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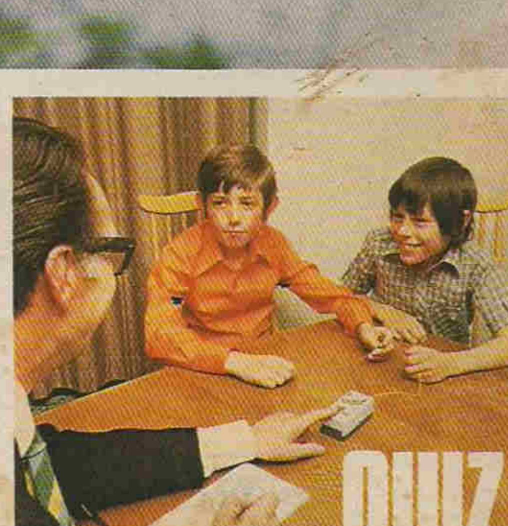

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QUARTZ LCD 5 Function

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

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

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

£10.65 Thousands sold!
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M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs., month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions

* Hours, mins., secs.
* Months, date, day.
* Basic alarm.
* Memory date alarm.
* Timer alarm with dual.
* Time and 10 country zone.
* Back-light.
* 8mm thick.

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M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags,
22 functions.
Constant display of hours and mins., plus optional seconds or date display.
AM/PM indication, month, date.
Continuous display of day.
Stop-watch to 12 hours 59.9 secs., in 1/10 second steps.
Split and lap timing modes.
Dual time zones.
Only 8mm thick.
Back-light. Fully adjustable open bracelet.
Guaranteed same day dispatch

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M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags.
22 functions.
Solar panel with battery back-up.
6 basic functions.
Stop-watch to 12 hours 59.9 secs., in 1/10 sec., steps.
Split and lap timing modes.
Dual time zones.
Alarm. 9mm thick. Back-light.
Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones

* 6 digits, 5 flags.
* 6 basic functions.
* 8 further time zones.
* Count-down alarm.
* Stop-watch to 12 hours 59.9 secs. in 1/10 sec. steps.
* Split and timing modes.
* Alarm.
* 9 mm thick.
* Back-light.
* Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up.
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
Guaranteed same day despatch.

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 MEMORY BANK

Calendar watch M354
Hours, mins., secs.
Month, day, date in 12 or 24 hour format all indicated continuously.
Monthly calendar display month, year and all dates for any selected month over 80 year period.
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M11

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Mineral glass face.
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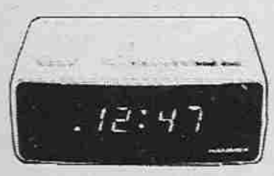
Top quality finish with fully adjustable bracelet.

£35.00

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). AC power 220V.

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M13

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* Snooze & sleep controls.
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* Battery operated. No plug required.
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* Drawstring carrying case included.
* Back-light.
* Batteries supplied free.
* Quartz crystal controlled.

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M14

QUARTZ LCD Ladies 5 Function

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

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M15

Price breakthrough only £18.95

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* **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
* **CALENDAR FUNCTIONS** include the date and day in each time zone.
* **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
* On command, stopwatch display freezes to show **intermediate (split/lap) time** while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
* **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch. M16

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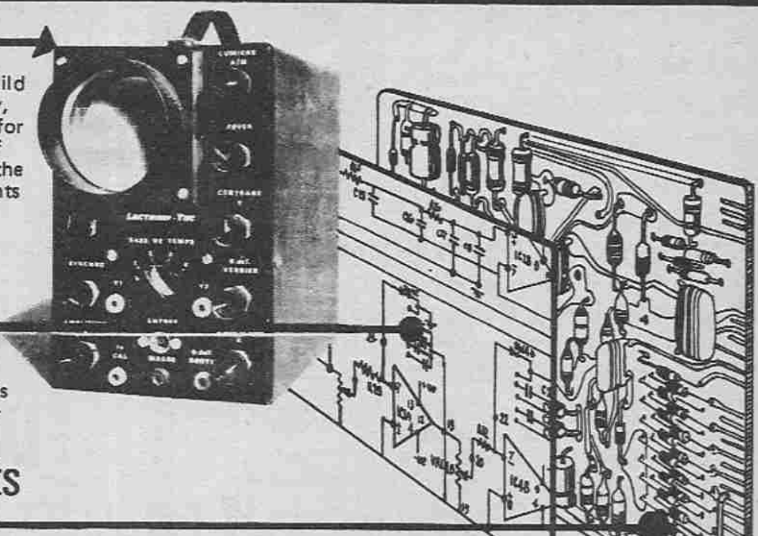

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Belt drive chassis turntable unit semi automatic, cueing device.
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Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors. £3.95
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LM921	0·50	CA3001	4·25	LF13331N	3·00
LM923	0·50	CA3002	3·30	LF13741H	0·49
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74C04N	0·24	74C74N	0·56	74C150N	4·14	CD4002	0·18	CD4015	0·75
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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74LS38N	0·32	74LS165N	1·15	74LS352N	1·07
74LS40N	0·26	74LS166N	1·65	74LS353N	1·07
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74LS47N	1·09	74LS169N	1·45	74LS366N	0·55
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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
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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
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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	12·50	2N3606	·18	2N3711	·12	2N4917	·27	2N5127	·22	2N5223	·16	2N5365	·24	2N5655	·55	2N6253	1·00	BD204	1·35	BFX29	·34
2N3439	·85	2N3607	·18	2N3712	1·35	2N4918	·65	2N5128	·22	2N5224	·16	2N5400	·33	2N5656	·65	2N6254	1·45	BD220	·66	BFX30	·34
2N3440	·75	2N3632	12·75	2N3713	1·50	2N4919	·70	2N5129	·22	2N5225	·16	2N5401	·44	2N5657	·75	2N6283	·50	BD221	·66	BFX34	·66
2N3441	·92	2N3638	·17	2N3714	1·55	2N4920	·83	2N5130	·22	2N5226	·16	2N5415	1·05	2N5661	17·00	2N6289	·50	BD222	·66	BFX37	·49
2N3442	1·45	2N3638A	·17	2N3715	1·55	2N4921	·54	2N5131	·22	2N5227	·16	2N5416	1·65	2N5786	·98	2N6290	·50	BD223	·75	BFX68	1·10
2N3444	1·35	2N3639	·33	2N3716	2·29	2N4922	·60	2N5133	·22	2N5232	·22	2N5447	·16	2N5813	·55	2N6292	·50	BD224	·75	BFX84	·30
2N3445	6·50	2N3640	·25	2N3724	·65	2N4923	·75	2N5137	·22	2N5232A	·23	2N5448	·16	2N6027	·64	AF239	·70	BD232	·75	BFX85	·38
2N3446	10·00	2N3641	·25	2N3725	·60	2N4924	1·15	2N5138	·22	2N5239	2·25	2N5449	·20	2N6036	1·39	AF240	1·25	BD233	·45	BFX86	·30
2N3447	10·50	2N3642	·22	2N3732	2·00	2N4926	1·70	2N5139	·22	2N5245	·37	2N5450	·16	2N6039	1·17	AF279	·88	BD234	·46	BFX87	·35
2N3448	12·00	2N3643	·38	2N3734	·75	2N4927	1·70	2N5140	·22	2N5246	·38	2N5451	·16	2N6099	·62	AF280	·95	BD235	·46	BFX88	·30
2N3466	1·32	2N3644	·40	2N3735	7·00	2N4928	2·20	2N5142	·22	2N5247	·44	2N5457	·35	2N6107	·45	AFY42	1·65	BD538	·77	BFX89	1·37
2N3507	10·00	2N3645	·38	2N4871L	·51	2N4944	·30	2N5143	·22	2N5248	·44	2N5458	·36	2N6108	·55	AU110	1·70	BD539	·60	BFY10	1·10
2N3512	1·10	2N3646	·26	2N4888	·54	2N4945	·30	2N5172	·24	2N5249	·38	2N5459	·32	2N6109	·55	AU113	1·70	BD540	·60	BFY18	1·10
2N3553	3·25	2N3662	·25	2N4889	·75	2N4954	·28	2N5179	·75	2N5266	3·00	2N5460	·65	2N6111	·49	BC409	·27	BD581	1·10	BFY19	1·10
2N3563	·25	2N3663	·29	2N4891	1·30	2N4965	·28	2N5180	·58	2N5293	·44	2N5461	·53	2N6121	·41	BC413	·16	BD582	1·30	BFY87	1·10
2N3564	·25	2N3690	·45	2N4898	1·55	2N4966	·28	2N5183	1·20	2N5294	·44	2N5462	·65	2N6122	·44	BC414	·17	BD675	·60	BFY89	·38
2N3565	·25	2N3691	·45	2N4901	1·65	2N4967	·28	2N5188	·44	2N5295	·44	2N5484	·37	2N6123	·48	BC415	·16	BD676	·65	BFY41	·88
2N3566	·25	2N3692	·45	2N4902	2·20	2N4968	·28	2N5189	·49	2N5296	·44	2N5485	·40	2N6124	·45	BD153	1·05	BD677	·70	BFY50	·35
		2N3693	·50	2N4903	2·75	2N4969	·28	2N5190	·65	2N5298	·44	2N5486	·40	2N6125	·47	BD155	1·10	BD678	·82	BFY51	·35
		2N3694	·50	2N4904	1·85	2N5010	5·75	2N5191	·75	2N5301	4·00	2N5490	·64	2N6126	·48	BD157	·70	BFS98	·33	BFY52	·35
		2N3702	·14	2N4905	2·40	2N5011	8·25	2N5192	·80	2N5303	5·50	2N5492	·64	2N6129	·60	BD158	·70	BFW10	·83	BFY53	·40
		2N3703	·14	2N4906	2·99	2N4030	·22	2N5193	·75	2N5305	·26	2N5494	·65	2N6130	·65	BD159	·70	BFW11	·83	BFY72	·99
				2N4907	4·90	2N5033	·65	2N5194	·80			2N5496	·67			BD160	3·40	BFW30	2·45	BFY75	·77

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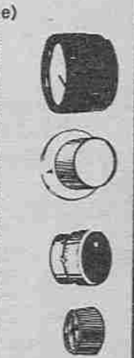

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Electronics provides something special in the way of creative pastimes, the pursuer of this hobby is kept in touch with developments in the most exciting technology of our times, and the permanent spin-off from his or her efforts can be of lasting value to the whole family.

Look at this month's projects. Is there a single household that could not make use of one if not more of these designs? Strictly functional devices for the kitchen, the bedroom, the front porch and even for the holiday-home-on-wheels, are complemented by some that come into the amusement category: an electronic quiz master, a tuning aid for the guitarist, and a Swanee Whistler! Finally, less glamorous but indispensable in the constructor's workshop, there is a mains operated power unit.

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Fred Bennett.

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Everyday ELECTRONICS

VOL. 8 NO. 8 AUGUST 1979

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OUR REGULAR FEATURE FOR BEGINNERS

SQUARE one

Is on page 504

Warbling TIMER

By O. N. Bishop

THIS device emits a warbling tone at the end of a pre-set period of time. The tone is loud and distinctive, yet reasonably melodious, so the timer is suitable for many applications in the home. It can time periods of a few minutes duration or periods as long as two or three hours.

TIMING CIRCUIT

The timing circuit consists of a field effect transistor TR1 and a low-value capacitor C1 together with a resistor R1 connected as in Fig. 1. The source-drain resistance of the f.e.t. is high when the circuit is first switched on; it immediately begins to decrease rapidly but later decreases more slowly. The effect of the change of resistance is to produce a change in the potential-divider. As the resistance of the f.e.t. decreases, the potential at A rises. (If you connect these three components together as shown in Fig. 1, using a patchboard or wires with crocodile clips, you can use a voltmeter to observe what happens.) After the circuit is switched on, the potential rises rapidly during the first second. Next it continues to rise but much more slowly, over a period lasting several minutes, Fig. 2. It eventually becomes steady at around 5·75V (assuming a 9V supply).

Typical values are:

C1 (pF)	Rapid limited rise to	Time to reach 5·75V
120	2·5V	1·5 minutes
6800	1·2V	2 hours

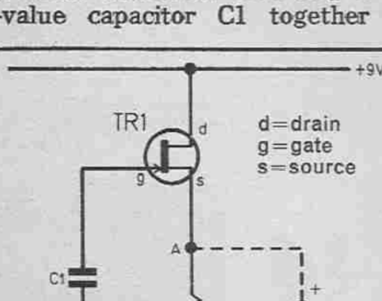


Fig. 1. The timing circuit. Changes of potential at point A may be examined by a voltmeter as shown.

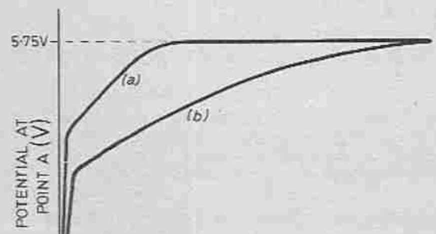


Fig. 2. Rise in potential at point A: (a) with low value capacitor (b) with capacitor of greater value.

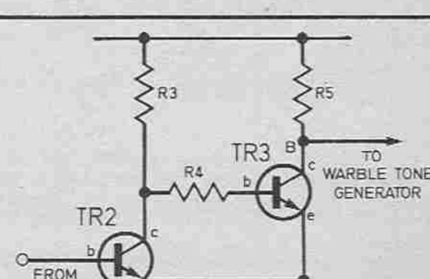


Fig. 3. The trigger circuit: b=base, c=collector, e=emitter.

Thus the operating period of the timer is partly determined by the value chosen for C1. For periods up to 1·5 minutes, C1 can be 120pF. For longer periods (up to about 45 minutes) C1 should have a greater value ,say 1500pF. For periods of 2-3hours, C1 should be 6800pF.

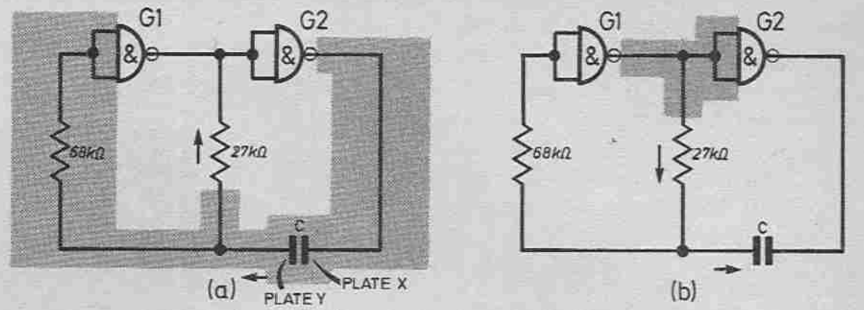


Fig. 5. The two states of an astable multivibrator, as used in the warble-tone generator. Parts of the circuit shaded are at "high" potential; other parts are at "low" potential.

TRIGGER CIRCUIT

The trigger circuit consists of two transistors TR2, TR3 and their associated resistors R3-R6 as shown in Fig. 3. When the potential at the base of TR2 exceeds a certain triggering level, a base current flows so switching TR2 on. The potential at the collector of TR2 falls and the base current to TR3 is thus reduced. TR3 is switched off. Since it is no longer conducting, the potential at its collector (point B) rises to almost 9V. Current then flows to the integrated circuit that generates the warbling tone.

The trigger circuit comes into action when the potential at the base of TR2 rises above 2·7V. VR1 and R2 (Fig. 4) form a potential divider. As the potential at A rises to 5·75V, the potential at the wiper rises to a lesser value. If the wiper is set at the end of VR1 nearer to A, the potential at the wiper exceeds 2·7V relatively quickly and timed periods are short.

To increase the length of timed periods, the wiper is set round the end of VR1 nearest to R2. If set *too* close to the R2 end, the potential may *never* reach 2·7V.

WARBLE TONE GENERATOR

The tone generator consists of two multivibrators, each built from two NAND gates.

The four gates are contained in a single CMOS integrated circuit IC1, type CD4011. In this circuit the two inputs of each gate are connected so that each gate acts as an *inverter*. When both gate inputs are "high" (9V), its output goes "low" (OV) and *vice versa*.

MULTIVIBRATOR ACTION

The action of a single multivibrator is shown in Fig. 5. In (a) the output of gate 1 has just gone 'low', making the input to gate 2 'low' also. This causes the output of gate 2 to go high, so raising the potential of all parts of the circuit that are shaded in Fig. 5a.

Current flows from plate Y of the capacitor through the 27 kilohm resistor to the part of the circuit that is at "low" potential, as indicated by the arrows. As the circuit current flows, the potential of this part of the circuit rises giving a steadily increasing input potential at gate 2. The rate at which potential rises depend on the values of the resistor and capacitor.

When the input potential becomes high enough to count as a "high" input the gate begins to change state. Its output potential begins to fall, giving a low input to gate 1, which then produces a "high" output.

We have now arrived at the state shown in Fig. 5b. Now the reverse conditions apply and the current begins to flow through the resistor in the reverse direction and charges plate Y. The input potential of gate 2 gradually falls. When it has fallen to a sufficiently low value, the gate changes state again and the astable returns to the original state shown in Fig. 5a. Thus this arrangement of 2 gates changes state regularly at a rate

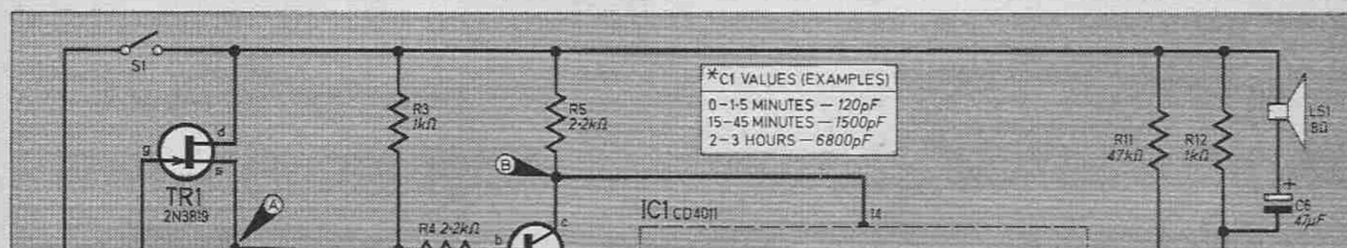
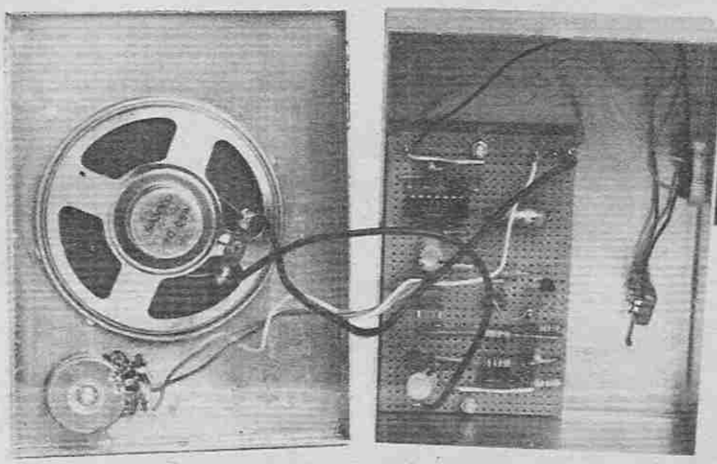


Fig. 4. The complete circuit diagram of the Warbling Timer.

dependent on the value of the capacitor and resistor.

TWO ASTABLES

In the warble-tone generator we have two such astables, one with a $0 \cdot 05\mu F$ capacitor oscillating at a few hundred hertz to give an audible tone, the other with a $33\mu F$ oscillating at about $0 \cdot 5Hz$ to produce the warbling effect. The two astables are coupled by capacitors C4 so that each astable has an effect on the action of the other. The result is not a simple combination of the two frequencies but a complex warbling tone that is very suited to this application. The combined output is fed through C5 to the final stage of the timer, the amplifier. This consists of a single transistor TR4 which drives the loudspeaker LS1.



The finished Warbling Timer showing positioning of board and components mounted on the front panel.

CONSTRUCTION starts here

COMPONENT BOARD

The unit is built on a single piece of stripboard (Fig. 7). Begin by constructing the timing circuit (TR1, C1, R1). If you have a Testmeter set it to a suitable voltage range and connect it between the ground rail (battery negative, strip B) and the source terminal of TR1. Switch on and observe the potential rise (Fig. 2).

Depending on the applications you have in mind for the timer, you may decide at this stage to use a capacitor of higher or lower value. Alternatively, if you need just a *slight* increase in the timing period, you can connect a second capacitor between strips L and T—in parallel with C1.

(When two or more capacitors are connected *in parallel*, their total capacitance is the sum of their individual capacitances. For example, if your C1 has a capacitance of 1000pF and the potential rises to $5 \cdot 75V$ in only 25 minutes, but you would like to be able to time up to 30 minutes, you can either use a capacitor value of 1200pF, or add a capacitor of value, 200pF in parallel with C1, whichever is more convenient.)

Next build the trigger circuit (TR2, TR3, R3-R6) and the potential-dividing network (VR1, R2). Test the output of this circuit by increasing the voltage at the collector of TR3 (S31). At switch-on this should remain low (a fraction of a volt) but rise sharply to almost 9V at the end of the timing period.

Altering the setting of VR1 varies the length of this period. The nearer the wiper of VR1 is set to the "R2" end of VR1, the longer the period. Note that if it is set *too* near this end, the wiper potential may never reach $2 \cdot 7V$ and the circuit will not be triggered. For initial testing, it is best to set it at the end nearest point A (Fig. 4), so that it is triggered after the shortest possible time.

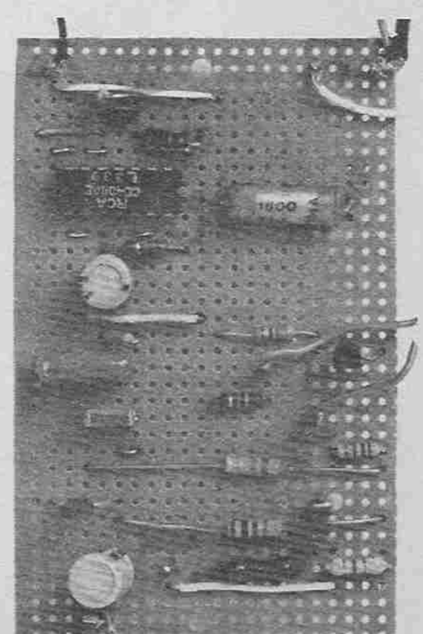
The amplifier section is best built next, including C5. To test roughly, switch on and then join the free terminal of C5 (G23) alternately to battery positive and negative. Loud clicks should result.

INTEGRATED CIRCUIT

IC1 is a CMOS device and needs special handling precautions. It is better to solder most of the other components in position first (C2-C4, R7-R10 and the various wire links) before soldering the i.c. Note that pins 3 and 12 and also pin 5 and 10 are to be joined by the copper strips beneath the board, so the strips should NOT be cut away at G9 and E9.

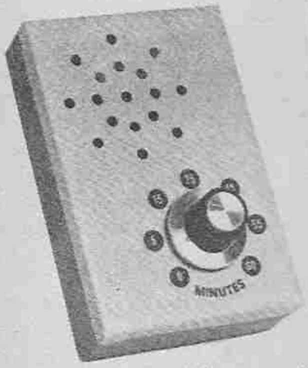
Keep the i.c. in its original packing until you are ready to solder it in place. Then spread a rectangle of kitchen foil on your workbench and connect this by wire to earth (for example, a cold water pipe). Alternatively use an earthed "tin" lid (unpainted) such as the lid of a biscuit tin.

Place the circuit board on the metal sheet. Roll up your sleeves if you are wearing clothing made of nylon or other man-made fibre. Touch your fingers against the earthed sheets before unwrapping the i.c. or removing it from the black conduction foam in which



The completed circuit board.

Warbling TIMER



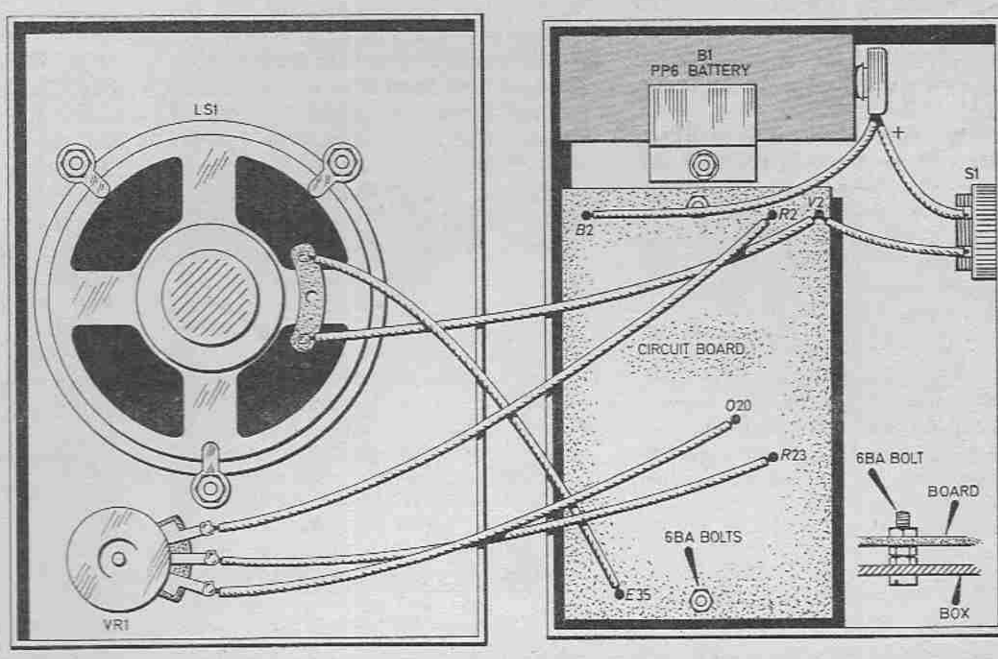
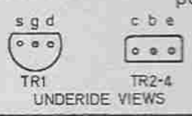


Fig. 6. The complete assembly with inter-wiring between the circuit board and the other components mounted directly onto the aluminium box.



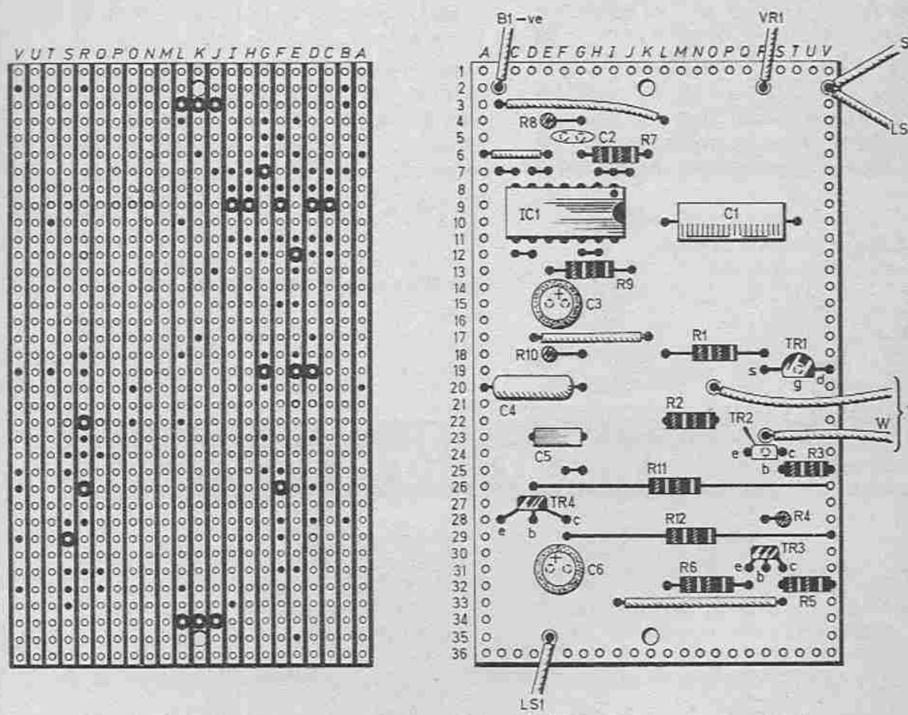


Fig. 7. Underside and top view of the stripboard. Note the breaks required in the copper strips, also the wire links.

COMPONENTS

Resistors

R1	10kΩ
R2	270kΩ
R3	1kΩ
R4	2·2kΩ
R5	2·2kΩ
R6	220Ω
R7	68kΩ
R8	27kΩ
R9	68kΩ
R10	27kΩ
R11	47kΩ
R12	1kΩ

All ¼ W carbon ±5%

See **Shop Talk** page 499

Potentiometer

VR1 47kΩ carbon linear

Capacitors

C1	1500pF (see text)
C2	0·05μF disc ceramic
C3	33μF 25V elect.
C4	0·22μF polyester type C280
C5	0·1μF polyester
C6	47μF 25V elect.

Semiconductors

TR1	2N3819 *n*-channel f.e.t.
TR2	ZTX300 silicon *npn*
TR3	ZTX300 silicon *npn*
TR4	ZTX300 silicon *npn*
IC1	CD4011AE Quad 2-input NAND gate, 14-pin d.i.l.

Miscellaneous

B1	9V battery PP6
S1	toggle switch, s.p.s.t.
LS1	3 inch dia., 8Ω speaker

Piece stripboard, 0·1 inch matrix, 22 by 36 holes; battery connector; metal box 5¼ × 4 × 1½ inch approx; 6BA screws and nuts; knob for VR1; connecting wire.

COMPONENTS approximate cost £4

you received it. Handle the i.c. as little as possible. Before each soldering operation, touch the tip of the soldering iron briefly against the metal sheet.

If you solder all 14 pins in rapid succession, the i.c. will become unduly hot. Solder two or three pins at a time and allow a period for cooling-off. Note that there are several wire links to be soldered between adjacent copper strips, so as to connect pairs of pins (1 to 2, 5 to 6, 8 to 9 and 12 to 13). Finally solder R7 and R9 in position, and thereafter there is no further need for the precautions described above.

TESTING

The circuit is now complete. After switching on, the speaker should be silent during the timing period. Then the warbling note begins and continues until the device is switched off.

Before enclosing the board in its case experiments can be made with different values of C2 and C3 to vary the warbling sound. Reduction in the value of C2 give tones of higher pitch. Reduction in the value of C3 gives a more rapidly modulated warble.

