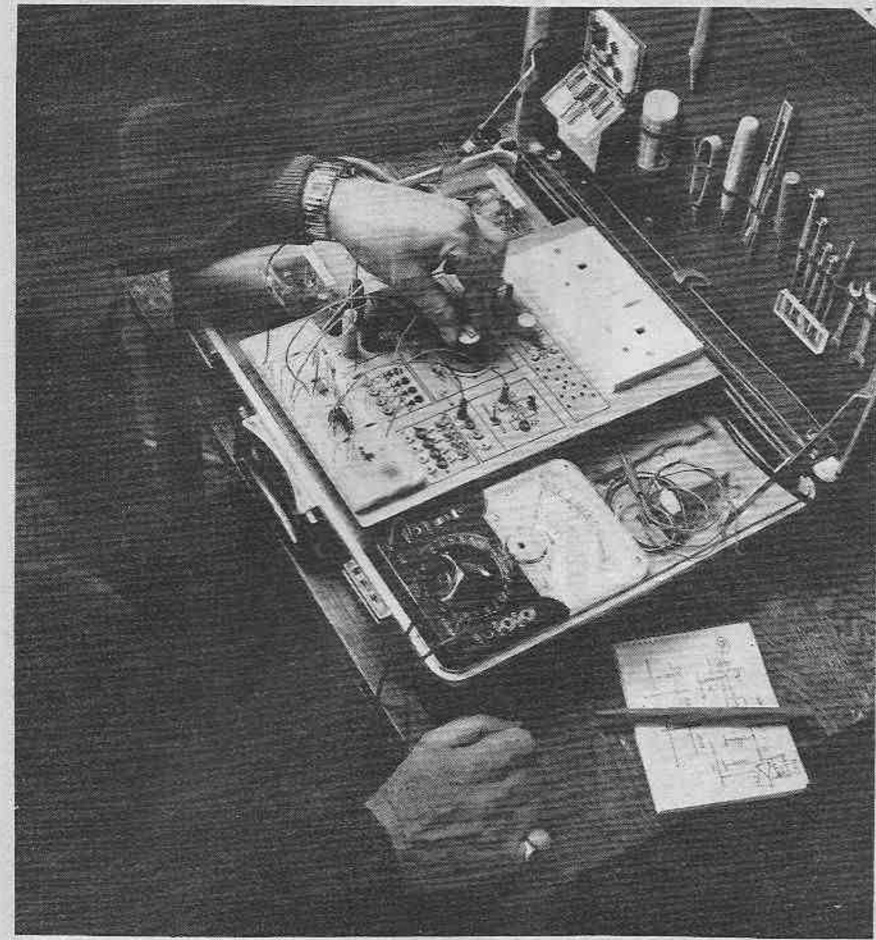
Entries arriving after the closing date or received incomplete, illegible, mutilated or altered or not complying with the instructions and rules exactly will be disqualified. No responsibility can be taken for entries lost or delayed in the post or otherwise.

Decisions of the judges and of the Editor in all other matters affecting the competition will be final and legally binding. No correspondence will be entered into.

The competition is open to all readers in the UK and Eire other than employees (and their families) of IPC Magazines Ltd., the printers of EVERYDAY ELECTRONICS and of Antex Ltd.

Winners will be notified and the result will be published later in EVERYDAY ELECTRONICS.

LAB CENTRE



PART 2

By R. W. Coles and B. Cullen

THE use of a printed circuit board makes the assembly of Labcentre quite straightforward. The circuit board used carries all of the active components, including the voltage regulators, and the only wiring which must be carried out by hand is the connection of front panel controls and the mains transformer connections.

The mains and transformer wiring requires attention to safety precautions for obvious reasons, but is otherwise quite straightforward. The front panel wiring on the other hand, is quite complex because of the sheer number of connections required. It is therefore necessary to take particular care over these interconnections so as to avoid mistakes and also to produce a neat appearance.

The wiring should be formed into looms, either by using traditional techniques (knotted looming string as employed in the prototype), or the now popular plastic ties or Spiralwrap.

Three versions of the Labcentre prototype have been built during development, and virtually no trouble has been experienced with leakage and/or crosstalk in the front panel wiring. Even so, it is advisable to be on the lookout for this sort of effect when your own wiring looms have been assembled.

A cure for any loom-induced crosstalk of instability can probably be effected by altering the routing of any sensitive wires. It is expected that the wiring to the Audio Amplifier and the Function Generator to be most at risk from this sort of problem, although in the prototypes no re-arrangement of loom connections or recourse to screened wire was ever found to be necessary.

Construction of the case and other hardware may be easy or difficult, depending on your own facilities and expertise. Every effort has been made to keep case construction as simple as possible, where this has been consistent with the production of a professional looking and versatile piece of laboratory equipment. Some further simplification can optionally be achieved by those with limited facilities, by dispensing with the component drawer in the main console.

The appearance of the prototype has attracted a good deal of favourable comment, and it is therefore felt that the results achieved have fully justified the small degree of extra care required during the painting and labelling of the front panel.

PRINTED CIRCUIT BOARD

All the principal components of Labcentre apart from the mains transformers and front panel controls, are mounted on a single Fibreglass printed circuit board measuring 12cm by 22cm. A full-size master pattern is shown in Fig. 2.1. The black regions are the copper areas to remain after etching.

For those not wishing to become involved in the manufacture of the board, this is available ready made, roller tinned and drilled from C. C. Consultants, whose address appeared in *Shop Talk* last month.

It can also be produced at home by readers with the proper facilities. The circuit board layout requires the accurate registration of several integrated circuit packages and the drilling of a large number of holes of three different sizes and therefore home production cannot be recommended for beginners in this field.

For those who are past-masters at the gentle art of board-etch, or those who feel that they can economise with a home-brew board, the following instructions are offered as a guide.

(1) Use Fibreglass board of good quality, s.r.b.p. is not suitable.
(2) Adhere to the published layout and the track widths as shown.
(3) Don't try to lay out your board using only an etch resist pen or a paint brush.
(4) Use etch resist transfers (or a photographic technique if you have the facilities).

If you can comply with the above requirements, then you are ready to start.

MAKING THE P.C.B.

Cut your copper-clad Fibreglass board to size and trim the edges. After cleaning the board well to remove dirt and grease, use the master as a guide to mark some critical registration points on the copper using the point of a pair of compasses or a similar implement. By critical registration points we mean, for example, the corner pins of an i.c. package or the mounting holes for the regulators. Readers should use their own judgement as to how many such points should be used, possibly all hole positions.

Points can be marked all at once, or a fraction of the board can be done and transfers applied, before moving on.

The next step is to apply the transfers, and here a great deal of care is necessary. It should be possible to lay out the complete board using only five sheets of transfers. You will need one sheet of 16-pin d.i.l. pads, two sheets of circular pads (in two sizes) and two sheets of circuit tracks (in two widths).

The larger track widths and the large copper areas can be filled in with an etch resist pen after the transfers have been applied.

There are now several types of etch resistant transfers on the market and most of these would be suitable.

ETCHING

The board is now ready for the etch bath, and a suitable solution should be prepared from ferric chloride crystals, following the suppliers instructions. A glass or plastic tray can be used for the bath, and the board should be left in the solution, with occasional agitation, until all the exposed copper has been removed.

When the etch is complete, the board should be carefully removed from the bath using tweezers and sluiced with cold water to remove any remaining ferric chloride solution. The transfers and ink-resist can be removed with wire wool or a household abrasive cleaner to reveal the bright copper underneath. We find it a good idea at this stage to coat the board with an aerosol cleaning fluid such as WD40. A coating of this sort helps prevent surface tarnish and makes soldering easier later.

Drilling the board is a tedious job if you don't have access to a printed circuit board drilling machine, but it *must* be carried out with great care or you may find that your integrated circuit packages will not fit!

Remember, if you have any doubts about making the Labcentre printed

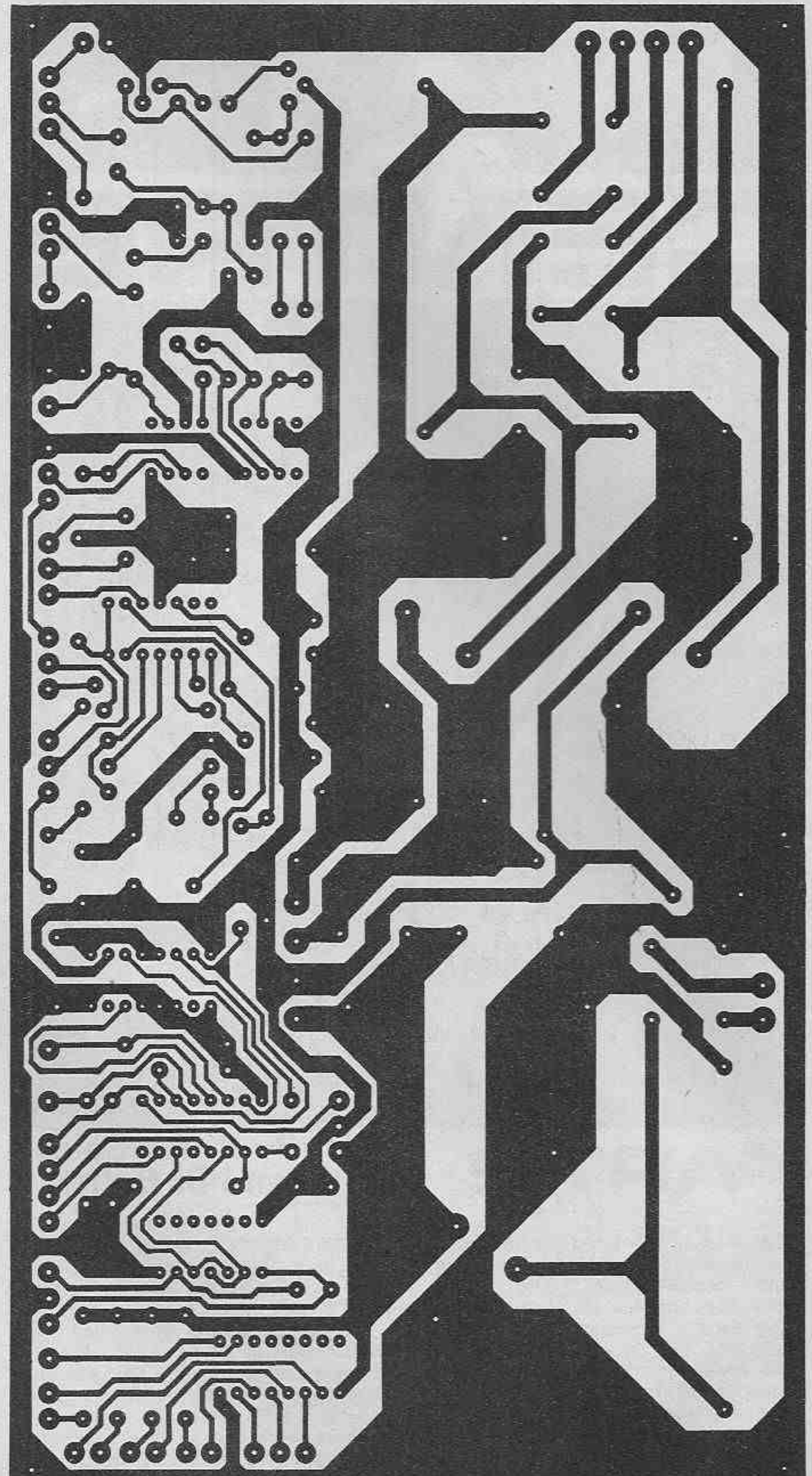


Fig. 2.1. The full-size master of the printed circuit pattern viewed from the copper side of the board. The black regions are the areas of copper to remain after etching.

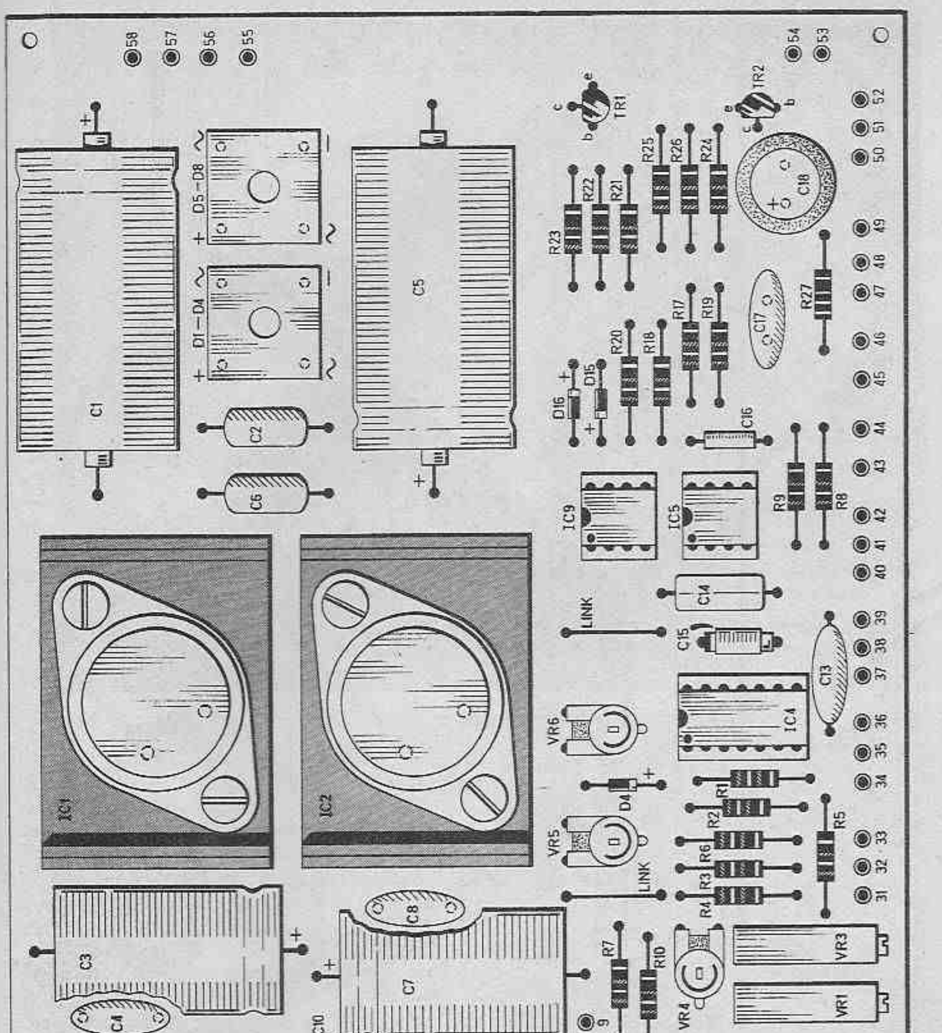
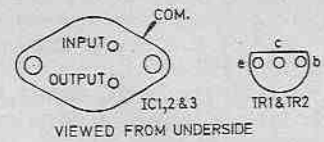


Fig. 2.2 The layout of the components on the top side of the p.c.b. It is important that the heatsinks of IC1 and IC2 do not touch. All connections to the p.c.b. are made at terminal pins numbered 1 to 58. (Semiconductor pin-details are shown top right.)



circuit board, it would be wise to purchase a ready made designer approved board. It could be cheaper in the long run!

MOUNTING PCB COMPONENTS

Construction can begin in earnest with the assembly of the components on the completed p.c.b. The complete layout of the components on the board is shown in Fig. 2.2.

Begin by mounting the i.c. voltage regulators (IC1, 2 and 3) and their associated heatsinks. Care should be taken to ensure a good fit between the heatsink and the i.c. package, and the use of silicon grease or other thermal compound is highly recommended to ensure efficient heat transfer. No mica washers or insulating bushes are necessary, providing that the heatsinks do not touch each other. This is particularly important with IC1 and IC2, since their packages are at different potentials.

Care must be exercised when tightening the regulator securing bolts, to avoid cracking the circuit board. Nylon nuts and bolts could be used to advantage in this position.

CONNECTING PINS

Terminal pins are best for "off-board" connections, because they make disconnection and reconnection easier if it ever becomes necessary. If you plan to use these pins, now is the time to solder them in. After the terminal pins, the power supply components, capacitors and bridge rectifiers and then the i.c. sockets can be soldered in. You don't have to use i.c. sockets of course, but once again we would strongly recommend their use because they make device replacement and test so easy. If you *don't* use sockets, leave the i.c.s until last anyway. When all the sockets have been soldered in, check very carefully between their pins to ensure that no "solder-bridges" have occurred.

Now you can apply all the smaller components, resistors first, followed by the wire links, capacitors, and preset potentiometers. You may experience some trouble with the leads of the skeleton presets being too large for the p.c.b. holes. This can be cured by suitably enlarging the holes or trimming the lead thickness with sharp wire cutters or a file.

The audio output transistors should be positioned very carefully in accordance with Fig. 2.2. The hole positions may seem awkward, depending on the type of transistor package you use, and so confirmation from the layout diagram and/or the circuit diagram should be sought.

At this point the board should be checked very carefully for inadvertent short circuits and open circuits, and also for correct component orientation. It is quite safe to plug the integrated circuits into their sockets, but care must be exercised with the CMOS logic parts to avoid damage from static discharge. Safety is assured if:

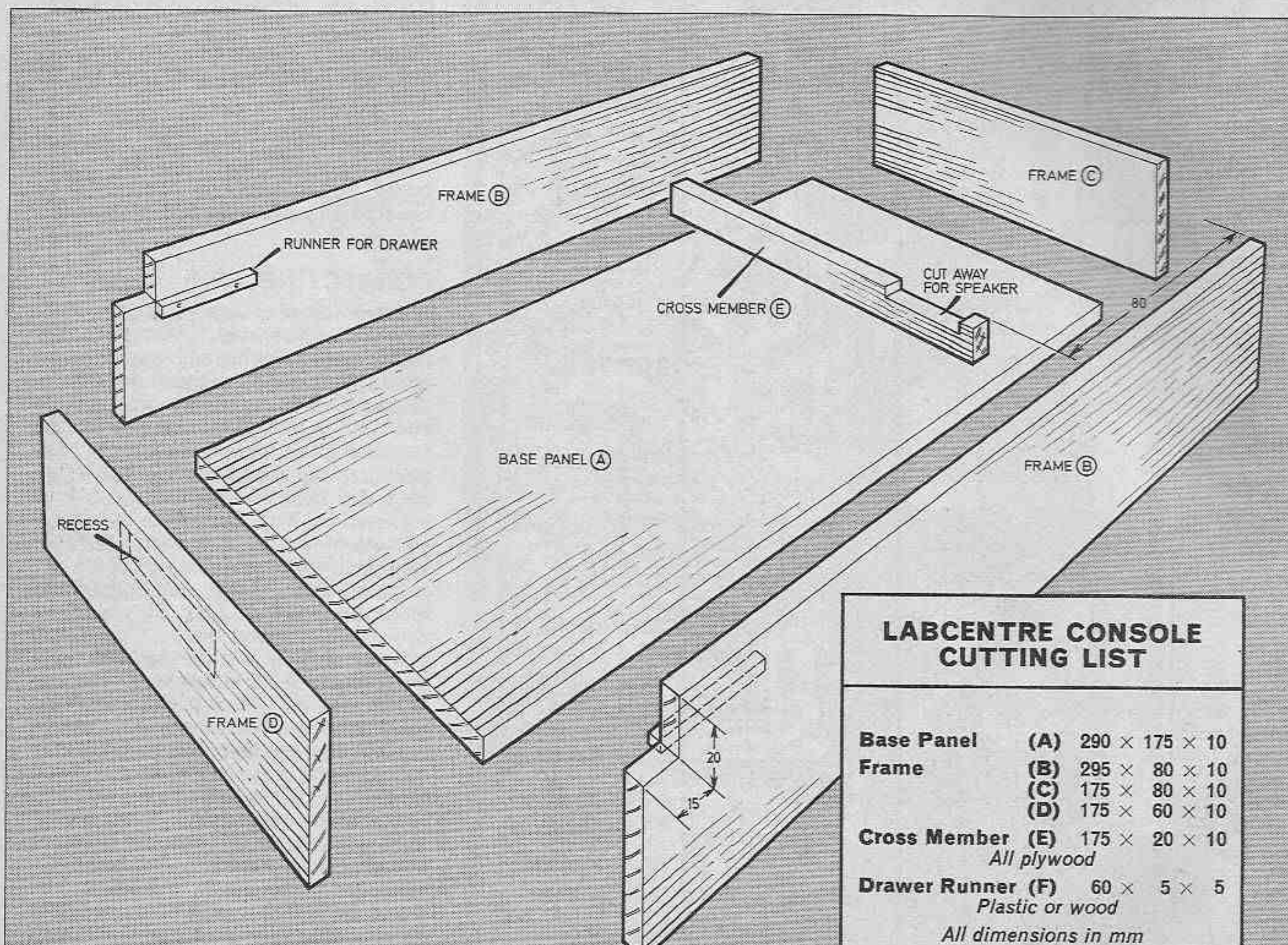
(1) You do not work in an area with nylon carpets.

(2) You keep the CMOS devices on their conductive foam or foil until the last minute.

(3) You make sure you, the circuit board and the CMOS circuits are all at the same potential by doing your assembly on an earthed metal, or other conductive surface. (A large baking sheet or roasting tin is ideal!)

(4) You keep i.c. handling to an absolute minimum.

Photograph of the completed console removed from briefcase.



LABCENTRE CONSOLE CUTTING LIST

Base Panel	**(A)**	290 × 175 × 10
Frame	**(B)**	295 × 80 × 10
	(C)	175 × 80 × 10
	(D)	175 × 60 × 10
Cross Member	**(E)**	175 × 20 × 10
All plywood		
Drawer Runner	**(F)**	60 × 5 × 5
Plastic or wood		

All dimensions in mm

Fig. 2.3. Exploded view of the woodwork construction of the Console with a component drawer.

(5) If you are soldering your i.c.s in directly, you must remember to discharge your soldering iron bit to the conductive surface before each joint.

Following the above procedures will guarantee success, but CMOS devices are not as fragile as they sound, so don't assume you have ruined an i.c. just because you accidentally break one or more of the rules, chances are you will get away with it! But who wants to risk valuable i.c.s?

When assembly is complete, the board can be set aside. If you can't wait it is possible to test the board at this stage, with the aid of external d.c. supplies and a temporary control hook-up. You will need two unregulated 20 volt a.c. or d.c. supplies, which can be connected (either way round) to the a.c. terminals on the bridge rectifiers D1 to D4 and D5 to D8 and a similar 10 volt a.c. or d.c. supply to connect to the a.c. terminals on D9 to D12 (again, either way round).

CONSOLE CONSTRUCTION

The next stage of construction concerns the frame which forms the sides of the console. Cut all pieces as accurately as possible to the dimensions given in Fig. 2.3, keeping the edges square and sanding to a smooth finish. The side frame should be pinned and glued using a woodworking adhesive such as Resin-W, keeping the assembly square.

When the sides have dried properly, use the *inside* edges of the frame as a template to mark out the base. Cut the base to size and sand to a smooth finish, then drill the four screw holes in the two longer sides of the frame. These will be used to secure the base to the sides.

The finishing and attachement of the cross member should be left until the front panel has been cut to size.

FRONT PANEL

The overall size and drilling details of the front panel are shown in Fig. 2.4. Scribe out the shape of the front panel and the hole drilling centres on a sheet of 1·5mm aluminium and then cut this out with a nibbling tool such as Goscut or metalwork shears. At this stage the panel/frame fixing holes can be drilled and the panel screwed to the frame before final filing and sanding to achieve a perfect fit. Next remove the front panel and carry out the drilling for the terminals and controls. The larger cut-outs can be made with further use of the nibbling tool or by drilling multiple holes around the edges and then filing smooth and to size. It is advisable to ensure that all your front panel components are compatible with the given layout *before* drilling takes place because there is room for manoeuvre, and non-specified components can be used if the panel layout is re-designed before drilling. In any event, hole sizes should be checked for compatibility, even if your components are superficially the same as those on the prototype.

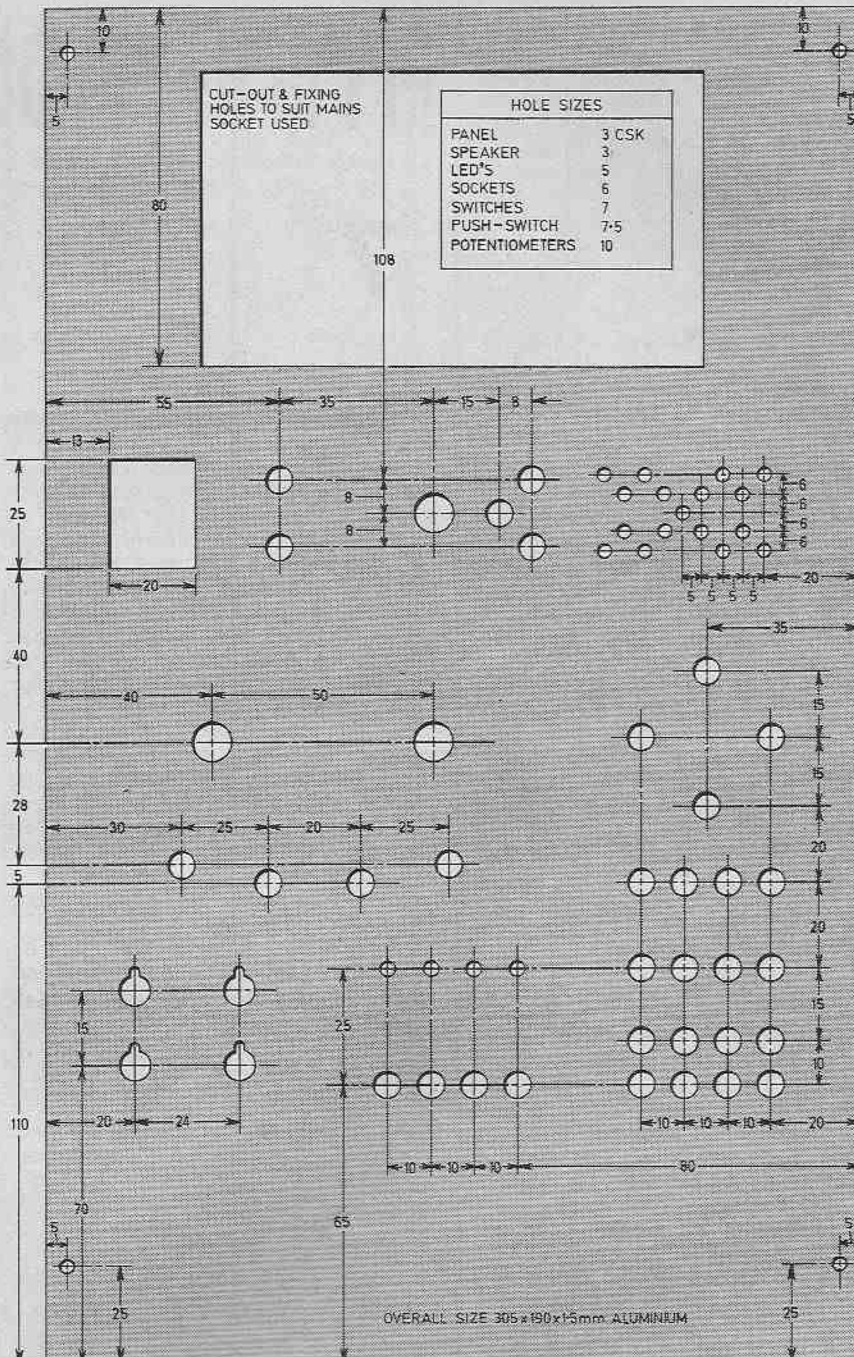


Fig. 2.4 Complete drilling details for the top panel of the Console. Dimensions in mm.

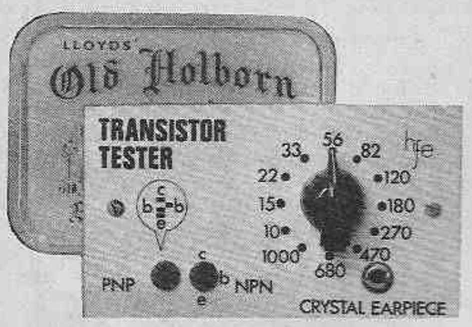
CROSS MEMBER

With the front panel holes and cut-outs complete, the twin 13 amp switched socket and the rocker switch should be temporarily fitted and the assembly used as a guide to fit the cross-member into the plywood console. It should be mounted as close as possible to the 13 amp socket, for which it acts as a support.

With the cross member properly located, it can be pinned and glued into position between the two console long side pieces. The case is now substantially complete, requiring only the construction of the component drawer, which will be described later.

This drawer is intended to be lined with conductive foam and used to house integrated circuits, but it can be left out of the design if not required, provided that its absence is taken into account before console construction is started.

To be continued



MINI-MODULES

By George Hylton

Handy "Beginner" projects based on simple circuits and featuring a variety of building methods.

7 TRANSISTOR TESTER

THE MAJORITY of simple transistor testers are very sensitive to variations in battery voltage. For example, a tester designed to operate from 9V will usually read low by at least 33 per cent if the battery voltage falls to 6V. Some testers require individual calibration. Some use expensive meters.

The present tester is simple, cheap and within its limits accurate. It needs no calibration and it is relatively insensitive to battery voltage variations. It measures the transistor parameter known as the small-signal current amplification factor or the forward current transfer factor and usually represented by the symbol h_{fe}. (This is generally about 20 per cent greater than the large-signal or "d.c." amplification factor, h_{FE}.)

PRINCIPLE

The transistor under test (either *npn* or *pnp* as in Fig.1) is placed in a positive feedback circuit. The feedback is varied by switching in different resistances using S1 until the circuit just oscillates. The current amplification h_{fe} can then be read off the switch setting, within limits.

A selection of twelve feedback resistances gives twelve bands of current amplification. These bands are narrow enough (30 per cent each side of the middle-of-the-band value) to give a useful indication of h_{fe} without the need for individual calibration. The overall range of h_{fe} covered is 10 to 1,000, which spans practically the entire range of practical transistor gains.

The tester deals with both silicon and germanium bipolar transistors, *npn* or *pnp*. Tests are made at a collector current of about 1mA and a collector voltage of about 3V.

CIRCUIT OPERATION

Transistor TR1 is a common-base a.c. amplifier with a current gain of almost exactly one. All the effective current amplification in the circuit must come from the transistor under test. This is connected as an emitter follower with a current gain of $h_{fe}+1$.

The a.c. output of this transistor is fed to the emitter of TR1 and appears virtually unchanged in strength at TR1 collector. The current therefore divides between TR1 load resistance, R1+R2 and whichever range resistance is in circuit. The portion which flows through the range resistance forms the base current of the test transistor and if large enough keeps the oscillation going.

If the range resistance is just low enough to permit oscillation the current gain of the test transistor is the range resistance divided by R2. Since R2 is 1kΩ this means that h_{fe} is given by the number of kilohms in the range resistance; for example, for a range resistance of about 100kΩ $h_{fe}=100$, and so on.

Simple theory says that R1+R2 should add up to 1kΩ but various factors conspire to make the circuit "read low" and R1 is added to compensate for these. (It is ignored in calibrating the tester.) The "+1" part of the gain of the emitter follower conveniently disappears because it just compensates for the loading of R1+R2 by the range resistances.

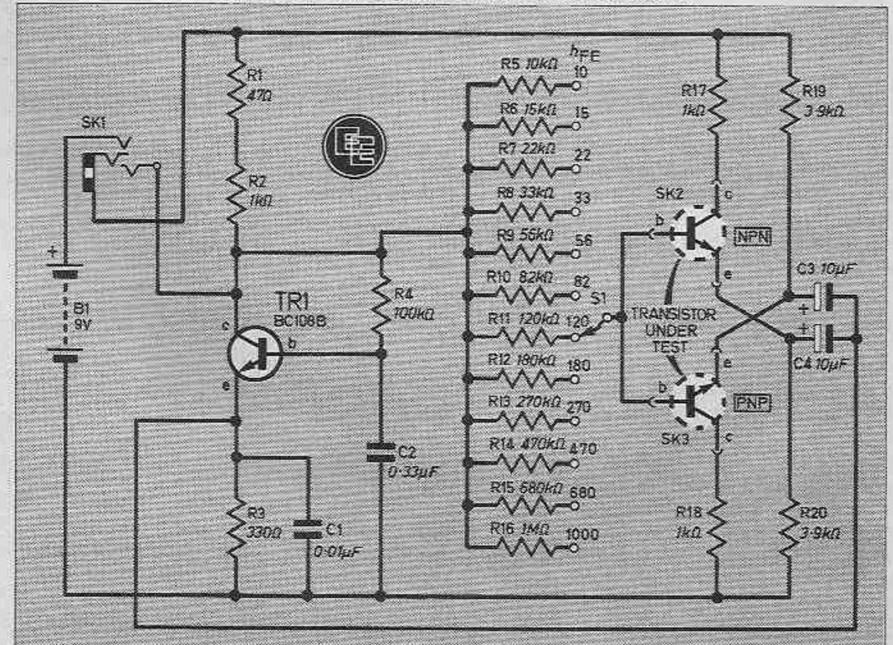
CONSTRUCTION

This project provided the opportunity of trying out an inexpensive plastic box which was seen at last year's Breadboard exhibition. This was described as a "potting box" and is a square, lidless box with two projecting rounded flanges which can be used as fixing brackets for a home-made Formica panel.

The particular "potting box" used for this project is larger than some other types and measures approximately 83×63×43mm. The depth of this particular size is useful for housing the range switch S1.

In practice the resistors were not attached to the switch tags like the spokes of a wheel, as shown for clarity in the diagram of Fig.2 but positioned vertically above the wafer. This reduces sideways spread and enables the common ends of the re-

Fig. 1. Circuit diagram of the Transistor Tester.



sistors to have their leads interconnected by twisting them all together and soldering instead of using separate linking conductors.

By using the usual small $\frac{1}{4}$W or $\frac{1}{3}$W resistors and keeping the leads short the overall depth can be fitted into the box. (Note. Solder the connection to the central tag before attaching the resistors.)

It is an advantage to mount all the circuitry on the back of the panel and so avoid connections between panel and "inside". To achieve the required compactness the circuitry around the transistor TR1 was assembled on a small piece of 0·15 inch matrix stripboard having nine strips by 11 holes. The finished board is held in place by its connecting leads.

SOCKETS

The jack socket SK1 for the crystal earpiece is also used to switch on the circuit when the plug is inserted. Many commercial jacks are equipped with "break" contacts rather than the required "make" contact but can generally be modified by bending the contact strips to the necessary shape.

At least two transistor sockets are needed, one for *npn* (SK2) and the other (SK3) for *pnp* transistors. The Eagle TS10 socket used in the prototype has three contacts arranged like the most common small metal-cased transistors (TO-5 or TO-18 case with their lugs near the emitter lead-out) plus an extra contact near the middle. By connecting this extra contact to the one which takes the base lead-out the socket takes some plastic transistors with in-line lead-outs and base in the middle.

Other types of small transistor with different lead-out configurations can usually be made to fit by bending their leads.

It is of course in order to add extra transistor holders wired for other lead-out configurations if desired. The base contacts are commoned with the existing holders and collector contacts of *like* polarity connected together, similarly emitter contacts of *like* polarity.

USING THE TESTER

Plug the transistor under test into the appropriate socket. Plug in the crystal earphone, it must be crystal: a magnetic earphone will not work. Turn S1 until a position is found where the oscillation just stops. The range marking indicates the upper limit of h_{fe}. The next lowest range where oscillation just starts, gives the lower limit. So if the circuit oscillates on "120" but not on "180" h_{fe} lies in the range 120 to 180.

If no oscillation is obtained either the transistor is a dud or of very low gain or is incorrectly connected. Protection resistors are included in the circuit to prevent damage from incorrect connection. An "unknown quantity" transistor can be tried in different positions and polarities to establish its polarity and lead-out connections.

Some transistors oscillate when the collector and emitter connections are reversed; that is they work in two positions. In this case the position which gives the higher gain is the correct one.

COMPONENTS

Resistors

R1	47Ω	R11	120kΩ
R2	1kΩ	R12	180kΩ
R3	330Ω	R13	270kΩ
R4	100kΩ	R14	470kΩ
R5	10kΩ	R15	680kΩ
R6	15kΩ	R16	1MΩ
R7	22kΩ	R17	1kΩ
R8	33kΩ	R18	1kΩ
R9	56kΩ	R19	3·9kΩ
R10	82kΩ	R20	3·9kΩ

All $\frac{1}{4}$W carbon ±5%, except R2 which is ±2%

Capacitors

C1 0·01μF polyester
C2 0·33μF polyester
C3 10μF 10V elect.
C4 10μF 10V elect.

Semiconductor

TR1 BC108B silicon *npn*

Miscellaneous

S1 1 pole 12 way rotary switch
SK1 3·5mm jack socket
SK2,3 Small transistor holders (2 off, see text)
B1 9V PP3 battery

Stripboard, 0·15 inch matrix 9 strips by 11 holes; plastic "potting" box, 83 × 63 × 43mm (see text); Formica panel 120 × 75mm; screws for fixing panel; one pointer knob; battery connector to suit B1; crystal earpiece with 3·5mm plug.

CONTINUOUS CALIBRATION

The tester relies on resistor tolerances for its accuracy. Even with the worst possible combination of high-limit and low-limit resistors h_{fe} should still be indicated within 35 per cent, which is a lot less than most manufacturing tolerances.

For some purposes (such as matching) a continuous adjustment of the range resistance is preferable to switched steps. This can be arranged (at the cost of having to calibrate a variable resistance) by substituting for the switched range resistors a 1 megohm carbon track potentiometer connected as a variable resistance.

For covering a wide range of h_{fe} a log. law or inverse log. law potentiometer is best, despite its erratic calibration. For a narrower range such as 11 to 1,000, a linear potentiometer may be used to cover the entire range of h_{fe} but it will not be accurately readable at the low end.

The principle of improving discrimination by restricting the range can also be applied to the circuit with S1. If an overall coverage of 100 to 820 were acceptable the twelve resistances could then be 100kΩ through to 820kΩ as in the standard "E12" series, giving 20 per cent (that is 10 per cent each side of nominal mid-range value) increments.

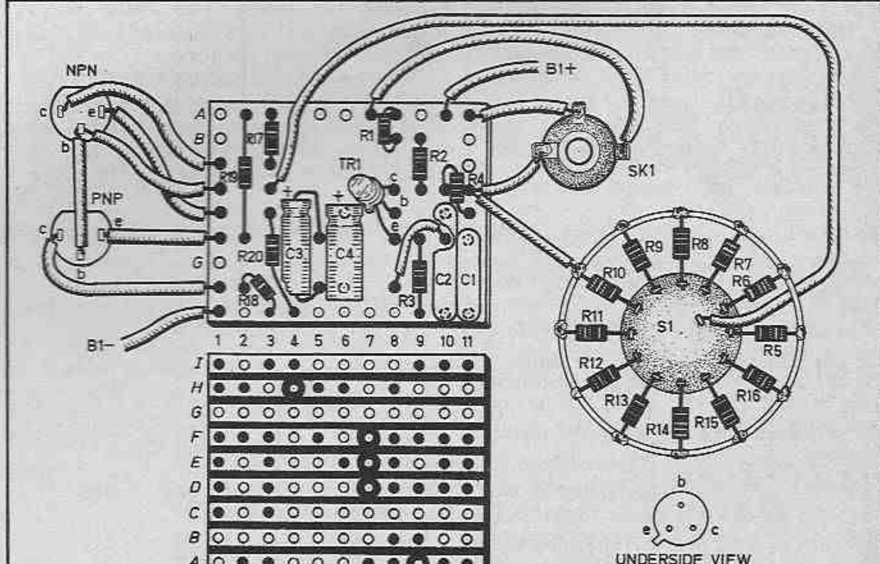


Fig. 2. Wiring details for the Transistor Tester. Note the remarks in the text regarding the modified jack socket.

SQUARE one FOR BEGINNERS

ELECTRONIC components are manufactured in all sorts of different shapes sizes and colours and each marked with a type number, and where applicable, values.

Components marked with values include resistors, capacitors, inductors, potentiometers, Zener diodes.

These markings are either alphanumerically printed on the body or "colour coded", the latter usually appearing as coloured bands or dots.

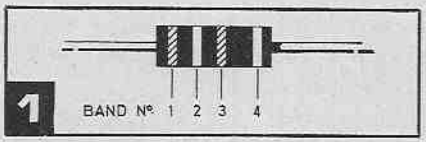
RESISTORS

A typical colour-coded resistor is shown in Fig. 1. You will note there are four bands (sometimes a pink, fifth band is included to indicate a high-stability resistor) displaced towards one end of the body. A table for "decoding" these bands appear in Table 1.

Begin decoding with the band nearest to the body end.

The first band gives the most significant digit of the value, with the second band producing the next most significant digit. The third band tells you the factor with which to multiply the first two digits to obtain the nominal value in ohms.

The fourth (and last) band provides information regarding the tolerance about the nominal value. This is a percentage figure and tells you the maximum difference to expect from the nominal value.



For example, a resistor coded RED, VIOLET, YELLOW, GOLD, has a value of 27×10^4 ohms ± 5 per cent. For those unfamiliar with index notation, 10^4 is the same as 10,000, so the resistor value is 270,000 ohms abbreviated usually to 270 kilohms (270kΩ). As can be seen, a number of zeros equal to the power of ten (in our example—four) is written after the first two digits.

The absence of a fourth band means that the tolerance is ± 20 per cent.

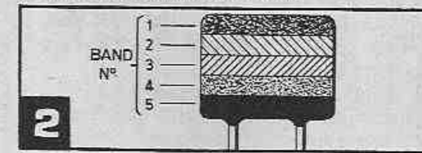
CAPACITORS

Non-electrolytic capacitors, in particular the Mullard C280 series, are also colour-coded and may be decoded by using Table 1. See Fig. 2 for C280 banding system.

Band 1 is the band farthest from the leads working through to band 5 nearest the leads. The value is in picofarads, pF (10^{-12} farads or $1 \div 1{,}000{,}000{,}000{,}000$ farads).

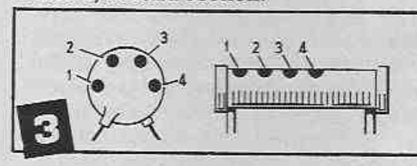
For some C280 values e.g., $0 \cdot 22\mu F$, $0 \cdot 033\mu F$, at first sight it will appear that there are only four bands and sometimes only three. This is due to neighbouring bands being of the same colour, but this is soon apparent from the width of the bands.

Unlike resistors, capacitors have a fifth band which informs the user of the maximum a.c. voltage that may be applied before destruction or breakdown of the device occurs.



For example, a C280 capacitor with band colours (from top) reading YELLOW, VIOLET, ORANGE, BLACK, RED, **has a value of 47×10^3pF$\pm$20% 250V;** 47×10^3pF = 47,000pF which is more usually written as $0 \cdot 047\mu F$ (microfarads).

Older types of ceramic disc and tubular capacitors are dot coded as shown in Fig. 3 and are decoded by Table 1, second section.



TANTALUM CAPACITORS

Some tantalum bead capacitors use a colour code system, see Fig. 4. There are in fact two similar systems although that at (a) is more common. The code unit is microfarads (μF) and the working voltage in volts (V).

For example, a type (a) tantalum capacitor with zone coding: BLUE, GREY, WHITE, GREEN, has a value equal to $6 \cdot 8\mu F$ 16V.

The tolerance of tantalum capacitors is usually ± 20 per cent.

Tantalum capacitors are polarised and must be connected in circuit the correct way round to avoid destruction.

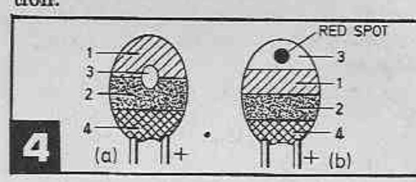


Table 1. Composite resistor and capacitor colour code "decoding" table.

Colour	Resistors (ohms Ω)				Capacitors (picofarads pF)					Tantalum Capacitors (microfarads μF)			
	Band No.				Band No.					Zone			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Black	—	0	1	—	—	0	1	20%	—	—	0	1	10V
Brown	1	1	10	1%	1	1	10	—	100V	1	1	10	—
Red	2	2	10^2	2%	2	2	10^2	—	250V	2	2	10^2	—
Orange	3	3	10^3	—	3	3	10^3	—	—	3	3	—	—
Yellow	4	4	10^4	—	4	4	10^4	—	400V	4	4	—	6·3V
Green	5	5	10^5	—	5	5	10^5	5%	—	5	5	—	16V
Blue	6	6	10^6	—	6	6	10^6	—	—	6	6	—	20V
Violet	7	7	10^7	—	7	7	10^{-1}	—	—	7	7	—	—
Grey	8	8	10^8	—	8	8	10^{-2}	—	—	8	8	10^{-2}	25V
White	9	9	10^9	—	9	9	—	10%	—	9	9	10^{-1}	3V
Gold	—	—	10^{-1}	5%	—	—	—	—	—	—	—	—	—
Silver	—	—	10^{-2}	10%	—	—	—	—	—	—	—	—	—
Pink	—	—	—	—	—	—	—	—	—	—	—	—	35V

MICROPROCESSOR BASICS 2

By R. W. Coles

A MICROPROCESSOR *system* will consist of a microprocessor *chip* combined with a variety of other semiconductor components and some peripheral hardware (Fig. 2.1). The microprocessor itself forms the heart of the system, but to understand how it works, it is first necessary to take a brief look at the environment in which it operates, and the various "life-support" systems it requires.

Most fundamental of all perhaps, it needs a power supply. Voltages vary depending on the semiconductor technology used, but there is a definite trend towards a single 5 volt supply these days. Microprocessors *do* require V.I.P. treatment, and so their supplies should be well regulated and within a fraction of a volt of their data sheet needs. Running a micro' from your 'bike dynamo just isn't on I'm afraid!

CRYSTAL CLOCK

Microprocessors are very time conscious, and do require a regular supply of "clock" pulses for proper operation. The actual frequency of the clock pulses varies from chip to chip, but a few MHz is common.

Because speed of operation is usually important, micro's are clocked at frequencies near to their data sheet maximum, and that's one of the reasons why crystals are used to set the clock frequency. Resistor-capacitor networks just couldn't be relied upon for stability.

Another reason is that with use of a crystal clock, basic computer operations such as ADD always take a fixed time, and therefore by cascading the required number of simple operations it is possible to count down to say, seconds.

RESET

The reset switch shown in Fig. 2.1 is there to symbolise the fact that a microprocessor chip *must* be started off at the *beginning* of its program (obvious really, isn't it?) Simple systems use a resistor/capacitor circuit to ensure that a reset operation is carried out when power is first applied, but evaluation cards let you reset the system whenever you like, by depressing a button. This is *very* useful when your programs go wrong (mine always do at first!).