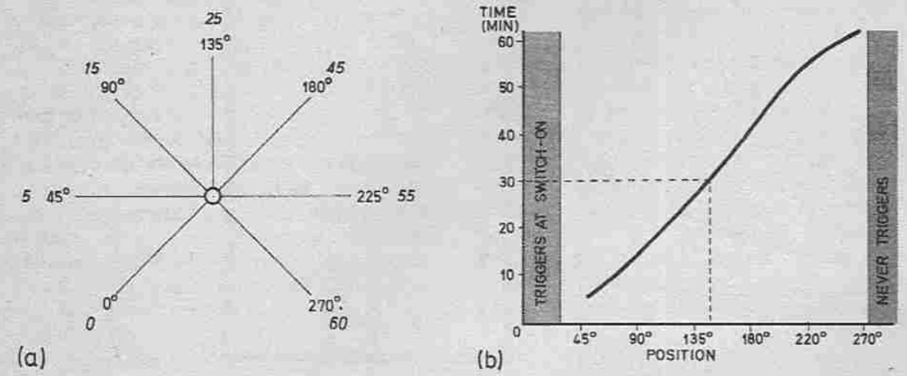


Fig. 8. (a) Positions of the knob of VR1, during calibration. (b) Calibration graph (see text) For 30 min setting the knob should be set to 140°.

If the sound is not loud enough, it is worth altering the value of R11 which supplies the bias current to TR4. Changing the value of this to say 39 kilohm or 56 kilohm alters the volume and may also alter the quality of the note providing a harsher or a more gentle tone, as required.

CASE AND BATTERIES

The board, loudspeaker, switch and VR1 may be mounted in a simple aluminium box, as shown in Fig. 6. There is space for a PP6 battery which may be held in position by a double-sided adhesive "Sticky Fixer". Such a battery is suitable for operating the timer for periods in the 10-20 minute range.

If it is intended to run the timer frequently for periods exceeding 1 hour, it is advisable to use a bigger case to allow a larger battery to be accommodated. For example: two 4·5V heavy duty batteries, such as are used for electric bell systems; a single 6V bell battery; or a battery holder containing four HP2 cells.

For use in the workshop one could dispense with batteries and mount two terminals on the front panel instead. These could be connected to the workshop d.c. supply (6V to 9V) such as a low voltage power pack.

CALIBRATION

The final operation is to calibrate the setting of VR1. The quickest procedure is to set the knob to the seven positions shown in Fig. 8a and measure the time taken for each position. Find the positions which give the shortest and the longest *useful* timing periods. For these positions and for the positions between plot a graph, Fig. 8b. You can then use this to read the exact position for any derived time and mark out a scale (calibrated in minutes) on the instrument case.

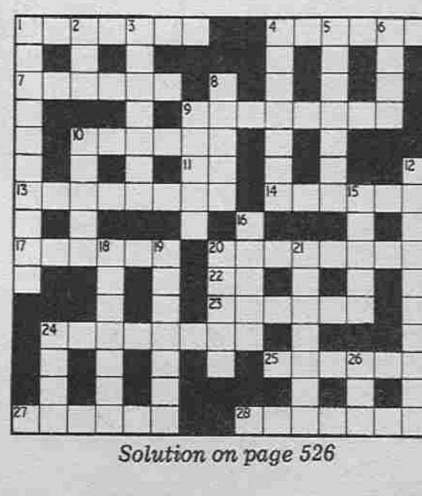
EE CROSSWORD No 18 BY D. P. NEWTON

ACROSS

1 Deliberate decaying of an oscillation.
4 Together with 27 Across, undesirable elastic property on making contact.
7 Wire attire.
9 Designator of operative conditions on $I_c - V_c$ characteristic (4, 4).
10 Grief.
11 Referring to ourselves in wave.
13 A conveyance characteristic of a transistor.
14 Module assembly with a purpose.
17 Compensating op-amp null pin.
20 Characteristic electronic reveille? (4, 4).
22 Knock off the end of an electron.
23 Drilling tools.
24 Aerial element of managerial status.
25 Standard twin emission reproducing extra orchestration.
27 See 4 Across.
28 Device with axe-like properties for converting a slowly changing waveform to a high frequency one.

DOWN

1 Lack of clarity often resulting from overloaded input.
2 Imperial honour.
3 In virtually all cases, this process turns signals over.
4 Areas of poor u.h.f. reception owing to material obstruction.
5 Renders a molecule charged.
6 Resistors, for example, have such a specialised language.
8 Square voltage on the top and resistance underneath.
10 Pole to aid walking.
12 Battery measure (6, 4).
15 Gates, but for some vehicles rather than for electronic purposes.
16 One of the smaller current carriers?
18 Circuit contraction of low resistance.
19 Charge at a slow rate.
20 Automaton.
21 Common prefix in this hobby.
24 Nothing is so dead.
26 About par for a blow.



Solution on page 526

9V POWER SUPPLY

By S. V. Essex

ONE OF THE first pieces of equipment a beginner to the hobby of electronics finds a need for, is a power supply. What is usually required is not an elaborate bench type supply with a high specification, but merely a battery substitute. To maximise the utility of the unit, it would be an advantage if it could be used to power a radio, cassette recorder or calculator when it is not being used for experimental purposes.

The power supply described in this article enables this to be done by simply using an ordinary phono socket as the output connection—by making up several different leads which will all plug into this socket, connections to different pieces of equipment can be changed readily and quickly. The number of different connectors that can be used on the ends of the leads is quite large; battery connectors (to connect in place of batteries), jack power plugs, ordinary connecting plugs or crocodile clips for use when experimenting, and so on. This enormously increases the versatility of the unit.

The circuit provides a continuously variable output from 0 to 9 volts at a maximum current of about 400mA. The power supply is fully protected against an accidental short circuit applied across the output—an essential requirement for use when experimenting. It can be built into quite a small box, and will therefore take up little space on the experimenters crowded workbench.

CIRCUIT DESCRIPTION

The complete circuit diagram of the unit is shown in Fig. 1.

As can be seen, this is entirely conventional. A transformer, T1, has its two 12V secondary windings connected in parallel to provide 12V r.m.s. This is then rectified by the bridge rectifier consisting of diodes D1 to D4, and the resultant d.c. is smoothed by reservoir capacitor C1.

The output voltage is regulated by transistors TR2 and TR3; they are connected as a Darlington pair emitter follower, and are controlled by the voltage applied to TR2 base. This voltage is derived from the Zener diode D5, across which an almost constant voltage is developed, via a potentiometer VR1 which is used to alter the output voltage.

Bias for D5 is provided by resistors R2 and R3, hum and ripple being reduced to a minimal level by C2 and C3.

Output short circuit protection is provided by TR1. When the output current rises above about 400mA, the voltage developed across R1 (about 0·6V) turns on TR1.

The collector of this transistor is connected to the base of TR2, so this action results in a drop in output voltage to counteract the increase in output current. This ensures that even when the output is completely short circuited, the current is limited to a safe value (about 430mA), protecting the power supply from damage.

Resistor R5 is included between the slider of VR1 and the base of TR2 to isolate the action of the overload protection circuit from C3. If this resistor were not present, operation of the protection circuit would mean that TR1 has to discharge C3 before any change in output voltage occurred. Not only would this lead to an increase in the reaction time of the circuit, but it entails TR1 having to pass a relatively heavy discharge current, which leads to unreliability, hence inclusion of R5.

Resistor R6 is included to stabilise the circuit at low output currents.

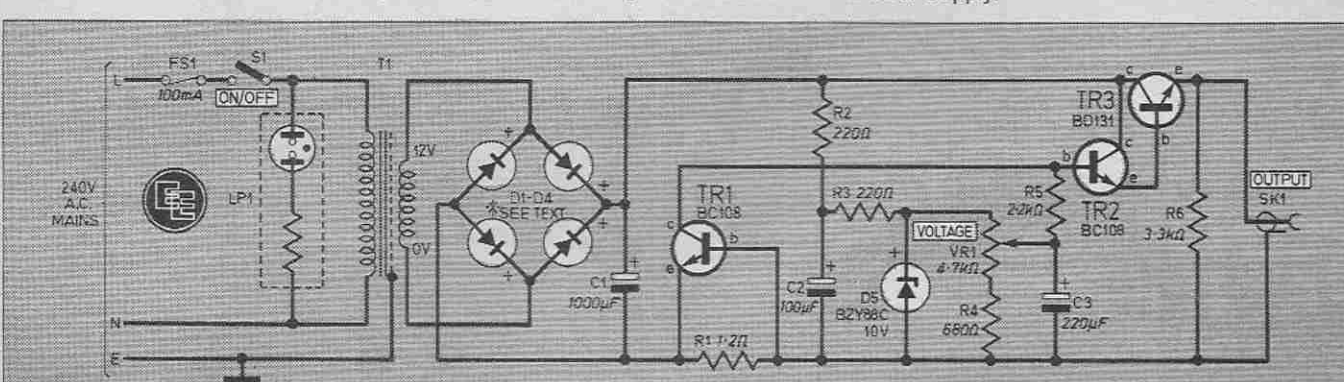
COMPONENTS

All components are readily available, but one or two points require noting.

The transformer used in the prototype featured two separate 12V, 0·25A secondary windings, which were connected in parallel to provide 12V, 0·5A but in reality any transformer capable of providing 12V at 0·5A with a single secondary can be used. Note that it would be wise to obtain the transformer before obtaining the box into which it is to be built, if any doubt exists over its dimensions, especially if the constructor intends to follow the prototype layout described here.

The bridge rectifier can either be bought as one encapsulated unit as used in the prototype, or four discrete diodes can be used. For the former, any bridge rectifier rated at 50V, 0·5A or more can be used—a BY164 is suitable. If four separate diodes are used, 1N4001's would be suitable.

Fig. 1. Complete circuit diagram for the Nine Volt Power Supply.

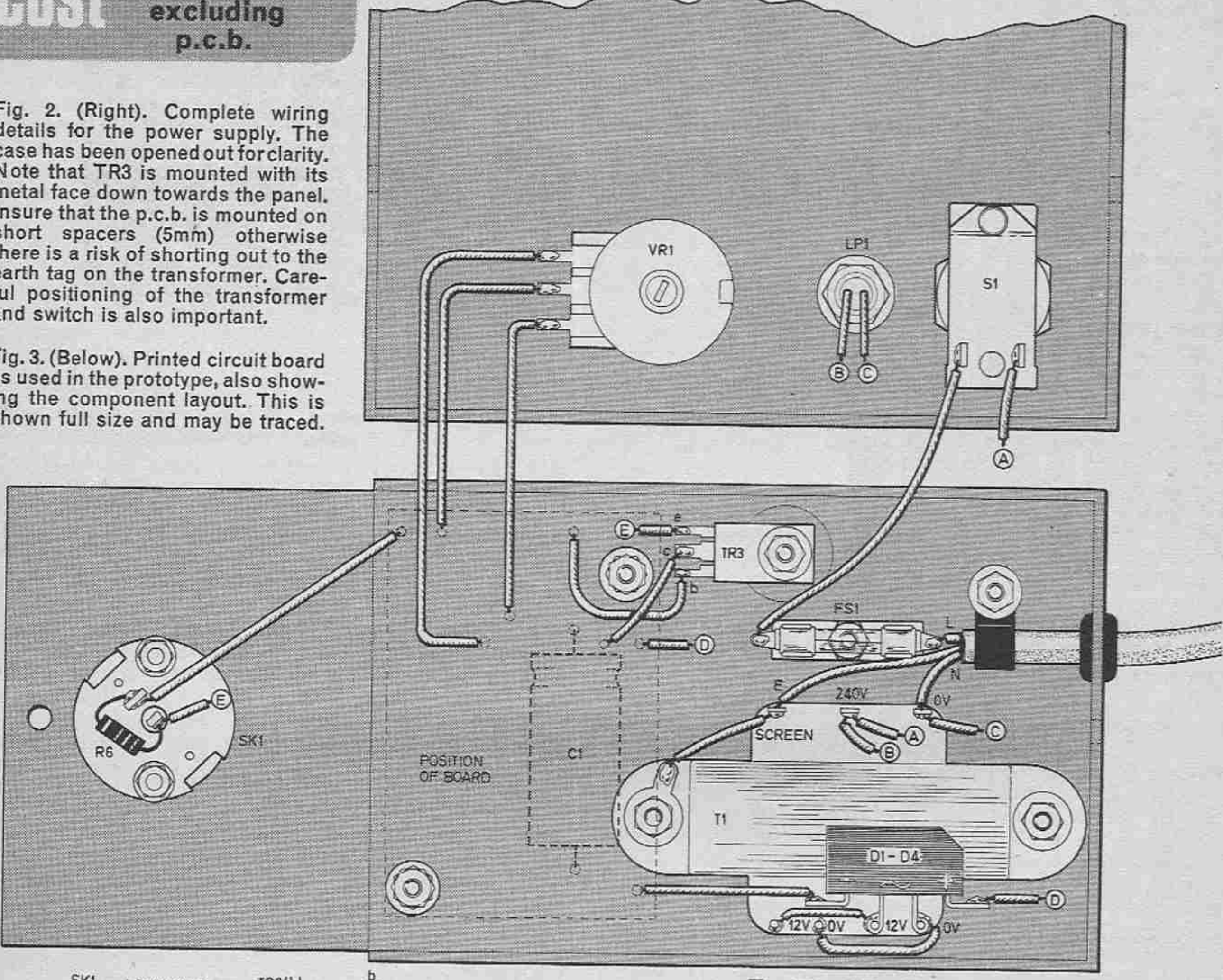


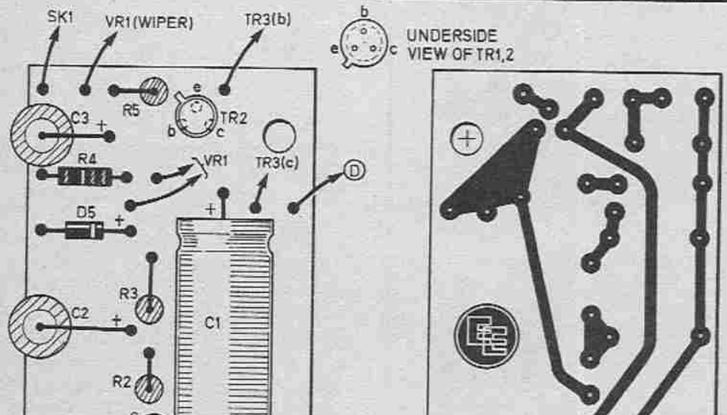
COMPONENTS
approximate cost £6.50 excluding p.c.b.

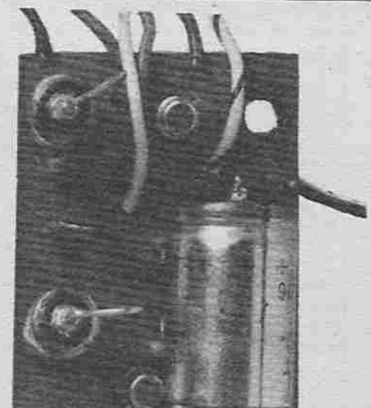
9V POWER SUPPLY

Fig. 2. (Right). Complete wiring details for the power supply. The case has been opened out for clarity. Note that TR3 is mounted with its metal face down towards the panel. Insure that the p.c.b. is mounted on short spacers (5mm) otherwise there is a risk of shorting out to the earth tag on the transformer. Careful positioning of the transformer and switch is also important.

Fig. 3. (Below). Printed circuit board as used in the prototype, also showing the component layout. This is shown full size and may be traced.

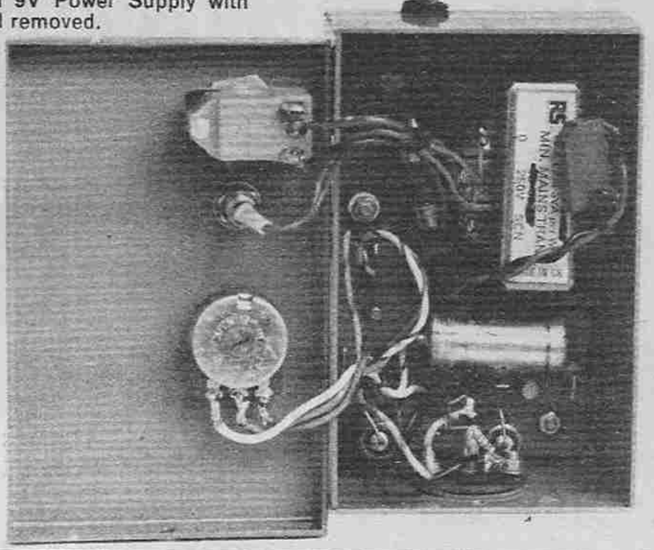






CONSTRUCTION starts here

Completed 9V Power Supply with front panel removed.



The prototype was built in an aluminium box, type AB5, size 100 x 63 x 50mm, with the on/off switch, neon indicator (LP1), and output voltage control (VR1) mounted on the lid. The output socket was mounted on one side of the box.

The drawing of Fig. 2 shows the internal layout adopted. As can be seen, a printed circuit board was used to support the majority of the components, with the exception of the mains input components, the bridge rectifier, which was mounted directly onto the secondary transformer tags, and R6, which was soldered directly onto the output socket.

Layout is not critical and other methods of construction, for example stripboard, can be used if desired. The printed circuit layout used in the prototype is shown in Fig. 3.

Transistor TR3, because it has to dissipate a reasonable amount of heat, should be firmly mounted to the box using a mica washer insulation kit and silicon grease. It will be found that the box will get quite warm if the output is left short-circuited for any length of time, and if the temperature of the box is thought to be excessive it can be painted matt black to allow it to dissipate the heat more readily.

The mounting hole for TR3 should be clean and free from burrs, to avoid puncturing the mica washer and to ensure good thermal contact.

For obvious safety reasons, the metal box *must* be reliably earthed and all components on the low voltage side of the circuit must be kept well clear of those carrying mains voltage. It will be found advantageous to leave the output electrically floating, i.e. with neither side of the output earthed, so insulation of all components, especially the output socket, should be ensured.

If the transformer is fitted with a screen this should be connected to earth.

COMPONENTS

Resistors

R1 1·2Ω
R2 220Ω
R3 220Ω
R4 680Ω
R5 2·2kΩ
R6 3·3kΩ
All ½W carbon ± 10%

Potentiometer

VR1 4·7kΩ carbon lin.

Capacitors

C1 1000μF 25V elect.
C2 100μF 10V elect.
C3 220μF 10V elect.

Semiconductors

TR1 BC108 *npn* silicon
TR2 BC108 *npn* silicon
TR3 BD131 *npn* silicon
D1–D4 BY164 bridge *or* 1N4001 silicon diodes (4 off)
D5 BZV88C10V 10V 400mW Zener diode

Miscellaneous

T1 mains primary, 0-12, 0-12V 250mA secondaries
S1 single pole on/off toggle
LP1 panel mounting mains neon
FS1 100mA 20mm with chassis mounting holder
SK1 single insulated phono socket
Aluminium case type AB5, 100 × 63 × 50mm or similar; printed circuit board; insulating kit for TR3; one small round knob; four rubber feet; 6BA hardware; ¼ inch grommet; length of mains cable as required; connecting wire.

See Shop Talk page 499

TESTING

The simplicity of the circuit means that there is very little to go wrong, but the following points are worth mentioning.

If, during testing, it is discovered that the input voltage to the bridge rectifier is almost zero then this, assuming the use of a transformer with two 12V secondaries will be due to them being connected in anti-phase, so that the voltage in each opposes the other. Changing the connections to one of the windings is the answer.

One common error is to connect the Zener diode into the circuit the wrong way—the voltage across it is then about 0·6V and the fault is easily detected using a multimeter.

A test of the short-circuit protection circuit can be done by connecting an ammeter on its 1A range directly across the output for a few seconds, if the current exceeds about 500mA, the circuit is not functioning correctly and a careful check should be made of TR1 and its associated components.

If all the tests perform satisfactorily, and there are no faults the unit can then be put into use. After a period of use you will wonder how you ever managed without a power supply—except of course the saving on the cost of numerous batteries! ☐

MINI~MODULES

By George Hylton

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

10

SWANEE WHISTLER

THIS month's Mini Module can serve either as a simple musical instrument or as a variable frequency audio oscillator for sound effects. Musical readers will be familiar with the Swanee Whistle. This is a simple wind instrument on the lines of a penny whistle, but instead of placing the fingers over stop holes to change the note you do so by moving a piston in the barrel of the instrument. This shortens or lengthens the pipe and so adjusts the note.

The Swanee Whistler does the same sort of thing but note adjustment is by moving a slider potentiometer. The output power is only a few milliwatts but is quite sufficient to produce an audible note in a high-impedance loudspeaker.

LOUDSPEAKER

A speaker of more than about 50 ohms impedance may be connected directly to the output. Speakers of lower impedances require a matching transformer for maximising the output, though no harm will come to the circuit from connecting a low-impedance speaker direct.

A transformer which converts the speaker impedance to 500 ohms will receive about 20mW. The d.c. through the primary is only about 5mA. These figures show that it should be possible to salvage a push-pull output transformer from an old pocket portable and connect to the Swanee Whistler using the pocket portable original speaker of 3-8 ohms impedance.

Any kind of high-impedance earphone may be connected.

If the output is used to drive an amplifier, several volts are available. If the amplifier input circuit has no d.c. blocking capacitor it will be necessary to add one: $0{\cdot}1\mu F$ should be suitable.

THE CIRCUIT

Readers who have been following this series may have noticed that the Swanee Whistler circuit (Fig. 1) bears a close resemblance to the circuit of the Continuity Tester which formed Number 4 of the series. This is no accident. While developing the Continuity Tester I realised that essentially the same basic arrangement could be used as an audio source, and here it is.

The two transistors TR1, TR2 form an amplifier. This is turned into an unstable amplifier by applying positive feedback from the emitter of TR2 to the emitter of TR1 via R4.

FEEDBACK

By itself this (d.c.) feedback would merely turn TR1 hard off while allowing TR2 to be turned hard on by current through R1. However there is also some negative feedback via VR1 and R3. This tries to stabilise the circuit but its action is delayed by C1, which takes time to charge or discharge. The result is that the circuit first flips into one state because of the positive feedback then, after a while, the negative feedback catches up and resets it.

COMPONENTS

Resistors
R1 100kΩ
R2 10kΩ
R3 3·3kΩ
R4 10kΩ
R5 330Ω
All carbon film ±5%. ¼W

Potentiometers
VR1 47kΩ or 50kΩ slider potentiometer log law

Capacitors
C1 47nF (0·047μF) polyester

Transistors
TR1, TR2 BC107, BC108 or BC109 (2 off)

Miscellaneous
Knob for slider pot. Case (twin-switch box). Formica for panel. Pins. Hardboard. 8BA nuts, solder tags, and 5/8 inch bolts. (4 of each). 4BA bolts (4).

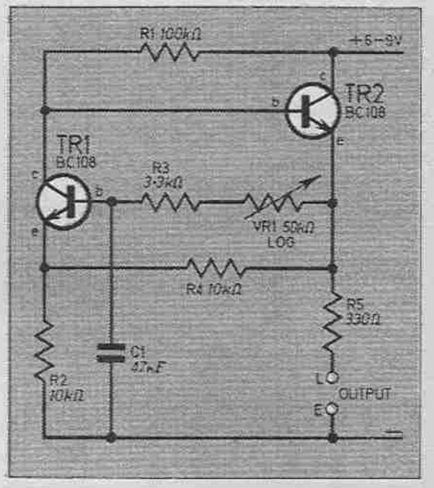


Fig. 1. Swanee Whistler circuit diagram.

The process continues, the negative feedback always lagging behind. TR2 is periodically turned on for a time then off and the current through it comes in pulses. Changing VR1 adjusts the rate at which C1 charges and this controls the frequency.

Quite large frequency sweeps can be obtained but the wider the coverage the harder it is to hit the right pitch by adjusting the slider pot VR1. So R3 is included to limit the frequency range at the high end. With the values shown the range is about 400-4,000Hz when a 100 ohm load is connected, falling to 300-1,000Hz when the load is of very high impedance.

EFFECTS

For sound effects use it may be preferable to dispense with R3 and connect the left-hand end of the potentiometer straight to C1 and TR1 base. This will enable the frequency to shoot up to infinity (or more likely to go high then stop) with VR1 set to zero resistance.

Battery drain is less than $100\mu A$ when no load is connected and rises to about 5mA with a low-resistance load.

CONSTRUCTION

The circuit board used in the prototype is designed for economy. A copy of the component layout diagram (Fig. 2) is laid over a suitably-sized piece of hardboard and pins inserted at each junction point to serve as solder tags for the components and wiring.

I used ordinary domestic pins one inch long then cut off the heads but domestic pins are easily bent and it may be preferable to substitute bright new half-inch panel pins which are much stiffer.

The four lead-outs are $^5/_8$-inch 8BA bolts, with a solder tag for connections on the inside and a nut on the outside. They can then serve to fix the board to the panel as well.

The panel is a piece of Formica. Cutting the slot for the slider control can be done either by drilling a straight row of small holes, close together, then breaking down the divisions and finally tidying up with a nail file, or by using a Stanley scoring knife to cut through the Formica from the decorative side.

This second method is neater but requires patience. When the cut has gone almost through to the back of the board drill a small hole at each end and break out the slot material carefully with the tip of a screwdriver.

The case for the prototype is a metal twin-switch box of the deeper kind as used for mounting the older sorts of light switches in the wall. Any other kind of case will serve and it need not be made of metal.

USING THE SWANEE WHISTLER

The circuit as it stands will enable you, with the addition of a suitable speaker, to make enough noise indoors to amuse yourself or drive the family mad: continuous sounds are very penetrating even at low volume.

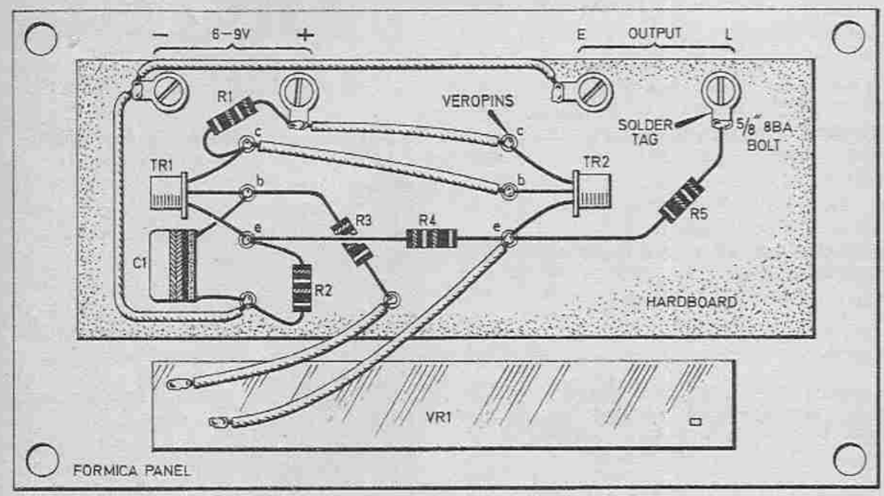


Fig. 2. Component layout on hardboard base. This is secured to the Formica panel by the four 8BA bolts.

If however it is desired to make serious musical use of the circuit some additions are desirable. First, a power amplifier to increase the volume. A low-power battery operated amplifier will be described later in this series, but it is possible to add-on a very simple low-power stage in the form of a complementary pair of transistors, Fig. 3.

Since we are dealing with square pulses and distortion is unimportant the transistors may be operated unbiased. If desired a volume control in the form of a 10 kilohm log law pot can be interposed between the Whistler output and the power amplifier. It can conveniently include an on-off switch.

If a separate tuning adjustment is needed it can be provided by substituting for R2 a linear pot of 22 kilohms or thereabouts, connected as a simple variable resistance.

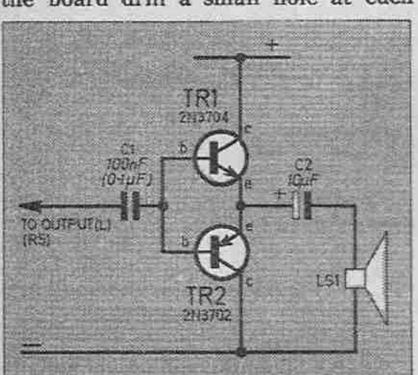


Fig. 3. An optional add-on amplifier stage.

CORRECTION

Mini Module 8 (June). Formula second line 355 should read:

R4 (new) = 100 kilohms/(*A*-1).

Next Month: Mini Amplifier.

DOING IT DIGITALLY

PART 11

By O. N. Bishop

SOLVING Jack Plug's Problem (Part 9) and adding two and two to get four have one thing in common—they are both logical operations. That being so, TTL can deal with arithmetic as well as the more perplexing problems that beset the Plug family. Since TTL has only two kinds of input and output, high (=1) and low (=0), it operates on numbers in binary form. This presents no difficulty, for it is easy to arrange a coding circuit (such as the keyboard coder described in Part 5) to turn decimal numbers into binary form, and a decoding circuit (such as the 7447 i.c.s of the Test-Bed display system) to convert the binary numbers back to decimal when the calculations are completed.

BINARY ADDITION

Since a digit can have only one of two values in binary arithmetic, a short truth table, Table 11.1, covers all the possible addition operations.

The equation for the last line of the table would be $1+1=2$, if written in *decimal* form. The carry digit (C) is added to the next column of figures to the left when you are adding two numbers each consisting of more than one digit. If we look for logical relationships in the truth table, we find that the carry column (C) is the AND of A and B. The sum column (S) is the exclusive-OR of A and B. Exclusive-OR is a little different from the ordinary OR operation we met earlier. In exclusive-OR the output is high if one or the other *but not both* of the two inputs are high. In Fig. 11.1 we obtain the exclusive-OR function by using five NAND gates. If you ever need this function in other applications, this is the way to obtain it, but if you need several exclusive-OR circuits use the 7486 i.c., which has four two-input exclusive OR gates on one chip.

In Fig. 11.1 we obtain AND, by inverting NAND, so constructing the entire half-adder with NAND gates. With two 7400 i.c.s on the Test-Bed you can assemble the half-adder and carry out all the basic binary additions listed in the truth table.