BUSES

Most of the microprocessor chip pins are dedicated to one of the three "buses".

The data-bus carries parallel binary data to and from the memory and peripherals. It is a *bi-directional* bus, and for most microprocessors it is eight bits "wide". (That is, to wire it up, you need eight wires!)

The address-bus is a unidirectional bus driven by the microprocessor itself, and it carries parallel binary information which represents the "address" of the unique location in memory with which the microprocessor wishes to communicate. The "width" of the address-bus determines the range of unique memory locations which can be addressed. A common width is sixteen bits, giving access to 65, 536 (2^{16}) separate locations, each of which may contain an eight-bit data value.

The control-bus is the name usually applied to the assorted control signals which are sent to, or received from, the memory and peripheral components of a system. Each individual control bus line will have its own specific significance, and examples are DBE (Data Bus Enable) and VMA (Valid Memory Access).

The nature of control-bus lines, and the control-bus width, varies from chip to chip, whereas the binary symmetry of the data and address buses is a standard feature of most microprocessor chips.

MEMORY

Memory is an essential part of any microprocessor system, it holds not only the data to be operated on, but also the program which tells the micro' *what* operations it must carry out.

Sometimes data and programs are segregated into Read/Write memory and Read Only Memory respectively, but this isn't necessarily so, since data can be stored in ROM and programs in RAM (RAM is a rather unfortunate shorthand for Read/Write Memory), where this is useful.

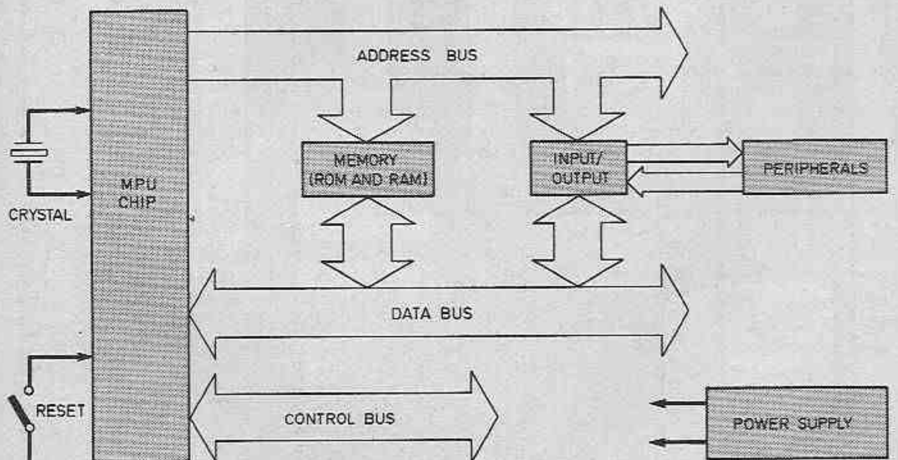


Fig. 2.1. A simple microprocessor system.

We will be examining memory devices in more detail in future articles, but for the moment just think of this important system resource as a series of pigeon holes, each of which has its own binary reference number, or address, and the ability to store one *word*, (a word is a parallel collection of bits) of either data or program instructions.

INPUT/OUTPUT

The last system ingredient we need to consider is what I have called, in Fig. 2.1, Input/Output. Obviously a microprocessor which is unable to communicate with the outside world is worse than useless. Inputs and Outputs in the form of switch closures, keyboard data, lights and printed text, are the bread and butter of most systems. They are also the only way the microprocessor has of receiving instructions and delivering the results to its human masters!

Input and Output circuitry comes in many shapes and sizes, some very simple (eight toggle switches or eight lamps for example) and some quite complicated (an interface for a printer or or a tape cassette for example).

Once again, we will be examining I/O as it is called in future articles and in more depth. But now, back to the *Prima Donna* of the system, the microprocessor chip itself!

THE MICRO' CHIP

To start with, let's zoom in on a microprocessor. First, we see a plastic or ceramic dual-in-line package; it has forty pins and is 0·6 inches wide and about two inches long. The pins are actually the visible part of a gold-plated "lead-frame" which appears on closer inspection to radiate from the very centre of the package.

At the focus of this golden tracery is an almost insignificant sliver of a shiny metallic material. Closer still we can see that this sliver is roughly square in shape, measures about 0·25inch on each side and is connected to the lead-frame via square pads around its peripherary and spidery links made of fine gold wire.

Through a magnifying lense, we can see that the surface of this sliver, now revealed as the silicon chip itself, is criss-crossed with an aluminium interconnection pattern of breathtaking complexity! At this point the information that there are more than 5,000 individual transistors on the chip seems to have the ring of truth.

Further study reveals that the interconnection pattern forms regular geometric arrays on certain areas of the chip's surface. These multi-transistor arrays obviously form the separate functional blocks which go to make up the complete microprocessor. But what blocks are required and what do they do? At this point our eyes fail us. Only the chip makers themselves can recognise the purpose of an integrated array by its appearance, we must content ourselves with a simpler model!

A FUNCTIONAL MODEL

The block diagram Fig. 2.2 shows, in simplified form, the sort of circuit blocks which are integrated on to a single silicon semiconductor chip to form a microprocessor. This is of course a functional *model* of a microprocessor chip; it says nothing about the relative complexity of each block, nor does it fully describe the necessary block interconnections.

The internal data bus used in this diagram can be considered to be an "everything" bus, which, for our convenience, can carry binary data of any necessary word length, in any direction. In the microprocessor chip itself the designers have to provide a whole collection of buses to achieve the same result!

TIMING AND CONTROL

On the left of the diagram is the important Timing and Control section which produces all necessary internal and external control signals together with clock or strobe pulses to ensure that all parts of the system act in synchronism. Exactly which control signals are produced is determined by

(a) A fixed time sequence

(b) The Control bus inputs

and

(c) The contents of the Instruction register.

By feeding the instruction register with a regular diet of new binary words, *Instruction* words in fact, we can control the resources within the microprocessor chip, and hence the entire system, in a sequential fashion.

A sequence of instruction words is normally called a program, and this can be held outside the microprocessor chip in RAM or ROM, as discussed earlier.

To get instructions from the memory and into the Instruction register, the Timing/Control section of the microprocessor generates a sequence of control signals to implement what is known as an "Instruction-cycle."

The first part of an instruction cycle is called a "Fetch", because during this period an instruction word is "fetched" from memory.

The second part of the cycle is referred to as an "Execute", because during this period the control signals generated depend on the nature of the instruction which

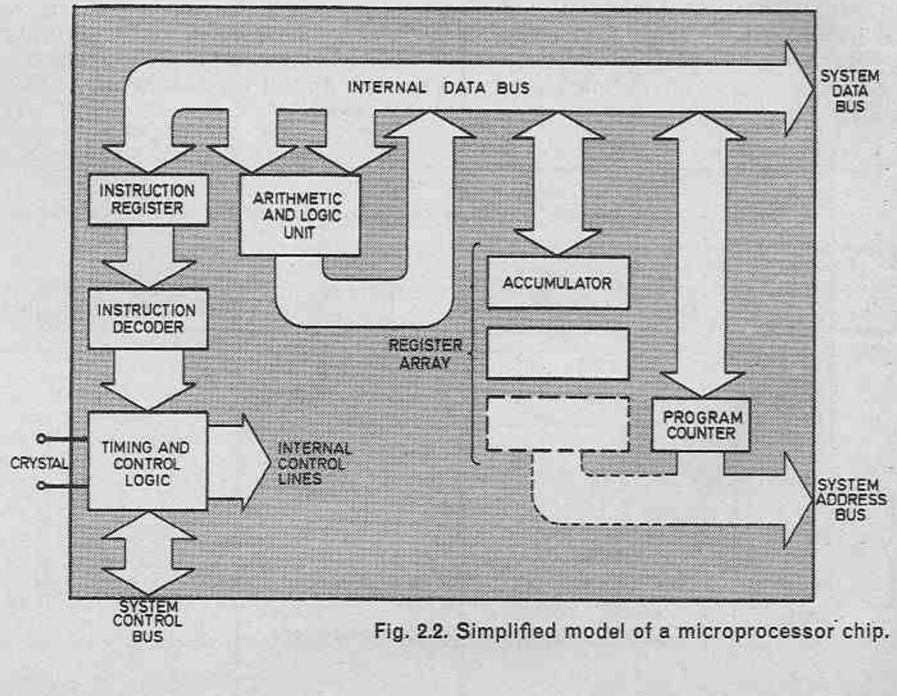


Fig. 2.2. Simplified model of a microprocessor chip.

MICROPROFILE: THE NATIONAL SC/MP

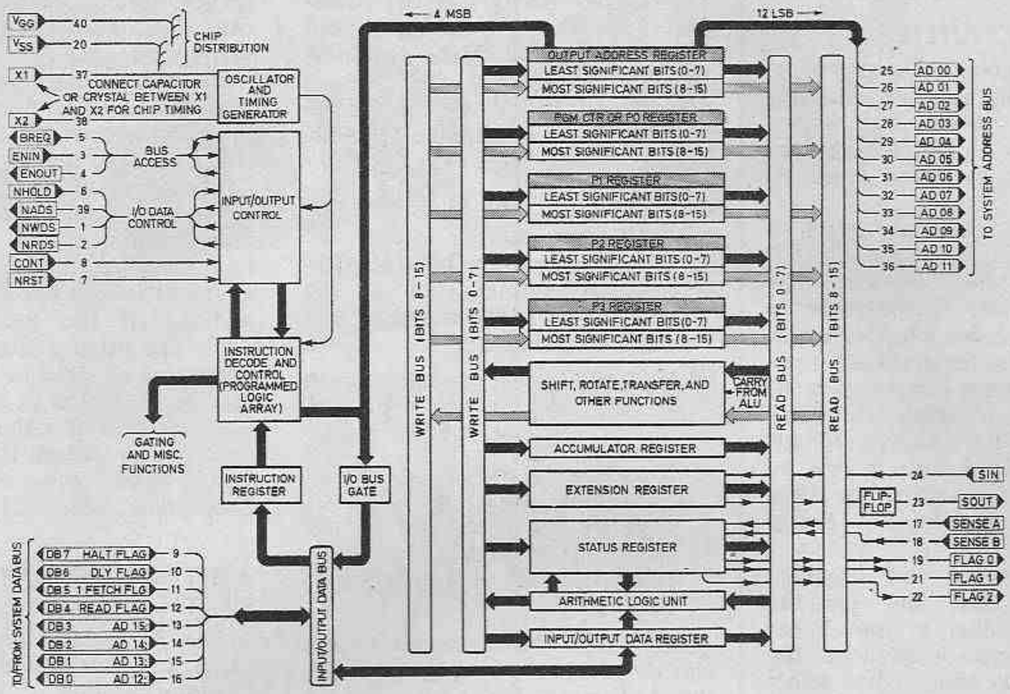


Fig. 2.3. Block diagram of the National SC/MP microprocessor.

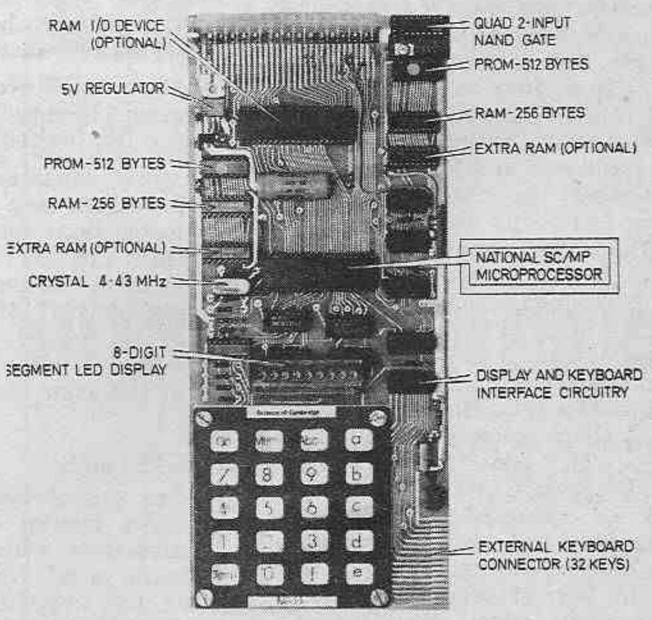
The SC/MP microprocessor is a fairly simple eight-bit device, intended mainly for controller type applications. It was originally fabricated using the cheaper PMOS technology, but is now made in NMOS which means it can operate from 5 volt supplies and is faster too. The chip has proved popular with microprocessor hobbyists because of its ease of use and low cost, and it is currently used in the Bywood "SCRUMPI" kits and in the Science of Cambridge MK14, *see photo*.

One nice feature of the SC/MP is the provision of an on-chip clock oscillator, so that only a crystal is needed externally. One major problem is that the address bus is only 12 bits wide and can therefore directly address only 4096 (2^{12}) memory locations. Another four bits *is* sent out on the *data* bus during strobe time, but this extension to 16 bits is not incremented automatically and has to be deliberately changed by program instructions. This in effect splits the 64K (K=1024) memory space up into 16 4K "pages", where the current page number has to be selected by the programmer.

The chip has one eight-bit accumulator and also has the rather unusual feature of an extension register, which among other things is used to implement a serial (bit by bit rather than word by word) input/output channel. Serial I/O is used for things like teletypes and cassette storage, so having this facility available on chip can save a lot of external hardware.

Four 16-bit registers are provided (called "pointers" by National because they can be used to hold a value which points to an address in memory), and one of these is used as the program counter. The remaining three pointers can also be used to hold two data words, rather than a single 16-bit address, because each eight-bit register half is separately accessible.

The instruction set of this microprocessor is rather basic in comparison to other eight-bit chips, but this can be an advantage for beginners who find it easier to learn!



One unusual and useful feature is a DELAY instruction which causes the chip to pause for a time count which can be selected by the programmer. Accurate time periods can easily be generated with this instruction, provided that a crystal is used with the on-chip clock oscillator.

SC/MP is housed in a 40-pin d.i.l. package and is readily available from numerous advertisers. Remember that to build a system using *any* microprocessor you will need a number of other components such as memory and power supplies, so it may be advisable either to buy a kit, or to wait until you have read the rest of this series before committing any hard earned cash!

was fetched, so that the microprocessor can be made to carry out the wishes of the programmer.

PROGRAM COUNTER

So far so good, the microprocessor can fetch instructions and even execute them. But where does it look for its instructions and how does it know what order to execute them in?

To take this step, we need to consider one more block in Fig. 2.2, the Program Counter. The Program Counter (P.C.) is a register which holds a binary word, rather like the Instruction register, but it has the extra facility of automatic incrementing or "counting" logic so that whatever binary number is loaded into it can be stepped up by a count of one after each operation of the Fetch-Execute cycle.

The contents of the Program Counter are sent out on the Address bus during the Fetch activity and are decoded in the memory circuits and used to select the location of the next instruction to be executed.

To start a microprocessor off on the right foot, a Reset signal must be applied to set up starting conditions. One of the things the Reset signal does is to clear the Program Counter to zero, and this means that program execution always starts at address zero and increments up through memory when left to its own devices.

What this means to us, the users, is that we must ensure that our first instruction is located at address zero, so that the microprocessor comes under *our* control immediately after Reset.

To add a little spice to programming, there are several instruction types which allow the contents of the Program Counter to be modified or replaced by the programmer, and these instructions can be used to force a "Jump" out of the normal sequential flow of instructions when necessary. We will see how useful this can be in later articles.

CHIP RESOURCES

We can now get instruction words from memory and let them influence the generation of control signals, but we haven't seen them do anything particularly useful yet. What we need to look at next are the remaining chip resources and how they can be made to do useful work.

What we have left in Fig. 2.2 are the Register Array and the Arithmetic and Logic Unit (ALU), and these are the key to the power of the microprocessor.

To do useful work, the microprocessor must be capable of carrying out instructions to:

(a) Manipulate data at the bit and word level,

(b) Carry out simple binary arithmetic operations such as the addition or substraction of one word from another,

(c) Perform logical operations such as AND and OR on a pair of words, and last but not least,

(d) Test bits or words for certain conditions such as positive, negative, or zero, and to use the result of such a test to decide what part of a program to do next.

All of the above operations use one or more of the registers and the Arithmetic and Logic Unit. A register is a storage area which will hold one word of binary data. Registers differ from RAM locations (which also hold one word of binary data) because they are:

(a) More easily accessed by a program because they have a special, limited address range.

(b) More capable, because they have their own set of dedicated instructions which may allow them to be directly incremented, decremented, tested and shifted. (Memory data has to be loaded into a register before it can be manipulated in the same way.)

REGISTERS

Most microprocessors have one or more special registers called accumulators, which are the most versatile of all. An accumulator is often the implied source of one operand in an instruction, and also the implied destination for the result. For example the instruction line:

```
ADD        FRED
```

means "Add the contents of the main memory location known as FRED to the accumulator register, and store the result back into the accumulator."

The registers within a microprocessor chip can also be used to form addresses for memory reference operations. In a microprocessor with an eight-bit word length, a pair of eight-bit registers can often be used together to form a 16-bit address.

In other cases special address registers called Index-registers are provided exclusively to hold and to step through, memory addresses.

The difference between general or Index registers being used to hold addresses and the Program Counter (which also holds an address) is that the P.C. holds the address of the next *instruction* while the other registers hold the addresses of *data* to be used during the execution of an instruction. The contents of either can appear on the address bus, the P.C. during Fetch and the other during Execute.

ARITHMETIC AND LOGIC UNIT

The Arithmetic and Logic Unit (ALU) can be thought of as the "Engine Room" of the microprocessor because it contains a complex collection of logic circuitry to carry out the activities demanded by Arithmetic. Logical and Manipulative instructions, under the control of the Instruction Decoder.

In an eight-bit ALU there will be at least eight binary full adders, detection logic for zero, positive, or negative data values, Logic to shift bits right or left, logic to detect carry or borrow conditions, and lots more.

Associated with the ALU there is a special register used to hold the results of tests. The length of this register depends on the number of conditions which can be tested, because one bit is used to 'flag" the result of each test.

All Flag Registers, as they are called, have one bit for arithmetic carry between words, and other bits can signal the arithmetic sign of an ALU result, the fact that the contents of an accumulator are zero, and so on.

Information on individual microprocessors can be found in their respective data sheets. They all have their strengths and weaknesses and often some strange idiosyncrasies! Why not have a look at the data on the National SC/MP chip and see if you can find all of its facilities, as I have described them?

To be continued

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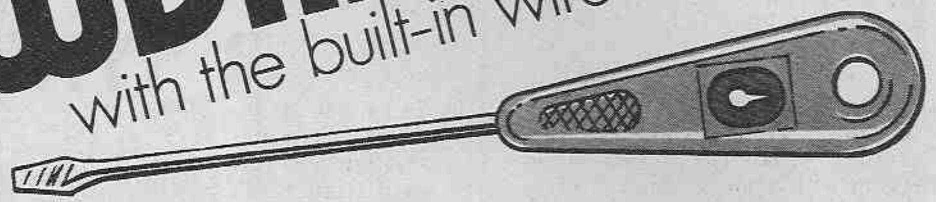

NEXT MONTH

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TRAINING FOR THE FUTURE

Recognising the tremendous thirst for further knowledge on the understanding and practical applications of microprocessors Texas Instruments have opened a Microprocessor Training Centre at its plant in Bedford.

Heading the new training school is Mike Hughes, Training Manager at TI Supply Division. He commented: "Engineers from all industries are finding it necessary to become familiar with microprocessing techniques, but it is difficult for many of them to find the time or opportunity to do so.

The new training centre will alleviate this problem with a series of courses designed as short but intensive training modules with the emphasis on 'hand-on' training."

The centre is designed to give a high teacher-student ratio, and is equipped with four complete sets of hardware to support the practical sessions.

The first courses available at the centre include a special low-cost two day "Introduction to Microprocessing" course. This serves as a starting point for anyone who has only minimal knowledge of logic gates and storage elements, and provides a firm grounding in microprocessor technology.

Run on a strictly "first to enrol first to be served" basis, the courses are open to all interested parties. Engineers can enrol at any level in the course structure, dependent on their requirements and current knowledge of microprocessors.

The courses will be regularly updated to keep pace with the rapid progress in microprocessor technology and applications.

For further information on proposed courses readers should write to: Microprocessor Training Centre, Texas Instruments Ltd, Supply Division, Manton Lane, Bedford MK41 7PA.

Market Trends

British manufacturers of small-screen portable monochrome TV's report a 66 per cent upsurge in deliveries with over half a million sets supplied last year. But larger sizes of monochrome sets were less popular with a decline in deliveries from 159,000 to 134,000. Deliveries of colour sets were on a level with 1977.

Clock radios were popular with big increases in sales but the fastest growth area was in videocassette recorders (VCRs) which quadrupled sales to 80,000 units last year. **What a pity they all had to be imported!**

CITIZENS ARREST

The prospect of Citizens band (CB) radio in the UK received another knock with reports that the Association of Chief Police Officers are at best lukewarm, at worst decidedly anti-CB.

Fears of continuous abuse of such a privilege appear to be the chief reason, including its use by criminal elements.

JUST THE JOB FOR MICRO'S

A recent announcement by the Minister of State for Industry, Mr. Alan Williams. of a £7m Government aid for the construction of a new manufacturing plant should bring up to 1,100 new jobs to the high unemployment area of Merseyside.

The plant is for the manufacture of microelectronic devices and is to be built by GEC Fairchild Ltd, a jointly owned subsidiary of Britain's GEC and the Fairchild Camera and Instrument Corporation of the USA. The plant is being erected on a site made available under the Community Land Scheme at Neston, Cheshire.

This project is part of the Government's strategy to couple its vast investment in new technology to help establish jobs in arrears of high unemployment.

Electronics Bazaar

A new show, The Great Britain Electronics Bazaar, is to be staged at London's Alexandra Palace between June 20 to 30. It will be aimed at the electronics hobbyist and admission is free to all those who register in advance to attend the show.

Talkback

Automatic telephone answering machines are now quite common. Ansafone, a leading manufacturer has now produced a machine allowing the owner to telephone from anywhere in the world and using a special personalised code activate the machine to replay all the recorded messages and to record, if required, instruction or orders.

This system, the mark-7, has obvious advantages for the long distance traveller who can access the machine at any time in the 24 hours from any time zone.

* * *

Dr. R. W. Burns, in a talk at the IEE recently, reminded us that the first patent for a colour TV system was taken out in 1895 and that a shadowmask tube was patented in 1938. Ideas were not lacking but it was many years before the technology was able to catch up and make colour TV for all a practical reality.

—RECRUITING—

The British semiconductor manufacturer INMOS has started a full-scale recruiting campaign for the technical HQ at Bristol. The plan is to develop MPUs in the UK and complementary memory devices in a parallel operation in the USA.

The location of the four production plants has not yet been announced but are expected to be in geographically dispersed areas scheduled for industrial development.

CHIPS ON THE LINE

Control switching on British Rail's Midland Region suburban lines from London to Bedford is to be monitored by a twin microprocessor system supplied by GEC-Elliott Process Automation under a £100,000 contract.

This is the first time MPUs have been used by BR for remote control of traction power supplies.

. . . from the World of Electronics

BUSINESS CALL

The office phone of the future, with the sort of "extras" executives usually only dream about, will become a reality next year when the Post Office launches a new system.