The circuit is called a *half-adder* because it has no input for accepting

Table 11.1. Binary addition

Inputs (the numbers to be added together) *A*	*B*	Outputs (the result of addition) Carry *C*	Sum *S*	Equivalent equations (in binary form)
0	0	0	0	0+0= 0
0	1	0	1	0+1= 1
1	0	0	1	1+0= 1
1	1	1	1	1+1=10 (or 0, carry 1,)

a carry from a previous stage of addition. For example, to add binary 11 and 1, we set out the addition like this:

$$\begin{array}{r} 1\,1 \\ +\;\;1 \\ \hline \end{array}$$

Answer ______

The half-adder can perform the first stage, adding the "units" column (or *least significant digits*), and giving the outputs $S=0$, $C=1$. The "units" digit of the answer is 0, and we carry 1 to the next most significant digit, the "twos" column. Here the half-adder could accept the 1 and 0 (not actually written but implied), but there is no way to tell it that there is a 1 carried over from the previous operation. We need a *full-adder* circuit that can accept this carry and work out that $1+0+1$ (carried over)$=0$, carry 1.

A third operation is required to work out the "fours" column (*most significant digit*), for which a full-adder would give $0+0+1$ (carried over)$=1$, carry 0. This gives us the final answer, $11+1=100$. In decimal, the equivalent operation is written $3+1=4$.

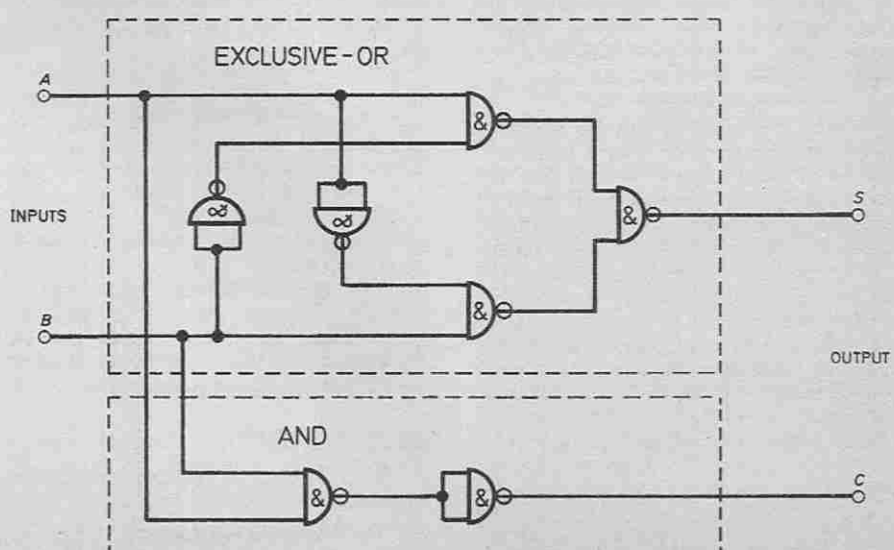


Fig. 11.1. Half-adder made from exclusive-OR and AND sub-units.

FULL ADDER I.C.

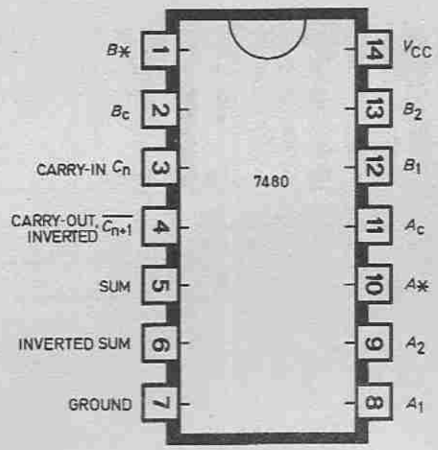
To assemble a full-adder we need several more gates, but fortunately we can buy a complete full-adder in a single i.c., the 7480 pinning details in Fig. 11.2. This contains a full-adder circuit which adds together two input digits (A and B) and the carry-in digit. The input gating allows us to vary the way we use the adder. The rules for inputs at the "A" set of pins are listed below.

(1) If A_c is low, the input to the adder circuit is high (=1) whatever the state of the other A inputs. Normally we wire A_c to V_{cc}, to allow the other inputs to function as in rules (2) and (3) or for short-periods use we leave it disconnected, effectively high.

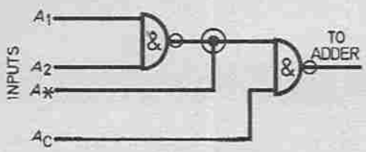
(2) If A^* is high, the input to the adder is the AND of A_1 and A_2.

(3) If A^* is low, the input to the adder is the NAND of A_1 and A_2.

The same rules apply to the B inputs. In the circuit and Test-Bed layout shown in Figs. 11.3a and b, we make A_c and B_c high, we leave A_2, A^*, B_2 and B^* disconnected (=high), and use A_1 and B_1 to input the digits to be added. If A_1 *is* high, the adder receives the AND of A_1 (=high) and A_2 (=high), which is high. If A_1 is low, the adder receives low. The inputs to the adder are thus identical with those appiled at A_1 and B_1, and their sum S *is* obtained from IC1 pin 5, with the carry digit appearing *inverted*, at pin 4. If we require a carry-in, this can be applied to pin 3 (C_n), so for the first stage of an addition we always make C_n low.



(a)



(b)

Fig. 11.2a Pinout details for the 7480 Full-adder i.c. and (b) gating on A inputs (B input gating is identical).

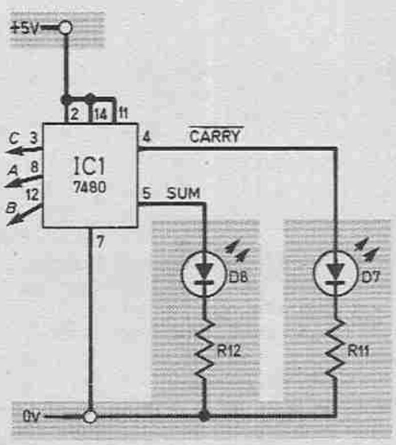


Fig. 11.3a. Circuit diagram for a Full-adder using the 7480.

SERIAL AND PARALLEL ADDITION

The 7480 can add only one pair of digits and the carry-in at a time. To add numbers with more than one digit, we can work in one of two ways:

(1) SERIAL. Add the columns one at a time, working from right (least significant digit) to left (most significant digit), just as we do when working with pencil and paper.

(2) PARALLEL. Add all columns simultaneously, taking carries into account. For parallel adding we need a row of 7480's, one for each column to be added, with the carry from one i.c. fed to the i.c. dealing with the next most significant digit. Serial addition requires fewer i.c.s, for we simply present the pairs of digits to the i.c., one pair at a time in order from l.s.d. to m.s.d., and arrange for a memory unit to retain the carry digit until the next stage of addition. In this month's adding circuit we use serial addition.

SHIFT REGISTER

Before we can put the 7480 to work we must have some means of registering the numbers we wish to add, and presenting them to the adder, digit by digit, in order. In the previous series of Doing It Digitally we punched a paper tape to represent the rows of digits and fed this through a special home-made tape-reader. In this series we store the numbers electronically in a device called a shift register.

Many types of shift register are available, a suitable one being the 7495, see Fig. 11.4. It contains four flip-flops A, B, C, and D, each of which can be *set* (output=1) or *reset* (output=0) when one of the clock inputs *changes* from high to low.

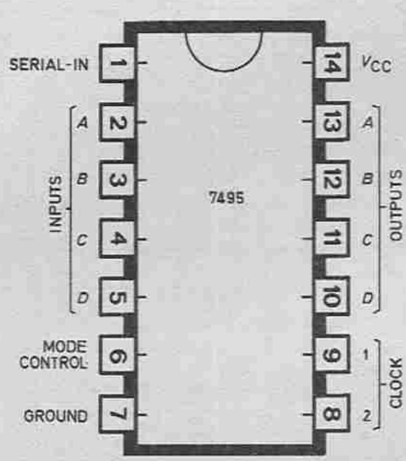


Fig. 11.4. Pinning details for the 7495 shift register.

MODE CONTROL

To load the flip-flops we make the mode control input high, make the inputs A to D high or low (depending

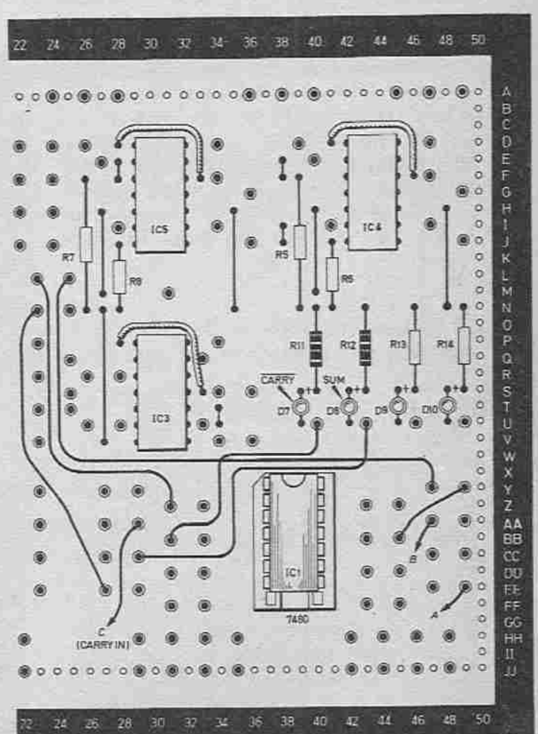


Fig. 11.3b. The circuit of Fig. 11.3a wired on the Test-Bed for testing the 7480 Full-adder.

on what number we wish to store) and wait for the clock to change from high to low. At that instant the data at the inputs is transferred to the flip-flops, and their outputs become identical with their inputs. Once the clock has gone low, the data is *stored* (or *loaded*) and changing the inputs does not alter the outputs (until the *next* time the clock goes low).

If the mode control is made low, data is *shifted* the next time the clock goes low. At that instant the content of flip-flop A is transferred to flip-flop B (all inputs A to D are ignored), the content of B is transferred to C, the content of C is transferred to D, and the content of D is lost. What happens to flip-flop *A* depends upon the state of the "serial in" input (pin 1). Whatever is applied to this input, is tranferred to flip-flop *A* when shifting occurs.

In Fig. 11.5a, serial *A* is grounded, so flip-flop *A* goes low when shift occurs. The i.c. has two clock inputs. Clock 1 input is used during shifting, and clock 2 input during loading, so that the two functions can, if required, be clocked independently. Here we clock both functions from the same clocking sequence by joining the pins together.

The easiest way of applying data to the register is to use the keyboard decoder described in Part 5 (February 1979). Note that corrections to the keyboard appeared last month. One of the spare keys is used to apply mode control. We use the lower left-hand spare key; join the drawing-pin to ground by inserting a wire link from *BB*24 to *I*24, and cut the copper strip at *BB*23; solder a soldercon socket at *AA*28, to provide a connection to mode control, and cut the strip at *AA*29. We call this the SHIFT key, for when the key is pressed, mode control is grounded and shifting occurs. The four l.e.d.s display the state of each register.

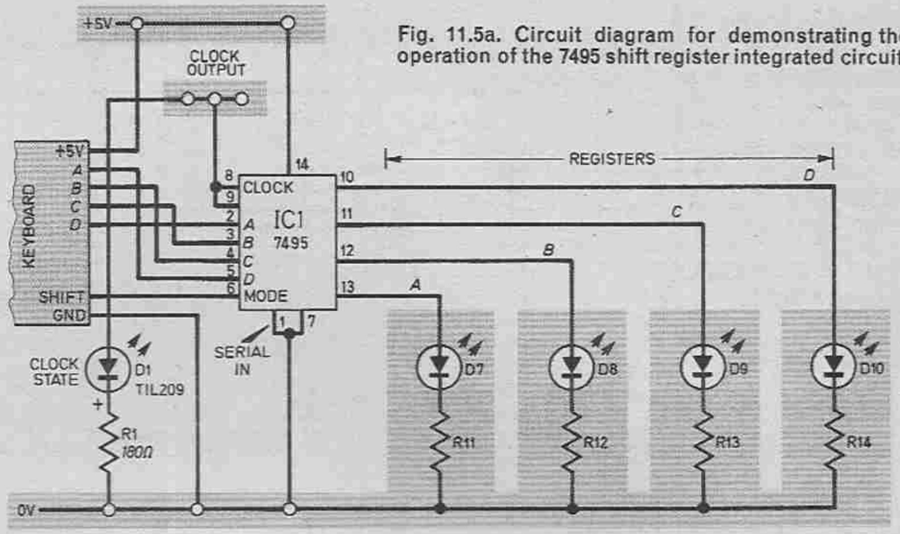


Fig. 11.5a. Circuit diagram for demonstrating the operation of the 7495 shift register integrated circuit.

KEYBOARD SHIFT REGISTER ANNOTATION

There is some unavoidable confusion over the lettering on the keyboard diagram and that on the 7495. The keyboard (and also the outputs of the in-built counters IC4 and IC5, and the inputs to the Test-Bed display system) are labelled so that the l.s.d. is called *A* and the m.s.d. is called *D*. When using the shift register, we use flip-flop *A* to store the m.s.d., and flip-flop *D* to store the l.s.d. The l.e.d.s are lettered *according to the shift registers* so that they display a number just as it is written on paper, with the l.s.d. on the right. It is very helpful to know the state of the clock output and for this purpose a CLOCK l.e.d. is incorporated.

To load a number, press one of the number keys while the clock output is high; hold the key until the clock goes low, when the binary version of the number should appear on the l.e.d.s *A* to *D*. Unless you continue to hold the number key down, the number is cleared when the clock next goes low, for the input will have become 0000 if the key is released. However, if (while the clock is high) you press and hold the SHIFT key, the number shifts one place to the right each time the clock goes low. Since "serial in" is grounded, the display is cleared digit by digit from the left.

Try entering various numbers and shifting them, to gain experience at keeping your key-pressing in time with the clock, see Fig. 11.5b.

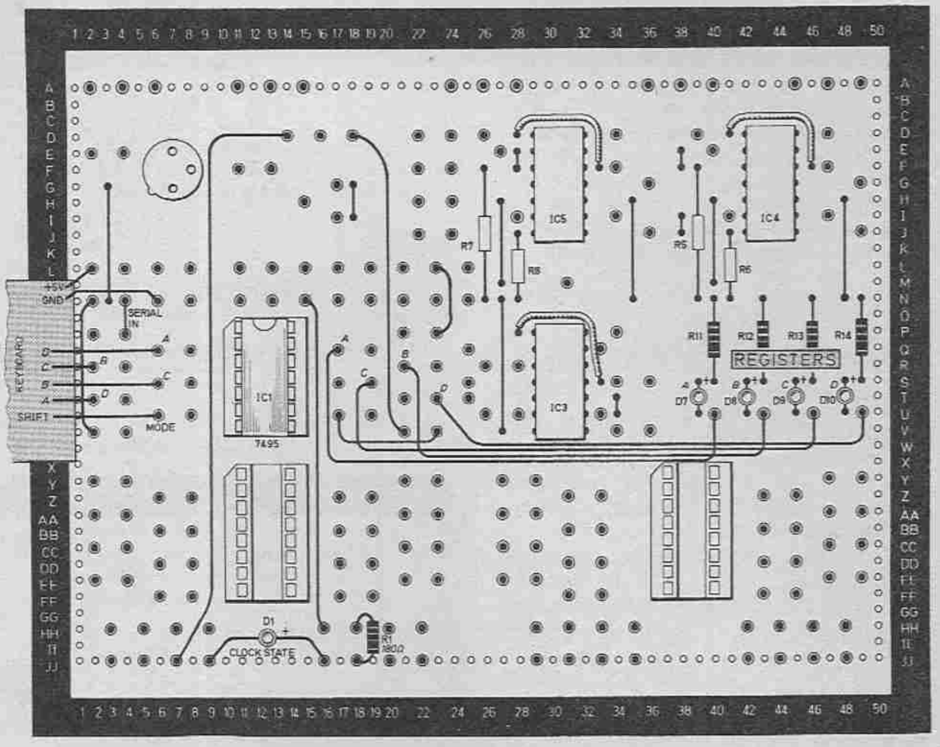


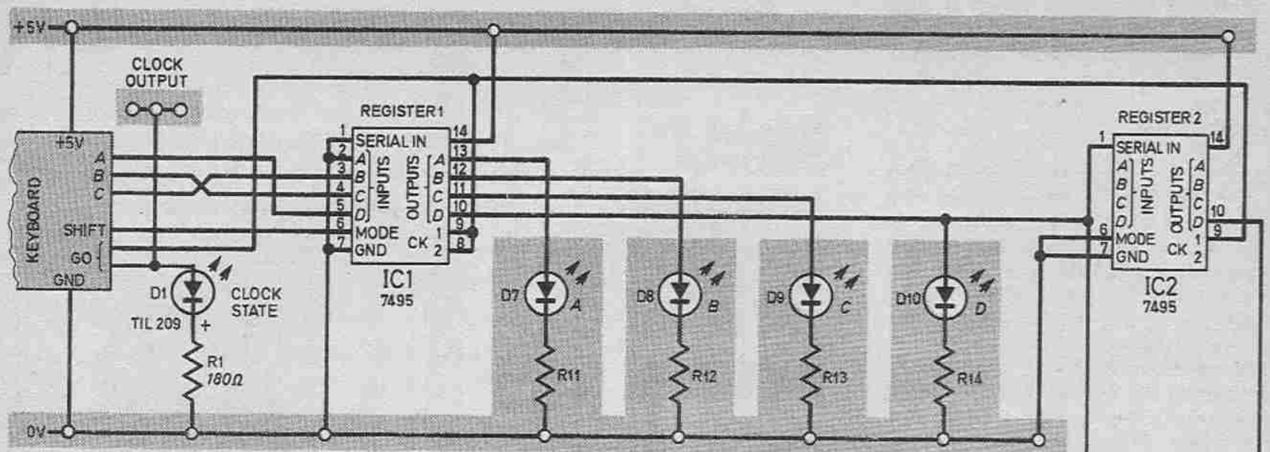
Fig. 11.5b. The circuit of Fig. 11.5a wired on the Test-Bed for testing the 7495.

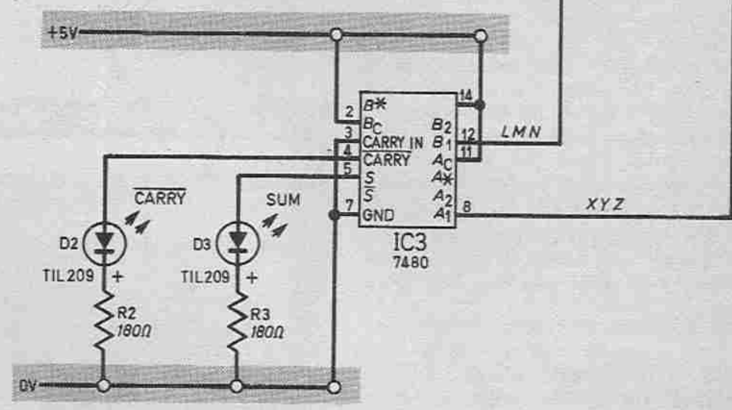
A SIMPLE CALCULATOR

Now we are ready to combine two shift registers and an adder to make a calculator, but let us get it clear that this is in no way a substitute for your pocket calculator. The most it can do is add 7 plus 7.

The main purpose of setting it up—as with almost all the other projects set up on the Test-Bed—is to give you some insight into how logic circuits work. With only three i.c. sockets available, the Test-Bed can never carry any really complex logical circuit. Its purpose is simply to try out simple combinations of i.c.s which, once understood, can be built into a permanently wired unit.

This simple calculator is particularly valuable as it is a good example of a *sequential* logical circuit. This is a circuit in which the output is not decided simply by its present inputs, but partly by inputs at earlier stages. The circuit (Fig. 11.6a) is designed to add together two three-digit binary numbers, which we shall represent by *XYZ* and *LMN*. We first load *XYZ* into shift register 1, then shift it serially in shift register 2; as it leaves register 1, we enter *LMN* in register 1. The digits are then shifted out of the *D* flip-flops of both registers and into the adder, which sums *Z* with *N*, *Y* with *M*, and *X* with *L*, making any carries that are necessary.





TEST-BED CALCULATOR

The layout on the Test-Bed is shown in Fig. 11.6b, but for the moment we will simplify matters by omitting the carry-over facility, and therefore ground the carry input of the 7480. To make the circuit easier to handle, a switch is included between the clock output and the registers. For this GO key, we use another of the spare keys on the keyboard, the bottom right-hand key. To make this suitable cut the copper strip at *BB*29, and insert soldercon pins at *AA*34 and *BB*34.

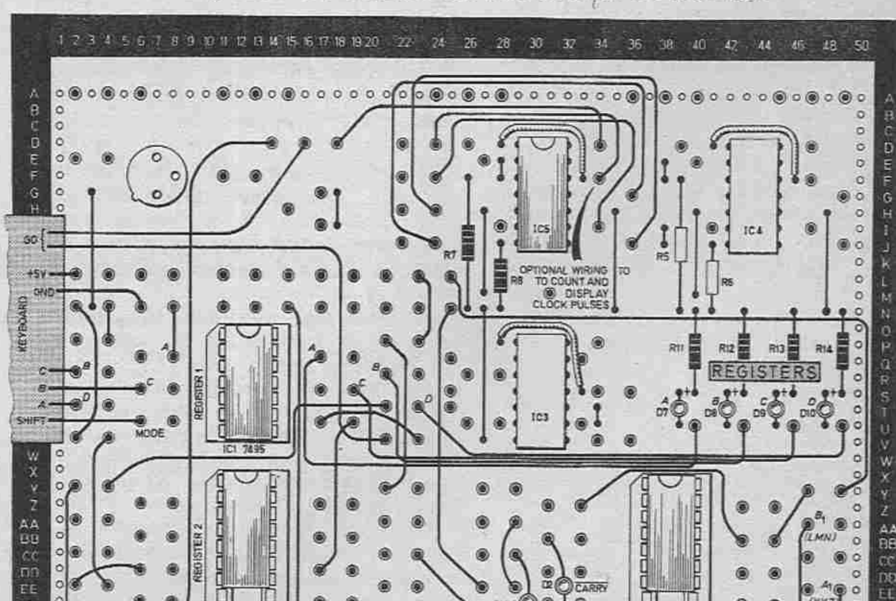
Fig. 11.6a. Circuit diagram for a simple calculator (without carry facility).

SHIFT SEQUENCE

Since Register 2 has simply to receive number *XYZ* shifted from Register 1, its mode control is permanently grounded and only the clock 1 input is required. The output from flip-flop *D*, Register 1, is shifted direct to flip-flop *A*, Register 2 by way of the serial-in pin.

The addition sequence, reading from top to bottom is illustrated in Fig. 11.7. Remember that loading and shifting occur as the clock goes from *low to high*. To feed in the clock pulses, the GO key must be pressed and held all the time. To halt the sequence, release GO when the clock is high; to resume the sequence press GO when the clock is high. If GO is pressed when the clock is low, this may cause multiple low pulses which will shift the data one or even more places along. You will probably need to watch the clock state l.e.d. and count out aloud as you run through the stages of calculation.

Fig. 11.6b. The circuit of Fig. 11.6a wired on the Test-Bed.



CLOCK SPEED

If the clock runs too fast for you to keep up with it, try feeding the clock output into IC4 (pin *D*47) and use the output from pin *F*47 as a clock running at half frequency (or even pins *I*47, *J*49, or *G*49 for lower frequencies). You may find it easier to keep count if you wire up IC5 as a counter, connecting its output to the right-hand 7-segment display. The display changes each time the clock goes low.

OPERATION

In Fig. 11.7 it can be seen that the answers appear on the SUM and $\overline{\text{CARRY}}$ l.e.d.s immediately after counts 5 to 8. The l.s.d. comes first. You will have noticed that this calculator has only a 3-digit input, input *A* of Register 1 being wired to ground. This is necessary because a blank space is needed between *X* and *N* to make room for the final carry after *X* and *L* have been added.

Since this circuit has no provision for carry, use it only with additions in which no carry is required, for example, 1+10, 101+10, 1000+101.

When you have tried out a few additions you will begin to realise how much easier it would be if there could be additional control circuits to make shifting take place at exactly the right stages, and to record the serial output from the adder. It is possible (and not really difficult) to shift the answer digits back into Register 1 and display a four-digit answer, but there is just no room on the Test-Bed to mount both the calculator circuit and the few control circuits that are needed. Perhaps the reader may be motivated to design and build a slightly more sophisticated calculator incorporating these refinements.

DIRECTION OF SHIFT →

OPERATION	CLOCK OUTPUT	COUNT	OUTPUTS REGISTER 1 A	B	C	D	OUTPUTS REGISTER 2 A	B	C	D	OUTPUTS OF ADDER	
	LOW	START	0	0	0	0	0	0	0	0	0	IGNORE
PRESS KEY FOR XYZ	HIGH	↓										
XYZ LOADED	LOW	1	0	X	Y	Z	0	0	0	0	Z	
	HIGH	↓										
PRESS & HOLD SHIFT KEY	LOW	2	0	0	X	Y	Z	0	0	0	Y	
	HIGH	↓										
	LOW	3	0	0	0	X	Y	Z	0	0	X	
	HIGH	↓										
	LOW	4	0	0	0	0	X	Y	Z	0	0	
PRESS KEY FOR LMN	HIGH	↓										
LMN LOADED	LOW	5	0	L	M	N	0	X	Y	Z	Z+N (l.s.d)	READ ADDER OUTPUTS IN ORDER AND RECORD RIGHT TO LEFT
	HIGH	↓										
PRESS & HOLD SHIFT KEY	LOW	6	0	0	L	M	N	0	X	Y	Y+M	
	HIGH	↓										
	LOW	7	0	0	0	L	M	N	0	X	X+L	
	HIGH	↓										
	LOW	8	0	0	0	0	L	M	N	0	FINAL CARRY (m.s.d.)	
	HIGH	FINISH										

INPUTS TO ADDER

Fig. 11.7. The sequence of operations for adding two binary numbers *XYZ* and *LMN*.

CARRY

The carry function can be performed manually by disconnecting the carry input from ground at each step of the calculation when the *previous* step has produced a low output at $\overline{\text{CARRY}}$. With so many other things to think about at the same time, manual carrying taxes the patience of the most cool-headed, and an automatic carry is almost essential. Fortunately it can just be fitted on to the Test-Bed, making use of the remaining built-in circuits.

CIRCUIT DESCRIPTION

The complete carry circuit is shown in Fig. 11.8a. The bistable changes state when a low pulse appears on lines *P* or *Q*, depending upon which state it is in already; *P* and *Q* cannot both go low at the same time, and neither can go low while the clock is high. The bistable can change state only during the second half of a clocking period, that is to say the time leading up to a "count" when loading or shifting occur.

During the first half of a time period, immediately after a count, the two digits presented to the adder are added and $\overline{\text{CARRY}}$ becomes high (=carry 0) or low (=carry 1). This has no immediate effect on the bistable, but $\overline{\text{CARRY}}$ remains high and when clock next goes high, *P* goes low. This triggers the bistable to change state (if the bistable is not already in that state) giving a low output to the carry-in terminal of the adder.

When the clock goes low again, at the next count of the calculation sequence, there is no change in state of the bistable. Its output remains low, giving low carry-in to the next stage of the calculation. Thus the low carry from one stage gets added in with the new pair of digits of the next stage. Suppose that this addition results in $\overline{\text{CARRY}}$ going low (=carry 1). There is no immediate effect on the bistable, but when the clock goes high *Q* goes low and it changes state. This gives a high input to carry-in and this is retained ready for the next stage of addition. Note that when the clock goes high and there is a change of state of the bistable the *new* carry-in is being fed to the adder, which may then give a different output. This does not affect the carry-over operation but may affect the SUM display. This display should therefore be read immediately after each count, *while the clock is still low.*

USING DISCRETES

To make this carry circuit we use in-built IC3 to provide the bistable, the INVERT gate and one of the NAND gates. The other NAND is made from discrete components. This is a useful reminder that although we use i.c.s. most of the time, there are occasions

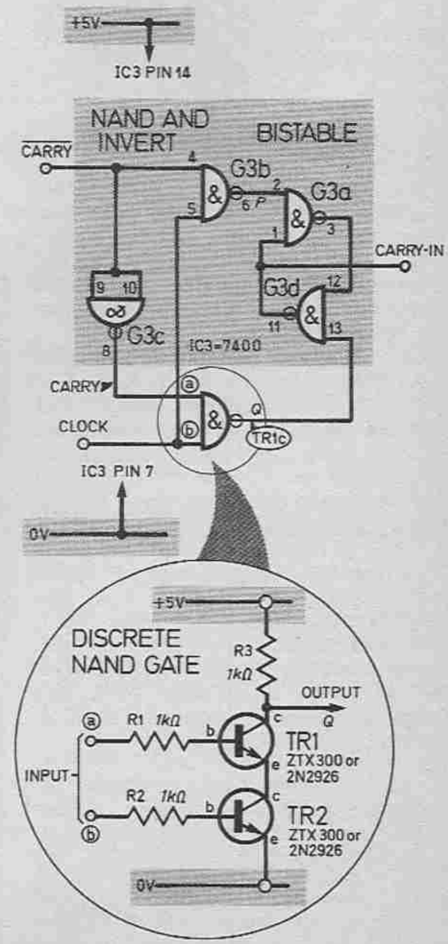


Fig. 11.8a. Circuit diagram for carry function and circuit of a discrete NAND gate.

when it is more convenient to go back to first principles and build a gate from a few transistors and resistors.

From Fig. 11.8a it can be seen that the output is high unless *both* transistors are switched on. When both are switched on, by applying high inputs to both bases, the output is effectively connected to ground, and becomes low. Almost any *npn* transistor can be used to build this gate. The additional wiring for the carry circuit is shown in Fig. 11.8b. The link from *AA*29 to *EE*29 (Fig. 11.6b) is removed, and the $\overline{\text{CARRY}}$ l.e.d. is no longer required.

When the carry circuit has been connected, try calculations involving carrying, such as 1+11, 1111+1111, 110+110.

SUBTRACTION

The Test-Bed is looking more like a bird's nest than ever before, but there is still one more improvement to make.

Luckily, binary subtraction can be carried out by a process involving addition. The rule is simple; for example, to subtract 110 from 1000, we first find the *complement* of 110. We do this by replacing all the 1's by 0's and all the 0's by 1's, so the complement of 110 is 001. We then *add* the 001 to 1000 and finally add 1 to the total:

	1000
+complement of 110	001
+1	1
equivalent to 1000−110=10	

Ignore the first 1 in the answer, arriving at 010, which is the difference required.