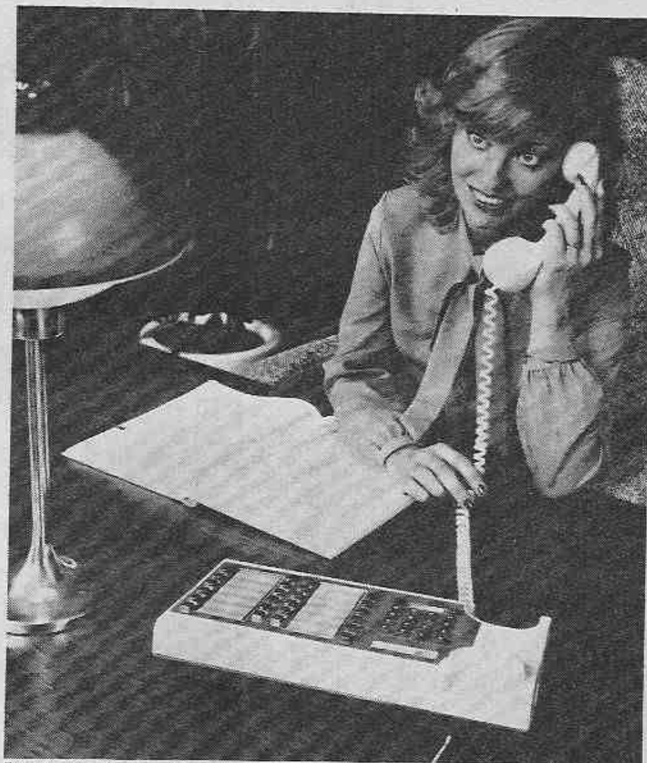
Known as small business system (SBS), this new phone will harness the power and flexibility of microprocessor control to offer many more facilities over those of ordinary telephones.

Typical facilities to be provided by SBS include: Hold an incoming call to make a call on the same phone to another phone on the system (and transfer the call to that phone if necessary). Automatic diversion of incoming calls to another phone on the system so that calls can be answered in someone's absence. Executive break-in on internal calls, allowing someone to cut in on an existing conversation to reach someone urgently.

Conference calls, enabling people on up to six phones on the system to talk together. Storage and automatic calling of frequently-called numbers at the touch of a button. Direct calling between phones on the system for internal office communication.

The basic system can take up to ten exchange lines and serve up to 30 phone extensions—but for the smaller company or business office it need involve no more than two lines and, say, ten phones, with the minimum of extras. The system is designed to grow with the firm; extra lines, more phones and new facilities can be added later when needed.

Each phone has push-buttons instead of a dial—making for easier calling—and also "function" keys that are pressed to obtain the extra facilities. Each facility is clearly identified by its own key.



On the road

The EMI-Scanner 7000 series of advanced computerised X-ray equipment is being taken on a four-month European tour by the Medical Division of EMI. The 40ft trailer of the demonstration vehicle has two-air-conditioned compartments, one for discusion, the other housing a diagnostic viewing console.

Although sales to the US have fallen away due to spending cuts by American hospitals, the EMI-Scanner is doing well elsewhere in the world, especially in West Germany. Twenty-five systems were sold in a three-month period.

New TTL family

The possible replacement of CMOS is just one of the many areas of impact that Texas Instruments foresee for their new range of Schottky TTL devices.

This claim was made at a recent press conference announcing the introduction of a Texas third generation TTL family.

—ANALYSIS

COMMUNICATING WITH LIGHT

What could be the biggest breakthrough in telecommunications since the original invention of the electric telegraph in the early 19th century is now becoming a reality. Instead of using a metallic wire and an electric current to carry intelligence from one point to another, why not use a modulated light beam and convey the light through an optical duct?

A light beam is capable of carrying vast amounts of information expressed in terms of bits per second. Far more than radio waves, even the microwave systems used in space satellites and from those horn antennas which grace the upper reaches of the Post Office towers in London and other great cities.

Serious work on optical fibre communications systems started in the mid-1960s with the UK in the forefront in Europe with work at STL at Harlow and in the Post Office laboratories. It was an uphill slog involving the development of low-loss fibres and methods of manufacture, the laser and l.e.d. transmitters, the photodiode detectors. After some ten years of laboratory development, experimental systems are now undergoing field trials in many parts of the world. What is more, they seem to be successful.

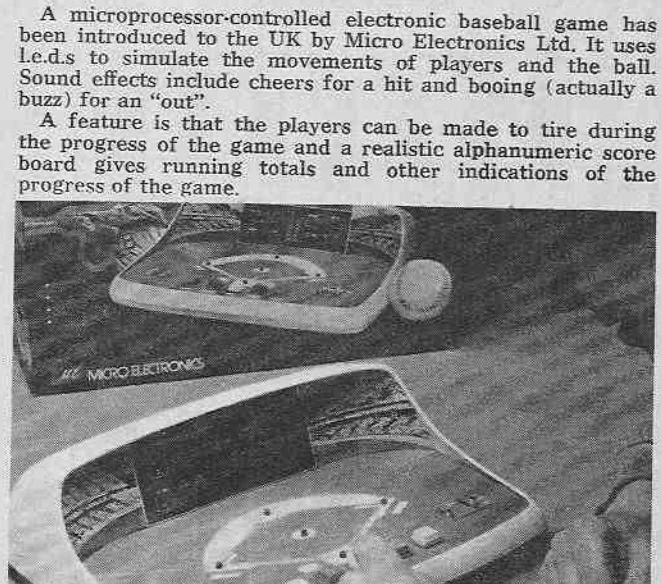
What is exciting telecommunications engineers throughout the world is that now we have learnt how to make fibre-optic cables they look like being cheaper, lighter, more flexible and yet just as rugged as their metal counterparts. A cable with eight fibres can carry 8,000 two-way telephone conversations. Moreover, the very wide band-width available means that you could have video conferences for business people over telephone lines and more versatile cable TV services for the home

Brian G. Peck

HOME RUN

A microprocessor-controlled electronic baseball game has been introduced to the UK by Micro Electronics Ltd. It uses l.e.d.s to simulate the movements of players and the ball. Sound effects include cheers for a hit and booing (actually a buzz) for an "out".

A feature is that the players can be made to tire during the progress of the game and a realistic alphanumeric score board gives running totals and other indications of the progress of the game.



Fringe Members

THE other day a friend of mine came out with an extraordinary statement. He told me that the devotees of Model Railways were far more numerous than those of Electronics. I must say I very much doubted that statement but I think I would have had quite a job disproving it, because of the difficulty deciding who were the genuine Electronic Hobbyists. In our hobby there are so many fringe members. For example is the chap who makes an Electronic Flash a genuine electronic enthusiast? With the model railway buffs it is more clear cut.

I rather went off Model Railways ever since a colleague invited my wife and I to see his layout. He had it going round a huge table and when we were seated, he said "You are now going to have a railway tea". The goods trucks were loaded with comestibles and the train set in motion. The idea being, that when it passed you, you took out anything you fancied.

Unfortunately, before it reached us it passed by three small voracious thugs which my friend, in a moment of misguided enthusiasm called his offspring. By the time it reached us it was denuded of everything except two sticks of stringy celery. We left the table with empty stomachs and long faces.

However, as the indigenous African native said when asked how he happened to be in the Judges hen yard, "Well sah, I must have digressed". To get back to electronics the range of TV electronic childrens games is truly impressive, both in number and sophistication. Aeroplanes that fly across a blue sky and drop bombs and anti-aircraft guns that can be aimed at them and shoot them down.

I was discussing this with a retailer friend who did good business over Christmas by selling the parts for a small Crystal Set. He said "I wonder if the children who are given these expensive toys, really get as much fun out of them as the little lad with an inexpensive crystal set kit, who puts it together and enjoys the thrill of hearing it actually work! I do not think they do! I must say I am inclined to agree with him. On a purely practical level, the latter is much more likely to be a convert to the hobby than the former.

Readers Problems

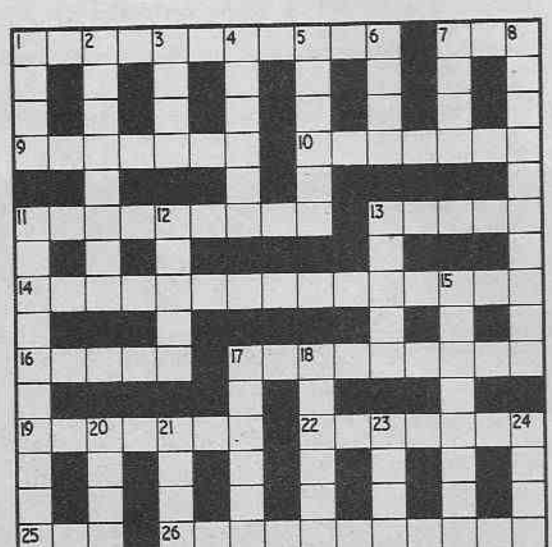
Being in the trade, I sometimes feel I should air customers grievances, because although I am pleased to report that we receive surprisingly few complaints, I always have the nagging suspicion, that the same thing may have upset other customers, who just could not be bothered to write. If this is so, then clearing up one problem may set other customers minds at rest.

The first point I would like to make is this. If you suffer a long delay on the arrival of your goods, make sure it is not the Post Office, before you throw the book at your supplier! My house is only eight miles away from our Editors Office, and yet it sometimes takes a week for my letters to reach him.

Sometimes goods are delayed because the supplier himself is held up by the manufacturer, and this brings me to the second point. Customers are sometimes surprised and indignant, because we have paid their cheque into the Bank before they have received the goods. Let me assure all customers, that it is done from the kindliest possible motives. That is, by paying it in promptly the customer has proof that his order has arrived safely.

EE CROSSWORD No 14

BY D. P. NEWTON



ACROSS

1 Basic unit (6, 5)
7 Transmitter, but not commercial?
9 Circuitous delay from a reaction.
10 Dig up and disconnect dangerously.
11 Touched for electrical purposes.
13 Deep and noisy channel.
14 Communications code for one-to-one connections (9, 6)
16 Lengthy unit.
17 Extremely short-tempered with certain meter-like connections (4, 5).
19 Devices for component privacy?
22 Spectral schizophrenia, best known to be yellow.
25 Trial.
26 This musical device is without analytical ability.

DOWN

1 Aerial elevator.
2 This far and no further! Unless another connection is made.
3 False god.
4 Intensely intelligent.
5 Lots everywhere make a jump.
6 Temporal location on a daily basis.
7 Coat hanger from a telephone.
8 Emitted from a negative electrode in a vacuum under high tension (7, 3).
11 Sharp scholarly deed in making a disc (3, 1, 6).
12 Core and all in a fruity way.
13 By-pass.
15 Transistor on two legs with its bottom knocked out.
17 Prophetic imagery on the TV.
18 A hot salad dish in the radar aerial?
20 Precipitation generally.
21 A pair is needed for the phones.
23 Runs to the pots (Anag.).
24 Rip a sad drip.

Solution on page 248

BOOKS AND COMPONENTS

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OPTOELECTRONICS

NEW INCREASED RANGE—ALL 1ST QUALITY

LED'S (diffused)

O/no.	Type	Size	Colour	Price
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1502	MIL3232(TIL211)	·3mm (.125)	GREEN	£0·15
1503	MIL3331 (OPL212A)	·3mm (.125)	YELLOW	£0·15
1504	ARL4850(FLV117)	·5mm (.2)	RED	£0·10
1505	MIL5251(TIL222)	·5mm (.2)	GREEN	£0·15
1506	MIL5351(MV5353)	·5mm (.2)	YELLOW	£0·15
1509	FLV111	·5mm (2)	CLEAR (ill. Red)	£0·11

SUPER 'Hi-Brite' Type

1521	MIL32	·3mm (.125)	RED	£0·10
1522	MIL52	·5mm (.2)	RED	£0·10
1514	ORP12 Light dependent resistor			£0·55
1520	OCP71 Photo transistor			£0·35

LED CLIPS

1508/125	pack of 5 125 clips	£0·15
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ALL @ 8% V.A.T.

DISPLAYS:

DL303 7 segment D.P. left (.30" height) RED Single Digit	Commom Anode O/NO. 1523	£0·70
DL707 7 segment D.P. left (.0·3" height) RED Single Digit	Common Anode O/NO. 1510	£0·95
DL527 7 segment D.P. left (.50" height) RED Two-Digit Reflector	Common Anode O/NO 1524	£1·70
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CILD74	Multi-Channel 8 pin DIP Two Isolated Channels	O/NO. 1498	£1·00
CILQ74	Multi-Channel 16 pin DIP Four Isolated Channels	O/NO. 1499	£2·20

ALL @ 8% V.A.T.

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	14p*
DPDT standard slide	1974	15p*
Toggle switch SPST 1½ amp 250V a.c.	1975	33p*
Toggle switch DPDT 1 amp 250V a.c.	1976	42p*
Rotary on-off mains switch	1977	50p*
Push switch—Push to make	1978	14p*
Push switch—Push to break	1979	18p*

ROCKER SWITCH	Colour	No.	Price
A range of rocker	RED	1980	30p*
switches SPST—moulded	BLACK	1981	30p*
in high insulation.	WHITE	1982	30p*
Material available in a	BLUE	1983	30p'
choice of colours ideal	YELLOW	1984	30p*
for small apparatus.	LUMINOUS	1985	30p*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	70p*
Miniature SPST toggle, 2 amp 250V a.c.	1959	75p*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	80p*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	95p*
Push button SPST, 2 amp 250V a.c.	1962	90p*
Push button SPST, 2 amp 250V a.c.	1963	95p*
Push button DPDT, 2 amp 250V a.c.	1964	98p*

MIDGET WAFER SWITCHES

Single-bank wafer type—suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	48p*
2 pole 6 way	1966	48p*
3 pole 4 way	1967	48p*
4 pole 3 way	1968	48p*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V a.c.	1970	25p

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	7p*
1¼in x ¼in chassis mounting	507	12p*
1¼in car inline type	508	16p*
Panel mounting 20mm	509	20p*
Panel mounting 1¼in	510	30p*

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	6p	1A	615	5p	3A	619	5p
250mA	612	5p	1·5A	616	6p	4A	620	9p
550mA	613	5p	2A	617	5p	5A	621	5p
800mA	614	7p	2·5A	618	6p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
2A	637	3A	639	5A	642

All 6p each

NUTS AND BOLTS

BA BOLTS—packs of BA threaded cadmium plated screws slotted cheese head.
Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·20	½in 4BA	846	32p
½in 0BA	840	75p	½in 4BA	847	25p
1in 2BA	842	65p	1in 6BA	848	40p
½in 2BA	843	45p	½in 6BA	849	21p
¼in 2BA	844	52p	¼in 6BA	850	25p
1in 4BA	845	44p			

BA NUTS—packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	855	72p	4BA	857	30p
2BA	856	48p	6BA	858	24p

BA WASHERS—flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	859	14p	4BA	861	12p
2BA	860	12p	6BA	862	12p

SOLDER TAGS—not tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	851	40p	4BA	853	22p
2BA	852	28p	6BA	854	22p

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	85p*

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1·00
2025	MT150-0-12V, 0-12V RMS	£1·00

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
2029	15V-0-15V 1 amp	£2·75*	P. & P. 66p
2030	30V-0-30V 1 amp	£3·45*	P. & P. 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp. 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Voltages available by use of taps.
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	½ amp	£3·40	P. & P. 86p
2032	1 amp	£4·40	P. & P. 86p
2033	2 amp	£5·45	P. & P. £1·10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	60p*
113	3·5mm Jack plug to 3·5mm jack plug. Length 1·5m	75p*
114	5 pin DIN plug to 3·5mm. Jack connected to pins 3 & 5. Length 1·5m	85p*
115	5 pin DIN plug to 3·5mm. Jack connected to pins 1 & 4. Length 1·5m	85p*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·25*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	68p*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·08*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0·2m	90p*
120	Car stereo connector. Variable geometry plug to fit most car cassette. 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	80p*
123	6·6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·80
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	75p*
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	75p*
126	5 pin DIN plug to Tinned open end. Length 1·5m	75p*
127	5 pin Din plug to 4 Phone Plugs. All colour coded. Length 1·5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	80p*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	68p*
131	5 pin DIN plug to 3 pin DIN plug. 1 & 4 and 3 & 5. Length 1·5m	83p*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	98p*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3 & 5. Length 1·5m	75p*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3 & 5. Length 23cm	68p*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3 & 5. Length 23cm	68p*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1·75*
178	AC mains lead for calculators etc.	45p*

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides, aluminium bottom, front and back.

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155	8in	5¼in	2in	£1·25
156	11in	6in	3in	£2·12
157	6in	4¾in	1¾in	£1·30
158	9in	5¼in	2¼in	£1·76

ALUMINIUM BOXES. Made from bright ali., folded construction each box complete with half inch deep lid and screws.

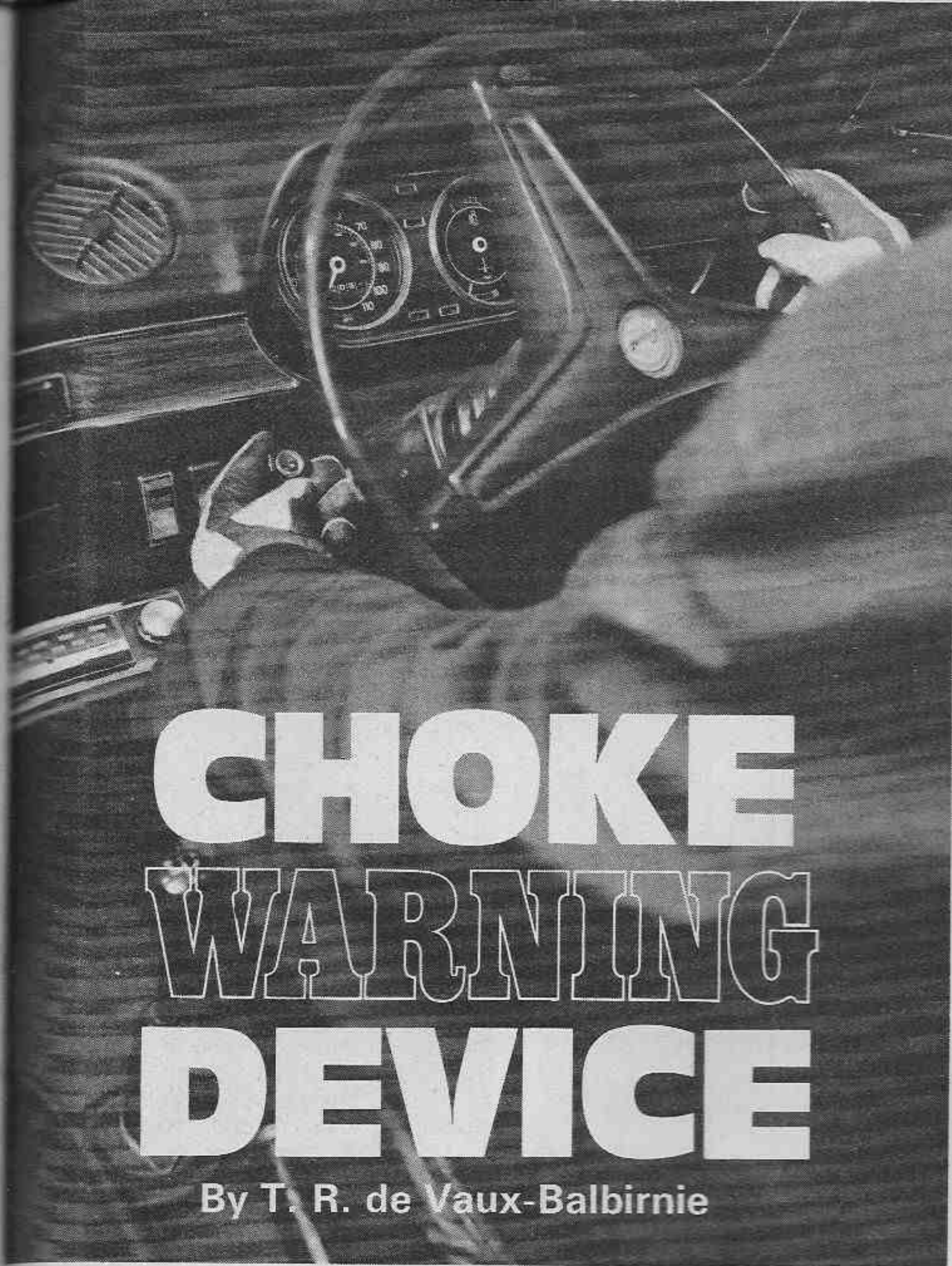
No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	62p
160	4in	4in	1½in	62p
161	4in	2½in	1½in	62p
162	5¼in	4in	1½in	70p
163	4in	2½in	2in	64p
164	3in	2in	1in	44p
165	7in	5in	2½in	£1·04
166	8in	6in	3in	£1·32
167	6in	4in	2in	86p

V.A.T. Add 12½% to prices marked*, 8% to those unmarked Items marked are zero rated.
P&P. 35p unless otherwise shown.

BI-PAK

DEPT. EE4, P.O. Box 6, Ware, Herts.

COMPONENTS SHOP: 18 BALDOCK STREET, WARE. HERTS.



CHOKE WARNING DEVICE

By T. R. de Vaux-Balbirnie

Most car owners know that it is very bad practice to leave the choke control pulled out for longer than necessary. Doing this habitually has two bad effects. Firstly, and most immediately, the fuel consumption rises alarmingly. Secondly—in the longer term—engine wear is greatly increased due to the extra fuel delivered by the carburettor washing the protective oil film from the cylinder walls.

Short and long term interests are protected by this project which automatically signals the driver when the choke control remains out after the engine has reached a predetermined temperature.

The project is suitable for both positive and negative-earth vehicles and requires very little mechanical aptitude to fit it.

The circuit is provided with two sensing devices. The first is a microswitch at the choke control which is in the main battery line and switches on power to the circuit as soon as the choke control is moved out a little. Secondly, there is a thermistor which causes the circuit to activate and the warning lamp to light when the temperature of the engine reaches a certain level providing, of course, the choke control is out (i.e. choke is in use).

CIRCUIT

The circuit diagram of the Choke Warning Device is shown in Fig. 1 and uses an operational amplifier (op-amp), IC1. The cheapest type—the 741—is specified. For those constructors who have not used operational amplifiers before, a much- simplified description is included. The operational amplifier, which is housed in an 8-pin d.i.l. package, has two inputs and one output as well as positive and negative power supply connections. The input to pin 2 is called the "−" or "inverting" input whilst the input to pin 3 is called the "+" or "non-inverting" input. The output is at pin 6. If the non-inverting input is at a higher voltage than the inverting input, the output will high, otherwise it will be low. These voltages are measured with respect to the earth (negative) line.

CIRCUIT DESCRIPTION

In the circuit of Fig. 1 the inverting input voltage is obtained from the slider of the potentiometer VR1 which is connected between supply positive and negative. In this way any voltage between zero and full battery voltage (nominally 12 volts) may be supplied to pin 2.

The voltage to the non-inverting input is derived from the potential divided formed by the fixed resistor R1 and the thermistor RTH1 which has a negative temperature coefficient of resistance, that is to say, its resistance reduces as the temperature of the device rises. The thermistor will be remote from the rest of the circuit where it can sense the temperature of the engine.

With VR1 correctly adjusted, the output from the op-amp will be high at and above a certain engine temperature. This will only be indicated on LP1, of course, if the choke control is not in use the circuit does not receive power and LP1 is off.

As the output from the op-amp is not sufficient to operate a filament panel light the rest of the circuit is designed to do this. It consists of two transistors connected as a *Darlington pair*. This gives a very sharp response. When the op-amp switches on, it turns on TR1 which turns on TR2 and hence the indicator. When the engine reaches a certain temperature, then, the indicator lamp will switch on sharply. It will be noted that the variations in voltage which always occur in car battery systems are of no consequence.