In our calculator we can find (*XYZ-LMN*) by loading *XYZ* in the normal way, but when *LMN* is being fed to the adder at input A_1 we make A^* *low*, so that the *inverse* of each digit it presented to the adding circuit of the 7480. We can use a third spare key on the keyboard to ground A^* when it is pressed.

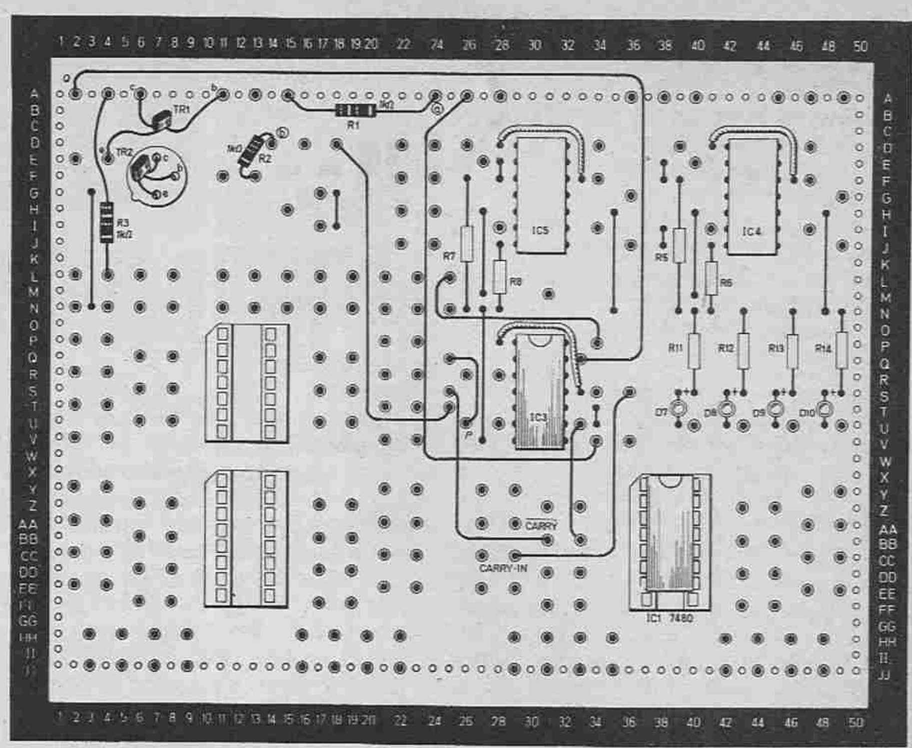


Fig. 11.8b. The circuit of Fig. 11.8a wired on the Test Bed.

The top left key is used, by soldering a wire link between *N*29 and *I*29, inserting a soldercon socket at *R*24 and cutting the strip at *R*28. Call this the COMPLEMENT key.

To add in the extra 1, we make the carry-in high at the first stage of addition. This can be done by grounding the $\overline{\text{CARRY}}$ output briefly when clock is high, just before the first count of the subtraction sequence. The top right-hand key (ADD ONE) can be used for this; the connection to ground is already wired in; solder a socket at *R*34 to connect to $\overline{\text{CARRY}}$. The sequence for subtraction is as follows:

Load and shift *XYZ*, as in counts 1 to 4 of Fig. 11.7.

Just before count 5, press the ADD ONE key briefly, then press the number key for *LMN*.

After count 5, release the number key, but press COMPLEMENT key down for the rest of the sequence.

Press and hold SHIFT key as in Fig. 11.8.

The answer to the subtraction is found by reading the digits obtained after counts 5, 6, 7, and 8. the digit at count 9 is normally 1, and should be ignored when writing down the answer.

Problem

What happens when you take 1001 from 1000, or 111 from 1? What does it mean when the digit at count 9 is 0?

To be continued

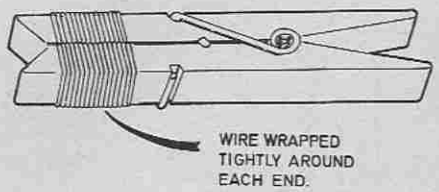
BRIGHT IDEAS

COMPONENT HOLDER

When constructing a circuit it is usual to have the components in front of you. I normally use plastic bags and small boxes. This has not really been suitable, due to the time involved sorting out the right component. I then decided to use a piece of foam plastic. The components, resistors, capacitors etc, are simply pushed in the foam.

Using this method I find it easier to pick out the required components. Also when they are accidently knocked on to the floor, as with boxes the components go everwhere, but with foam they stay put.

L. Privett, Barking, Essex.



THIRD HAND HEATSINK

To allow a free hand when soldering I have developed a simple peg heatsink to protect components against excessive heat.

All that is necessary is two 200mm lengths of 1·5mm dia. copper wire and a wooden clothes peg, see diagram. The peg can easily be clipped onto the lead being soldered and will remain there without being handheld.

D. G. Taylor, Merseyside.

I.C.MUSIC

R.A.PENFOLD

ELECTRONIC TUNING FORK

THIS DEVICE is primarily intended to permit quick and easy tuning of a guitar, but it has also been used successfully with a violin and could no doubt be employed with other musical instruments of this general type. Like an ordinary tuning fork the unit has an audible output against which the unit can be tuned by ear. Each of the six guitar notes can be selected by means of a front panel switch.

BEAT NOTE

An additional and very useful feature of the unit is the ability to compare the frequency of the guitar with the internal reference oscillator, and produce an output note which is equal to the difference in the two frequencies, normally termed the beat note. The beat note can be heard in the earphone as a sort of phasing effect due to the interaction between the two input signals. The note itself is usually too low to be audible as such.

A light emitting diode has therefor been incorporated in the unit, and this flashes on and off at a rate equal to the beat frequency. This gives a clear indication of the tuning error, and facilitates accurate and easy tuning merely by adjusting the guitar for the lowest attainable flashing rate. In this way it is very easy to bring the guitar to within 1Hz of the reference oscillator's frequency, which is far more accurate than most people can achieve by usual means.

COMPONENTS approximate cost £7.50 excluding microphone

CIRCUIT DESCRIPTION

The complete circuit diagram of the Electronic Tuning Fork is shown in Fig. 1.

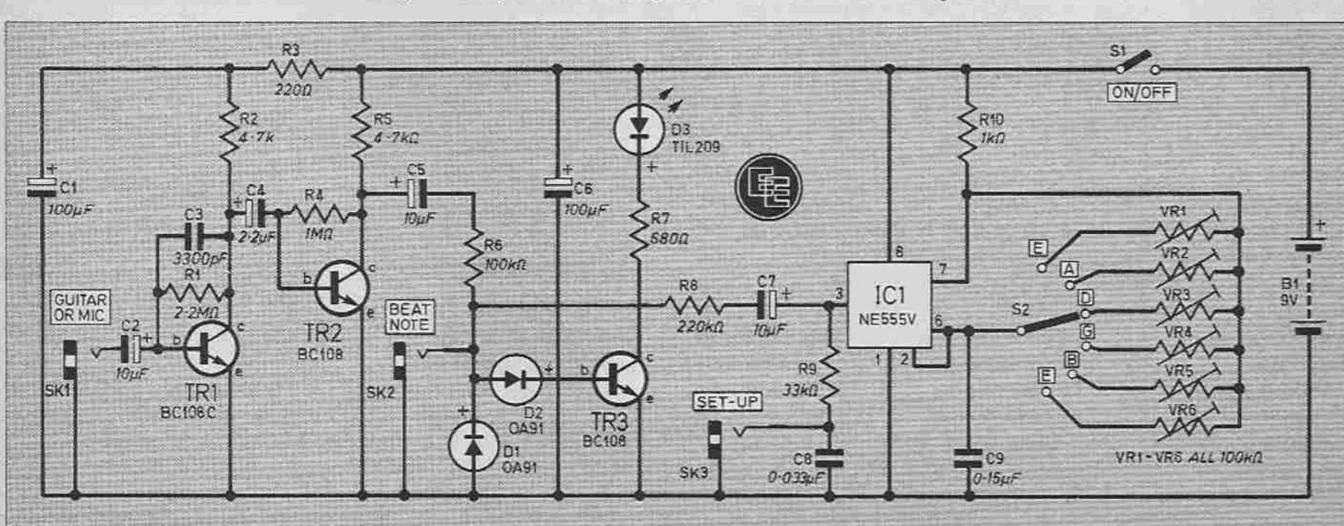
With an acoustic guitar the input signal to the unit must be obtained via a microphone, but an electrical signal can obviously be taken direct from an electric instrument. In either case only a fairly low signal level will be obtained, paticularly in view of the fact that the output from a guitar quickly decays to only a small fraction of its initial peak level. This makes it necessary to considerably amplify the input signal to bring it up to a suitable level to drive the next stage of the unit.

This amplification is provided by TR1 and TR2, both of which are connected as high gain common emitter amplifiers. Less than 1mV. is needed at the input in order to drive TR2 beyond the clipping threshold. This is adequate to give good results if the unit is fed direct from an electric instrument, or driven from an acoustic guitar via a low impedance dynamic (cassette type) microphone. An electret microphone having an internal preamplifier should also be suitable, but a crystal type is unlikely to prove satisfactory due to the fairly low input impedance of the circuit.

REFERENCE OSCILLATOR

The reference oscillator uses an NE555V device, IC1 in the astable mode. The six preset resistors, VR1

Fig. 1. Complete circuit diagram of the Electronic Tuning Fork.



to VR6, are each tuned to a different open string guitar note, with the desired preset and note being selected using S2. A rough squarewave output is obtained at pin 3 of IC1, and this is fed to an earphone socket by way of a simple top cut filter comprised of R9 and C8. The purpose of the filtering is to attenuate the harmonics on the output which are otherwise excessive, and tend to drown the fundamental frequency.

Some of the output from IC1 is coupled by C7 to one input of a passive mixer formed by R8 and R6. The output of TR2 is coupled to the other input by C3.

MIXING

If the two signals are at the same frequency the mixing will either result in the two signals adding together if they are in phase (if they rise and fall precisely in step and are of the same polarity), or cancelling one another out if they are out of phase (if they rise and fall in step but are of opposite polarity to one another). This results in either a rapid stream of pulses being fed to TR3 base via the rectifier circuit consisting of D1 and D2, or no signal at all being fed to TR3.

Transistor TR3 has l.e.d. indicator D3 and current limiting resistor R7 as its collector load, and the positive pulses to TR3 base will result in D3 glowing brightly. If the signals are out of phase and there is no input to TR3, D3 will switch off. The important thing is, that, the l.e.d. indicator remains in the same state and does not switch on and off. Of course, the two input signals may not be perfectly in or out of phase as has been assumed above, but may be somewhere in between these two extremes. This causes the two signals to either partially add together or cancel one another out, producing an intermediate but steady level of illumination from D3.

PHASE EFFECT

If the two input signals are at slightly different frequencies they will not have a fixed phase relationship, but will alternate between the in phase and out of phase states. This results in the signals first adding together and switching on D3, and then cancelling out and switching off D3. This happens continuously with D3 flashing on and off in consequence. The greater the difference in the two input frequencies the quicker the changes in phase relationship, and the faster the flashing rate of D3. In fact D3 switches on and off at a rate equal to the difference in the two input frequencies.

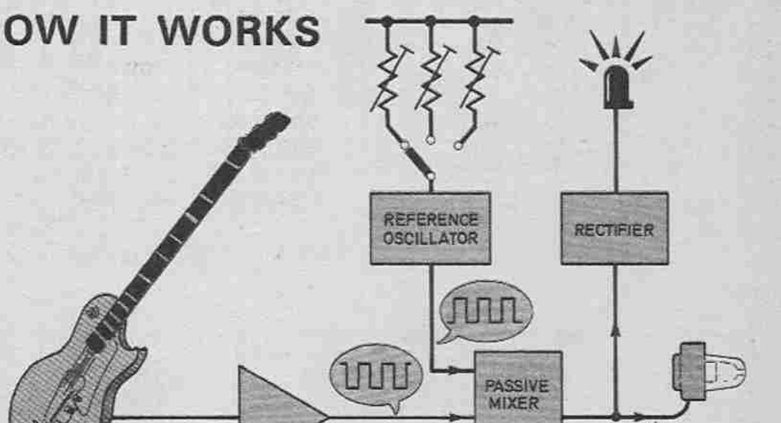
The mixing process produces an audible phasing effect at the junction of R6 and R8, and this can be heard using a crystal earpiece plugged into SK2. Note that only a crystal earphone is suitable for use with this unit, and magnetic types are unsuitable.

On/off switching is provided by S1. The current consumption of the unit from a 9 volt supply is approximately 18mA, and this is provided by a PP6 size battery which gives many hours of operation.

CONSTRUCTION starts here

Most of the components are assembled on a 0·1inch matrix stripboard which measures 13 copper strips by 37 holes. This

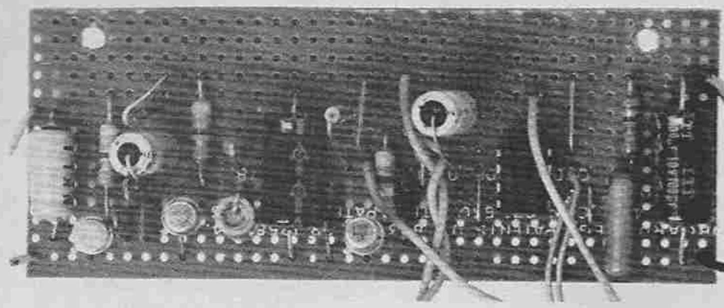
HOW IT WORKS



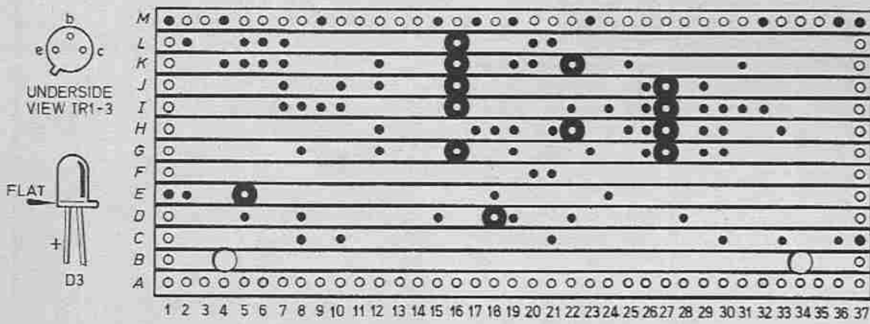
A note from either an acoustic or electric guitar is applied to a *high gain amplifier* which turns the very low input from the guitar into a much larger signal which is sufficient to be applied to one input of a *mixer*. The other input is connected to a stable *reference oscillator* having six switched frequencies which correspond to the six notes of a guitar.

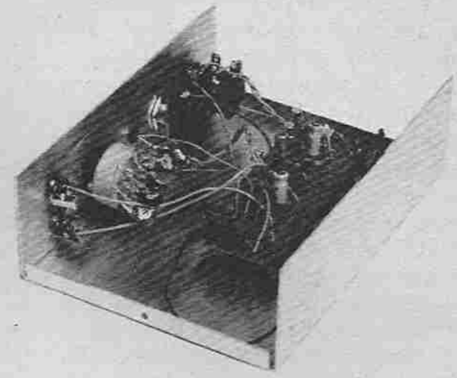
The output from the *mixer* is equal to the difference between the two input frequencies. The guitar is then tuned for minimum output frequency (zero beat) so that it is brought to the same pitch as the reference oscillator. Both audible and visual indication is provided, the latter being useful for fine tuning.

ELECTRONIC TUNING FORK



The completed circuit board for the Electronic Tuning Fork.





The finished unit showing how the preset potentiometers are mounted on the tuning switch.

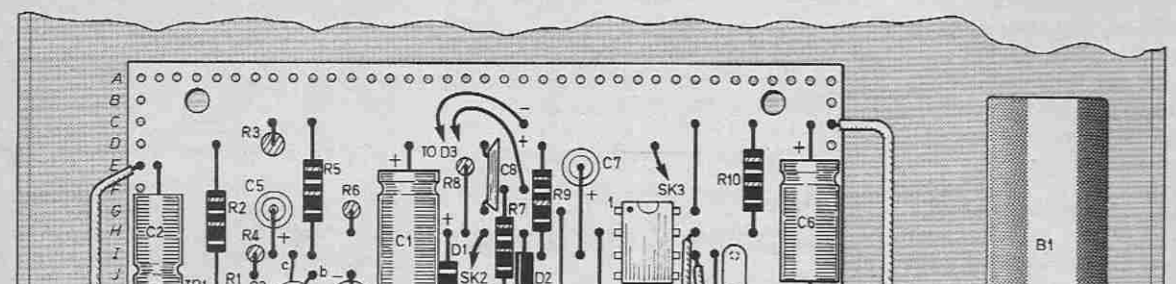


Fig. 2. Complete wiring details for the unit also showing the stripboard layout and breaks to be made. All the tuning presets are mounted on the switch to save space on the board. It is not neccessary to use screened wire when wiring to the sockets, as the metal case provides sufficient screening.

must be cut down from a larger board using a hacksaw, and any rough edges are then filed smooth. Next the two 3·3mm diameter mounting holes and the breaks in the strips are made at the points indicated in the component panel layout diagram of Fig. 2.

The components are then soldered into place with the semiconductor devices being left until the end. D1 and D2 are germanium diodes, and these are more easily damaged by overheating than the other devices. Either a heatshunt should be used on each of their leadout wires as it is soldered into place, or the leads should be connected fairly swiftly so that there is no chance for the diodes to overheat. Be careful not to omit the four link wires around IC1.

COMPONENTS

Resistors

R1 2·2MΩ
R2 4·7kΩ
R3 220Ω
R4 1MΩ
R5 4·7kΩ
R6 100kΩ
R7 680Ω
R8 220kΩ
R9 33kΩ
R10 1kΩ
All ¼W carbon ± 5%

Capacitors

C1 100μF 10V elect.
C2 10μF 10V elect.
C3 3300pF ceramic plate
C4 2·2μF 10V elect.
C5 10μF 10V elect.
C6 100μF 10V elect.
C7 10μF 10V elect.
C8 0·033μF ceramic plate
C9 0·15μF polyester

Potentiometers

VR1-6 100kΩ miniature vertical presets (6 off)

Semiconductors

TR1 BC108C *npn* silicon
TR2 BC108 *npn* silicon
TR3 BC108 *npn* silicon
D1,2 OA91 germanium (2 off)
D3 TIL209 red light emitting diode
IC1 NE555V timer

See Shop Talk page 499

Miscellaneous

SK1 ¼ inch mono jack socket
SK2, 3 3·5mm jack socket (2 off)
S1 standard single pole toggle
S2 2-pole 6-way rotary switch (only one pole used)
B1 9V PP6 battery

Stripboard, 0·1 inch matrix 13 strips by 37 holes, metal case 152 × 120 × 51mm or similar; PP3 type battery connector for B1; small round control knob; mounting clip for D3; extra 2·5mm jack socket if required—see text; 8 pin i.c. socket if required; low impedance dynamic microphone (200 ohm cassette type); connecting wire; crystal earpiece with 3·5mm plug.

CASE

A metal instrument case having approximate outside dimensions of 152 x 120 x 51mm was used as the case for the prototype, and any similar case should provide a suitable housing. It is recommended that a metal case should be used as this will screen the sensitive amplifier circuitry from possible sources of electrical interference.

The general layout of the unit can be seen from the photographs, but is not critical and any sensible layout can be used.

Many low impedance dynamic microphones have a 2·5mm jack plug as well as the 3·5mm one which carries the output signal, and it is quite common for the two plugs to be contained in a single moulding. If a microphone of this type is to be used with the unit it will be necessary to mount a 2·5mm jack on the front panel to accommodate the unused 2·5mm plug. Alternatively an ordinary 3·5mm plug can be fitted to the microphone in place of the original.

In order to minimise the amount of wiring between the component panel and the controls, VR1 to VR6 are mounted on S2 rather than on the component panel. The component panel is mounted using 6BA screws about 12mm or so long, and spacers are used to ensure that the connections on the underside of the panel are kept well clear of the metal case.

The small amount of point to point wiring must be completed before the panel can finally be bolted into position.

ADJUSTMENTS

Initially VR1 to VR6 should all be set for about half maximum resistance. With an earphone connected to SK3 and the unit switched on, a fairly low audio tone should be produced with S2 set to any of its positions. If this does not happen, switch off at once and check the wiring for errors.

The presets are adjusted by ear against a piano, pitch pipes, or other such source, to give the six open string notes of a guitar at the six settings of S2. This should obviously be done as accurately as possible. Once set, the unit should not need any readjustment for a considerable period of time as the reference oscillator is very stable, and is not, for instance, significantly affected by variations in the battery voltage.

IN USE

In use, each guitar string must be brought fairly close to the correct pitch before D3 will flash on and off at a rate which is slow enough to be perceived. The unit must therefore be used as a conventional tuning fork when making the initial adjustments to an instrument which is badly out of tune. With the earphone connected to SK2, an audible beat note will often be heard before the indicator light flashes at a slow enough rate to be perceived, but once the tuning is almost correct, the flashing light will probably give a clearer indication of the beat note.

It should be borne in mind that harmonics of the two input signals to the mixer can interact to produce beat notes even when the guitar is well off tune. However, this is not really too much of a problem as these spurious results only occur when the tuning is so far out that it should be obvious that it is an erroneous response.

Also, the flashing of D3 is far less pronounced at these secondary responses, with only minor fluctuations in its brightness occurring. At the main response it will vary from full brightness to no output whatever. ⌑

LETTERS

Subjective Response

Having just read Adrian Hope's article (*For Your Entertainment*) in the June issue of Everyday Electronics I feel it necessary to reply to that part subtitled "Sound off".

Sound level meters measure sound pressure and not energy. These meters generally incorporate an "A" weighted network which closely relates to the subjective response of the normal human ear to sound. In the field of acoustics the "A" weighting is accepted as the best descriptor of human perception to sound.

The difference between subjective response to a shout and speech recorded at identical energy levels lies in the frequency content of the sounds rather than the energy output. Since the ear is sensitive to frequency changes these differences are readily noticeable.

A great deal of work has been done by persons such as Stevens, Zwicker and Beranek to establish equal loudness contours and their results are remarkably similar, from large but differing samples of people. Modern microtechnology has made the incorporation of these equal loudness contours into a sound level meter a real possibility although of limited use to the acoustician.

Finally, I should like to offer a possible solution to the mystery of the differing maximum frequency sensitivity between the sexes. In young children the threshold of audibility of 4kHz can be as low as −2dB. This alters with age and more important noise exposure. Men are generally subjected to greater noise exposure than women. This exposure leads to a shift in the maximum frequency sensitivity from around 4kHz to 3kHz or less. This shift is characteristic of noise induced hearing loss both temporary and permanent.

R. N. Lovett
Dunstable

Matter of "Sferics"

I find your *Counter Intelligence* articles very interesting and informative. In the May issue you query the usefulness of static electricity and I wonder if my memory of an article in the magazine "Scientific American" back about 1956 would be of help.

It was on the use of old radio material rewired to measure the "crackles" that in some cases was due to static and the suggestion for using the machine was to predict the nearness of lightning. If I can find the copy I will send it to you for passing on to Mr. Young, as I feel the task would be helped by your colleagues upgrading the apparatus to modern terms and it might even be of use.

I am hesitant about mentioning this as it was quite a time ago but I know most libraries can obtain this publication and its unusual in that it gives good scientific reports and practical schemes in esoteric fields. I mention this before saying that the static should be measured in units called "sferics", but I think it really was a serious article (I once was told by a technical officer that they would make the apparatus if I got a research grant of about £50! I am afraid I never tried).

I hope this is of interest and you can make something of it as this might be the time when technology has the means to discover what static can be used for, rather than shocking us in our synthetic world.

D. S. Mayne,
Armagh.

Suitable definition

In reply to Mr. Young's question concerning static electricity *(Counter Intelligence,* May 1979 issue), first a suitable definition must be found; for this I have decided upon—an electric charge which is at rest—i.e., a charge which remains on an object without change.

This reveals the basic difference between static electricity and ". . the ordinary sort . . ." since the latter must travel to produce an effect. Coincidentally this movement is due to attempts, by the electrons, to produce an equilibrium of potential, i.e. to become static electricity.

By definition static electricity is therefore unable to do anything useful except to attract and repel an electron beam, i.e. move the dot on an oscilloscope.

David R. Clarke (aged 15)
Rugby.

Static Charge

As regards to Mr. Young's query about static electricity *(Counter Intelligence,* May 1979 issue*)*, I hope the following information might be useful.

As we all know, "electricity" is due to the fact that charged particles (electrons) move from one point to another, e.g. down a wire, their movement being caused by a difference in potential at the two ends of the wire. Now static electricity is due to the build up of charges on an object.

The charges that have built up do not "move" and so there is no current flow. If, however, the charges are allowed to leak away by contact with something at earth potential, there is an associated current, which is the result of the much lower potential to which charges tend to flow.

So, electricity is the flow of charge whereas static charge is the result of the build up of charge on an area; giving the same effects when they move as do electric currents due to a battery for example. However, in electrostatics we are usually dealing with a small charge (few microcoulombs) and several kV; in current electricity the opposite is usually the case.

Well, what use is static charge? Today's modern technology has put electrostatics into some quite useful situations.

Coal-fired power stations, steel, cement and chemical industries use electrostatic precipitation in order to contain flue gas outputs which would otherwise be discharged into the atmosphere. The flue gases pass through some positively and some negatively charged grids. The gas particles pick up the charge from one of the grids and are thus attracted by the other, causing collection of the particles on the grids.

Electrostatic spraying of paints is possible; electrostatic loudspeakers and microphones are in common use as are electrostatic copying machines. In nuclear physics electrostatic generators are used to produce static which then generates several million volts and is used to accelerate atomic particles for research.

A knowledge of static electricity is also needed to combat situations where the static could produce disastrous results. Static charges build up on wings of aircraft in flight and on plastics in industry creating potential explosion hazards if not combated; lightning conductors are used to protect buildings.

Nearer home ground, static charges come into play when a capacitor is fully charged and no more charge flows from one plate to the other.

But as we can appreciate, most of the functions described need "current" electricity to produce the charged surface in the first place, but we can consider functions such as employed using Van de Graff generators (e.g. nuclear physics) as being static electricity on its own performing useful functions.

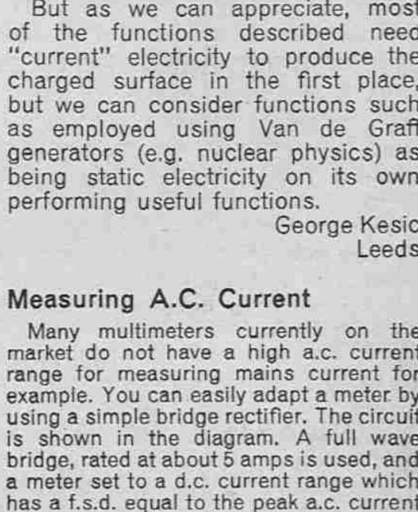
George Kesic
Leeds

Measuring A.C. Current

Many multimeters currently on the market do not have a high a.c. current range for measuring mains current for example. You can easily adapt a meter by using a simple bridge rectifier. The circuit is shown in the diagram. A full wave bridge, rated at about 5 amps is used, and a meter set to a d.c. current range which has a f.s.d. equal to the peak a.c. current to be measured.

As the meter will indicate only the peak value of the current, a shunt can be made up and connected across the meter so that it will indicate true r.m.s. instead of peak current.

R. H. Marco,
London SW10



BRIGHT IDEAS

STORAGE

I have found a simple and cheap method of storing components. Components are placed into plastic bags of the press to seal variety about 150mm x 100mm. A hole is punched through the unused plastic above the seal in the centre. The bags are then hung on a length of string, fastened between any two points.

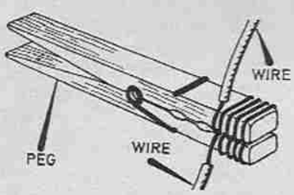
A simple hook is made from stiff wire 55mm long which provides an easy method of removal when required. A system of this kind I think compares favourably with commercial storage bins etc.

J. Fleming, London E7.

CROCODILE CLIPS

Needing a few additional crocodile clips (when the shops were closed) I made up suitable alternatives, using just an ordinary clothes peg and thin insulated wire. The clothes pegs can be shaped to a point similar to that on pliers. The leads are then stripped for about 150mm and then wound round the ends as shown in the diagram.

S. Moss, Bath.



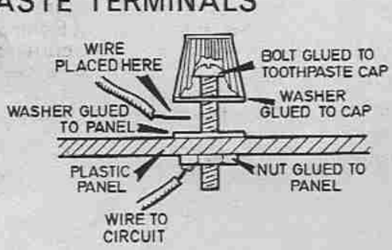
COMPONENT BREADBOARDING

As a devoted electronics enthusiast, I construct projects purely for the fun of it. As such I very rarely keep the projects so constructed. Therefore I have found it wise to mount certain components on a board. A size of 25cm x 15cm seems about right.

The component, for example a speaker, is mounted on one side of the board, plywood for instance and nails driven through from the other side. When the component is to be used I just connect it up using crocodile clips.

A. White, Burbage, Leicestershire.

TOOTHPASTE TERMINALS

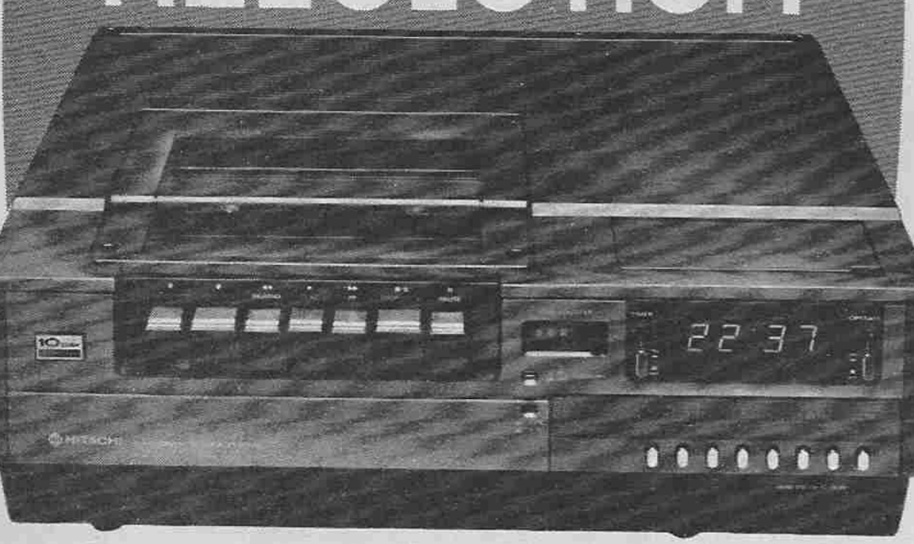


When constructing test equipment etc. the cost of terminals can be quite high, and is often cheaper for the constructor to make his own. My idea is to use an old toothpaste cap. The drawing above shows how this is made.

Thus the external wire can then be gripped firmly between the two washers when the terminal is screwed down.

P. Baily, Rutherglen, Scotland.

THE VIDEO REVOLUTION



BY ADRIAN HOPE

SUDDENLY video is happening. There are two reasons why the long awaited video revolution has now finally arrived. Most people who can afford a hi fi system already have at least one and are "in the market" for another electronic gadget; and the new generation of video cassette recorders, which are now selling from a wide variety of UK shops, offer greatly increased playing time and drastically reduced "feeding" cost. This latter phrase neatly sums up the cost in blank cassette tape of using a video recorder.

Until a year or so ago feeding costs were high enough to be a marked deterrent for all but the very well-heeled. Now they are at a very low level, £5·00 an hour or less.

FIRST GENERATION

The first generation of domestic video recorders (the N1500 series) came from Philips of Eindhoven in 1974, the result of research and development work carried out by a Philips team in Austria.

It costs around £25 an hour to record television programmes off-air using one of the original N1500 series Philips video recorders. This was fine if you re-used the same cassette over and over again but not so fine if you wished to store a programme. Also the cassette had a maximum playing time of one hour.

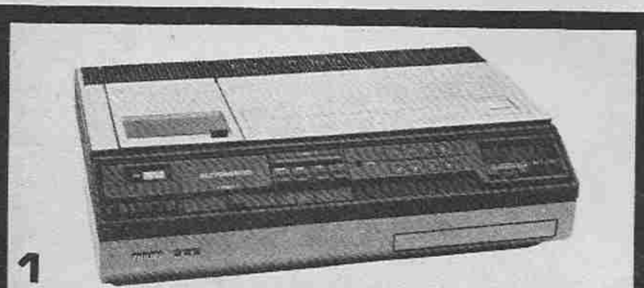
Everyone recognised that tape cost must be reduced and playing time per cassette increased. The break-through came from Japan with announcement by JVC of the VHS system and by Sony of Betamax. Although VHS and Betamax are very similar they are not the same and are not compatible, that is to say a cassette recorded on the VHS machine will not replay on a Betamex machine and vice-versa.

LONGER PLAY

Both VHS and Betamax machines are now available in the UK and both have in common a much increased playing time, around three hours per cassette, and a greatly reduced feeding cost, less than £5·00 an hour. This is achieved by a very low tape speed which enables a lengthy recording to be made on a relatively short tape.

In response to the Japanese competition, Philips launched a Long Play version of their original N1500 series machines, the N1700 series. Grundig then launched SVR a Super Long Play version of the long-play Philips format. It is only necessary to compare tape speeds over the years to get some idea of the astonishing rate at which video technology has moved. All domestic machines use tape which is ½ inch wide.

The original Philips N1500 recorders ran the tape past the recording heads at 14·29cm per second. To enable the tape to hold a bandwidth of 3MHz (which is necessary for recording colour television) the recording heads spin round very rapidly indeed laying a series of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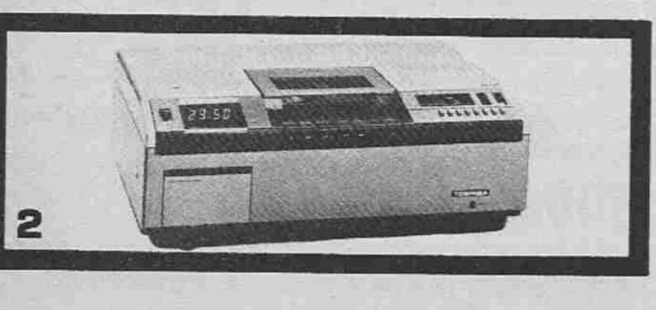
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1—Philips N1702 video recorder (VRC).

2—Toshiba Betavideo V5250B (Beta).

3—Ferguson Videostar 3V00 (VHS).

closely packed helical strips across the slowly moving tape. Hence the term "helical scan recorder".

All domestic video recorders work on the helical scan principle, the heads rotating up to 20 miles an hour to "write" the necessary video information onto the tape.

TAPE SPEED

The Philips Long Play video cassette recorder (N1700) uses the same video cassettes as the original N1500 but the tape speed is reduced to 6·56cm per second. But even this is a much higher tape speed than the two Japanese systems and the German Grundig modification.

The VHS system as marketed in this country for instance by JVC, Akai and Ferguson (most VHS machines are actually made by JVC) relies on the almost unbelievably low tape speed of 2·34cm per second.

Think about that figure: 3MHz bandwidth on half-inch wide tape moving at 2·3cm per second. Just a few years ago anyone who dared to suggest that this might be possible would have been publicly mocked.

But Betamax recorders suitable for use in the UK run at an even lower tape speed—just 1·9cm per second. And in an "anything you can do we can do slower" confrontation the Beta and VHS designers in Japan have recently announced even slower tape speeds to offer up to nine hours recording from a single cassette.

Initially Philips also responded to the commercial challenge of lower feeding costs from Japan by slashing the price of blank cassettes by as much as 40 per cent. Although the price of Philips format blank cassettes in the shops varies widely, depending on where you shop, it is now possible to buy a Philips format LVC 150 that runs for $2^{1}{}_{2}$ hours on an N1700 machine for as little as £15·00.

PRICE CUTTING

But video cassettes are expensive to make and price cuts such as these must have left the tape manufacturers with a very tight profit margin.

Usually firms tend to sell hardware (such as cameras and recorders) cheaply and then make their money on the software (blank tape and raw film). Doubtless this is one reason why Grundig chose the different approach of launching SVR. This uses what at first appears to be a standard Philips format video cassette and a tape running speed of 3·95cm per second. (ITT incidentally are selling the German-made Grundig SVR recorder under their own name.)

Although the SVR machine appears to take standard Philips-format cassettes it is in fact designed to take only Philips-format cassettes which have been modified by the addition of a special lug. Grundig say that the very low tape speed on which the machine relies necessitates the use of especially good tape and precision cassette construction and that Philips format cassettes with the extra lug and labelled SVC can be relied on this respect.

Inevitably this has created some confusion in the shops. Also it initially created some pretty bad will because the price of special lugged Philips-format SVC video cassettes was at first higher than the cost of apparently, but not actually, identical Philips-format cassettes without lug. Now the situation has improved because some tape firms, like BASF, are simply selling only SVC lugged Philips-format video cassettes which can be used on either Philips N1700 series or Grundig SVR machines.

FIVE STANDARDS

But the trade and public is still confronted with a choice between five video standards—two generations of the Philips-format, the Grundig modification of the Philips-format plus VHS plus Betamax. And that is by no means all. At the Berlin Radio Show in August it is almost certain that some new formats will be launched.

It is almost certain, for instance, that BASF will introduce its Linear Video Recording System. In LVR a length of tape shuttles very fast backwards and forwards past a fixed recording head which switches position at each pass of the tape, rather like the heads of a car cartridge player.

Moreover, although Grundig's new video factory in Nuremburg is producing 500 SVR machines a day, and although Philips has launched the N1702, a slightly improved version of the basic Long Play N1700, it is expected that Philips and Grundig will very soon make a joint announcement about their future plans for a new format.

Meanwhile the overall uncertainty caused by such rumours has created a drastic fall in video recorder prices. You can now buy a brand new machine for under £500, instead of the £700 or £800 it cost just a few months ago.

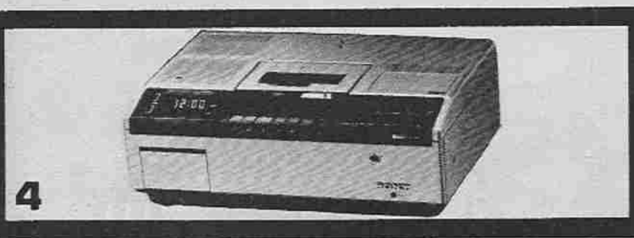
VIDEO DISCS

As explained, a helical scan video tape recorder captures the wide bandwidth colour television signal (around 3MHz) by spinning the record heads fast past slowly moving tape. A video disc player adopts a more obvious approach, although the technology involved is equally daunting. All video discs systems, and many have been proposed, work by spinning the disc very fast under a stationary pick-up head.

The first video disc was made by John Logie Baird in 1928 who used an old, ordinary 78r.p.m. disc to capture the low bandwidth signals necessary to generate a muzzy picture on his mechanical TV system. Some discs were actually sold for seven shillings each at Selfridges in the mid 1930's. Video discs then virtually died for forty years.

INSTANT REPLAY TV

Many television companies now use a computer-style magnetic disc which rotates very fast to capture short TV picture sequences. This is how freeze-



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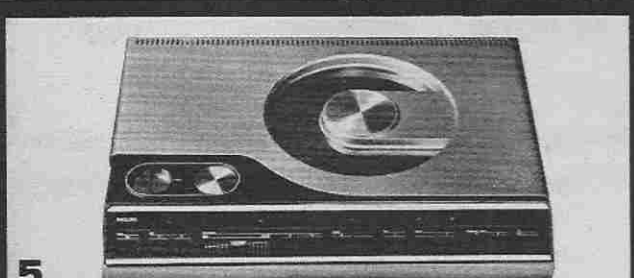

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4—Sony Betamax (Beta).

5—An early Philips/MCA videodisc player.

6—The Philips Compact Disc player.

frame and instant replay pictures are presented on TV. The transmitted signal is continually recorded onto the magnetic video disc. The disc has around half-a-minute recording ability. Thus at any moment the broadcaster can instantly replay up to half a minute of the programme just transmitted, slowing down or speeding up or freezing the picture, for instance to highlight a goal in a football match.

A SERIOUS LIMITATION

On the domestic market many systems have been developed but none yet commercially marketed in the UK. All systems so far are for replay, that is, they do not enable the user to make recordings of his own. This is one reason why video discs have not yet succeeded commercially.

No one yet seems quite sure what kind of material the public will be prepared to buy on a pre-recorded video disc. After all, very few television programmes or feature films bear watching once, let alone several times! And there is an unsolved problem over royalties for the performers.

TELDEC SYSTEM

The first domestic video disc system to be announced was the Teledec system developed by Telefunken (of Germany) and Decca. The Teldec system was first publicly shown in Berlin in 1971 and by 1975 Teldec discs and players were actually being sold in some Continental countries.

A Teldec disc is not really a disc at all. It is a thin flexible sheet of plastics foil with the video information encoded in a spiral groove superficially similar to that of an ordinary gramophone record. But the video information is encoded by frequency modulation and the groove is cut in vertical or hill and dale fashion.

The Teldec disc rotates at 1,500-r.p.m. and is tracked by a special diamond stylus and piezo transducer. Each disc holds up to ten minutes of colour video. But the system has never succeeded commercially or met with much enthusiasm from engineers.

RCA DISC SYSTEM

RCA in the USA has meanwhile developed a video disc with a groove in which the video information is encoded as capacitance variations. These are sensed by a pick-up serving as an electrode. Very few people have seen the RCA system in action and no one seems to know when or whether it will ever be launched. But recently when I was in New York I was given a very professional demonstration of the newest prototype RCA player, which is mechanically very simple and performed well.

OPTICAL SYSTEMS

Most people still regard the optical system developed by Philips in Europe and MCA in the States (with a similar system independently developed by Thomson in France and Sony in Japan) as the front-runner.

According to the Philips system the video information is encoded as variations in reflection on the surface of a rapidly rotating shiny disc. A tiny laser beams a narrow pencil of light down onto the surface where minute pits vary the strength of the beam reflected up again onto a sensor. (The French Thomson system uses a transparent disc with variation in light transmission.)

For several years Philips and MCA annually promised to launch their system "next year" but it never quite seemed to happen. But just before Christmas 1978 the Philips subsidiary Magnovox started marketing Philips disc players and discs in Atlanta Georgia and the company demonstrated the system in the UK.

Performance of the Philips player is beyond reproach; the reproduced pictures are of broadcast standard.

VISC SYSTEM

The Japanese company Matsushita have developed the Visc system which is in many respects a modern version of Teldec. Visc looks like an ordinary vinyl audio disc. In fact it is an ordinary vinyl disc except that the groove is of very fine pitch and (like Teldec) contains video information of around 3MHz bandwidth recorded as frequency modulation in hill and dale fashion. But whereas Teldec only provides 10 minutes of colour video on one side of the flimsy foil disc, a Visc can carry over an hour of colour video and stereo sound on each side.

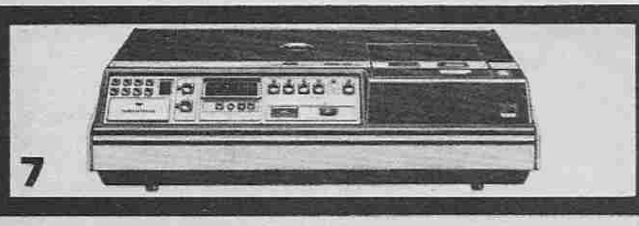
Visc was first demonstrated in 1978 and has subsequently been modified to squeeze longer playing time from smaller disc sizes. But now the future of Visc is in doubt because Matsushita has signed a deal with the sister company JVC, who had developed a completely different system. This relies on capacitance, like the RCA disc, but has no grooves. The electrode stylus tracks across the smooth disc surface under electronic servo control.

Although Sony is "flexible" over standardisation the company has so far shown most enthusiasm for an optical system, like the Philips disc. Other Japanese companies, including Pioneer, have made similar moves. So it seems likely that in the future the main battle will be between Sony, Philips, Pioneer and a few others on the one hand and Matsushita and JVC on the other, with RCA in the middle.

FUTURE SYSTEMS

It remains to be seen now what further video disc systems are launched by other companies prompted into disclosing their researches by the USA marketing moves by Philips. Companies like RCA and JVC will not lightly ditch their own systems in favour of that of a rival. But while there is rivalry and no standardisation, no system will succeed. There is even the added problem that video discs tailored for the USA or Japan will be incompatible with European TV.

Although video discs may seem an irrelevancy to anyone who has no desire to buy a pre-recorded TV programme or feature film, they do have massive potential for education. Also they happen, by a happy coincidence, to be the ideal medium on which to record digital sound.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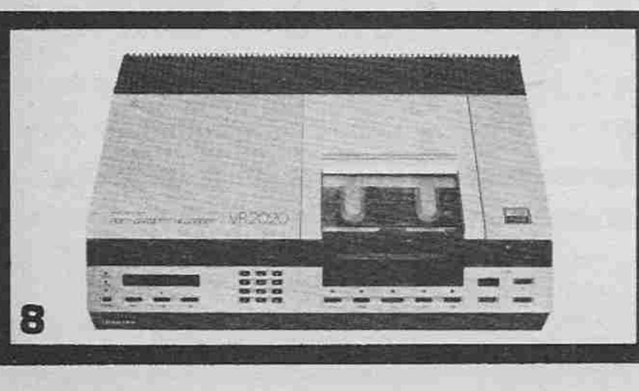
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7—Grundig SVR4004 with 10 day timer (SVR).

8—Latest Philips VR2020 uses paper-back size cassettes.

9—Hitachi VKC500 colour video camera for use with the VT5000E 10 day recorder shown in our heading pic.

By Dave Barrington

THIS month we have some new products which should be of particular interest to the constructor and should prove useful acquisitions,

PCB Etcher

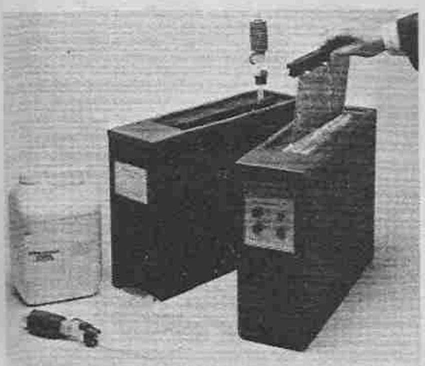
For the person keen on making his own printed circuit boards, a new bubble etcher aimed at both the hobbyist and professional has just been marketed by Mega Electronics.

Designated the type PLBE-1210 bubble etcher this new p.c. production ancillary has a fluid capacity of 5 litres, and accepts printed circuit boards up to 305 × 254mm. Extra capacity in the tank has been achieved by positioning the heating element so that it does not obtrude into the tank.

The average etching time for both single-sided and double-sided boards is claimed to be 4 to 5 minutes. Other features include full thermostatic control of the fluid temperature and protection against evaporation and splashing.

The PLBE-1210 bubble etcher is priced at £55 including VAT and further details can be obtained from Mega Electronics Ltd., Dept EE, 9 Radwinter Road, Saffron Walden, Essex, CB11 3HU.

The PLBE-1210 bubble etcher from Mega Electronics.



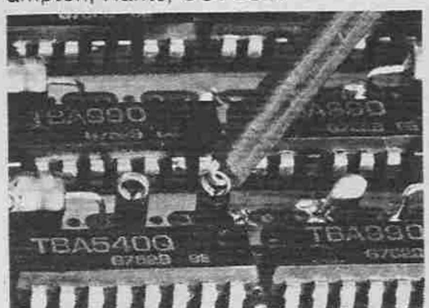
Mini Stripper

Anyone who has tried stripping and using the very fine gauge wire now commonly used for interwiring multi-pin devices will welcome the latest offering from OK Machine & Tool (UK) Ltd.

The CAS-130 "Clip and Strip" is claimed to cut and strip without nicking 0·025mm wire and is ideal for Kynar wire-wrapping wire. Shaped similar to a miniature paper fastener, the stripper is held between thumb and finger and the wire placed in the jaws which are squeezed together to clip and strip a 25mm length of wire.

Produced primarily for the hobby market and selling for £1.52 (excluding packageing and VAT), the CAS-130 wire stripper could prove equally useful for the prototype wireman in industry.

Further information and addresses of nearest stockists can be obtained from OK Machine & Tool (UK) Ltd., Dept EE, 48a The Avenue, Southampton, Hants, SO1 2SY.



Miniature terminal assemblies from Vero Electronics.

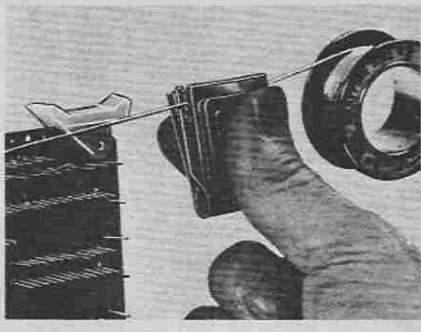
Terminal Posts

Designed as terminal posts for test points on circuit boards for clipping test probes such as multimeter or oscilloscope leads, we are sure readers will find many applications for the new terminal assemblies from Vero Electronics.

The sprung metal "split" pin is surrounded by a sintered glass bead which allows the eye of the pin to stand proud from the board for easy access and will remain in place when the board is reversed for soldering.

Intended for "through-hole-plated" printed circuit boards, we found that the terminals made ideal mounting posts for components on 0·15in plain perforated board. The interwiring is easily soldered on the underside of the board between the protruding pins.

Details of prices and nearest stockists can be obtained from Vero Electronics Ltd., Dept EE, Industrial Estate, Chandler's Ford, Eastleigh, Hants, SO5 3ZR.



The OK CAS-130 wire stripper.

CONSTRUCTIONAL PROJECTS

Although we have a bumper number of constructional projects this month no buying problems are envisaged as components are available from a number of sources.

Trailer Flasher Unit

It is most important that first grade components are used for the *Trailer Flasher* project, the 2N3055 transistors must be new types. Also particular care must be taken when mounting the mica washer to ensure it is not punctured during mounting.

This is usually caused by insufficient cleaning of the metal work after drilling to accept the power transistors. When the drilling is completed for the power transistors it is a good idea to clean the surface with a damp rag and some household cleaning powder to remove any surplus swarf.

9V Power Supply

Any transformer with a 12V at 0·5A secondary will be suitable for the *9V Power Supply*. The only limitation is the physical size of the component and the one used in our prototype used two secondaries of 12V at 250mA wired in parallel.

Mini Module

Although this months *Mini Module, Swanee Whistler* calls for a slider type potentiometer there is no reason why a normal rotary potentiometer should not be used. These are approximately 50 per cent cheaper and more likely to be to hand in the spares box.

Apart from the above comments, readers should have no difficulty in obtaining components for the rest of our projects this month as they are listed in most advertisers catalogues.

VAT

Due to recent change of VAT rates at time of going to press, readers are advised to check prices in advertisements before ordering any components.

TRAILER FLASHER

CAMPING and caravanning have enjoyed a considerable growth in popularity in recent years and many D.I.Y. motorists will be tackling the job of wiring up a trailer socket so as to connect the motor car lighting circuits to a trailer or caravan. In the case of the tail lights and brake lights these are usually straightforward d.c. connections. However complications arise in the connection of the flashing indicator lights.

OPERATING FREQUENCY

Nearly all car flasher systems are affected by the number of bulbs in circuit, and connecting extra lamps will usually upset the flasher frequency, often causing the lights to flash much too fast, or, perhaps, not at all.

To be legally correct the flasher system must operate between 60 and 120 times per minute, and also, when the trailer is connected, there must be some means of indicating the failure of the trailer flasher lamps to the driver.

The purpose of the unit described here is to drive the trailer flashers correctly and to monitor their operation.

CIRCUIT PRINCIPAL

Fig. 1 is a simple illustration of the basic circuit. A 21 watt flasher bulb (LP2) has a much lower resistance than a 2 watt panel lamp (LP1), so that if the two are connected in series as shown and connected across a 12 volt car battery nearly all the 12 volts appears across LP1. LP1 lights up therefore, there being insufficient voltage across LP2 to illuminate it. LP1 remains lit as long as the filament of LP2 is intact, and therefore acts as a monitor.

If switch S1 is now closed LP1 is shorted out and the full 12 volts appears across LP2, causing it to light. If S1 is made to operate in unison with the car flasher system then both LP1 and LP2 would flash, alternatively but at the correct speed.

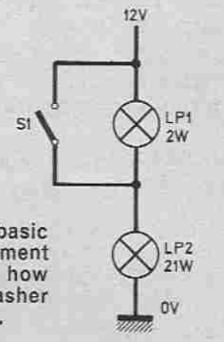


Fig. 1. The basic circuit arrangement which shows how the Trailer Flasher Unit functions.

FULL CIRCUIT

Fig. 2 shows the full circuit of the trailer flasher unit connected to the motor car circuits. The dotted line encloses the additional components comprising the unit.

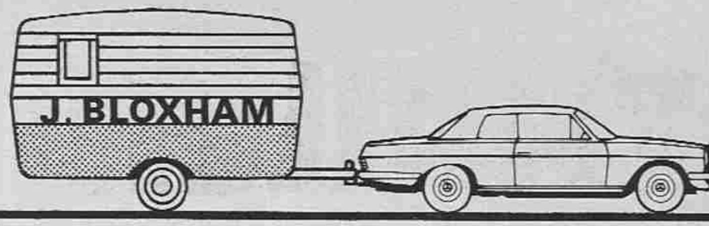
It will be seen that a 12 volt feed, via a 4 amp fuse FS1, supplies two parallel circuits—one for each trailer lamp. The panel lamp LP1 is in series with the trailer right rear lamp via the 7-pin trailer socket, likewise LP2 is in series with the trailer left rear lamp.

SWITCHING

Instead of mechanical switches two *npn* power transistors are connected across the panel lamp, with their emitters connected to the trailer lamps. Each transistor base is connected via a 10 ohm 1 watt resistor and series diode to the left and right flasher feeds from the car direction indicator switch. When the flashers are not working there are no base voltages for the transistors and they are therefore virtually open circuit. This means that the panel lamps remain lit, showing that the trailer lamps are intact.

If S1 is moved, say, to the right, the right hand flasher lamps are energised via the car flasher unit, which causes them to flash as usual. 12 volt pulses are fed via D1 and R1 to the base of TR1,

UNIT



causing it to turn hard on, shorting out LP1 and switching on LP3. Thus both LP1 and LP3 flash (alternately) in time with the car circuit, which only has to provide a few milliamps base current for TR1—a negligible loading. Virtually all the current for LP3 comes via FS1 and TR1. A similar sequence occurs when S1 is moved to the left, to operate LP4.

CONSTANT REMINDER

It will be seen that when the trailer plug is disconnected from the socket there is no connection to chassis and the unit is effectively switched off. Inserting the trailer plug completes the circuits and causes both panel lamps to come on—providing the trailer lamps are intact of course. The twin lights give a constant reminder that the trailer is connected—some small camping trailers are invisible through the driving mirror!

The base resistors R1, R2 are of a low value (10 ohms) to give some limit to the base current yet ensure that the transistors turn fully on. The diodes D1, D2 have no effect on circuit operation, but they were found necessary in the prototype to prevent reverse leakage through the base/emitter junctions of TR1 and TR2. This caused LP1 and LP2 to glow slightly when the trailer plug was disconnected.

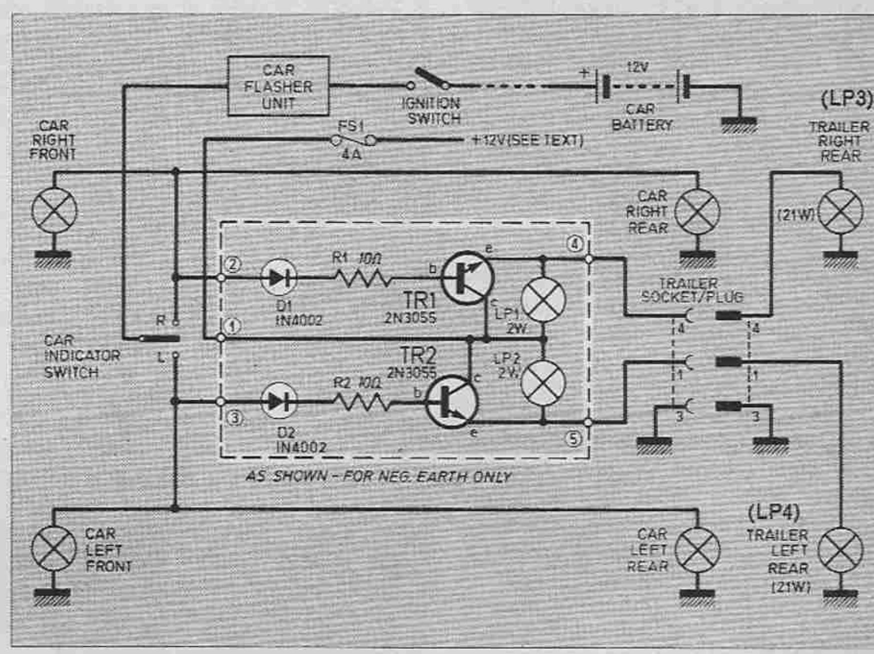


Fig. 2. Full circuit diagram of the Trailer Flasher Unit (within broken line) shown connected to the car circuits and, via trailer socket, to the trailer or caravan circuits. For positive earth TR1 and TR2 must be replaced by *pnp* types.

The circuit shown is for negative earth vehicles. For positive earth operation the transistors must be *pnp* types and the diodes D1, D2 reversed.

COMPONENTS

Almost any type of power transistors may be used, providing they have a current rating of at least two amps, and some suitable types are shown in the components list. Nondescript surplus transistors should not be used. One should bear in mind that the failure of a cheap transistor when on the road might bring all sorts of unpleasant consequences.

The 2 watt panel lamps are standard plastic types which are usually a push fit into a 12·5mm hole. These are readily available from motor shops and will probably have spade-type push-on terminals, to which connecting wires may be soldered directly. It is important that the lamps are isolated from their mountings if they are to be fixed into a metal panel.

The five-way terminal strip is cut from a mains connector block as sold in Woolworths.

The wiring of the unit and its connections to the car circuits should be of reasonably stout insulated wire. Motor shops do sell proper automobile type connecting wire, but wire stripped from 13 amp mains cable is just as good and somewhat cheaper. The four amp fuse FS1 should be mounted in an in-line fuseholder as used for car radios.

COMPONENTS

Resistors
R1 10Ω
R2 10Ω
All 1W carbon ±10%

Diodes
D1 1N4002
D2 1N4002

See Shop Talk page 499

Transistors
TR1, TR2
NEG. EARTH
2N3055, 2N3054, AD2161, BD130, TIP33A etc.

POS. EARTH
AD162, AD143, AD149, BD132
OC36 etc.

Miscellaneous
FS1 4 amp fuse.
LP1,2 12·5mm plastic panel lamp 12V 2W (2 off)
Five-way terminal strip.
Fuseholder. "Scoth-loc" connectors.
Sheet aluminium.

COMPONENTS approximate cost £2.80

CONSTRUCTION starts here

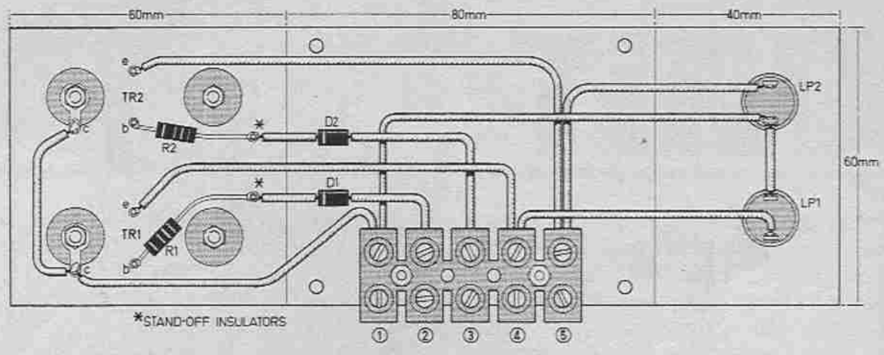


Fig. 3. The complete Flasher Unit shown "opened up" for clarity. The chassis is made from a single piece of 18 or 20 s.w.g. aluminium, with two bends as indicated. All drilling should be carried out before bending. See text for further details.

The constructional layout is not important and will depend to a great extent on the layout of the motor car and the materials to hand. The panel lamps may be mounted in the dashboard proper, if space permits, and remotely connected to the other components which may be mounted anywhere convenient.