Preset VR2 is provided to match the output from the op-amp to the Darlington pair. This will be set to give the correct operation since there are variations in transistors even of the same type.

The panel light will be chosen to blend with the rest of the equipment on the dashboard and can be a 12 volt type rated at up to 3 watts. It may be mounted anywhere to give a neat appearance although a conspicuous position is needed. The author used a panel indicator of the throw-away type. These are particularly small and neat but the bulb cannot be replaced.

The author drilled a very small hole in the position illustrated in Fig. 2. An ordinary *lever arm* microswitch was then modified by bending the arm very gently then filing the end to a needle.

A suitable bracket was made out of aluminium to support the switch behind the dashboard in such a way that the filed end protruded through the hole a short distance. The switch was so positioned that the choke control knob just switched it off when it was pushed fully in. This may not be possible with some cars.

In more difficult cases the rotary type of microswitch which is

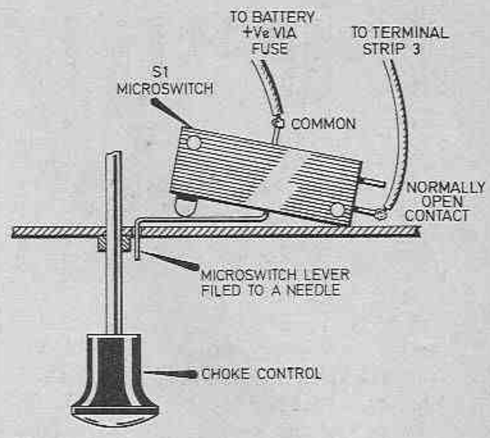


Fig. 2. One method of mounting the microswitch.

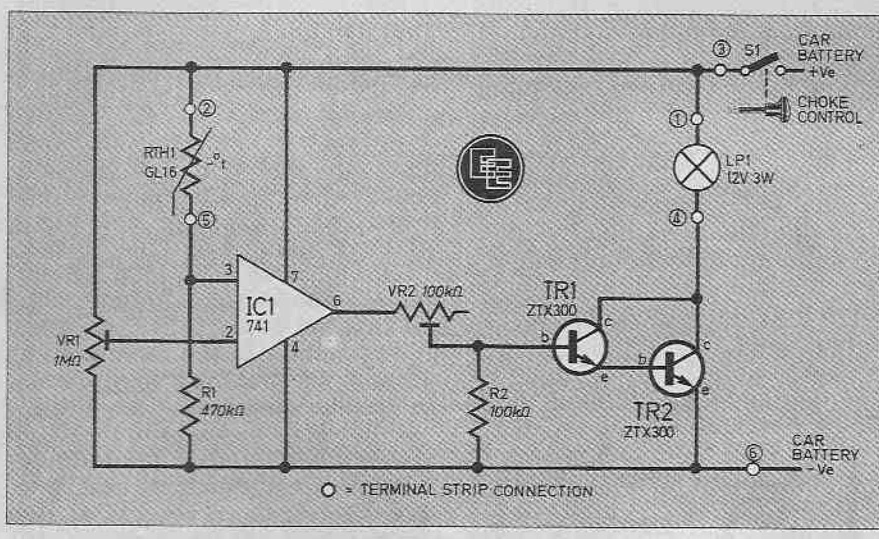


Fig. 1. Complete circuit diagram of the Choke Warning Device.

CONSTRUCTION starts here

MICROSWITCH

The microswitch at the choke control presents the greater problem and the constructor is strongly advised to check his particular car to make sure that it is possible to fit it before building the actual circuit.

Although certain models and light vans have a lever-operated choke control which lends well to direct operation of a microswitch, most cars have a knob which is pulled out from the dashboard. operated by a piece of wire may be considered. The controlling wire may be bent into a variety of shapes so that the switch may be sited conveniently. In this case care must be taken in choosing suitable wire.

In all this work one thing must be borne in mind. The action of the microswitch must on no account interfere with the operation of the choke control. The control knob must be able to return to its "off" position without obstruction. Only when the constructor is certain that the job can be done should he continue.

As stated previously, the microswitch will switch off when the lever is held in. This means that normally open contacts will be used. The correct contacts may be found by checking with a simple battery and bulb circuit but there is often a diagram of the contact arrangements on the body of the switch itself.

THERMISTOR

The thermistor is a very delicate component and must be adequately protected. At the same time it must efficiently pick up engine heat. When considering any other method than that suggested it must be remembered that cool air flows freely in the engine compartment so unless the thermal contact is efficient the device will give all sorts of false results depending on the speed of the car. Thin aluminium was used to make the holder for RTH1 as illustrated in Fig. 3. For the prototype the aluminium from an old "Anadin" tin was used. Any other thin aluminium container may be cut up to serve the same purpose.

The channel for the thermistor was made using a nail—the aluminium being squeezed around it using pliers. This nail should be slightly larger than the diameter of the thermistor so that this may be secured deeply in the channel using quick setting epoxy resin adhesive or similar.

The delicate leads from the thermistor should be sleeved with short lengths of plastic insulation.

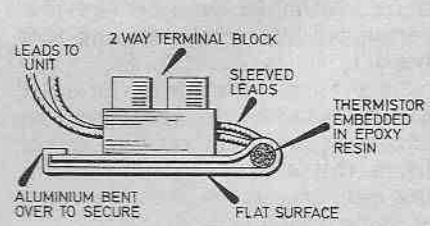


Fig. 3. A small holder is constructed as shown to accommodate the thermistor.

COMPONENTS approximate cost £3·60

Neither lead must be in contact with the aluminium. The leads should then be brought to a small two-way connector block stuck to the top of the aluminium using the same adhesive.

All materials must be capable of withstanding boiling water temperature at least. The complete assembly should then be attached, again using epoxy resin adhesive, to a suitable metal part of the car engine. It should be kept well clear of the exhaust system and any moving parts.

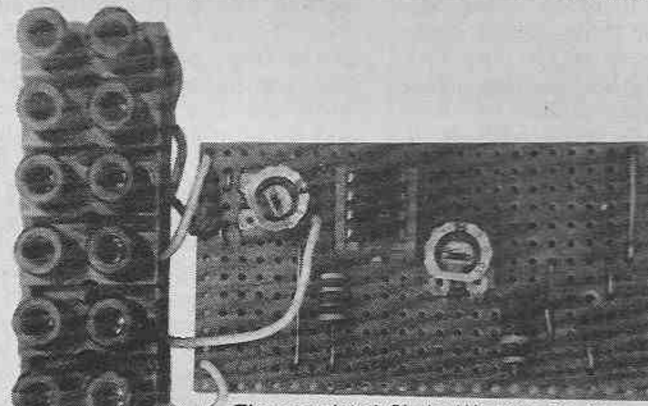
The author found that the best position was horizontal as no support was needed as the adhesive hardened. It is best to spend some time finding the most suitable place by running the car for a short while then, with the engine switched off, feeling for a good flat surface which is warm to the touch.

Before attaching the thermistor assembly make sure that all traces of oil and dirt have been removed—detergent may be used—to ensure good adhesion. It was found that the clip could be subsequently lifted with one's finger nail, so the device is easy to replace at any time.

CONSTRUCTION

Construction of the circuit panel itself is very straightforward and non-critical. The suggested layout is shown in Fig. 4 and is based on 0·1 inch pitch stripboard 25 holes by 15 strips. The copper strip must be broken in the places indicated using either a special stripboard tool, a small twist drill or a penknife. Although an i.c. holder is recommended for the op-amp it is possible to solder it direct to the circuit board. This saves a little money but is hardly worthwhile as the i.c. could easily be damaged by excessive heat from the soldering iron.

Be careful to insert the op-amp the correct way round in the holder. Soldering the components



The completed Choke Warning Device.

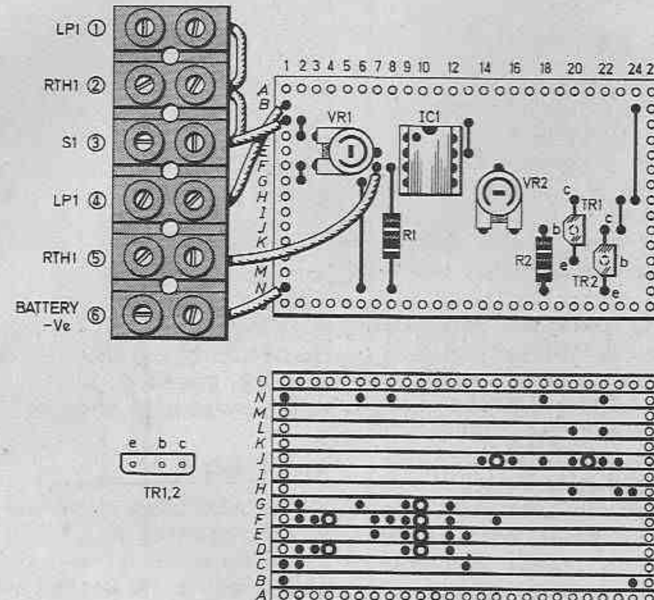


Fig. 4. Stripboard layout, also showing the breaks to be made and other wiring.

COMPONENTS

Resistors
R1 470k Ω
R2 100k Ω
Both 2 watt carbon ±10%

Potentiometers
VR1 1M Ω miniature preset
VR2 100k Ω miniature preset

Semiconductors
TR1, 2 ZTX300 silicon *npn* (2 off)
IC1 741 operational amplifier (8 pin d.i.l.)

Miscellaneous
RTH1 GL16 or similar bead type thermistor approximately 1 megohm at 20°C
LP1 12 volts up to 3 watts
S1 lever-operated microswitch with one normally open contact
Stripboard: 0·1 inch matrix 15 strips × 25 holes; 8-pin d.i.l. socket to suit IC1; 5A terminal block 8-way; standard connecting wire.

See Shop Talk page 236

must be carried out with great care especially to avoid "bridging" between copper strips. Use a heat-shunt on the leads of TR1 and TR2 when soldering in position. The whole circuit should then be carefully checked. To begin with, both VR1 and VR2 should be set at approximately mid-position. The external connections—i.e. thermistor leads, microswitch and panel light connections are brought out to a small strip of terminal block. The circuit may then be mounted in a small plastic box. All external wiring to the terminal block must be done with stranded wire as single wire soon fails under vibration.

NEGATIVE EARTH

If the car is *negative earth* i.e. the car's battery negative terminal is connected directly to the car body then the negative connection for the circuit is also earthed by taking the lead to a small eyelet and securing it to a self-tapping screw attached to a nearby metal body part.

The positive connection will then be taken to the microswitch and the other microswitch terminal taken to the battery positive. This must not be a direct connection but to a fuse which is only 'live' when the ignition is switched on. There are usually spare outlets from the fuse made with spade type connectors readily available from a motor accessory shop.

It is important to make the connection to the correct side of the fuse. If it is taken to the live side of the fuse (direct to the battery) then, although the circuit will work, the fuse will be ineffective and this could be dangerous in the event of a short circuit. If in doubt a simple check may be made with a 12 volt bulb.

With the fuse removed and one side of the bulb earthed the live side of the fuse may be found. The connection should then be made to the other side of the fuse which is then replaced. During this check the ignition should be switched on.

POSITIVE EARTH

If the car is of the *positive earth* type then the procedure is slightly different. In this case, the positive lead from the circuit panel is earthed and the negative lead taken to the microswitch and then to the fuse. The connections are made in exactly the same way.

Make sure that the wires leading from the thermistor unit into the car are protected by a rubber grommet as they pass through the chassis. In many cases space in an existing grommet can be found which saves a lot of time.

SETTING UP

The unit is checked and set up in the following way. With the ignition switched on and the choke pulled out a little (but with the engine not running), VR1 should be adjusted one way and then the other. The panel light should come on and go off; VR2 should be adjusted if necessary to give the best effect. When the choke control is pushed in the lamp should go off.

It should be noted that the choke control should not be used excessively during checking as it could lead to difficult starting next time. Preset VR1 should then be left so that the light is just off. The engine should then be started and allowed to run a little. The light should come on as the engine warms up (the choke has to be out, of course). A test drive with an assistant will be needed to set VR1 correctly and over the next day or two further adjustment may be needed. The light should come on when the engine will run comfortably without choke.

It is important to regard this as a device to act as a reminder should the choke be left out. It is not intended as a device to signal the driver when to put the choke in. The choke should be used progressively in the usual way. It should be pushed completely in as soon as possible—the driver should not wait for the light to come on.

Some high-quality cars are already fitted with a choke warning light as standard equipment. You can now put your car into the same category—cheaply! ⌑

By Dave Barrington

Component Catalogue

It was only recently that we had cause to pass the comment on a catalogue received, ". . . and feel it does not do justice to the service this company provides". We are happy to report that the complete opposite is true of the latest components catalogue received from Watford Electronics.

In keeping with the quality of service this company provides, it would seem that no expense has been spared in the production of their very first components catalogue. Using top quality paper, the pages of the catalogue are clearly laid out with a large main heading and page number at the top.

Most pages are sub-divided into various types under the main heading and contain details of the products, including prices. Also included on most pages is a photograph or illustration of the listed components.

The 13 page transistor section is very good and lists the main parameters and case outlines of over 600 devices. The pages covering integrated circuits lists the type number and function, but do not give pinning details. Apart from components, complete construction kits, audio equipment and test gear are also listed.

It's refreshing to see that Watford have devoted two pages, one in the form of a specimen order, on how to order components. At 50p (plus 25p post and packing) the cost of the 92 page Watford Electronics Components Catalogue is money well spent.

CONSTRUCTIONAL PROJECTS

The components for this month's constructional projects are listed in most of our advertisers' catalogues. Provided readers have taken our advice over the past months and stocked up on new editions, as they became available, there should be no component buying problems.

However, regarding the *Shaver Inverter* this calls for some Ferranti transistors which may prove troublesome to locate. A complete kit of parts can be obtained from Davian Electronics, 13 Deepdale Avenue, Royton, Oldham OL2 6XD. Price £10·80, including p & p.

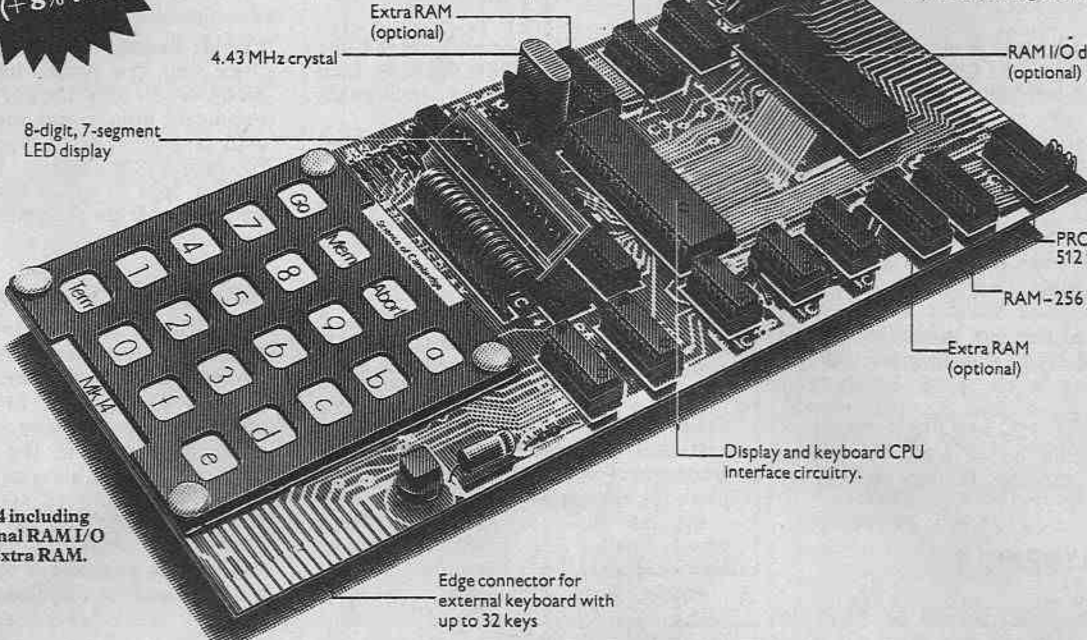
POWER SUPPLY

It would appear from correspondence received that some readers are experiencing difficulty in obtaining the CA3085 specified in the *General Purpose Power Supply* published in our February issue.

The LM305H from Watford Electronics is a direct pin-for-pin replacement.

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory – and peripherals!

Optional extras include:

1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

●Hexadecimal keyboard ● 8-digit, 7-segment LED display ● 8 x 512 PROM, containing monitor program and interface instructions ●256 bytes of RAM ● 4 MHz crystal ● 5 V regulator ● Single 8 V power supply ● Space available for extra 256-byte RAM and 16 port I/O ● Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Please send me the following, plus details of other peripherals:

☐ MK 14 Standard Microcomputer Kit @ £43.55 (inc 40p p&p.)
☐ Extra RAM @ £3.88 (inc p&p.)
☐ RAM I/O device @ £8.42 (inc p&p.)

I enclose cheque/money order/PO for £________ (indicate total amount.)

Name________________
Address (please print)________________
____
____
____

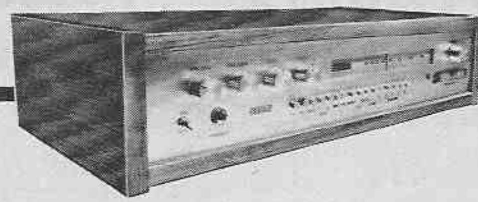
EE4 Allow 21 days for delivery.

Science of Cambridge

EE2020 TUNER AMPLIFIER PART 5

BY E.A. RULE

HI-FI SERIES



WE have now arrived at what is likely to be the most interesting and absorbing stage in the construction of the 2020: the final assembly of parts and wiring up. The latter is a comparatively large task calling for close attention and care throughout, but this work is readily divided into logical stages and can be carried out over a number of sessions, as convenient to the individual constructor.

First read through the whole of this article and study the diagrams. When commencing work, have before you Parts 1, 2, 3 and 4. The circuit diagrams Fig. 1.2a and Fig. 1.2b in particular should be at hand for cross-reference throughout the wiring-up operation.

FINAL ASSEMBLY

Rear Panel

The rear panel should be fitted to the base plate (as per Part 4). Now assemble the rear panel components as shown in Fig. 5.3.

See Fig. 5.1 for details of preforming the power transistor leads and assembly of associated items. Correct positioning of the mica washer is most important.

The aerial coaxial socket, the four power transistors, the two fuse holders, the solder tag and the resistor R104 are secured with 6BA $\frac{1}{2}$ inch screws and nuts. All other components have their own locking nuts.

Fit a grommet to the mains lead hole.

Main Base Plate

Secure the mains transformer. Secure the three electrolytic capacitors C55a, b and C58 (as shown in Fig. 5.3) in their clips with 6BA 1 inch screws and nuts. Fit the R. F. Unit with 4BA $\frac{3}{8}$ inch screws and nuts.

Front Panel

It will be more convenient if the front panel is removed from the base plate for the following operation.

Fit the three l.e.d.s to the front panel, having first fitted the correct bushes in each hole, Fig. 5.2a.

Solder two thin leads (about 6 inches in length) to each of the three l.e.d.s, D1, D2 and D3. Now refit the front panel (with the scale panel assembly mounted) to the base plate (five 8BA C/SK screws and nuts). Bring the six l.e.d. leads up and hook temporarily over the tuning drum bracket to clear the area for Board A.

NOTE. The mains switch and the phones jack should NOT be fitted at this stage.

Circuit Boards

Fit the five p.c.b.s on to the base plate, Fig. 5.3. Locate boards over mounting pillars and push down onto seat of pillars. (If it is ever necessary to remove a board, pinch in the sprung legs to allow the board to be withdrawn from the pillars.)

INTER-UNIT WIRING

Providing that the specified components have been used and the wiring diagrams are studied carefully, no difficulty should be encountered with the final wiring. Position the wires as shown in the photographs, since the wiring diagrams have been drawn for clarity of connections and do not show the actual physical routing or layout of the wires and cables. The position of the wires is not critical and if in doubt take the shortest route around the p.c.b.s. Do not drape wires across the p.c.b.s except where there is no alternative.

Longer "runs" such as wires from the front panel to the rear panel should dressed closely against the flanges of the base plate, along the side and near edges.

Use plastic covered tinned stranded copper wire 7/0·2mm for all wiring, except where otherwise stated.

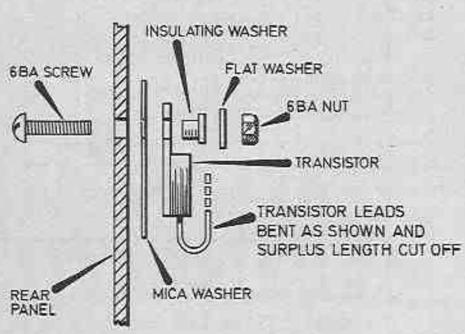


Fig. 5.1. Power transistors: preforming leads and assembly onto rear panel.

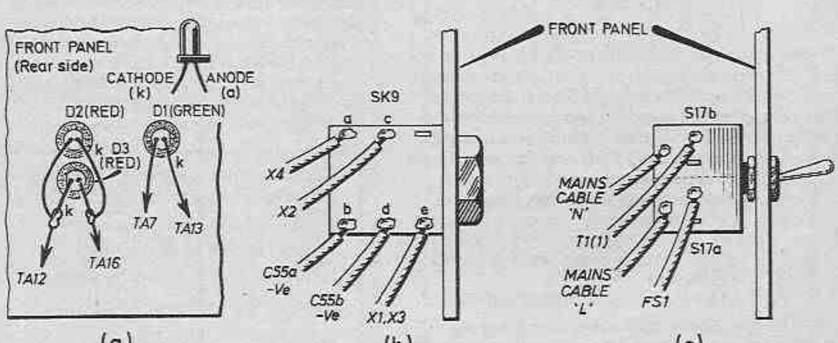


Fig. 5.2. Front panel components wiring details: (a) l.e.d. tuning indicators (b) phones jack socket (c) mains on/off switch.

WIRING SCHEDULE

STAGE 1—BOARD A

First complete the on-board wiring, that is TA3, TA7 and the three l.e.d.s, D1, D2 and D3. The leads already attached to D2 and D3 should be shortened to about two inches, which will be adequate to reach TA12 and TA16.

Care is required when making connections to TA12, TA14 and TA16 which are immediately under the tuning drum.

Proceed with remainder of Terminal Pins in numerical order as given in table.

NOTE: Tuning meter/pushbutton wiring is dealt with later under Stage 11.

See Figs. 5.2a, 5.3, 5.4, 5.5.

Terminal Pin	*Wire to*
TA1	R.F. Unit(8)
TA2	R.F. Unit(6) (screen)
TA3	TA7
TA4	S2a
TA5	R.F. Unit(3)
TA6	S2a
TA7	*(i)* R.F. Unit(4) *(ii)* TA3 *(iii)* D1
TA8	not used
TA9	not used
TA10	S13a (Board B)
TA11	S13b (Board B)
TA12	D2, D3
TA13	D1
TA14	R.F. Unit(5)
TA15	VR3
TA16	D2 and D3
TA17	VR3
TA18	S2b

P.B. Switches (topside)

S2a	ME1(a)	Stage 11
S2b	ME1(b)	Stage 11
S3	VR3 (slider)	Stage 11

STAGE 2—R.F. UNIT

See Fig. 5.3.