The transistors do not really need heatsinking in this application as they are being operated as switches, that means fully on or fully off, and so generate little heat. However, it is by far the simplest method to bolt up the transistors in the normal way, one arrangement is shown in Fig. 3.

CHASSIS

Here the complete unit is built on a simple chassis made up from aluminium sheet about 60mm x 180mm, and is intended to be mounted under the dashboard or parcel shelf. The panel should be drilled before being folded up. No dimensions are given as these will vary with the devices used. The transistors must be isolated from the metal panel with the usual mica washer which may, with care, be used as a template for making the holes.

Fig. 3 shows the wiring connections with the chassis opened out for clarity but in fact the connections should be fairly short and rigid. When connecting wires into the terminal block ensure that the screws bite firmly onto the wire and not the insulation. Plastic sleeving should be used on any bare component leads.

INSTALLATION

The unit may be mounted under the dashboard or parcel shelf with small bolts or self-tapping screws, using spacers if necessary. Wires may then be run from the car circuits to the terminal block. The five numbered terminals in Fig. 3 correspond with the circled numbers in Fig. 2.

Connections 2 and 3 are probably best made to the wiring loom alongside the steering column. The car wiring diagram will show the correct wires to tap into if the connections to the indicator switch are not visible.

Sound insulated connections are required and the simplest method is to use "Scotchloc" connectors, also available from motor shops.

The two wires to the trailer socket from the unit should be tucked out of the way under the carpet or behind the trim, taking care that they are not likely to chafe on sharp metal edges. Fig. 4 shows the internationally agreed pin connections for the trailer socket and it should be wired accordingly.

PIN	CIRCUIT
1	L.H.FLASHER
2	SPARE
3	EARTH (CHASSIS)
4	R.H. FLASHER
5	R.H.REAR AND NUMBER PLATE
6	BRAKE LIGHTS
7	L.H.REAR

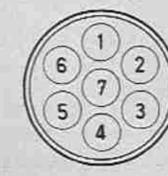
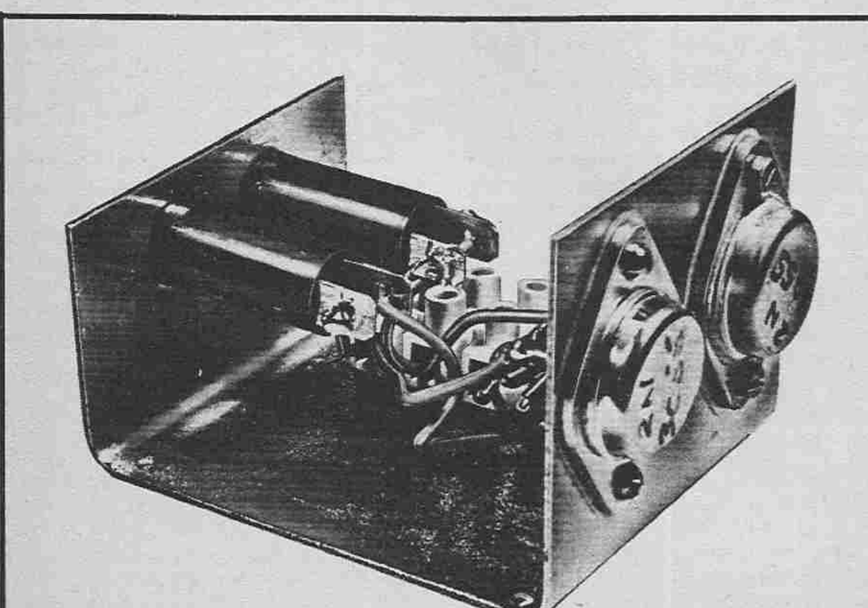


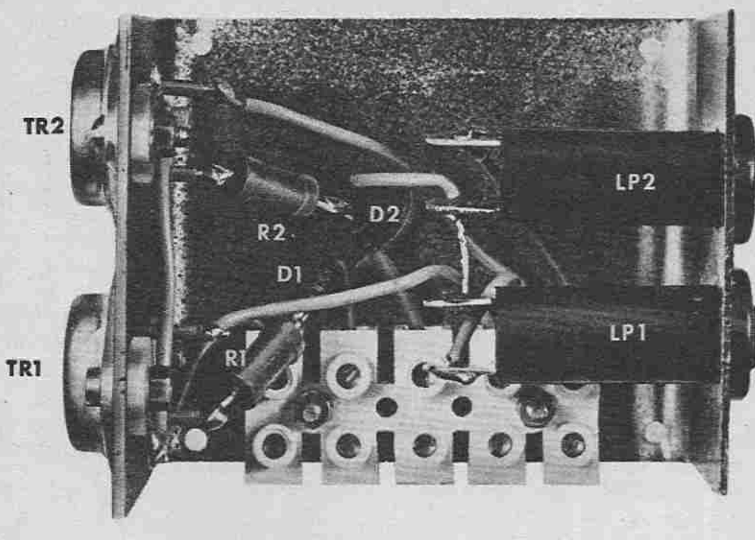
Fig. 4. Pin connections to Trailer Socket. The pin numbers are usually marked on the socket.



The completed Trailer Flasher Unit showing the mounting of the power transistors.
Care must be taken to ensure that the mica washers are not punctured.

HAZARD SYSTEM

The 12 volt feed via FS1 should be connected to the car fuse box, or perhaps to the ignition switch directly, so that the supply is live only when the ignition is turned on. If there is a spare fuse position in the fuse box it may be used instead of an in-line fuse holder.



The finished unit showing layout of components and interwiring.

The reason for this arrangement is that most modern cars are fitted with a "hazard" flasher system which causes all four flashers to light, to give warning of a breakdown etc. If the trailer is connected and the Trailer Flasher Unit in use this would cause both trailer lamps to flash as well—a useful feature.

However, six flasher bulbs means a load in excess of 120 watts, which could drain the car battery if left on for a lengthy period. Providing the engine is kept running, and therefore the charging system working, there is not likely to be any difficulty.

If the unit is wired to an ignition-controlled source as described, then switching off the engine will extinguish the trailer lamps and limit the hazard system load to the four lamps on the car. ⌑

Electronic wizards

I am sure that one of these days some of my readers are going to tick me off for my predilection for poking fun at computers. The truth is, I think, we all have a certain animosity towards these electronic wizards and I believe the reason for it is this, we feel that they are getting too smart for us.

They can beat us at any game from noughts and crosses to chess, solve arithmetical problems that are far beyond our mental capacity and there are now pocket translators that can handle any language including Japanese. In short they tend to give us a massive inferiority complex.

Consequently when one falls flat on its nose (perhaps they do not have noses, so perhaps I had better rephrase it and say falls flat on its software) our mirth is not only uncontrollable but understandable because it has re-established our self esteem. What we must never lose sight of is the fact it was the human brain that conceived and built the computer in the first place.

To redress the balance I will say something in their favour. About seven years ago we bought an electronic calculator, that would do any calculation and give a print-out. It was a splendid machine but it measured about eighteen inches by eighteen inches by six inches and weighed about forty pounds. To-day we have replaced it with a Cannon P10 which does the same job, only measures about four inches by six inches by three inches and weighs a few ounces. It is completely portable and operates from a rechargeable cell.

Poste Haste

In this connection I would like to give a pat on the back to the suppliers "Poste Haste". Every calculator is supplied complete with a charger, so when one of my staff said "We want some new batteries in the P10" looking very superior I said "not at all, you simply plug in the charger; here, let me show you." Do you think I could find the charger? I could not!

So I telephoned "Poste Haste" and explained my predicament. The girl who answered the phone said "I do not deal with it, but I will get my colleague who does to contact you".

The very next morning a parcel arrived in the post containing one P10 charger and to date I have had no bill! With all the tales one hears of poor service, it is nice to discover there is another side to the coin!

Static reply

I was pleased to receive letters from readers on my static query. In particular I would like to thank David Mayne, David Clarke and George Kesic for their helpful suggestions and I would ask them to accept my apologies for not sending individual replies. I can honestly claim pressure of business. Some of these letters are reproduced in this issue.

If I sum up the answers correctly the concensus is that static and ordinary electricity are basically the same thing, but with static we are dealing with a very high voltage and very low current and with the more familiar sort, the voltages are usually lower and the current correspondingly higher.

Readers also reminded me of the innumerable uses to which static is put, from moving the spot on your television screen, to photocopying and even the plating of plastics. One even mentioned the uses to which the piezo electric phenomena is put, but I have the feeling that this is something different again.

Of course, what I had in mind was static being used to power some kind of electric motor, perhaps with enough urge to drive a car! That really would be something. Here is a chance for you inventors!

SQUARE one FOR BEGINNERS

SOLDERING is the most important aspect of project building. Unless you are competent in this "art" your projects are more than likely to fail. The importance of good, neat, clean soldering cannot be overstressed. As with most things a good soldering technique comes with practice.

STAGE 1
The tools required are few and simple. Choose an iron with a bit size appropriate to the job in hand. Always use a resin-cored solder of 60/40 tin/lead composition.

STAGE 2
Tinning the bit. The tip is "tinned" with a thin coat of solder. Do not allow the solder to run down the main body of the bit.

STAGE 3
An essential part of soldering is clean components. Use a piece of fine sandpaper and then tin the lead.

STAGE 4
A tidy looking board is a pleasure to see, so don't insert components as on the right! Be neat.

STAGE 5
The joint is now ready to be soldered. This shows the correct position of iron. Note that it is in contact with both lead and copper strip.

STAGE 6
An even flow of solder is necessary to produce a sound, bright looking joint as the one on the left. Bad workmanship produces dry joints (centre) and bridges, etc (right).

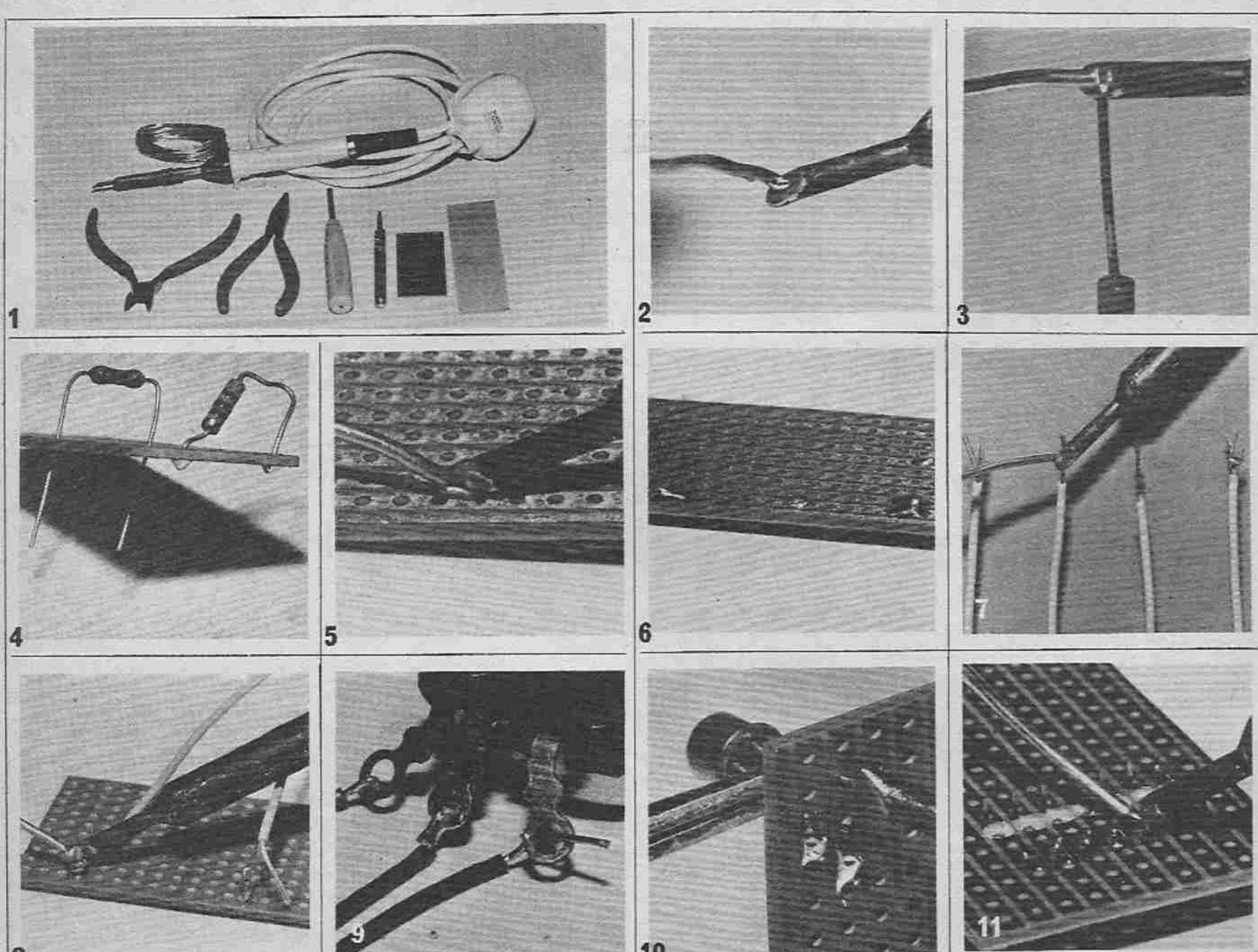
STAGE 7
Stranded wires should always be tinned. Here we show how this is done, and the final result if you are unlucky (far right).

STAGE 8
The correct way to solder a wire to say, a Veropin. The wire on the right is obviously wrong, the loose wires could cause a short circuit.

STAGE 9
As in the previous photo, a good mechanical joint is essential when wiring up to tagged components. Do not let the wire "hang" in the tag.

STAGE 10
Although nothing to do with good soldered joints, the use of a heat shunt on heat sensitive component leads is a "must".

STAGE 11
One tricky operation is the soldering of an i.c. Here we show the correct angle for the iron bit and solder.



SEMICONDUCTORS

TRANSISTORS

Type	Price
AC107	£0·23
AC113	£0·21
AC115	£0·21
AC117	£0·32
AC117K	£0·36
AC121	£0·21
AC122	£0·15
AC125	£0·19
AC126	£0·18
AC127	£0·19
AC128	£0·15
AC128K	£0·28
AC132	£0·21
AC134	£0·21
AC137	£0·21
AC141	£0·23
AC141K	£0·32
AC142	£0·21
AC142K	£0·32
AC151	£0·21
AC153	£0·23
AC153K	£0·32
AC154	£0·21
AC155	£0·21
AC156	£0·21
AC157	£0·27
AC165	£0·21
AC166	£0·21
AC167	£0·21
AC168	£0·27
AC169	£0·21
AC171	£0·27
AC176	£0·19
AC176K	£0·28
AC178	£0·27
AC179	£0·27
AC180	£0·21
AC180K	£0·30
AC181	£0·21
AC181K	£0·30
AC187	£0·19
AC187K	£0·30
AC188	£0·19
AC188k	£0·30
ACY17	£0·37
ACY18	£0·37
ACY19	£0·37
ACY20	£0·37
ACY21	£0·37
ACY22	£0·37
ACY27	£0·37
ACY28	£0·37
ACY29	£0·54
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ACY40	£0·37
ACY41	£0·37
ACY44	£0·37
AD130	£0·75
AD140	£0·64
AD142	£0·91
AD143	£0·81
AD149	£0·64
AD161	£0·37
AD162	£0·37
ADT61/162	£0·75
ADT140	£0·59
AF114	£0·27
AF115	£0·27
AF116	£0·27
AF117	£0·27
AF118	£0·43
AF124	£0·32
AF125	£0·32
AF126	£0·32
AF127	£0·34
AF139	£0·37
AF178	£0·64
AF179	£0·64
AF180	£0·64
AF181	£0·62
AF186	£0·54
AF239	£0·41
AL102	£1·29
AL103	£1·27
ASY26	£0·41
ASY27	£0·43
ASY28	£0·41
ASY29	£0·41
ASY50	£0·32
ASY51	£0·32
ASY52	£0·32
ASY54	£0·32
ASY55	£0·32
ASY56	£0·32
ASY57	£0·32
ASY58	£0·32
ASY73	£0·32
AU104	£1·51
AU110	£1·51
AU113	£1·51
BC107	£0·09
BC107A	£0·09
BC107B	£0·10
BC107C	£0·11
BC108	£0·09
BC108A	£0·09
BC108B	£0·10
BC108C	£0·11
BC109	£0·09
BC109A	£0·09
BC109B	£0·10
BC109C	£0·11
BC113	£0·18
BC114	£0·18
BC115	£0·21
BC116	£0·21
BC116A	£0·21
BC117	£0·23
BC118	£0·16
BC119	£0·27

Type	Price
BC120	£0·43
BC125	£0·19
BC126	£0·25
BC132	£0·20
BC134	£0·20
BC135	£0·17
BC136	£0·20
BC137	£0·20
BC139	£0·35
BC140	£0·32
BC141	£0·30
BC142	£0·24
BC143	£0·24
BC145	£0·52
BC147	£0·08
BC148	£0·08
BC149	£0·08
BC150	£0·23
BC151	£0·25
BC152	£0·23
BC153	£0·28
BC154	£0·21
BC157	£0·11
BC158	£0·11
BC159	£0·11
BC160	£0·28
BC161	£0·41
BC167	£0·14
BC168	£0·14
BC169	£0·10
BC169C	£0·11
BC170	£0·10
BC171	£0·10
BC172	£0·10
BC173	£0·10
BC174	£0·17
BC175	£0·39
BC177	£0·17
BC178	£0·17
BC179	£0·17
BC180	£0·27
BC181	£0·28
BC182	£0·10
BC182L	£0·10
BC183	£0·10
BC183L	£0·10
BC184	£0·10
BC184L	£0·10
BC186	£0·24
BC187	£0·24
BC207	£0·12
BC208	£0·12
BC209	£0·14
BC212	£0·10
BC212L	£0·10
BC213	£0·10
BC213L	£0·10
BC214	£0·10
BC214L	£0·10
BC225	£0·29
BC226	£0·41
BC227	£0·18
BC238	£0·18
BC251	£0·17
BC251A	£0·18
BC301	£0·30
BC302	£0·31
BC303	£0·30
BC304	£0·41
BC327	£0·18
BC328	£0·17
BC337	£0·17
BC338	£0·17
BC440	£0·32
BC441	£0·32
BC460	£0·41
BC461	£0·41
BC477	£0·22
BC478	£0·22
BC479	£0·22
BC547	£0·11
BC548	£0·11
BC549	£0·11
BC550	£0·16
BC556	£0·16
BC557	£0·15
BC558	£0·14
BCY30	£0·59
BCY31	£0·59
BCY32	£0·65
BCY33	£0·59
BCY34	£0·65
BCY70	£0·16
BCY71	£0·16
BCY72	£0·15
BCZ10	£0·65
BCZ11	£0·65
BCZ12	£0·65
BD115	£0·54
BD116	£0·86
BD121	£0·70
BD123	£0·70
BD124	£0·76
BD131	£0·38
BD132	£0·38
BD131/132mp	£0·86
BD133	£0·43
BD135	£0·41
BD136	£0·38
BD137	£0·38
BD138	£0·39
BD139	£0·39
BD140	£0·39
BD139/140mp	£0·86
BD155	£0·86
BD175	£0·65
BD176	£0·65
BD177	£0·72
BD178	£0·72
BD179	£0·81
BD180	£0·81
BD181	£0·92
BD182	£0·97
BD183	£1·03

Type	Price
BD184	£1·19
BD185	£0·73
BD186	£0·73
BD187	£0·81
BD188	£0·81
BD189	£0·84
BD190	£0·84
BD195	£0·97
BD196	£0·97
BD197	£1·03
BD198	£1·03
BD199	£1·07
BD200	£1·07
BD201	£0·86
BD202	£0·86
BD201/202mp	£1·84
BD203	£0·86
BD204	£0·86
BD203/204mp	£1·84
BD205	£0·86
BD206	£0·86
BD207	£1·08
BD208	£1·08
BD222	£0·51
BD225	£0·51
BD232	£0·59
BD233	£0·52
BD234	£0·59
BD235	£0·59
BD236	£0·63
BD237	£0·59
BD238	£0·65
BD239A	£0·54
BD240A	£0·54
BDX32	£2·38
BDY11	£1·40
BDY17	£1·94
BDY20	£0·86
BDX77	£0·97
BF115	£0·24
BF117	£0·54
BF118	£0·84
BF119	£0·84
BF212	£0·56
BF123	£0·68
BF125	£0·56
BF127	£0·68
BF152	£0·28
BF153	£0·27
BF154	£0·24
BF155	£0·38
BF156	£0·32
BF157	£0·32
BF158	£0·32
BF159	£0·32
BF160	£0·34
BF162	£0·34
BF163	£0·34
BF164	£0·54
BF165	£0·54
BF167	£0·27
BF173	£0·22
BF176	£0·41
BF177	£0·28
BF178	£0·28
BF179	£0·30
BF180	£0·32
BF181	£0·32
BF182	£0·32
BF183	£0·32
BF184	£0·22
BF185	£0·22
BF186	£0·29
BF187	£0·28
BF188	£0·43
BF194	£0·11
BF195	£0·11
BF196	£0·11
BF197	£0·14
BF198	£0·16
BF199	£0·16
BF200	£0·32
BF202	£1·01
BF222	£0·97
BF224	£0·19
BF240	£0·19
BF241	£0·19
BF244	£0·34
BF257	£0·27
BF258	£0·27
BF259	£0·38
BF262	£0·68
BF263	£0·68
BF270	£0·39
BF271	£0·34
BF272	£0·86
BF273	£0·41
BF274	£0·43
BF324	£0·39
BF336	£0·32
BF337	£0·34
BF338	£0·41
BF457	£0·40
BF458	£0·40
BF459	£0·41
BF594	£0·34
BF596	£0·32
BFR39	£0·26
BFR40	£0·28
BFR79	£0·32
BFR80	£0·32
BFX29	£0·24
BFX30	£0·32
BFX84	£0·24
BFX85	£0·26
BFX86	£0·27
BFX87	£0·24
BFX88	£0·24
BFX90	£0·62
BFY50	£0·18
BFY51	£0·18
BFY52	£0·18
BFY53	£0·18
BIP19	£0·41

Type	Price
BIP20	£0·41
BIP19/20	£0·86
BSX25	£1·57
BSX19	£0·19
BSX20	£0·19
BSY25	£0·17
BSY26	£0·17
BSY27	£0·17
BSY28	£0·17
BSY29	£0·17
BSY38	£0·21
BSY39	£0·21
BSY40	£0·31
BSY41	£0·31
BSY51	£0·27
BSY95	£0·14
BSY95A	£0·14
BRY39	£0·49
BU105	£1·51
BU105/02	£2·11
BU204	£1·51
BU205	£1·51
BU208	£2·05
BU208/02	£2·43
E1222	£0·41
MAT100	£0·21
MAT101	£0·22
MAT120	£0·21
MAT121	£0·22
MJ480	£1·03
MJ481	£1·13
MJ490	£1·03
MJ491	£1·24
MJE340	£0·49
MJE370	£0·59
MJE371	£0·65
MJE520	£0·49
MJE521	£0·70
MJE2955	£0·97
MJE3055	£0·65
MJE3440	£0·56
MP8113	£0·56
MPF102	£0·30
MPF104	£0·38
MPF105	£0·38
MPSA05	£0·23
MPSA06	£0·23
MPSA55	£0·23
MPSA56	£0·23
ND120	£0·19
OC19	£0·92
OC20	£2·00
OC22	£1·62
OC23	£1·62
OC24	£1·46
OC25	£1·08
OC26	£1·08
OC28	£0·86
OC29	£1·03
OC35	£0·97
OC36	£0·97
OC41	£0·22
OC42	£0·24
OC44	£0·26
OC45	£0·22
OC70	£0·26
OC71	£0·16
OC72	£0·26
OC74	£0·28
OC75	£0·32
OC76	£0·38
OC77	£0·54
OC81	£0·24
OC81D	£0·26
OC82	£0·26
OC82D	£0·32
OC83	£0·28
OC84	£0·41
OC139	£0·86
OC140	£0·86
OC169	£0·38
OC170	£0·38
OC171	£0·38
OC200	£0·41
OC201	£1·03
OC202	£1·30
OC203	£0·92
OC204	£0·97
OC205	£1·24
P346A	£0·38
P397	£0·49
R20008B	£2·70
R20108	£2·81
ST140	£0·16
ST141	£0·23
TIC44	£0·33
TIC45	£0·39
TIP29A	£0·43
TIP29B	£0·45
TIP29C	£0·48
TIP30A	£0·43
TIP30B	£0·45
TIP30C	£0·48
TIP31A	£0·43
TIP31B	£0·45
TIP31C	£0·48
TIP32A	£0·43
TIP32B	£0·45
TIP32C	£0·48
TIP41A	£0·48
TIP41B	£0·50
TIP41C	£0·52
TIP42A	£0·48
TIP42B	£0·50
TIP42C	£0·52
TIP2955	£0·65
TIP3055	£0·54

Type	Price
TIS43	£0·24
TIS90	£0·20
UT46	£0·22
ZTX107	£0·11
ZTX108	£0·11
ZTX109	£0·11
ZTX300	£0·14
ZTX301	£0·14
ZTX302	£0·18
ZTX303	£0·18
ZTX304	£0·23
ZTX330	£0·17
ZTX500	£0·14
ZTX501	£0·14
ZTX502	£0·18
ZTX503	£0·14
ZTX504	£0·28
ZTX531	£0·28
ZTX550	£0·18
2G301	£0·24
2G302	£0·24
2G303	£0·24
2G304	£0·32
2G306	£0·43
2G308	£0·39
2G309	£0·39
2G339	£0·22
2G339A	£0·19
2G344	£0·22
2G345	£0·19
2G371	£0·19
2G371B	£0·13
2G373	£0·19
2G374	£0·19
2G377	£0·35
2G378	£0·19
2G381	£0·19
2G382	£0·19
2G401	£0·35
2G414	£0·35
2G417	£0·28
2N388	£0·39
2N388A	£0·60
2N404	£0·22
2N524	£0·43
2N527	£0·54
2N596	£0·43
2N599	£0·50
2N696	£0·14
2N697	£0·13
2N698	£0·13
2N699	£0·35
2N706	£0·11
2N706A	£0·13
2N707	£0·52
2N708	£0·15
2N711	£0·32
2N717	£0·32
2N718	£0·27
2N718A	£0·54
2N726	£0·31
2N727	£0·31
2N743	£0·22
2N744	£0·22
2N914	£0·16
2N918	£0·32
2N929	£0·22
2N930	£0·19
2N1131	£0·19
2N946	£0·43
2N1132	£0·19
2N1302	£0·16
2N1303	£0·19
2N1304	£0·19
2N1305	£0·19
2N1306	£0·27
2N1307	£0·27
2N1308	£0·32
2N1309	£0·32
2N1599	£0·38
2N1613	£0·22
2N1711	£0·22
2N1889	£0·49
2N1890	£0·49
2N1893	£0·32
2N2147	£0·81
2N2148	£0·76
2N2160	£1·08
2N2192	£0·41
2N2193	£0·41
2N2194	£0·41
2N2217	£0·24
2N2218	£0·24
2N2218A	£0·22
2N2219	£0·22
2N2219A	£0·26
2N2220	£0·22
2N2221	£0·22
2N2221A	£0·24
2N2222	£0·22
2N2222A	£0·22
2N2368	£0·19
2N2369	£0·15
2N2369A	£0·15
2N2411	£0·27
2N2412	£0·27
2N2646	£0·51
2N2711	£0·24
2N2712	£0·24
2N2714	£0·24
2N2904	£0·19
2N2904A	£0·23
2N2905	£0·19
2N2905A	£0·22
2N2906	£0·17
2N2906A	£0·21
2N2907	£0·22
2N2907A	£0·24
2N2923	£0·17
2N2924	£0·17
2N2925	£0·17
2N2926G	£0·10
2N2926Y	£0·09
2N2926O	£0·09

Type	Price
2N2926R	£0·09
2N2926B	£0·09
2N3010	£0·70
2N3011	£0·16
2N3053	£0·17
2N3054	£0·43
2N3055	£0·43
2N3391	£0·23
2N3391A	£0·25
2N3392	£0·23
2N3393	£0·23
2N3394	£0·23
2N3395	£0·25
2N3402	£0·24
2N3403	£0·24
2N3404	£0·33
2N3405	£0·47
2N3414	£0·18
2N3415	£0·18
2N3416	£0·33
2N3417	£0·33
2N3614	£1·08
2N3615	£1·13
2N3616	£1·13
2N3646	£0·10
2N3702	£0·09
2N3703	£0·09
2N3704	£0·08
2N3705	£0·08
2N3706	£0·09
2N3707	£0·09
2N3708	£0·08
2N3708A	£0·08
2N3709	£0·08
2N3710	£0·08
2N3711	£0·08
2N3772	£1·73
2N3773	£2·38
2N3819	£0·19
2N3820	£0·38
2N3821	£0·65
2N3823	£0·65
2N3903	£0·11
2N3904	£0·11
2N3905	£0·11
2N3906	£0·11
2N4058	£0·14
2N4059	£0·16
2N4060	£0·16
2N4061	£0·14
2N4062	£0·14
2N4284	£0·20
2N4285	£0·20
2N4286	£0·20
2N4287	£0·20
2N4288	£0·20
2N4289	£0·20
2N4290	£0·20
2N4291	£0·20
2N4292	£0·20
2N4293	£0·20
2N4921	£0·62
2N4923	£0·73
2N5135	£0·11
2N5136	£0·11
2N5138	£0·11
2N5172	£0·16
2N5194	£0·60
2N5245	£0·45
2N5294	£0·37
2N5296	£0·39
2N5457	£0·35
2N5458	£0·35
2N5459	£0·38
2N5551	£0·41
2N6027	£0·37
2N6121	£0·76
2N6122	£0·76
2S301	£0·54
2S302	£0·46
2S302A	£0·46
2S303	£0·60
2S304	£0·77
2S305	£0·86
2S306	£0·86
2S307	£0·86
2S321	£0·62
2S322	£0·46
2S322A	£0·46
2S323	£0·62
2S324	£0·77
2S325	£0·77
2S326	£0·77
2S327	£0·77
40311	£0·41
40313	£1·03
40316	£1·03
40317	£0·43
40326	£0·43
40327	£0·49
40346	£0·49
40347	£0·70
40348	£0·86
40360	£0·39
40361	£0·39
40362	£0·41
40406	£0·49
40407	£0·38
40408	£0·56
40409	£0·81
40410	£0·81
40411	£2·76
40430	£1·03
40476	£1·73
40494	£0·76
40495	£0·86
40512	£1·46
40594	£0·97
40636	£1·19

74 SERIES TTL ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0·10	7427	£0·26	7473	£0·27	74110	£0·39	74166	£0·84
7401	£0·12	7428	£0·28	7474	£0·27	74111	£0·63	74174	£0·70
7402	£0·12	7430	£0·12	7475	£0·31	74118	£0·86	74175	£0·67
7403	£0·12	7432	£0·24	7476	£0·27	74119	£1·27	74176	£0·63
7404	£0·12	7433	£0·32	7480	£0·48	74121	£0·26	74177	£0·63
7405	£0·12	7437	£0·23	7481	£0·92	74122	£0·42	74180	£1·62
7406	£0·24	7438	£0·23	7482	£0·73	74123	£0·43	74181	£0·63
7407	£0·24	7440	£0·13	7483	£0·63	74136	£0·56	74182	£0·76
7408	£0·14	7441	£0·54	7484	£0·95	74141	£0·59	74184	£0·76
7409	£0·14	7442	£0·43	7485	£0·73	74145	£0·59	74190	£0·73
7410	£0·12	7443	£0·76	7486	£0·24	74150	£0·73	74191	£0·67
7411	£0·18	7444	£0·76	7489	£1·84	74151	£0·52	74192	£0·65
7412	£0·16	7445	£0·70	7490	£0·34	74153	£0·52	74193	£0·63
7413	£0·26	7446	£0·65	7491	£0·69	74154	£0·88	74194	£0·67
7414	£0·54	7447	£0·52	7492	£0·38	74155	£0·54	74195	£0·65
7416	£0·25	7448	£0·60	7493	£0·32	74156	£0·54	74196	£1·13
7417	£0·25	7450	£0·12	7494	£0·81	74157	£0·54	74197	£1·13
7420	£0·12	7451	£0·12	7495	£0·54	74160	£0·63	74198	£2·00
7421	£0·22	7453	£0·12	7496	£0·54	74161	£0·67	74199	£2·00
7422	£0·17	7454	£0·12	74100	£0·92	74162	£0·67		
7423	£0·23	7460	£0·12	74104	£0·42	74163	£0·67		
7425	£0·20	7470	£0·27	74105	£0·41	74164	£0·73		
7426	£0·25	7472	£0·22	74107	£0·28	74165	£0·73		

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·15	CD4015	£0·82	CD4026	£1·30	CD4043	£0·95	CD4070	£0·18
CD4001	£0·16	CD4016	£0·45	CD4027	£0·54	CD4044	£0·89	CD4071	£0·18
CD4002	£0·17	CD4017	£0·81	CD4028	£0·73	CD4045	£1·51	CD4072	£0·18
CD4006	£0·99	CD4018	£0·92	CD4029	£0·92	CD4046	£1·40	CD4081	£0·18
CD4007	£8·18	CD4019	£0·45	CD4030	£0·52	CD4047	£0·94	CD4082	£0·19
CD4008	£0·99	CD4020	£0·97	CD4031	£2·16	CD4049	£0·45	CD4510	£1·07
CD4009	£0·49	CD4021	£0·87	CD4035	£1·08	CD4050	£0·45	CD4511	£1·03
CD4010	£0·52	CD4022	£0·87	CD4037	£1·03	CD4054	£1·19	CD4516	£1·08
CD4011	£0·16	CD4023	£0·16	CD4040	£0·95	CD4055	£1·08	CD4518	£1·08
CD4012	£0·17	CD4024	£0·70	CD4041	£0·82	CD4056	£1·46		
CD4013	£0·45	CD4025	£0·16	CD4042	£0·78	CD4069	£0·18		

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0·90	LM301	£0·33	MC1312	£2·14	UA710C	£0·45	SN76660	0·84
CA3014	£1·52	LM304	£1·73	MC1350	£1·35	72710	£0·34	SL414A	£2·19
CA3018	£0·73	LM308	£1·12	MC1352	£1·57	UA711C	£0·36	TAA550B	£0·38
CA3020	£1·91	LM309	£1·62	MC1469	£3·19	72711	£0·36	TAA621A	£2·25
CA3028	£0·90	LM320-5V	£1·62	MC1496	£1·01	UA723C	£0·49	TAA621B	£2·81
CA3035	£1·57	LM320-12V	£1·62	NE536	£2·99	72723	£0·49	TAA661	£1·60
CA3036	£1·12	LM320-15V	£1·62	NE550	£1·03	UA741C	£0·27	TAD100	£1·46
CA3042	£1·69	LM320-24V	£1·62	NE555	£0·26	72741	£0·27	TBA540	£2·36
CA3043	£2·08	LM380	£0·96	NE556	£0·65	741P	£0·22	TBA810S	£0·84
CA3046	£0·79	LM381	£1·63	NE565	£1·35	UA747C	£0·67	TBA810	£1·10
CA3052	£1·80	LM3900	£0·65	NE566	£1·69	72747	£0·67	TBA820	£0·79
CA3054	£1·24	MC1303L	£0·96	NE567	£1·91	UA748	£0·39	TBA9200	£2·81
CA3075	£1·69	MC1304	£2·14	UA702C	£0·52	72748	£0·39	TCA270S	£2·25
CA3081	£1·69	MC1310	£1·07	72702	0·52	748P	£0·39		
CA3089	£2·25			UA703	0·28	SN76013N	£1·97		
CA3090	£4·05			UA709	0·28	SN76023	1·97		
CA3123	£2·14			72709	£0·52	SN76110	1·69		
CA3130	£1·00			709P	£0·28	SN76115	2·14		
CA3140	£0·76								

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0·09	BAX13	£0·08	BY164	£0·55	OA10	£0·37	SD10	£0·06
AA120	£0·09	BAX16	£0·09	BY176	£0·84	OA47	£0·09	SD19	£0·06
AA129	£0·09	BY100	£0·23	BY206	£0·32	OA70	£0·09	IN34	£0·08
AAY30	£0·10	BY101	£0·23	BYZ10	£0·48	OA79	£0·11	IN34A	£0·08
AAZ13	£0·16	BY105	£0·23	BYZ11	£0·48	OA81	£0·11	IN914	£0·06
BA100	£0·11	BY114	£0·23	BYZ12	£0·48	OA85	£0·11	IN916	£0·06
BA102	£0·34	BY124	£0·24	BYZ13	£0·43	OA90	£0·11	IN4148	£0·06
BA148	£0·16	BY126	£0·16	BYZ16	£0·44	OA91	£0·11	IS44	£0·05
BA154	£0·13	BY127	£0·17	BYZ17	£0·38	OA95	£0·11	IS920	£0·06
BA155	£0·15	BY128	£0·17	BYZ18	£0·38	OA182	£0·14		
BA173	£0·16	BY130	£0·18	BYZ19	£0·38	OA200	£0·09		
BB104	£0·16	BY133	£0·23	OA5	£0·64	OA202	£0·09		

TRIACS

2 amp Volts	T05 Case No.	Price	10 amp Volts		
100	TR12a/100	£0·33	100	TR110a/100	£0·83
200	TR12a/200	£0·55	400	TR100a/200	£0·99
400	TR12a/400	£0·77	400	TR100a/400	£1·21
6 amp Volts			**10 amp Volts**		
100	TR16a/100	£0·55	400	TR100a/400p	£1·21
200	TR16a/200	£0·66		**Diacs**	
400	TR16a/400	£0·83	BR100 £0·22	O32	£0·22

ORDERING. Do not forget to state order number and your name and address.

V.A.T. All prices include V.A.T. at the appropriate

P & P 35p unless otherwise shown.

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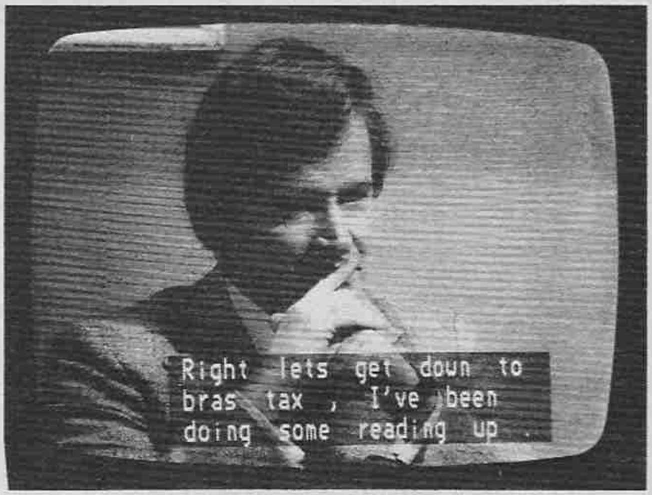
Everyday News

SATELLITES AND SUPERTITLES



At a recent open day at the Independent Broadcasting Authority (IBA) Engineering Centre at Crawley Court, some of the many areas of activity were demonstrated. Of particular interest are the use of space Satellites for broadcasting and the work being carried out to help the deaf and hard of hearing to receive subtitles on normal television programmes.

Satellites

Studies are at present underway using a transportable trailer-mounted 2·5 metre dish antenna transmitting at 14GHz to a geostationary Orbital Test Satellite (OTS) situated 22,300 miles above the Earth. Transmissions from the satellite are received on a 3·5 metre parabolic dish antenna part of a compact satellite receiving terminal located at Crawley Court.

This set-up provides temporary links from remote places (reached by truck and trailer) allowing "live" news and other programmes to be received. This could eventually lead to direct-broadcasting satellites providing programmes direct to the home.

The IBA's prime concern is to secure suitably frequency allocations for mobile satellite operations and provided suitable terminals can be made available, it would be possible to set up a temporary outside broadcast link via a satellite very quickly, with a minimum of forward planning.

Theoretically, with a smaller dish, a roving reporter in a news car could make use of the satellite.

Supertitles

Optional subtitles on television programmes, or "Supertitles" as the IBA have named them, for persons with impaired hearing are being researched and developed by the IBA and the ITCA in conjunction with a team led by Dr. Alan Newell at Southampton University.

The idea is to make use of the *Oracle* teletext system which incidentally has not been as enthusiastically received by the general public as all concernèd had expected. The reception of Supertitles requires the use of a t.v. capable of teletext reception.

The main concern has been the time and cost involved in the preparation of the subtitles requiring man-hours in the order of 20 to 30 times the programme running time for perfect subtitling. This makes subtitling of "live" programmes impossible.

In an effort to overcome this, a system is being explored that uses a Palantype shorthand machine linked to an electronic processor. In basic form the subtitles require some experience and training on the part of the viewer, phonetic spellings being one problem.

Subtitled test programmes are being shown to deaf and hard of hearing viewers for their reactions and comments. Later a number of experimental transmissions will be made through the *Oracle* service.

The UK-developed microprocessor chip used in the Chromatronics 24-tune door chime is now available as a component for home constructors.

Officials of the EEC are keeping a watch on Japanese TV and other electronic goods companies seeking to set up manufacturing units in Spain.

They see the current Japanese interest in Spain as a back-door entry into the EEC by the Japanese in advance of Spain becoming an EEC member by the mid-1980s.

Electronic White Sticks

An experimental guidance system for the blind is in use in a Swedish shopping centre. It uses an underground cable and a portable receiver.

An unsighted person can follow a prescribed route by listening to a signal which changes tone if deviation takes place. A further development suggested for the blind is a stick fitted with laser-beam equipment which will allow detection of obstacles up to six feet away. Again the user is warned by an audible signal.

. . . from the World of Electronics

—ANALYSIS

HOPPING MAD!

Superficially, radio communications and radio broadcasting appear to be the same thing. Yet there is a major difference. Communication is person-to-person or organisation to organisation and is essentially private in character. In contrast, broadcasting, as the name implies, is something for everybody to hear.

Technically, however, they are the same thing. Once a radio transmitter goes on the air everyone within range who has appropriate receiving equipment can listen equally well to the transmission whether it be a radio communications link (private) or a broadcast (public). The general rule is that if one inadvertently hears a transmission not intended for public reception then it should be ignored, and if not ignored then the message content should certainly not be passed on to a third party or in any way made public.

As well as amateur listeners there are professional listeners, mainly government and defence services. They constantly monitor diplomatic radio links of friendly as well as potentially enemy powers and also listen in to military networks. They want to know what's going on and it goes under the name of communications intelligence (COMINT), a branch of electronics warfare and an esoteric form of spying.

The traditional way of keeping such communications private is by enciphering the messages so that they are meaningless unless the recipient has the key to the cipher. The trouble is that modern code-breaking by electronic computer is now so powerful that nobody can really be sure that even the most complex cipher cannot be broken by the key being discovered in a matter of hours.

One solution is to make unauthorised reception more difficult for casual or, more important, intentional listeners. And one way of doing this is by frequency hopping. Imagine you are sitting down in front of your radio and the signal you are trying to listen to is hopping from one spot on the dial to another and then to a third and so on. It would be hard to keep up.

Imagine the frequency hops are at the rate of hundreds of hops per second, each new frequency at which the signal settles appearing to be completely random with no detectable sequence. This is now being achieved.

In fact radio system designers are now hopping mad! The frequency synthesizer, broad-band r.f. circuits which need no tuning, microprocessor control and large scale integration are the new tools which make frequency hopping possible in even military manpack sets.

The pattern of the hopping sequence is determined in a similar way to modern electronically generated ciphers so that if you haven't got the key there is no way of telling where the next hop will be. The technical problem of making the receiver tuning hop in exact synchronism with the transmitter has been overcome, at least in the laboratory, and the first UK-designed frequency hopping tactical field radio will be demonstrated later this year.

Apart from communications security, frequency hopping in the battlefield has another advantage. If several radio nets are all operating and all hopping about at the same time it would be immensely more difficult for an enemy direction finding station to detect their individual locations.

Needless to say, while one bunch of radio boffins are slaving away perfecting frequency hopping radio, another bunch are spending sleepless nights solving the problem of perfecting the broadband receivers and hopping analysers which may be able to follow the hops and so allow COMINT to continue unchecked.

Brian G. Peck

The National Television Rental Association is one of the bodies leading the campaign to popularise the Prestel TV-based information service among the UK's 20 million TV viewers.

The rental companies, members of NTRA, expect rental charges of Prestel-equipped receivers to be about £24 a month.

FLY-BY-TOUCH

The Royal Aircraft Establishment is evaluating the Digilux "touch mask" developed by Marconi Radar for use in the cockpits of combat aircraft. The "touch mask" enables a large number of controls and functions to be centralised on a single panel on which the pilot can exercise command by merely placing a finger at the appropriate point instead of operating conventional switches and knobs.

The "touch mask" is already in use in air traffic control functions and this is the first time it has been tried in aircraft cockpits with the intention of easing the pilot's work load.

Underground Computer

Military mainframe computers are generally well fortified, even underground, to protect them from nuclear attack. Now the first civilian computer has been built in an underground bunker.

Not from military threat by a foreign power but against internal terrorists and vandalism. It has happened in Italy which has experienced over two dozen attacks on computer installations in the last three years.

SOLAR WITCHCRAFT

Mass production of solar cells on a continuous strip is now a fact in the United States. Dr Paul Maycock of the US Department of Energy states that four years ago this technology looked like witchcraft and today it is a viable solar alternative.

He believes that such techniques will so lower costs of direct conversion of sunlight to energy that solar energy will become economically viable in the USA by the mid-1980s rather than earlier forecasts of the year 2000.

The new Eurovision Control Centre in Brussels is now in operation. Crow of Reading supplied the monitoring and control system which provides push-button routeing for 30 audio and video channels.

The equipment was built in the UK and shipped to Brussels in a single 12-ton consignment.

Speed of light

The IBM Company is working on solid state devices with switching speeds more than 10 times faster than the fastest transistor logic circuits. The technique is called current injection logic and to obtain a switching speed as little as 7 picoseconds the circuits need to operate at extremely low temperatures.

Total switching time is 13 picoseconds because it takes 6 picoseconds for the signal to move from one circuit to the next. And if you wonder what a picosecond is—it is a trillionth of a second.

SHOWING THE WAY AHEAD

For the first time ever, the British telecommunication industry is joining forces to present a co-ordinated display of its systems, equipment and capability to the world.

Five leading firms are joining with the Post Office to show their products and services at *Telecom '79*—the world telecommunications exhibition and conference to be held in Geneva from September 20 to 26. The companies are: GEC Telecommunications, Plessey Telecommunications, Standard Telephones and Cables, Marconi Communication Systems and Pye TMC.

The six co-ordinated exhibits will form, with a working model of System X, Britain's all-electronic telephone exchange system for the 80s and beyond. This will include the full range of services, systems and marketing skills available to meet the needs of overseas telecommunications administrations.

RADIO WORLD

By Pat Hawker, G3VA

The whispering gallery

Almost all standard textbooks tell us that short-wave (h.f.) signals travel round the world in a series of "hops" each having a maximum range of about 5000km. The signals, so we are told, travel up to the *F* layer of the ionosphere, then down again to the surface of the earth, up again to the *F* layer and so on. Well yes; there is plenty of evidence that this is what happens with powerful signals at frequencies significantly below the maximum usable frequency (i.e. at what is often called the optimum "working frequency").

But over the past 20 years or so there has been convincing evidence that this is *not* the path that allows radio amateurs and short-wave listeners to work or listen to low-power stations at very long distances. For example signals arriving from Australia and New Zealand around dawn and dusk are often at strengths that do not stand up to conventional "path-loss" calculations that assume a 6dB loss at each intermediate ground reflection point.

Chordal Hop

It has in fact become increasingly clear that these stronger-than-expected signals are virtually always propagated by what is called "chordal hop" or sometimes the "whispering gallery" mode (from the effect that can be observed with speech in the gallery of St Pauls Cathedral, London), and which are close to or even a little above the "maximum usable frequency" for the route. The signals are trapped between different layers of the ionosphere or skim along the under surface of a layer, often being launched into or out of this mode by ionospheric "tilts". In fact such signals may not return to Earth anywhere between the transmitter and the receiver.

It was a German radio amateur, Hans Albrecht, working in Australia, who first showed that the amateur radio signals he could receive from Europe just did not tie up with the conventional ideas about h.f. propagation and linked this with the investigations in the USA with "round-the-world echoes". It was one of the important new discoveries in an era when it had been thought that most of the mysteries of radio propagation had been solved. But most textbooks have still not caught up with the new concept.

Helping travellers

The BBC is due shortly to begin field trials of CARFAX, the time-multiplexed area-broadcasting system intended to provide local traffic information over an interlocking network of transmitters sharing a single channel at the low-frequency end of the medium-wave band.

While technically the system now seems promising (although the original proposals ran into the problem of poor definition of areas and had to be modified) I still find it difficult to believe that motorists really need or want a 24-hour information system.

However in the USA, with its vastly greater geographical area, the Federal Highway Administration has commissioned a research organisation to conduct a systems analysis and provide guidelines for a chain of "Highway Advisory Radio Stations" designed to provide a "travellers information service". These will be low-power, short-range stations operating on 530 or 1610kHz (i.e. both ends of the present a.m. broadcast band). Stations may also be set up by city authorities.

In some cases, apart from announcements about traffic conditions, detours, emergencies and weather news, the broadcasts will draw attention to historic sites and local recreational areas. Road signs will tell the motorist when he is coming into range of one of these stations, and no special form of decoder or automatic switching will be needed.

Crackles and buzzes

Certainly in the London area, and I suspect elsewhere, the levels of man-made electrical interference (r.f.i.) continue to rise over most of the l.f. m.f, h.f, and v.h.f. bands. Thermostats and small motors and hundreds of other sources continue to clobber or mask weak signals, while the Russian "Woodpecker" radar, broadcast jammers and military pseudo-noise spread spectrum systems all go to show that Governments are among the worst offenders. We really do need a society for the preservation of the ionosphere and the elimination of pollution!

Among the latest noises are those coming from "home computers" (and even pocket calculators) and in the United States the Federal Communications Commission have begun a special enquiry into this new source of r.f.i. Part of the troubles are faulty modulators used to connect into the TV sets (a problem also with video-games) but there is also interference from the pulses surging around in the logic circuitry. This problem of digital techniques seems to be often overlooked by those who believe that conventional analogue techniques are now becoming obsolete.

With the Post Office looking ahead to an all-digital telephone network (System X etc) one wonders how much thought has been given to the question of radiation from telephone circuits (at least until we all use optical fibres to carry the signals in the form of light). Is this why the P.O. keep promoting that confounded bird "Buzby"?

And there is trouble coming in the kitchens. Sir Bernard Lovell has recently drawn attention to the way microwave ovens can play havoc with weak radio astronomy signals. He claims that poorly constructed ovens can interfere with his radiotelescopes at distances of several miles.

It has also been suggested that microwave ovens may present a problem when it comes to direct-broadcast satellites working on 12GHz—a sort of TV/dinner confrontation?

Cow and pig power

The search for alternative, small-is-beautiful technology that would free us from dependence on electricity supply mains is being taken seriously by some radio amateurs. Quite a lot has been written about harnessing wind, water, sunshine and even muscle power (an energetic man with a pedal generator can deliver about 100 watts of electric power for a short time).

At least two radio amateurs, Tim Hutchinson, 5Z4DV in Kenya and Lars-Erik Johansson, SM4AQL in Sweden, have found a practical way of obtaining power not only for their amateur radio equipment but also for their domestic and farm appliances. Both use "output" from farm animals to obtain a regular supply of methane gas which can then be used to generate electricity.

Tim Hutchinson began using a cow and pig powered transmitter as long ago as 1955, using a modified 2HP paraffin engine to charge a 32-volt bank of large Nife cells. This engine has clocked up over 60,000 hours running on "biogas" (methane/carbon-dioxide mixture) produced from cow and pig manure, coffee skins, grass etc, roughly the equivalent of 10 gallons of fuel a day, and providing him also with a rich organic fertiliser for his coffee crop.

The Swedish amateur has an even more impressive installation, using a 22,000 gallon methane-digester which produces 70 cubic metres of methane gas from the "throughput" of 50 Friesian cows and 40 heifers and again ending up as non-smell fertiliser.

STEVENSON

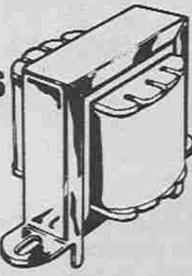
Electronic Components

REGULATORS

78L05	30p	7805	60p	79L05	70p	7912	80p
78L12	30p	7812	60p	79L12	70p	7915	80p
78L15	30p	7815	60p	7905	80p	LM723	35p

HARDWARE

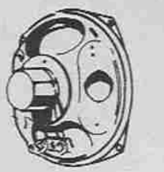
MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6 - 0 - 6, 9 - 0 - 9 and
12 - 0 - 12. 92p. each.

LOUDSPEAKERS

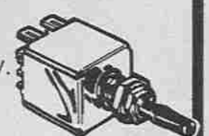


56mm dia. 8 ohms 70p
64mm dia. 8 ohms 75p
64mm dia. 64 ohms 75p
70mm dia. 8 ohms 100p
70mm dia. 80 ohms 110p

TERMINALS

Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES



Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p

Standard toggle
SPST 34p DPDT 48p

Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide switches (DPDT)
Miniature 14p Standard 15p

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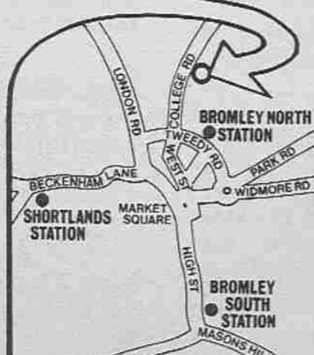

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AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC148	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214L	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

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1N4001	4p	BZY88ser.	8p

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		CA3140	38p	NE555	21p
		LM301AN	26p	NE556	50p
		LM318N	85p	NE565	85p
		LM324	45p	NE567	170p
		LM339	45p	SN76003	200p
709	28p	LM380	75p	SN76013	140p
741	16p	LM382	120p	SN76023	140p
747	40p	LM1830	150p	SN76033	200p
748	30p	LM3900	50p	SN76477	220p
CA3046	55p	LM3909	65p	TBA800	70p
CA3080	70p	MC1496	60p	TDA1022	650p
CA3130	90p	MC1458	32p	ZN414	75p

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TANTALUM BEAD each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68,
1 & 2.2uF @ 35V 8p
4.7, 6.8, 10uF @ 25V 13p
22 @ 16V, 47 @ 6V, 100 @ 3V 16p

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RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	screened	unscreened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits, Red & black.
Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each

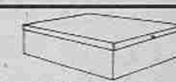
PHONO PLUGS AND SOCKETS
Insulated plug in red or black 9p
Screened plug 13p
Single socket . . 7p Double socket . 10p

VERO

Size in.	0.1in.	0.15in.
2.5 x 1	14p	13p
2.5 x 3.75	42p	40p
2.5 x 5	52p	50p
3.75 x 5	60p	60p
3.75 x 17	195p	180p

Veropins— single sided per 100
0.1in 35p
0.15in 40p

BOXES



Aluminium boxes with lid and screws

	Length	width	height	
AL1	3	2	1	48p
AL2	4	3	1½	58p
AL3	4	3	2	65p
AL4	6	4	2	70p
AL5	6	4	3	85p
AL6	8	6	2	116p

THYRISTORS

Plastic-cased Thyristors: Texas

	4A	8A	12A
100V	36p	45p	62p
200V	42p	53p	68p
400V	51p	66p	86p

TRIACS

Plastic cased Triacs. Texas. All rated at 400V.

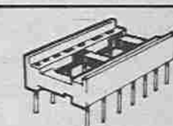
4A	70p	42A	90p	20A	185p
8A	80p	16A	95p	25A	215p

CMOS

		4018	55p	4050	25p
		4023	12p	4066	35p
		4024	40p	4068	18p
4001	12p	4026	90p	4069	12p
4002	12p	4027	30p	4071	12p
4007	12p	4028	48p	4081	13p
4011	12p	4029	50p	4093	45p
4013	28p	4040	60p	4510	65p
4015	50p	4042	50p	4511	65p
4016	30p	4046	90p	4518	65p
4017	48p	4049	25p	4520	60p

FULL DETAILS IN CATALOGUE!

SKTS



Low profile by Texas

8 pin	8p	16 pin	11p	28 pin	22p
14 pin	10p	24 pin	18p	40 pin	32p

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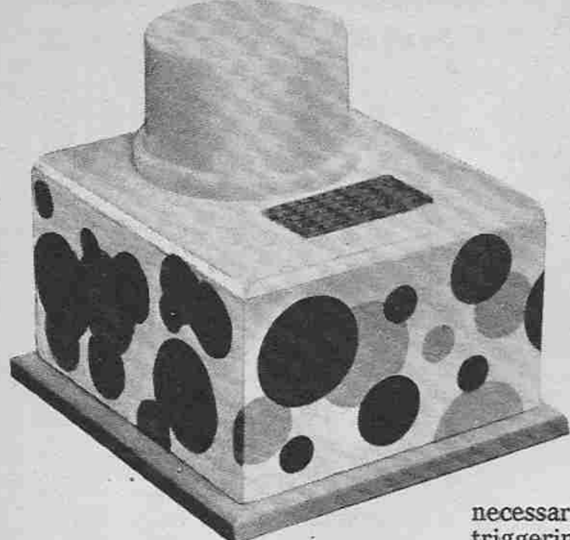


TOUCH-ON PILOT LIGHT

By F. G. Rayer

THE SIMPLE project described here operates from a 4·5V dry battery and so is completely safe. It is not necessary to locate and operate a switch in darkness, as the light is put on by light finger contact with a touch pad. The lamp remains on until extinguished by a switch fitted on the unit.

CIRCUIT DESCRIPTION

The circuit of the unit is shown in Fig. 1. The lamp receives current through the silicon controlled rectifier CSR1. As CSR1 is normally in a non-conducting state, the lamp is extinguished. Push switch S1 is normally closed.

The touch pad has no circuit from TR1 collector to base, so there is no base current for TR1. As a result, no collector current flows and the emitter cannot provide gate current for CSR1.

When a finger is placed on the touch pad, base current flows and the emitter of TR1 moves positive since TR1 is now turned on. As gate g of CSR1 is connected to the emitter, it is triggered into conduction. Current through CSR1 then lights the lamp. It now remains in the conducting state once triggered, even though gate current is no longer available when the finger is withdrawn from the touch pad.

When the light is no longer required, S1 is pressed. This breaks the anode supply to CSR1, so that it reverts to its non-conducting state.

A 3·5V 0·3A bulb is used, but a 6·3V 0·15A bulb can be substituted if only a relatively weak light is needed, as for seeing the time. Capacitor, C1 was found necessary to avoid occasional triggering of a sensitive thyristor when S1 closes. The value is not critical.

CONSTRUCTION starts here

Most of the components are mounted on a piece of 0·15 inch matrix stripboard, 5 strips by 16 holes. This is shown in Fig. 2. Only one break is required and can be made with a sharp drill or cutter.

Pass the component wires through the holes shown, and solder them below. Snip off unwanted wires. External wires, of thin flex, are then soldered on as required.

CASE

It is clear that any insulated box large enough for the battery and board will be suitable. However, the case shown was made from plywood and looked quite presentable.

Two pieces 90 x 50mm and two pieces 100 x 50mm form the sides The top is 100 x 90mm. Fit these together with panel pins and woodworking adhesive, and glasspaper the joints later.

The bottom is about 3mm larger all round, and is fixed with four small screws. The whole box can then be painted or varnished.

TOUCH PAD

A piece of 0·15 inch stripboard, 5 strips by 10 holes is used as the touch pad. Short wires are soldered to alternate strips and pass down through holes in the top as shown in Fig. 3. The stripboard is cemented to the box, foils upwards, and the leads are joined as shown, and taken to the circuit board.

The circuit board is fixed with two screws, with nuts or other spacers underneath it.

The "lens" is quite simply a white aerosol can top. Choose one which is fairly opaque so as to let the most amount of light through.

Three small cheese head screws are placed equally around a circle corresponding to the internal diameter of the aerosol top. The top can then be simply pushed into place, whereby the screws should hold the top fairly well. It is not advisable to glue the top into place, as changing of the bulb would be difficult at a later date.

Depending on its height the lamp holder can either be mounted on top of the case, or, as in the prototype on the underside, with just the bulb projecting through.

IN USE

A 4·5V 1289 type flat battery fits in the case. Make tinplate clips for its contacts, or solder positive and negative leads directly to it. Polarity must be correct.