Pin	*Wire to*	
1	Aerial socket SK1	coaxial cable
2	Aerial socket SK1 (screen)	coaxial cable
3	TA5	
4	*(i)* TA7 *(ii)* TC3	
5	*(i)* TA14 *(ii)* C1+ve	
8	TA1	
6, 7 linked	*(i)* TA2 (screen) *(ii)* C1−ve	

STAGE 3—BOARD B

NOTE: Screened wiring to push-button switches S10, S11, S12, and S16 is dealt with later, under Stage 10. Likewise, screened cables to VR13 and VR14.

See Figs. 5.3, 5.4.

Terminal Pin	*Wire to*	
TB1	not used	
TB2	TE5	
TB3a	VR13	
TB3b	VR13	Stage 10
TB4	VR14	Stage 10
TB5a	VR11a	
TB5b	VR11b	
TB6a	VR11a slider	
TB6b	VR11b slider	
TB7a	VR11a	
TB7b	VR11b	
TB8a	VR12a	
TB8b	VR12b	
TB9a	VR12a slider	
TB9b	VR12b slider	
TB10a	VR12a	
TB10b	VR12b	

P.B. Switches (Topside)

Switch	*Wire to*	
S9	no connection	
S13a	TA10 (Board A)	
S13b	TA11 (Board A)	
S12a	TC1a	Stage 10
S12b	TC1b	Stage 10
S11		Stage 10
S10		Stage 10
S16		Stage 10
S15	no connection	
S14	no connection	

STAGE 4—BOARD C

NOTE: Connection of screened cables to TC1a and TC1b should be left until Stage 10.

See Figs 5.3, 5.4

Terminal Pin	*Wire to*	
TC1a	S12a	Stage 10
TC1b	S12b	Stage 10
TC2	not used	
TC3	*(i)* R.F. Unit(4) *(ii)* TE9	
TC4a	SK4a	
TC4b	SK4b	
TC5	SK4a, b (earth)	

STAGE 5—BOARD D

All connections to be made with 16/0·2mm wire.

NOTE: Connection of screened cables to TD1a and TD1b should be left to Stage 10.

See Figs. 5.3, 5.4.

Terminal Pin	*Wire to*	
TD1a	VR14a slider	Stage 10
TD1b	VR14b slider	Stage 10
TD2	common screens	
TD3	C58−ve	
TD4a	TR20a, base	
TD4b	TR20b, base	
TD5a	TR20a collector	
TD5b	TR20b, collector	
TD6a	TR20a, emitter	
TD6b	TR20b, emitter	
TD7a	TR22a, base	
TD7b	TR22b, base	
TD8a	TR22a, collector	
TD8b	TR22b, collector	
TD9a	TR22a, emitter	
TD9b	TR22b, emitter	
TD10a	FS2	
TD10b	FS3	
TD11	C58−ve	
TD12a	C55a+ve	
TD12b	C55b+ve	
TD13a	C55a−ve	
TD13b	C55b−ve	

STAGE 6—BOARD E

All connections (except pair to ME1) to be made with 16/0·2 mm wire. For ME1 use 7/0·2mm, or thinner wire.

ME1 connections should be left until Stage 11.

Other side of C65 is connected to base plate by solder tag.

See Figs. 5.3, 5.4.

Terminal Pin	*Wire to*	
TE1	R104	
TE2	C58–ve	
TE3	C58+ve	
TE4	C58–ve	
TE5	*(i)* TB2 *(ii)* C65	
TE6	T1(20V)	
TE7	T1(OV)	
TE8	ME1(c)	Stage 11
TE9	*(i)* ME1(d) *(ii)* TC3	Stage 11
TE10	R104	
TE11	not used	

STAGE 7—MAINS TRANSFORMER

Use 16/0·2mm wire.

See Figs. 5.2c, 5.3.

Primary	*Wire to*
1	S17b
2, 3	linked
4	FS1
SCREEN	Earth terminal
Secondary	*Wire to*
0	TE7
20V, 0V	linked
20V	TE6

STAGE 8—FRONT PANEL COMPONENTS

First fit SK9 to the front panel, and wire up. Then fit S17 and wire up. Feed mains cable through grommet in rear panel. Connect earth lead to Earth Terminal tag.

Use 16/0·2mm wire for S17 connections.

See Figs. 5.2, 5.3.

	Wire to
SK9a	X4
b	C55a-ve
c	X2
d	C55b-ve
e	X1, X3
S17a	Mains Cable "L"
S17a	FS1
S17b	Mains Cable "N"
S17b	T1(1)

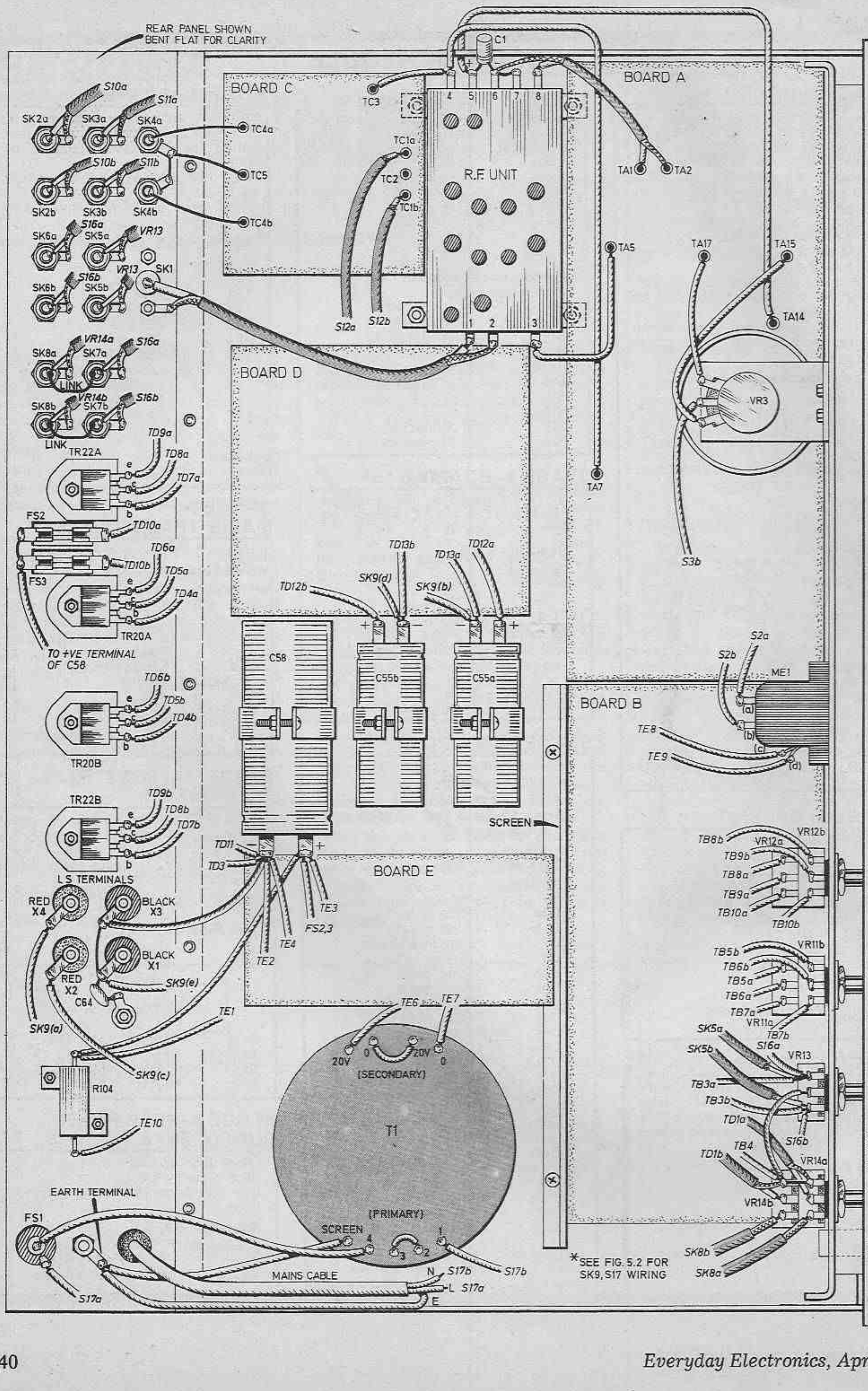
STAGE 9—REAR PANEL COMPONENTS

Other side of C64 is connected to base plate by solder tag.

Use 16/0·2mm wire for all connections.

See Figs. 5.3, 5.4

Component	*Wire to*
FS2	TD10a
FS3	TD10b


REAR PANEL SHOWN BENT FLAT FOR CLARITY
BOARD C
BOARD A
BOARD D
BOARD B
BOARD E
R.F. UNIT
C1
TC3
TC4a
TC5
TC4b
TC1a
TC2
TC1b
TA1
TA2
TA5
TA17
TA15
TA14
TA7
VR3
S3b
S12a
S12b
SK2a
SK3a
SK4a
SK2b
SK3b
SK4b
S10a
S11a
S10b
S11b
SK6a
SK5a
S16a
VR13
SK6b
SK5b
S16b
SK1
SK8a
SK7a
VR14a
S16a
LINK
SK8b
SK7b
VR14b
S16b
TR22A
TD9a
TD8a
TD7a
FS2
TD10a
TD10b
FS3
TD6a
TD5a
TD4a
TR20A
TO +VE TERMINAL OF C58
TD6b
TD5b
TD4b
TR20B
TR22B
TD9b
TD8b
TD7b
L.S TERMINALS
RED X4
BLACK X3
RED X2
BLACK X1
C64
SK9(e)
SK9(a)
SK9(c)
TE1
R104
TE10
EARTH TERMINAL
FS1
S17a
MAINS CABLE
N
L
E
S17b
S17a
TD13b
TD12a
TD12b
SK9(d)
TD13a
SK9(b)
C58
C55b
C55a
TD11
TD3
TE2
TE4
FS2,3
TE3
TE6
TE7
20V
0
20V
0
(SECONDARY)
T1
(PRIMARY)
SCREEN
4
3
2
1
S17b
SCREEN
S2a
S2b
ME1
TE8
TE9
(a)
(b)
(c)
(d)
TB8b
VR12a
VR12b
TB9b
TB8a
TB9a
TB10a
TB10b
TREBLE
TB5b
VR11b
TB6b
TB5a
TB6a
TB7a
VR11a
TB7b
BASS
SK5a
SK5b
S16a
VR13
TB3a
TB3b
TD1a
S16b
BALANCE
TD1b
TB4
VR14a
VR14b
SK9*
VOLUME
SK8b
SK8a
S17*
*SEE FIG. 5.2 FOR SK9, S17 WIRING

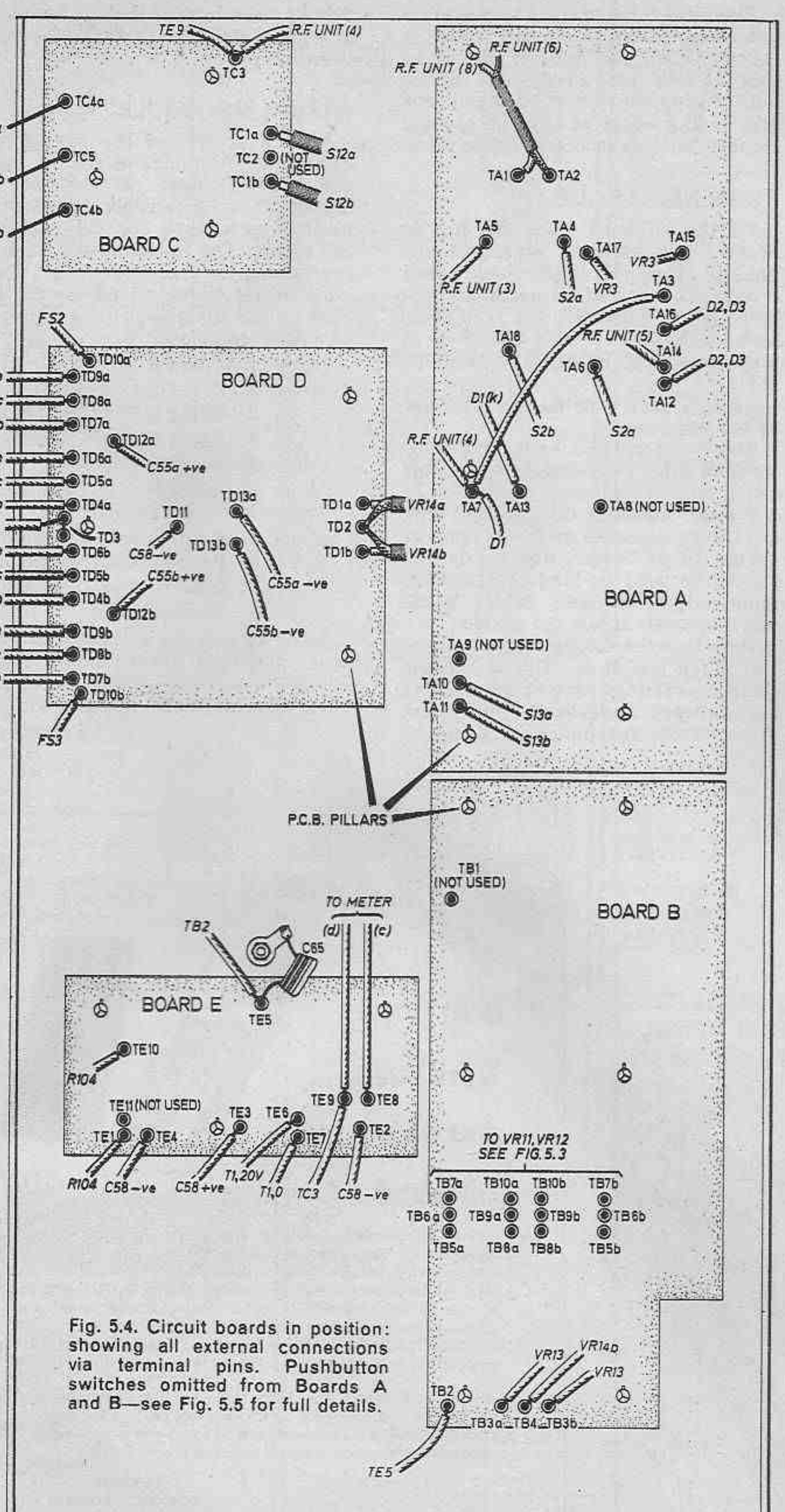


Fig. 5.4. Circuit boards in position: showing all external connections via terminal pins. Pushbutton switches omitted from Boards A and B—see Fig. 5.5 for full details.

Fig. 5.3. (Left) Main assembly: chassis-mounted components with wiring details. For circuit boards see Fig. 5.4. Observe carefully the screen arrangements for each individual cable; on some, no connection is made to the screen at this end.

FS2,3	(com.)	C58+ve
TR22a	(base)	TD7a
	(collector)	TD8a
	(emitter)	TD9a
TR20a	(base)	TD4a
	(collector)	TD5a
	(emitter)	TD6a
TR20b	(base)	TD4b
	(collector)	TD5b
	(emitter)	TD6b
TR22b	(base)	TD7b
	(collector)	TD8b
	(emitter)	TD9b
X4 (Red)		SK9(a)
X2 (Red)		SK9(c)
X1,2 (Black)		(*i*)SK9(e) (*ii*)C58–ve (*iii*)C64
SK4a		TC4a
SK4b		TC4b
SK4a, b (earth)		TC5
R104		(*i*)C58+ve (*ii*)TE1 TE10
FS1		(*i*)S17a (*ii*)T1(4)
Earth terminal		(*i*)Mains cable "E" (*ii*)T1(screen)

STAGE 10—SCREENED CABLES

Use coaxial cable for SK1.
For all other connections use lightweight screened cable.
Note the correct termination for each cable. Screening must be earthed ONLY where indicated in the diagrams.

See Figs. 5.3, 5.4, 5.5.

(a) Input/Output Sockets

Socket	*Name*	*Wire to*
SK1	Aerial	R.F. Unit (1) inner (2) screen
SK2a	Aux. 1	S10a
SK2b	Aux. 1	S10b
SK3a	Aux. 2	S11a
SK3b	Aux. 2	S11b
SK5a	Tape Out	VR13
SK5b	Tape Out	VR13
SK6a	Tape in	S16a
SK6b	Tape In	S16b
SK7a	Amp. Out	S16a
SK7b	Amp. Out	S16b
SK8a	Amp. In	VR14a
SK8b	Amp. In	VR14b

(b) Complete all remaining screened cable connections, see stages 3, 4 and 5. Add links to SK7—8.

STAGE 11—TUNING METER AND POTENTIOMETER

See Fig. 5.3, 5.4, 5.5.

ME1	*Wire to*
a	S2a
b	S2b
c	TE8
d	TE9
VR3	
Slider	S3b TA15 TA17

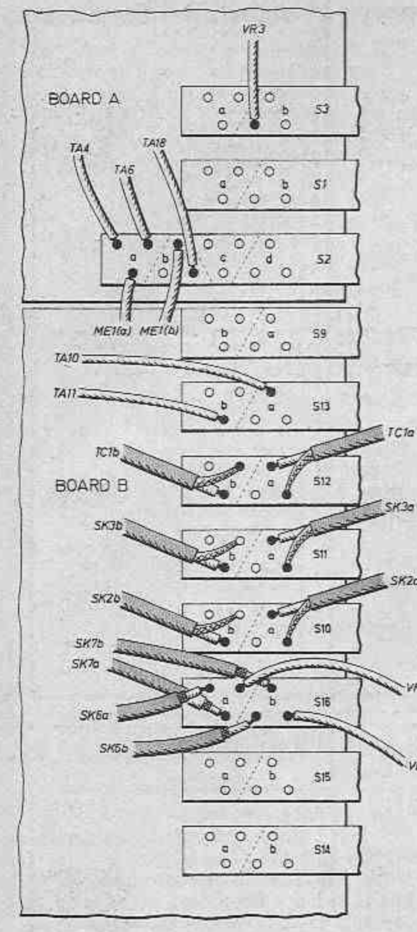


Fig. 5.5. Pushbutton switches: wiring details. Observe carefully the screen arrangements for each individual cable. The screening on cables associated with S16 is NOT connected at this end.

This kind of connecting wire is available in a variety of colours, and it is recommended that several colours be used to help identification of wiring both during the initial wiring-up and also in the event of any subsequent trouble-shooting or maintenance work.

SCREENED LEADS

Fit the screened leads last but do observe the earthing arrangements: not all screened leads have their braiding connected to earth at both ends: this is deliberate and is to avoid hum loops. Use 7/0·1mm (single core) p.v.c. insulated lightweight screened cable.

Tick off each wire on the diagrams as you progress.

Twist and tin the ends of flexible wires to avoid "whiskers" which could cause shorts to adjacent pins etc.

Plastic cable ties can be used with advantage to secure groups of leads or cables. In particular, five or six ties should be used to bind together the input/output screened cables which run diagonally across the chassis.

Note that the tuning meter is fitted and wired last of all. This is because some connections have to be made to the switches underneath the meter. When fitting the meter it should be held in place by double-sided Sellotape at each end, between the meter and the scale pan.

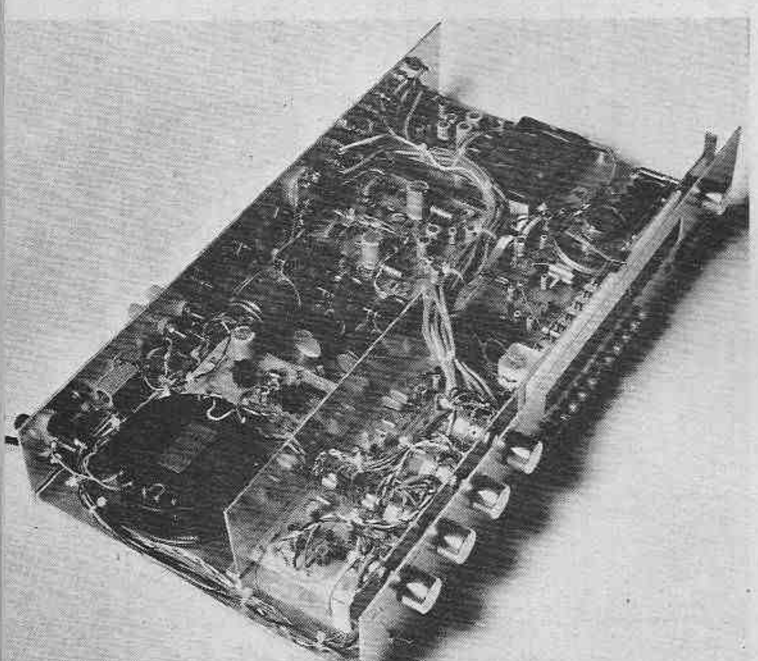
WIRING SCHEDULE

With a project of the size of the 2020 Tuner Amplifier where the work will extend over a number of "sessions" it is sensible to adopt a planned procedure for carrying out the wiring. The following sequence of operations is recommended. Each item should be ticked off on the list (and on the diagrams) immediately it has been completed.

Stage 1	Board A
Stage 2	R. F. Unit
Stage 3	Board B
Stage 4	Board C
Stage 5	Board D
Stage 6	Board E
Stage 7	Mains Transformer
Stage 8	Front Panel Components
Stage 9	Rear Panel Components
Stage 10	Input/Output Connections
Stage 11	Tuning Meter

Some operations will have already been completed, during earlier stages —but this comprehensive listing provides a useful double check.

To be continued



QUARTZ LCD 5 Function

Hours, mins., secs., month, date, auto calendar, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.

Very slim, only 6mm thick.

M1

QUARTZ LCD 7 Function

Hours, mins., secs., month, date, auto calendar, back-light, seconds STOP WATCH.

£9.65

Guaranteed same day despatch.

Very slim, only 6mm thick.

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet.

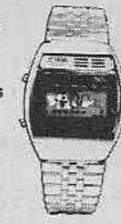
Metac Price

£12.65 Thousands sold!

Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 6 Function

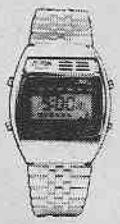


Hours, mins., secs., month, date, back-light, 24 hour ALARM. Adjustable stainless steel bracelet. Only 9mm thick.

£16.65

M4

QUARTZ LCD ALARM 7 Function



Hours, mins., secs., day, date, alpha day, back-light, auto calendar. Adjustable stainless steel bracelet. Only 9mm thick.

£19.65

M5

QUARTZ LCD Alarm Chronograph with Dual Time Zone Facility

Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication. Perpetual calendar, day, date, month and year. 24 hour alarm with on/off indication. 1/10 second chronograph measuring net, lap and first and second place times. Dual time zone facility night light. Only 9mm thick.

£27.65

M6

QUARTZ LCD Alarm Chrono with front alarm

Dual time. Ten function, 6 digit. Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light.

£29.65

M7

QUARTZ LCD Alarm Chrono

Ten function, 6 digit. Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light. FRONT BUTTON OPERATION.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

6 digit, 11 function. Hours, mins., secs. 1/100, 1/10 secs., mins. Split and lap modules. Auto calendar and back light. Powered from solar panel with battery back-up.

£15.95

M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

£105.00

M10

SEIKO Chronograph

LCD, hours, mins., secs., day of week, month, day, date, 12 hour chronograph, 1/10th secs. and lap-time. Back light, stainless steel water resistant, HARDLEX glass.

List Price £85.00

METAC PRICE

£68.00

M11

SOLAR QUARTZ LCD 5 Function

Genuine Solar

Solar panel with battery back-up. Back light and auto calendar. Hours, mins., secs., day, date. Quality metal bracelet.

£ 9.95

Guaranteed same day despatch.

M12

HANIMEX Electronic LED Alarm Clock

Features and Specification: Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm). Weight: 1.43 lbs (0.65 kg).

£8.65

Guaranteed same day despatch.

M13

QUARTZ LCD Ladies Slim Bracelet

5 function.

Hours, mins., secs., day, date and back light and auto calendar. Elegant metal bracelet in silver or gold. State preference.

£15.95

Guaranteed same day despatch.

M14

QUARTZ LCD Ladies 5 Function

Only 25 x 20mm and 6mm thick. 5 function. Hours, mins., secs., day, date and back light and auto calendar. Elegant metal bracelet in silver or gold. State preference.

£9.95

Guaranteed same day despatch.

M15

DIGITAL LED CLOCK

Automatic brightness control. Weekend alarm cancel.

Features and Specification: Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on-off control. Display flashing for power loss indicator. Repeatable 9-minute snooze. Automatic brightness control. Weekend alarm cancel.

£10.95

M16

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RADIO WORLD

By Pat Hawker, G3VA

A Balanced Level

ONE COMPLAINT which all broadcasting organisations receive frequently is that some listeners consider the balance between the levels of speech and music (or between programmes and advertisements) is poor and results in having to keep adjusting the volume control.

In practice broadcasters go to considerable trouble to try to ensure a correct balance (the IBA for example specifies peak programme levels in nine different categories to take into account subjective differences between music and speech in differing degrees of comparison). Of course, sometimes operational mistakes are made but the simple truth is that it is impossible to please all listeners all of the time—and for very good technical reasons.

Work carried out in Finland some years ago, involving over 3000 listeners, showed conclusively that: (a) young people have preference towards music sounding louder than that preferred by older listeners; (b) what is recognised as a "good balance" between speech and music differs for light and pop music and classical music; (c) preferred listening levels may fall by as much as 6dB in the 20 minutes following the start of listening; (d) people living in cities are appreciably less critical of "loud" sounding music than those living in the country; and (e) in a noisy environment (particularly applicable to listening to car radios) listeners require speech to be some 6dB louder, compared to music, than in a quiet domestic environment.

With all these variations, it is no wonder that broadcasters are still, after 50 years of broadcasting, unable to satisfy all listeners, all of the time.

Exorcising TV Ghosts

One of the most common defects of TV pictures as seen by the ordinary viewer is the ghost image(s) caused by multipath reception due to the radio signals bouncing off high buildings, towers, hills and mountains. Multipath can also produce problems in the reception of "teletext" pages since even short "echoes" can sometimes result in errors. Of course, it is often possible to reduce or even eliminate ghosts by careful choice and adjustment of aerials but at times one comes up against the really persistent ghost.

Today there is a promising technique that seems capable of eliminating one or more ghosts: the charge-coupled-device (c.c.d.) which can be used as a delay line in order to provide a signal which cancels out the ghost(s). Some very successful work along these lines has been reported by the Technical Research Laboratories of NHK, Japan. They have shown that a 64-element (or preferably a 128-element) c.c.d. could bring a substantial improvement.

It still remains to be seen whether the cost of such devices, in mass production, can be reduced to a price that would enable them to be put into the ordinary TV set.

Amateurs into Space

Amateur radio enthusiasts have long been proud of the contribution made to space communications by the *OSCAR* ("Orbiting Satellite Carrying Amateur Radio") series of satellites of which the first was launched as long ago as December 1961. Apart from making posible long-distance contacts on 144 and 432MHz transmissions they have proved of enormous educational value in space techniques.

Today there are a number of amateur satellites in orbit, both American and Russian, with the equipment built by amateur groups in a number of countries, including West Germany and Australia. But so far no amateur satellite equipment built in Britain has ever been launched.

Now however a serious attempt to build the first such spacecraft is being undertaken at the University of Surrey, with the support of British industry and the AMSAT-UK group. One of the aims of this work is to provide "real-time" ionospheric data of interest to h.f. as well as v.h.f. amateur operators, as well as a number of experiments of general interest. The project is under the management of Martin Sweeting, G3-YJO.

Another specialised field of amateur radio that seems to be attracting increasing support and practical activity in the U.K. is the use of the moon as a large passive reflector: in other words bouncing signals off its surface (moonbounce) to provide a earth-moon-earth path for v.h.f. or u.h.f. signals.

This is no easy task and indeed is difficult to achieve even with a special 1kW transmitter permit, since it requires a highly sensitive and stable receiver of restricted bandwidth and very high-gain aerials in order to wrinkle out the very weak returning echoes. The path loss is between about 258dB at 300MHz increasing to some 290dB at about 10GHz, and a path loss of 280dB means that to receive back one micromicrowatt of power, an effective radiated power of some 10-million-million kilowatts would have to be shot along the line of the aerial beam!

Because higher aerial gains can be more readily achieved at 432MHz and above, most amateur moonbounce operations have been on u.h.f., but recently a South Wales amateur, David Price, GW4CQT has completed a "worked all continents" feat on 144MHz, possibly a world first for amateur moonbounce.

Commercial and professional interest in moonbounce largely disappeared with the development of the active communications satellite and its main attraction even to amateurs is that, like Everest, it is there. To adapt an old nursery rhyme:

"The moon shines bright,
The stars give light,
And little fading signals,
Will come tomorrow night."

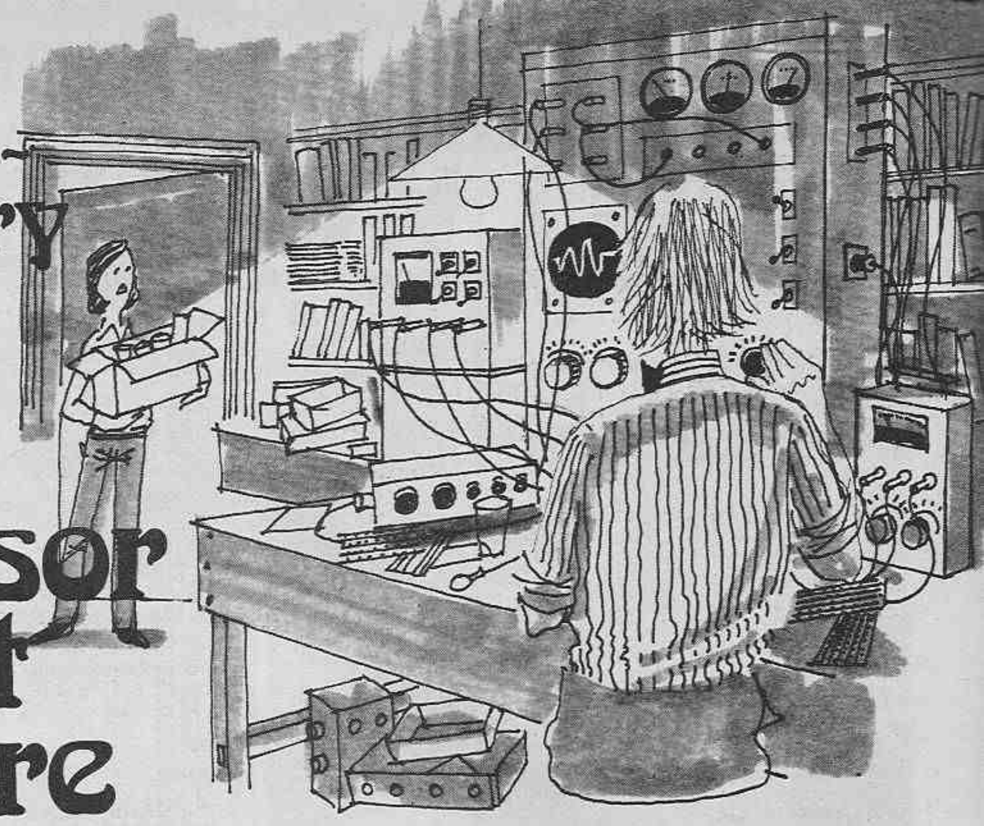
The moon has many peculiarities which affect the bounced signals. Early workers believed that returning signals would be too blurred by the large size of this spherical mirror in the sky to be useful. A breakthrough came some 20 years ago with the realisation that the moon appears to radio signals as a partially polished sphere with an efficient central reflecting area, rather like a bright point on a matt ball bearing.

The leading echo thus contains rather more than half the total echo power and is largely unblurred. In fact the moon is about 7 per cent effective as a reflector when compared to the theoretical "equivalent target cross section" in radar terms. Lunar echoes however do have both slow and rapid fading.

World at their Fingertips

By the time these words appear, the BBC2 Open Door programme on amateur radio ("World at their Fingertips") will already have been transmitted. The Radio Society of Great Britain took responsibility for the programme at very short notice and, at the time of writing, are in the thick of preparations.

Fortunately Brian Rix, G2DQU, was willing to present the programme which it is hoped will underline how this unique hobby appeals to enthusiasts of all ages, performs valuable community services including emergency communications and involvement with the handicapped, continues to contribute significantly to the development and scientific study of radio, and generates goodwill across international frontiers.



The Extra-ordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett

WHILST Professor Ernest Eversure and his young friend Bob had been discussing and carrying out various modifications and improvements to an Audio amplifier, a team of the Prof's experimental robots had been busily constructing a huge device in another part of the Prof's laboratory. Bob has just been shown this device, and reacted with amazement.

"Your comment that it resembles a giant bathysphere is very appropriate, Bob, as the main structural shell is designed to withstand high pressures both from within and from without.

VACUUM CHAMBER

"Although this device is intended mainly for use as a large vacuum chamber it can also be pressurised for experiments with gases under pressure, and I intend to use it for all sorts of experiments which I found were difficult in my smaller vacuum chambers. Many of these experiments will demonstrate how electronics can be made to work not only here but also in the vacuum of outer space; not only now, but also in the future."

"Prof., this is tremendous, its like something from a science fiction story."

"Do you read much 'Science Fiction', Bob?"

"Yes, Prof., when I have the time. But recently I've found myself disappointed with a lot of the stories. The trouble is that so many of them are written by people who are against scientific progress, so they describe all sorts of harmful results. These are 'Anti-Science' fiction writers who describe all sorts of really great amazing inventions, which makes the story really interesting at first. Then they make all the inventions go wrong, explode, destroy themselves and kill people. It makes science look very bad; and something makes me feel quite bad too after I've read such terrible things!

"There does seem to be a shortage of fiction that is 'pro-science' Bob. Remember that there are those people in the world who will try very hard to misuse the tremendous new powers made available by science. Possibly in the future, more authors will become inspired by the great potentials of scientific discovery correctly used, to usher in a 'New Age of Science', which I think is only just the beginning. Then pro-science fiction will begin to prevail over the current spate from the anti-science writers, and give people a more balanced and positive feeling, especially regarding the advances in electronics which is the biggest growth area of science-based technologies!"

SPACE SUIT

"Now I am about to inspect my new experimental vacuum chamber, as the air has now been removed from inside it. One of the advantages of such a large chamber is that I will be able to actually go inside it, unlike the others which are too small!"

"But Prof., how can you go inside a vacuum-chamber? I have been told that it is not possible to survive in a vacuum."

"Of course, Bob, exposure of the human body to vacuum would have immediate dire consequences. So I have designed a special suit which I will wear. It is similar to the space-suits worn for extra vehicular activity in the latest manned space explorations."

The Prof. whistled up one of his robots which brought the gleaming new space suit and helped him into it as Bob watched enviously.

After careful checks, the Prof. opened the door of the airlock and went inside. Bob watched through the transparent panels of the air lock and vacuum chamber as the Prof. emerged from the airlock into the larger space inside the chamber.

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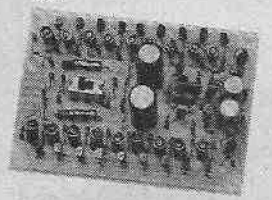
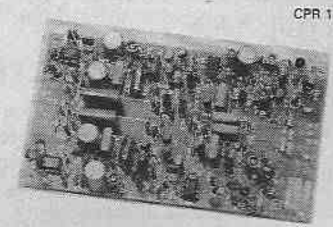


CPR 1



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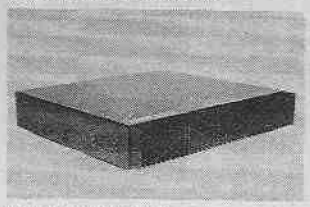

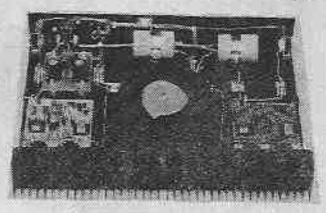

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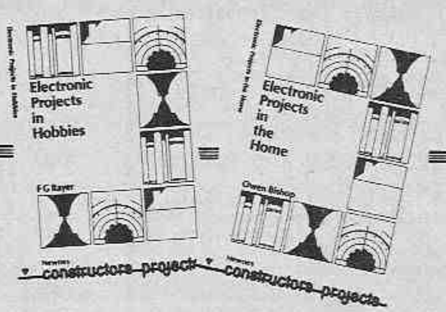

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They could converse through a nearby intercom as the Prof. carefully checked some of the apparatus. "I feel left out, Prof.", Bob complained as he watched. "I wish I could wear a spacesuit and come inside the vacuum chamber! It looks almost as exciting as being a real explorer in outer space!"

"Okay Bob, if you stand on that platform I will get the robots to measure you for a suit!" Bob eagerly clambered onto the nearby platform and stood with his arms slightly raised as the Prof. instructed from inside the vacuum chamber.

LASER METROLOGY

Now three robots carefully positioned themselves at equal distances from the platform and pointed strange pieces of electronic apparatus in the direction of Bob's body.

"Prof., what are they doing?" Bob asked apprehensively. "It looks as if the robots are about to blow me apart with ray guns!"

"Too much anti-science fiction, Bob! What the robots are about to do is quite harmless. They will use a modern electronic method of 'Laser Metrology' to measure you. This combines electronic sensors and measuring devices with low-power laser optics."

The platform began to rotate very slowly and pale laser beams flickered over Bob as the robots used their laser metrology devices to measure him for the spacesuit. "Don't worry, they are specially programmed not to shine their lasers into your eyes, Bob", the Prof. reassured him.

"For something as important as a space suit, the measurements must be accurate as possible and the suit is specially made to fit the wearer. Laser metrology gives the advantage of accurate measurement in three dimensions and will produce a much better fit.

"In the future, similar techniques may be used to measure clients for ordinary clothes. Then, combined with an electronic machine which will make a suit in a matter of moments when fed with the measurements, electronics will have a huge impact on the world of fashion, and enable people to have more appropriate and better clothing according to their needs, conditions, the weather and so on!"

"Wow, Prof. Soon we'll see the instant spray-on suit of clothes in an aerosol can with a disposable micro-processor built into the biodegradable plastic push-button!"

Next the robots brought the materials for Bob's space suit and took them through the airlock into the vacuum chamber where, under the Prof's supervision they began to use a number of interesting electronic devices to aid them in making the spacesuit. One was a laser cutter which they used to trim the plastic material to size.

"The robots will use a number of techniques of fabrication which rely heavily upon electronics for their effectiveness," the Prof. informed him, "and these same techniques will, I expect, be used more in future space missions. In most instances results will be better than could be obtained in open air due to the lack of atmospheric contamination. However, this will mean more electronics yet again. Many of these operations, involving use of heating, are carried out with heat from fuels such as coal, oil and gas here in the Earth's atmosphere.

SOLAR RADIATION

"To carry out similar operation in space the heat will be produced either by using direct solar radiation with electronically position and focused mirrors, by mechanical friction for operation such as friction welding, or by electrical and electronic means. Experience with these methods could mean an increasing use of electronic methods of heat processing on earth and a reduction in the use of fuels which pollute the environment, as most of these electronic methods produce clean heat with very accurate control."

Bob watched as the laser sliced neatly through the shining plastic and the robots carefully manoeuvred diffusers to dissipate the energy of reflected portions of the beams. "I can see," he observed, "that even inflammable materials may be laser-cut in a vacuum without catching fire, and with some fusible materials the cut portions would be sealed by heat fusion."

"Yes, Bob, and in cutting, joining and heat-treating metals and semiconductors with the aid of electronics in a vacuum, the quality of the final product can be much better than when similar operations are carried out in air. Many metals and semiconductors, when hot, would absorb oxygen, nitrogen, hydrogen and other gases with which they come into contact, and this can ruin the properties of a highly purified substance."

DIELECTRIC WELDING

Now the robots began to use a high-frequency dielectric welder to join the seams of the suit.

"This is a method which may be used to join dress materials and clothing fabrics, sheet plastics and small components. When applied to clothing and similar fabrics it has many advantages over older traditional methods such as stitching.

"Dielectric welding doesn't have to be done in a vacuum, it can be done in the air; however, when it is done in a vacuum this avoids the trapping of air-bubbles and airborne dust and impurities within the weld.

"This means that in your space suit the fabrics are being joined with strong, fault-free seams which could not be done so easily by other methods."

"That is good to know," Bob watched as the space suit rapidly took shape before his eyes, "Prof., some of the uses of electronics in space and other environments are really fascinating and I would really like to know a lot more about these things."

"You'll be able to learn about some of them by first hand practical experience very shortly, Bob."

To be continued

Crossword No. 14—Solution

1M	A	2T	R	3I	X	4B	O	5A	R	6D		7B	B	8C
A		E		D		R		B		A		U		A
S		R		O		I		O		T		R		T
9T	I	M	E	L	A	G		10U	N	E	A	R	T	H
		I				H		N						O
11C	O	N	T	12A	C	T	E	D		13S	O	U	N	D
U		A		P						H				E
14T	E	L	E	P	H	O	N	E	N	U	M	15B	E	R
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16M	E	T	R	E		17V	E	18R	Y	T	E	S	T	Y
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19S	C	20R	E	21E	N	S		22D	O	23U	B	L	E	24T
T		A		A		I		I		R		E		E
E		I		R		O		S		N		S		A
25R	U	N		26S	Y	N	T	H	E	S	I	S	E	R

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W839 50V ac (24V DC) coil. 11 pin plug in type. 3 pole c/o 10A contacts. Only **85p**
W846 Open construction mains relay. 3 sets 10A c/o contacts. **£1·20**
W877 675R 12-27V. DPCO 23 × 20 × 10mm sealed can **86p.**
W880 230V a/c DPCO 10A contacts, enclosed case **£1·30.**
W830 200R 6-12V DPCO, 23 × 20 × 10mm, sealed can **88p.**
Send SAE for our relay list—84 types listed and illustrated.

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Copper TO5 sink 17mm dia × 20mm. 10 for **40p**; 100 for **£3**; 1000 for **£25**

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Size 36 × 18" 200g. Hundreds of uses around the home. 100 sheets for **£1·50.** Box of 1500 for **£19**

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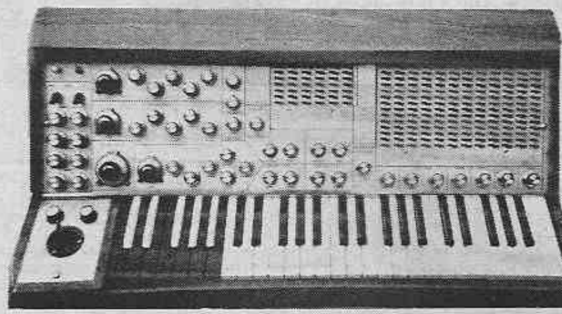
NO SPECIAL SKILLS / SPECIAL EQUIPMENT **REQUIRED**



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Latest improved transistorised Telephone Amplifier with detached plug-in speaker. Placing the receiver on to the cradle activates a switch for immediate two-way conversation without holding the handset. Many people can listen at a time. Increases efficiency in the office, shop and surgery. Perfect for "conference" calls; leaves the user's hands free to make notes, consult files. No long waiting, saves time with long-distance calls. On/off switch, volume control. Conversation recording model at **£19·95** + VAT £1·60. P. & P. 89p.

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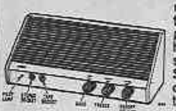
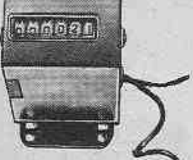
BUSH "PARTY AMP"



This very attractive unit is a complete mono amplifier originally designed as the second channel BUSH record players. All solid state, the case houses good quality speaker, power supply, pre-amp and controls. Standard DIN socket input accepts ceramic cartridge direct. 240v operation. Brand new and boxed complete and screened DIN to DIN connection lead and instruction leaflet. Many uses include baby alarm, guitar practice amp, booster amp for transistor radios, etc. etc.
Two types available:
Type 1 2-3 watts output with volume and tone control **£7·50**
Type 2 2-5 watts output with separate bass, treble, volume controls and tape output **£8·50 + 56p, PP £1**
*NOTE For use as baby alarm and guitar practice amp it may be necessary to use our phono preamplifier module (BMI).



6 DIGIT COUNTER

one pulse at mains voltage moves 1 digit—not resettable—real bargain @ **80p.**

MAINS BLOWER

The Torrin—quiet but powerful outlet size 2¼ × 1¾ for cooling equipment etc. will extract of outlet is blowing outwards price **£5·50.**
Other models from £2·00.

PP3/PP9 REPLACEMENT

Japanese made in plastic container with leads size 2in. × 1½in. × 1½in., this is ideal to power a calculator or radio. It has a full wave rectifier and smoothed output of 9V suitable for loading of up to 100mA. **£2·53.**

MICRO SWITCH BARGAINS

Rated at 5 amps 250V. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 (two types) for **£1·25.**

INDUCTION MOTORS

One illustrated is our reference MM11 made for ITT ¾ stack 1½ spindle **£2·25**, ½ stack model **£1·75.** 1 stack **£2·75.** 1½ stack **£3·25.**

MOTORISED DISCO SWITCH

With 10 amp change-over switches. Multi adjustable switches are rated at 10 amps. This would provide a magnificent display. For mains operating. 8 switch model **£5·25.** 10 switch model **£5·75.** 12 switch model **£6·75.**

25A ELECTRIC PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp on/off switch. Switch on time can be set anywhere to stay on up to 6 hours independent 60 minute memory jogger. A beautiful unit. **£3·50.**

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

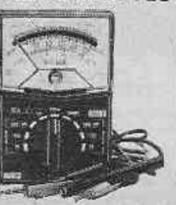
CAR STARTER CHARGER

Our own kit this has proved a godsend to many motorists contains 20 amp transformer and bridge rectifier switch HD resistor and full instruction **£9·95.**

RADIO STETHOSCOPE

Easiest way to fault find, traces, signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set **£3·95.**

MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000,
AC volts 10, 50, 150, 1000.
DC amps 0-1 mA and 0-100 mA
Continuity and resistance 0-150K Ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.
Unbelievable value only **£6·50+50p** post and insurance.

MULLARD UNILEX

A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£15** including VAT and postage.

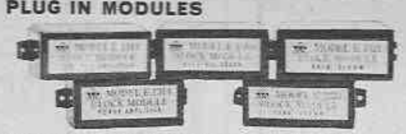
ELECTRONIC VOLTMETER/ SENSITIVE RELAY

Consists of a large, extremely readable, 4½" square drop through panel volt meter, 0/0-1 fsd. Built into the front of the meter are two screw adjusters which move two separate pointers, one red and one green, up and down the scale, the purpose being to set a minimum and maximum level so that when the needle falls below or rises above the preset levels a unique 'under' and 'over' circuit inside the meter operates one of two reed relays to bring an 'under' or 'over' circuit into action. The scale plate is detachable via two screws to be calibrated to your own individual requirements. The 10 transistor 'under' and 'over' circuit is completely separate from the meter movement so does not have to be connected to use this as a standard 0-1 meter. Many uses including level controls, light controls, auto battery chargers, alarm units, etc. etc. Manufacturers list price of over £120 each. An unbelievable snip at **£7·75 + 62p**, p & p. 80p. (Less than value of the meter alone). Circuit diagram included.

G.P.O. HIGH GAIN AMP/SIGNAL TRACER

In case measures 5¼ × 3¼ × 1¼ extremely high gain (70 DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. Functions very well as a signal tracer for fault finding in radios etc. etc. By connecting a simple coil to the input it becomes a useful mains cable tracer. Uses standard 4½v battery and has input, output sockets and on-off volume control mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. etc. An absolute bargain at only **£2·25.** Suitable 80 ohm earpiece 60p + 5p.

PLUG IN MODULES



MODULES Neat 'plug-in' size approximately 2" long × ¾" wide × 1" high. Japanese made, 6v operation, solid state, eight different types to perform various functions as follows—all supplied with connection diagrams:—
FIRE ALARM MODULE (BM 71) Used with thermostatic switch or switches and 6v battery this will drive a speaker and give audible alarm. Note: Ceiling type, white, fire operated thermal switches available **£2·50 + 12p** ea.
ELECTRONIC ORGAN MODULE (BM31) This is a tone oscillator especially designed for an electric organ. Requires an external 10k resistor miniature variable type to provide various notes.
RAIN ALARM MODULE (BM61) Intended to detect rain or moisture and will operate a loud speaker with a high frequency sound which will vary in intensity to a degree which depends on the amount of moisture collected. A grid type pick up is recommended with a spacing about 1/16" between grids (the raindrops short the grids).
PHONO PREAMPLIFIER (BM1) Will amplify the output of a magnetic cartridge, tape head, timer etc., up to about 1 volt, and give a reasonably flat response curve, should suit most amplifiers.
DUAL LAMP FLASHER (BM100) An electronic switch designed to flash two miniature bulbs alternatively at ½ sec. intervals with any 6v, ·1 to ·3 amp bulb. Ideal for flasher of model car, model plant and boat, warning of railroad crossing of HO gauge; display attention getter, car emergency warning, etc.
MORSE CODE OSCILLATOR (BM42) Miniature transmitter, it transmits a modulated signal (400-30mhz) which can be picked up with normal AM radio receiver. Also ideal for a signal source on test bench for tracing troubles in AM radios.
METRONOME MODULE (BM32) Designed to vary the tempo from approximately 40 to 208 beats per minute a complete solid state electronic timer only a speaker, a potentiometer and a 6v DC supply are required to complete. Could easily be tucked away into our £4 extension speaker to make a nice looking instrument.
BURGLAR ALARM MODULE (BM70) This module enables connection to as many trigger mats, window switches, micros etc. as you require, and when the circuit is closed will emit a horn type sound from the speaker. No power is consumed in the nonalarm condition, therefore giving long battery life.
PRICES any module **£1·95**, bases optional **56p.**

Terms: Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

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IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

COMPUTER EQUIPMENT We are stocking a wide range of computer equipment including:
MEMOREX 8" floppy disc drives, as new, **£180·56 + £14·44**
TELETYPES ASR33 from **£295.** KSR33 from £175
SPERRY UNIVAC Display Keyboard with VDU Uniscope 300 from **£60·00**
5V 2.5-6 AMP P.S.U. With Circuit **£6·71 + 54p**, pp £1·75
CLO RACAL Supergrade cassettes with library cases 2 for £1, 10 for **£5·20**
A range of TTL and other components is now stocked at the Shop.
OSCILLISCOPES We now have a good range of scopes ex stock at the shop, prices range from **£40—£275** for example:
Double Beam Scope—working order **£45**
Philips Single Beam—working order **£55**
CT436 Double Beam DC-6mhz, as soon **£75**
Marconi TF 2200 Double Beam DC-22mhz perfect order **£225**
Tektronix 545A double DC-24mhz **£175**
Scopes sell very fast we strongly advise a visit to the shop where personal callers can snap up bargains! Mail customers please telephone for availability.
Constant Voltage Auto-Transformers made for operating American made computer equipment off standard 230-240v mains. Input voltage can be plus or minus 20%, output voltage would be a steady 115v. They are beautifully made regardless of cost. We have two models, one 500w price **£49·50** or 750w price **£75.** Carriage depending on distance.
Telephone Headset and Mouthpiece As used by switchboard operators, made for the GPO so obviously best quality. Very lightweight so not uncomfortable to wear. **£3·75.**
Telephone Plug Short GPO 4 pole type, reference number 420, as currently used with plug-in telephones, ex equipment but unused. **92p.**
Telephone Socket Panel mounted, 4 pole, will take the 420 plug. **75p + 6p.**
Strong Metal Box Just the right size to hold in your hand approx. 5" × 3" × 1½", removable lid and top punched to take controls. This has dozens of uses, particularly suitable for making rugged portable test systems. **£1·38.**
1000 Watt Heat and Light Lamp Mullard, tubular, suitable high speed drying, or for quick heat, especially where localised heating is required in workshops are warehouses where general heating is impossible costwise. Supplied complete with holder and mounting clips. **£4·00.**
Making a Convector Heater? We can offer a bank of four 1kw metal clad elements all mounted on a 3" square iron plate. By comparatively simple switching 8 heat outputs ranging from approximately 250 watt to 4000 watt can be achieved. The elements, which are in the form of loops with push on tag connectors, extend to a length of approx. 17" from the plate, so a relatively compact simple convector heater could be made using this; if a blower is also fitted then the overall size can be kept relatively small. Suitable blowers are available price **£2** each. Price of the element **£3·50** plus 28p, pp £1·25.
Waterproof Heating Element Many uses include, winding round water pipes to prevent freezing, under seed boxes to assist germination in gloves or boots to keep these warm etc. 13 yard length gives approximately 30 watts at 230 volts, has self regulating temperature control. Price **85p + 7p.**
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Dual Range Panel Meter Scale calibrated 0-10v and 0-500v. 2¼" flush mounting this has internal resistor for the 10v range but would require external resistor for the 500v range. A very sensitive 20k per volt movement. First class British Manufacturer. **£3·24.**
SUPER VALUE HARDWARE PACK Ever been stuck for the right nut, bolt, giant hardware pack, contents include nuts, bolts, screws, washers, spacers etc. Mixed in BA, whitworth and metric threads, contents are in brass, bronze, steel, etc. 2lb per bag, average contents 400-600 pieces. **£2·50.**
900 WATT TRANSFORMER 110v 8 amps centre tapped. The winding however is extra heavy gauge so this will carry up to 16 amps at 55 volts. Made by Foster this is impregnated and varnished with very substantial clamps and punched for base mounting, also has a terminal platform with screw down terminals—weight approximately 30lbs. Has many applications including welding. **£17·28** carriage **£3** (mainland only). Order transformer ref. TM53F.
TELEPHONE CABLE Made for the GPO to very rigid specification, circular PVC overall. 15 core colour coded **40p** per metre. 10 colour coded cores **30p** per metre. 6 colour coded cores **25p** per metre. 4 colour coded cores **22p** per metre. 2 core, but made of extra strong wire for straining across open yards etc. **30p** per metre. *Please add* 25% to the price to cover cost of post and packing and VAT.
TELESCOPIC AERIAL 5 sections 21" when extended, Nickel plated superior make, one nut fixing, fold over for FM. **97p.**
HALF PRICE OFFERS. 1. Cassette player recorder not second hand but because of a small technical defect or case blemish or something similar we are not asking the recommended retail price of **£19·50.** Our price is **£12·15.** Don't miss this bargain.
2. **6 Transistor Radios** again new but slightly faulty, 10 for **£11·25. 12" GONG ALARM BELL** Mains operated for fixing outside. Metal case and gong are made from heavy cast iron, this is a real quality product suitable for factory, warehouse, block of flats etc. **£25·00 +** carriage **£3.** Mainland only.
CONTINENTAL RELAYS Plug in standard bases or can have wires soldered directly to tags:— Ref Rel C1 700 ohm (18-24v) coil 4C/O/**54p.** Rel C2 180 ohm (6-12v) coil 4C/O/**£1·08.**
BLEEPER Makes a sound very similar to the Black & Decker smoke alarm. 6-12ac or 12-24v ac. Ideal for fire and smoke alarm, anti-mugging device, car or motor anti theft. American made, compact about the size of an egg. **£1·35.** Order Delta Bleeper. A large quantity in stock so we will be glad to quote special price for quantity user.
8 TRACK CASSETTE PLAYER 12 volt Japanese make stereo amplifier for in car sound entertainment. Perfect order **£7·38.** Speakers in sloping cases only **£4** per pair if ordered with player.
VARIABLE INDUCTANCE CHOKE A choke will oppose the flow of AC depending on how much its core is saturated, therefore, if the choke is built with a spearate coil for deliberately saturating the core, a small variable dc current will act as a voltage regulator for lamp dimming and a multitude of other purposes. We offer such a choke of 8 amps AC rating requiring 75mA DC control current at bargain price of **£24·34.** Carriage **£5·00 + 40p.** This choke weighs approx. 60lbs.
PANEL METER 0-1mA Japanese made full vision perspex front, flush mounting. Price **£3·24.**
PHOTO MULTIPLIER TUBE American RCA, their type no. 4555. Have a gain of a million or more, regular price over £20 but we offer these brand new at **£4·86 + 36p.**

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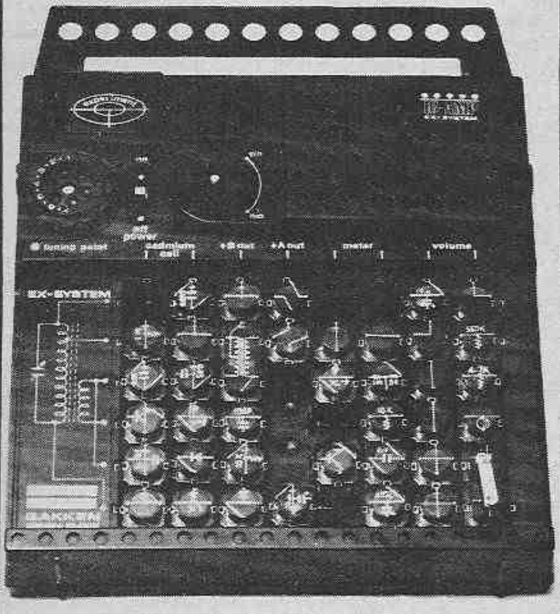
(AUDIO magazine)



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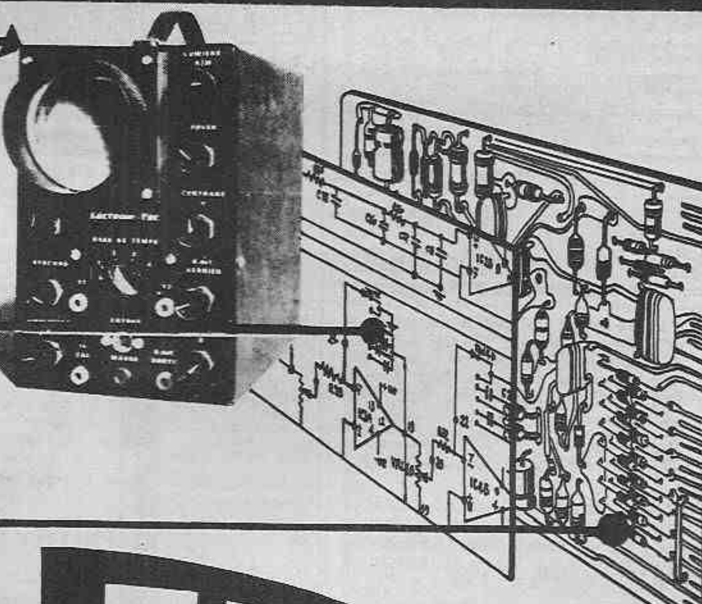

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Printed Circuit Boards & KITS for EE projects

Mag issue	PROJECT	Ref	P.C.B.	KIT	KIT CONTENTS (see key)
1978 Jan	Audio Visual Metronome	E001	+ 65	5·50	B.E.H.L.
	Touch Switch	E002	+ 74	1·80	B.E.
	Rapid Diode Check	E004	+ 52	2·23	B.E.H.L.
	Car Alarm	E005	+ 80	5·48	B.E.G.J.L.
Feb	Lead Tester	E006	51	4·17	B.E.H.L.
	Chaser Light Display	E007	1·75	20·32	B.E.H.L
	A.C. Meter Converter	E008	+ 60	5·37	B.E.H.L.
Mar	Audio Test (2 Pcb's)	E009	+1·74	14·96	B.F.G.J.
	C.R. Substitution Box	E010	—	8·45	E.H.L.
	Catch-a-Light	E011	+ 82	8·32	B.E.H.L.
	Weird Sound	E012	+ 62	5·29	B.E.H.L.
	Roof Rack Alarm	E013	+ 60	—	
Apr	Mains Delay Switch	E014	+ 94	12·48	B.E.J.L.
	Pocket Timer	E015	+ 60	3·46	B.E.H.L.
May	Flash Meter	E016	+ 75	11·09	B.E.H.L.
	Mains Tester	E017	+ 54	1·35	B.E.H.
	Teach In—Power Amp	E018	—	1·55	E.
	Power Pack	E019	+ 70	5·71	B.E.H.L.
Jun	Tele-Bell	E020	+1·00	10·69	B.E.H.L.
	Insitu—Transistor Tester	E021	+ 65	5·10	B.E.G.H.L.
	Teach In—S.W. Receiver	E022	—	2·81	E.
	Power Slave	E023	1·75	—	
	Visual Continuity Tester	E024	—	4·09	E.H.L.
Jul	Auto Night Light	E025	+ 85	9·39	B.E.G.H.L.
	Short Wave Radio	E026		7·86	E.J.
	Quagmire	E027	+1·40	7·39	B.E.G.H.
	Logic Probe	E028	+ 50	2·76	B.E.G.H.L.
Aug	Slave Flash	E029	+ 55	2·72	B.E.
	M.W. Mini Radio	E030	50	4·78	B.E.J.L.
	Audio Freq. Signal Generator	E031	+ 85	12·41	B.E.J.L.
	CHRONOSTOP	E032	+2·50	29·20	C.E.G.K.M.P.
Sep	R.F. Signal Generator	E033	—	15·82	E.H.
	Sound to Light Unit	E034	—	5·14	E.H.L.
	Guitar Tone Booster	E035	75	4·06	B.E.H.L.
	Car Battery State Indicator	E036	65	1·62	B.E.
Oct	C.M.O.S. Radio	E037	+1·45	10·76	B.E.G.H.L.
	Fuse Checker	E038	—	1·60	E.H.L.
	Treasure Hunter	E039	1·25	15·95	B.E.G.H.L.
	DOING-IT-DIGITALLY—TTL TEST BED	E040	—	20·65	N.
	DOING-IT-DIGITALLY—1st 6 PARTS	E041	—	3·60	N. (inc. add. comps.)
Nov	Audio Effects Oscillator	E042	—	2·40	E.H.L.
Dec	Water Level Alert	E043	+ 70	3·98	B.E.G.J.L.
Nov	SUBSCRIBERS TELE-TELL METER	E044	+2·80	19·90	C.E.G.K.M.P.
	Components to add 3rd digit to kit E044	E044A	—	3·00	E.
	Combination Lock (2 × PCB's)	E045	+2·55	19·90	B.E.H.L.
	Hotline Game	E046	+ 75	4·57	B.E.H.
Oct	Mini-Module—Passive Mixer	E047	—	2·47	B.E.H.
Dec	Audible Flasher	E048	—	1·21	E.H.
	Fuzz Box	E049	+ 75	5·20	B.E.H.L.
	Vehicle Immobiliser	E050	1·00	4·56	B.E.H.L.
	Mini-Module—Microphone Amp	E051	—	2·45	D.E.H.
1979 Jan	Mini Module—Continuity Tester	E052	+ 80	3·75	B.E.H.
	Lights Reminder	E053	+ 80	6·02	B.E.G.H.L.
	I'm First	E054	—	1·58	E.H.
	Roulette inc. colour printed wheel (2 × PCB's)	E055	+3·40	17·90	B.E.H.
	Headphone Enhancer	E056	—	2·06	E.H.L.
DEC TO FEB	EE 2020 Tuner Amp—Board A inc. RF unit	E057	3·65	54·44	B.E.G.H.
	EE 2020 Tuner Amp—Board B	E058	3·40	22·38	B.E.H.
	EE 2020 Tuner Amp—Board C	E059	1·45	4·30	B.E.H.
	EE 2020 Tuner Amp—Board D	E060	2·20	16·53	B.E.H.
	EE 2020 Tuner Amp—Board E Hardware & wire	E061	1·40	22·26	B.E.G.H.
		E062		11·95	K.
	EE 2020	E063	10·50	123·00	B.E.G.K.

+ P.c.b.'s designed by Tamtronic to EE circuit specifications

KEY TO KIT CONTENTS

A Vero-board(s)
B Printed Circuit Board(s)
C With screen printed component layout
D Tag strip
E ALL Resistors, potentiometers, capacitors, Semi-conductors
F As E but with exclusions—Please ask for details
G Dil and/or transistor sockets and/or soldercon pins
H Hardware includes Switches, Knobs, Lamps & Holders, Fuses & Holders, Plugs & Sockets, Microphones, Transformers, Speakers, Meters, Relays, Terminal Blocks, Battery Connectors, etc. BUT excludes nuts, bolts, washers, connecting wire, Batteries and special miscellaneous items.
J As H but with exclusions—Please ask for details
K As H but including connecting wire
L Suitable Case(s)
M Suitable Case with Screen printed facia.
N Full kit to magazine specified standards
P Kit with professional finish incorporating all prime features including screen printed PCB and case where appropriate

Doing-it-Digitally TTL ELECTRONIC TEST BED

Complete kit E040 £20·65

Components for first 6 parts E041 £3·60 (including additional components)

BOTH KITS (special price) £24·00

TELE-TEL

Nov. 78 **Ref. E044**

Subscribers phone call charge meter

A kit with a professional finish

CASE with screen printed facia similar to magazine photograph but includes provision for 3rd digit.
An aluminium sub-facia panel is also provided with screen printed hole centres to allow access to preset potentiometers.

PCB designed to incorporate 3rd digit facility and is screen printed for ease of assembly.

Basic kit (2 digits) £19·90
(3 digits) £22·90

BARGAIN CORNER

100 × ½w 1k carbon resistors 30p
10 × 1w 5% 1k5 resistors 10p
10 × 1w 5% 7k5 resistors 12p
10 × 1w 5% 100R resistors 12p
10 × 6w 5% 390R wirewound 50p
10 × 47u 10v Axial Elec. Caps 25p
4 × NE55 Timer £1·00

Plug in mains PSU
3v/6v/9v/12v DC
300mA suitable for calculators & T.V. Games £2·99

CHRONOSTOP

Aug. 78 **Ref. E032**

SPLIT 6 TAYLOR lap timing modes plus normal start/stop operation.

A kit with a professional finish including

CASE with screen printed facia

PCB with screen printed component layout

Full Assembly Instructions

PRICE INC. VAT £29·20

SOLDERING IRONS & ACCESSORIES

SRB 18 watt iron inc. No 20 Bit £3·78
Stand £3·25
Solder-Savbit 20 inch 52p

Bit sizes No. 90 (1·5mm)
" " " 20 (3mm)
" " " 21 (4·5mm)
" " " 22 (6mm)
Ideal for Home Constructor

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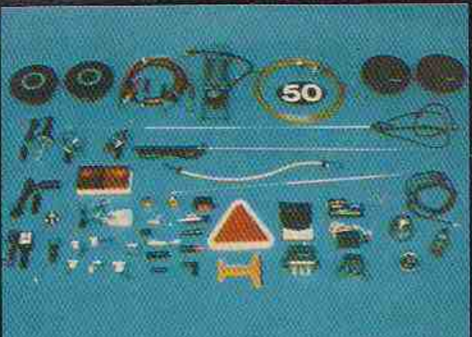
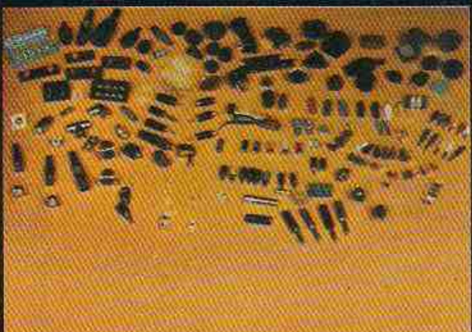


Our catalogue even includes some popular car accessories at marvellous prices.

A genuine 150W per channel stereo disco to build yourself. Full specification in our catalogue.

Speakers from 1½ inch to 15 inch; megaphone, PA horns, crossovers etc. They're all in our catalogue. Send the coupon now!

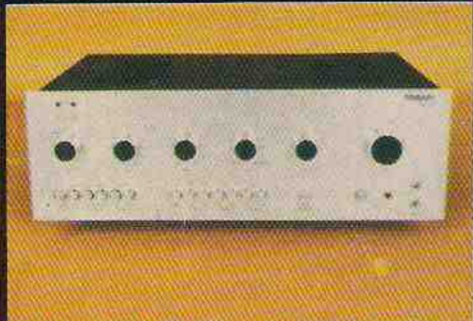


Our catalogue describes a wide range of plugs and sockets, all at marvellous prices. See cat. pages 114 to 129 for details.

61-note touch-sensitive piano to build yourself. Full specification in our catalogue

Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 106 and 183 to 188 for details.

A digitally controlled stereo synthesiser the 5600S with more facilities than almost anything up to £3,000. Build it yourself for less than £700. Full specification in our catalogue.



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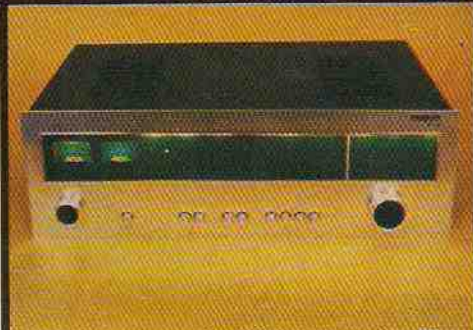
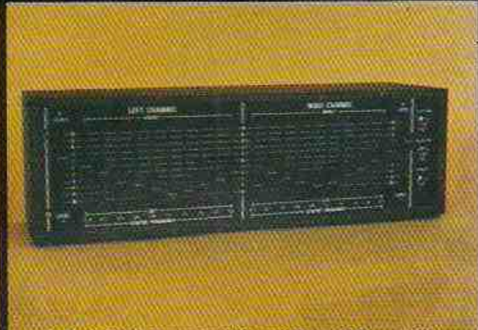
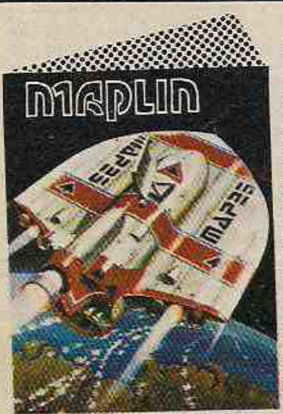


A hi-fi stereo tuner with medium and long wave, FM stereo and UHF TV sound! Full construction details in our catalogue.



A 10-channel stereo graphic equaliser with a quality specification at an unbeatable price when you build it yourself. Full specification in our catalogue.



A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages – some in full colour – it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data.

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