Light finger contact anywhere on the pad should bring the bulb on. Pressing S1 resets it to off. The pad should be clean, and connections to it properly insulated, or the bulb may come on too easily. Sensitivity can be reduced by placing a 2·2 megohm resistor connected between TR1 base and the negative line, but this was found to be unnecessary with the prototype. ⌑

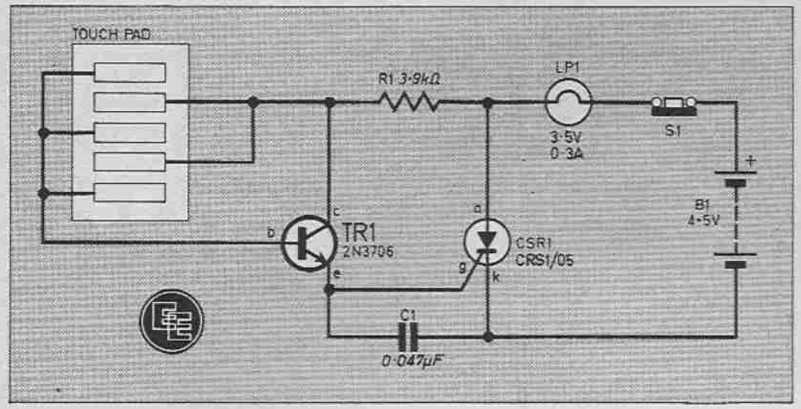


Fig. 1. Complete circuit diagram for the Touch-on Pilot Light.

COMPONENTS approximate cost £2

Resistor
R1 3·9kΩ ¼W carbon ±10%

Capacitor
C1 0·047μF polyester

Semiconductors
TR1 2N3706 silicon *npn*
CSR1, CRS1/05 or similar 50V 1A thyristor

Miscellaneous
LP1 3·5V 0·3A (or 6·3V 0·15A, see text) MES bulb
S1 single pole push-to-break switch
B1 4·5V, type 1289 battery
Stripboard 0·15 inch matrix, 5 strips × 16 holes, and 5 strips × 10 holes (one off each); MES type batten holder for LP1; white aerosol can cap; material for case or ready made type as required; connecting wire.

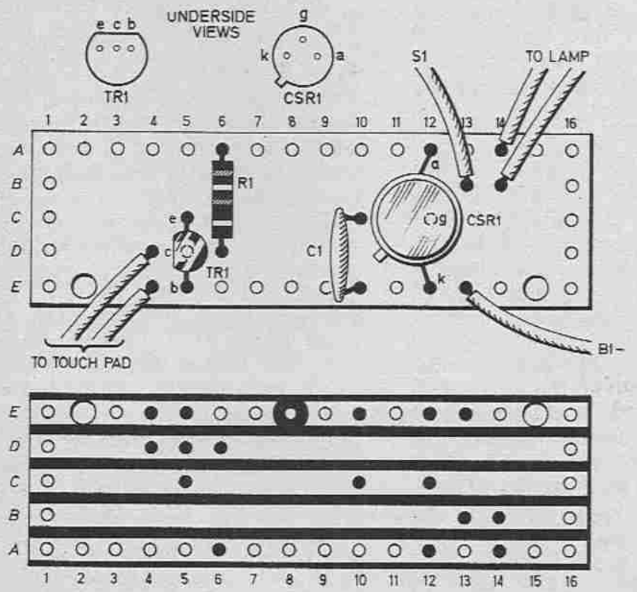
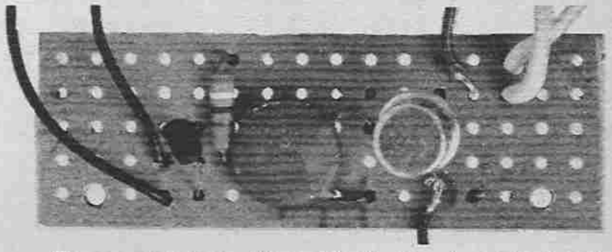
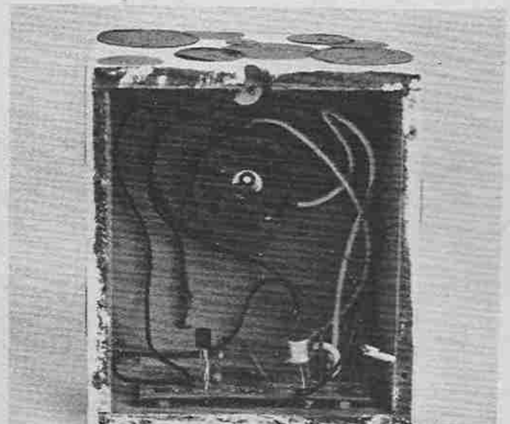


Fig. 2. Stripboard layout. Only one break is required. Insure that the thyristor and transistor are inserted correctly. If a metal case is used then it is necessary to isolate the mounting holes by means of breaks either side of the holes.



The completed circuit board for the Touch-on Pilot Light.



The completed Touch-on Pilot Light showing positioning of components and circuit board.

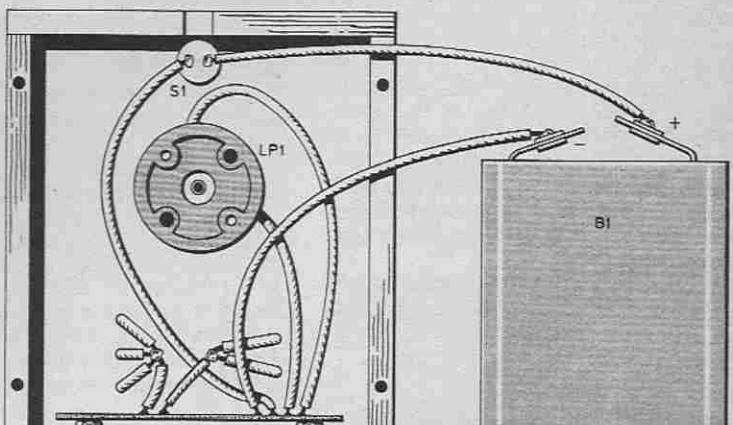


Fig. 3. The remainder of the wiring is completed as shown here. The holder for the bulb is simply glued into place.

WORKSHOP MATTERS

By Harry T. Kitchen

Metal Working

The art and science of "chassis bashing" disappeared with the advent of semiconductors. This is in many ways a great pity. "What," you may well ask "has this to do with modern electronics?". A great deal, I do assure you. Chassis bashing required a variety of skills, skills that can be usefully incorporated into "cabinet bashing" to coin a phrase.

Equipment, ancient or modern, requires cabinets, and commercially available cabinets are both expensive and rarely suit the project in hand; rather the project has to be tailored to suit the cabinet available, and thus there is considerable incentive to make your own cabinets.

What do we require, where do we start? Let us consider tools first, then techniques.

Marking Out

Cabinets vary in size and in shape, they have a number of holes, probably of varying size. The project will determine the size of the cabinet, and will require the holes to be in specific positions, sometimes to a high degree of accuracy.

We can, of course, use an ordinary rule for marking out our piece of virgin aluminium sheet, but a better method is to use a proper combination square. This enables a rule to be fixed at a precise position with respect to the frame, and thus repetitive accuracy, if required, is assured. It also enables marking-off at right angles to the edge of the aluminium to be effected automatically, and most also provide for a, fixed 45 degree angle.

An ordinary rule can slide about on the aluminium sheet; the combination square will not since the frame is in contact with the edge of the aluminium sheet. For more involved work, a fully adjustable combination square is available, but this is of course much more expensive.

If the combination square does not incorporate a scriber—most do—then you will need to buy one.

Cutting Tools

However you buy your aluminium sheets, sooner or later you will need to cut them, into smaller sizes say. Basically you can use a hacksaw or a pair of tin snips. Which do you buy? Ideally both, and both come in various shapes and sizes. So let us look at hacksaws first.

The most common saw is the 12 inch; most of these will also accept 10 inch blades by adjusting the frame. Most will also allow the blade to be rotated through 90 degrees permitting long lengths of metal to be cut, but the width is limited by the distance between the frame and the blade.

Then we have the little 6 inch saw, sometimes called the "junior" saw. This is a handy little tool since it can be used where space precludes the use of the larger saw.

Hacksaw Blades

Hacksaw blades do not, in my experience, get the attention they deserve from amateurs. Essential, when selecting a blade, is to discover the number of teeth per inch and the metal from which it is made.

The number of teeth per inch, or per 2·54cm for our metricated friends, must be chosen to suit the application; the thinner the metal, the more teeth you require per unit of length. A reasonable compromise is a blade having around 20 teeth per inch.

Blade material is selected by the manufacturer to suit different applications. Looking at the Eclipse catalogue, three types stand out for amateur use. These are the *HiCut* blades, claimed to be unbreakable under normal use, as are the *Flexible* blades. For use on soft materials, such as our aluminium sheets, are the *Low Alloy* blades.

Before leaving hacksaws, let us look at a most useful adjunct to these, the pad saw handle. This permits odd lengths of broken blades to be used, and is almost indispensable when cutting out straight-sided holes in sheets of metal once a hole has been started the length of the blade.

We can now look, briefly, at tin snips. Large or small, straight or curved? Four basic choices. Personally I prefer the straight snips, and whilst a large and a small snips may occasionally prove useful for coarse and fine work say, the large snips will prove adequate for most of the work.

Drilling

An electric drill on a stand, preferably, or on its own, is a useful aid to drilling holes. On the other hand a good quality hand drill will prove to be capable of coping easily with much of our work.

The drill should be one having machine-cut gears as these mesh better and run much more smoothly than cheap cast gears. An idler gear, opposite to the driving gear, assists greatly in reducing the sort of excessive slop that makes precision drilling difficult.

Most such drills have a chuck that will accept drill bits with a maximum shank diameter of $\frac{1}{4}$ inch, and this is perfectly adequate as larger holes can be filed or cut out as necessary. If the drill is to be used for very fine drill bits, for p.c.b. drilling say, then it is essential that the chuck will close sufficiently; many do not.

Drill Bits

Drill bits come in several sizes, denoted in four ways: letter, number, fractional, metric. Letter drills cover from A=0·234 inch to Z=0·413 inch; Number drills cover from No: 1=0·228 inch to No: 80=0·0135 inch; Fractional drills cover from $\frac{1}{64}$ to $\frac{1}{2}$ inch in $\frac{1}{16}$th inch increments; Metric drills cover from 0·5mm to 25mm.

The problem resolves into selecting any particular system—if you are starting from scratch. Undoubtedly metric will win the day, and this is perhaps, the way to go. Top quality drills, of any denomination, are expensive, but looked after they will give years of service.

If you are into p.c.b. work to any appreciable extent, then it will pay you to investigate one of the little electric drills and stands that are specifically marketed for this application. The motors are generally 12 volts d.c. working and can be run from a battery or from a power pack, and most of us have one of those lying around. If the power pack has a variable voltage output, this can be used to control drill speed, but of course the drill should not be operated above its rated voltage.

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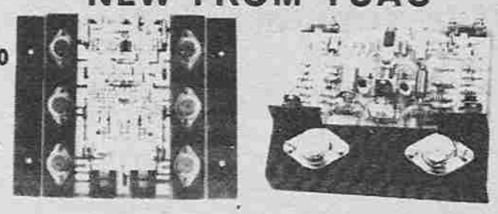

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LIGHT PLUS BELL

DOOR

By E. Vaughan

ECONOMICAL 2-WAY SIGNALLING CIRCUIT

THE SIMPLE project described here came about due to a situation which arose at the author's home. It was suggested that it would be a good idea to have a small light over the front door number, but without the trouble of another pair of wires running around the house. At the same time, it was decided not to use batteries.

Although originally intended for this purpose, the idea of sending two sets of conditions down a single pair of wires could have other possibilities.

CIRCUIT DESCRIPTION

The circuit for the device appears in Fig. 1. It was decided to use the only pair of wires available, and these were in fact for an electric bell. Many of the components in the circuit, will probably already exist. Components such as T1, WD1 and S1 will form the normal front door bell set-up.

Assume for the moment that diodes D1, D3 and the bell WD1 are not in circuit. A circuit therefore exists via LP1/LP2, D4 and D2, thus the bulb illuminates but only on negative portions of the a.c. produced by the transformer. Now with the other components, a circuit exists when S1 is pressed, but will only work on positive portions of the a.c. waveform. In effect, the diodes are being used in pairs, to *steer* both positive and negative voltages in the required directions.

Think of it another way. Assume that the a.c. waveform has gone positive, D1 conducts and passes this current via WD1 to the junction of D3 and D4. The current cannot go via D4, as this diode will be reverse biased. The only route for the current is via D3.

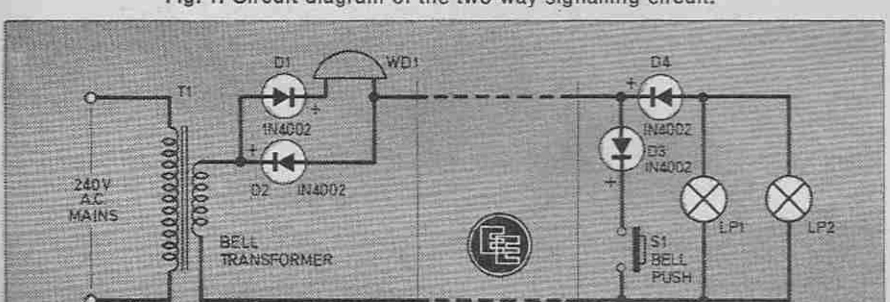
COMPONENTS

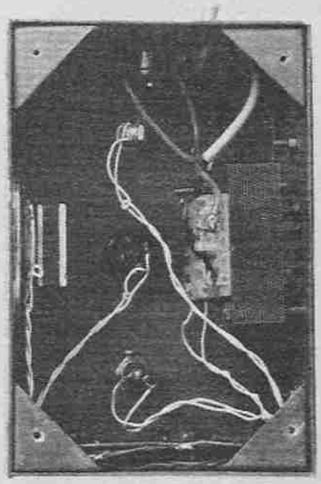
Semiconductors
D1–D4 IN4002 rectifiers (4 off)

Miscellaneous
T1, WD1, S1 — Part of the existing electric bell system
LP1, LP2 Type depends on the secondary voltage of T1 and size and shape required.

Approx cost Guidance only £1.25 excluding bell circuit and case

Fig. 1. Circuit diagram of the two-way signalling circuit.





The prototype unit used to prove the circuit.

A similar situation arises when the a.c. goes negative; D2 conducts, D3 is reverse biased and the current passes via D4 to light the bulbs.

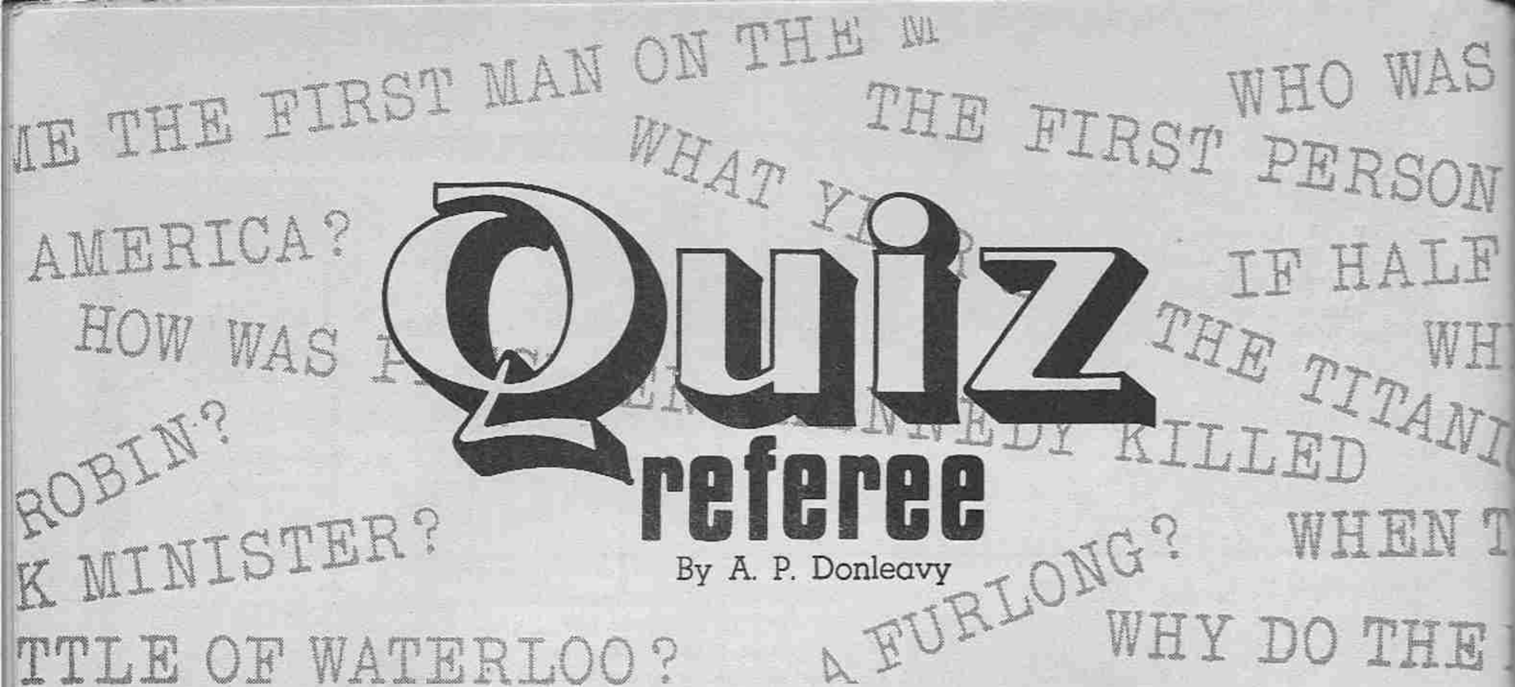
Lamps LP1 and LP2 are the additional lamps fitted over the front door number.

CONSTRUCTION

It is left to the reader to decide how best to wire the circuit. The diodes at the transformer end can easily be fitted somewhere inside the transformer. Those at the bell-push could even be wired inside the switch itself. The only extra wires that are required, are from the bell-push to the lamps.

The photograph shows the author's prototype demonstration unit, which was used to prove the circuit. It is not therefore necessary to construct the unit exactly as per the photograph.

Once constructed the circuit will prove to be trouble-free in operation, and will have solved quite a common problem; that is, getting four down two!



Quiz referee

By A. P. Donleavy

THE UNIT to be described here can be used by a quiz-master to referee more fairly a contest between two individual players or two teams. Each team is provided with a button or buttons to press when an answer to a question has been found. By means of two light emitting diodes the unit displays whichever team has answered first.

A timer is incorporated which allows a preset time in which the answer must be offered. If no replies have been given during this time, the unit will automatically prevent any further pressing of the buttons from illuminating the l.e.d.s.

The unit is very easy to build and should be ideal for the beginner.

CIRCUIT DESCRIPTION

The complete circuit for the Quiz Referee is shown in Fig. 1 and can be conveniently split into two sections: a timer and flip-flop.

Timer

The timer part of the circuit is formed by gates G1a and G1b of IC1. Together they form a monostable multivibrator, the timing interval being dependent on the values of VR1 and C1. With the values given, a maximum time of about 40 seconds is obtained.

To set the multivibrator in operation a momentary depression of S1 applies the positive supply to one input of G1a. This is quite sufficient to start the circuit. When it is desired to stop the multivibrator a short depression of S2 inhibits the charging action of C1 thus stopping the multivibrator.

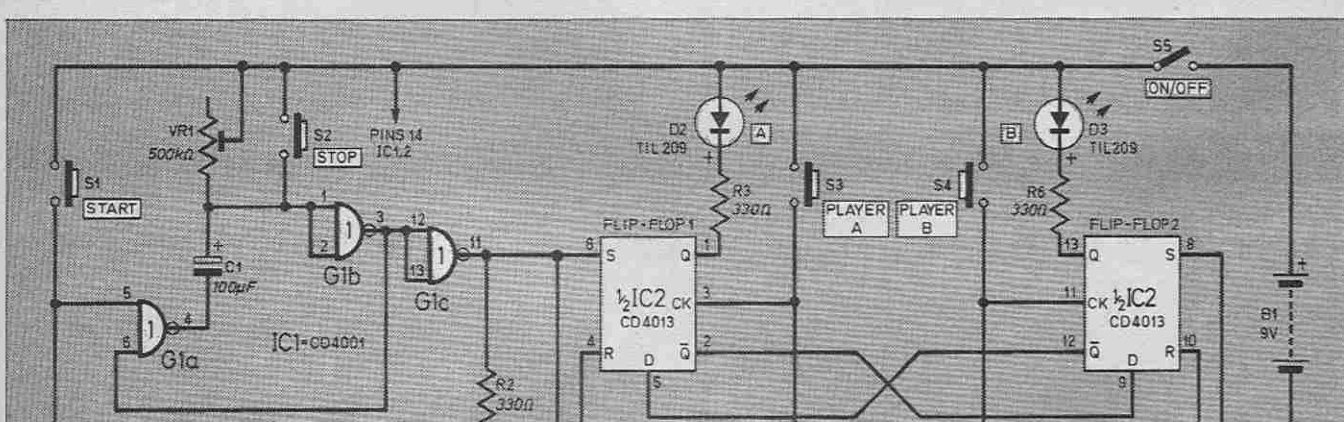
Gate G1c is used merely to invert the signal applied to IC2. During the timing period, the light emitting diode D1 is extinguished. At the end of the time it illuminates, thus alerting the user that "time is up".

Flip-Flop

The flip-flop part of the circuit is IC2 and associated components. There is in fact two separate flip-flops in this i.c., one for each player or team. Consider just one, Flip Flop 1.

During the timing period, the input to the SET terminal, pin 6

Fig. 1. Complete circuit diagram for the Quiz Referee.



is normally low. When S3 is pressed, a pulse is applied to the CLOCK terminal, pin 3. This causes the flip-flop to change state, producing a low output at pin 1 and a high output at pin 2. The low at pin 1 illuminates D2 thus indicating that player A has answered the question first. At the same time the high condition at pin 2 is applied to pin 9 of Flip Flop 2 preventing it from changing state if player B presses his button.

Precisely the same happens if player B presses his button first, this time however it is Flip Flop 2 which changes state and Flip Flop 1 which is inhibited. The circuit is quite precise at recognising which button is pressed first, a time difference of less than a microsecond is average.

At the end of the timing period the inputs to pins 6 and 8 of IC2 go high turning off which ever l.e.d. is on, and also prevents either flip-flop from changing state with further depressions of S3 or S4. If a further question is to be asked before the end of the timing period, the STOP switch is pressed thus ending the timing and resetting the flip-flops.

Although S3 is shown as a single switch it may be paralleled with as many as required depending on the number in each team. The same applies to S4.

CIRCUIT OPTIONS

If the timing section of the unit is not required then all the components to the left and including D1/R2 may be omitted. If this is done the flip-flop part of the circuit will require a reset switch. The circuit of Fig. 2 shows how this is done. The remainder of the circuit remains the same as in Fig. 1.

In the prototype, VR1 was a small preset mounted on the circuit board. This could easily be replaced by a standard potentiometer mounted on the case. If it is fitted with a pointer knob, a scale can be drawn and be directly calibrated in seconds.

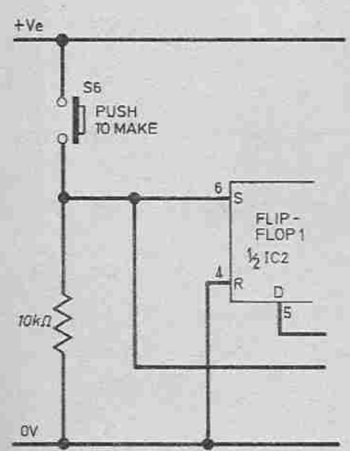
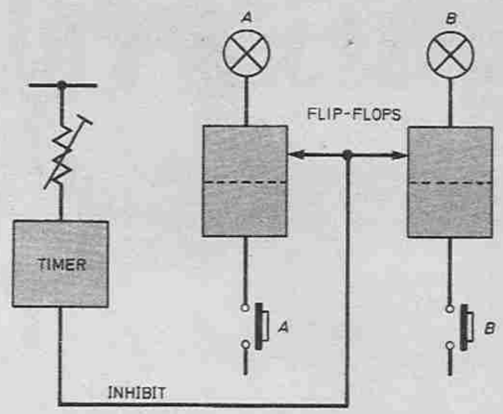


Fig. 2. Modification required to the circuit of Fig. 1 if the timing period option is not required.

HOW IT WORKS



The unit consists of two *flip flops*, one for each player or teams. A flip flop is an electronic circuit which has two stable states; a short clock pulse applied to the input will cause the device to change state. In this circuit, if player *A* presses his button the flip flop will change state and illuminate the light. At the same time a second output from the flip flop will inhibit player *B*'s flip flop.

Thus the circuit detects who was first in pressing his own button. At no time however will both lights be on, due to this "cross coupling" between flip flops. A further refinement to the circuit is a *timer* which only allows the flip flop to operate during a certain preset time, after which they are inhibited.

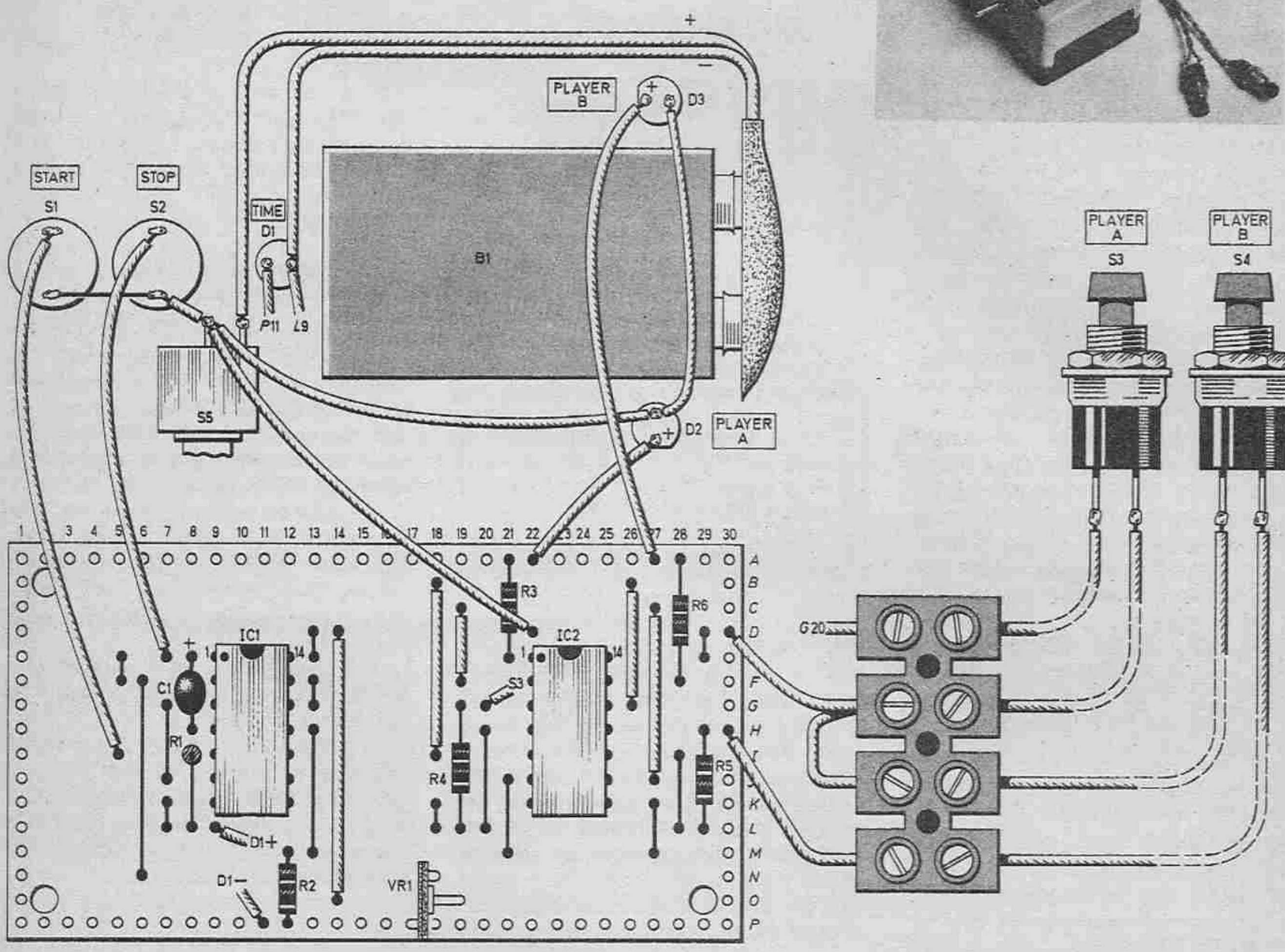
COMPONENTS

Although the two l.e.d.s D2 and D3 are both coloured red, it may be an advantage if different colours were used. The push switches as used on the prototype were miniature types, although larger types such as bell pushes will be more suitable. The unit is powered by a 9V battery, although the circuit will work with any voltage in the range 3 to 15V. If different voltages are used then it may be necessary to adjust the values of R3 and R6 to compensate for the varying brightness in the l.e.d.s.

Both i.c.s are of the CMOS type and as such must be handled with care. The use of sockets is recommended although they were not used on the prototype.

COMPONENTS approximate cost £5

Quiz referee



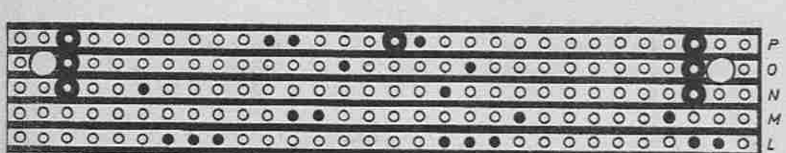
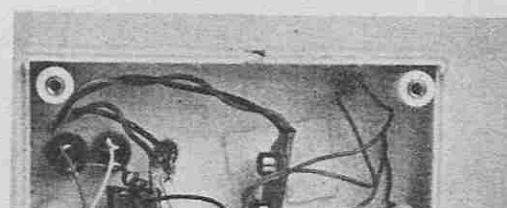


Fig. 3. Complete wiring details for the unit, also showing the stripboard and breaks to be made. There is nothing critical about the layout and can be varied if required.



The prototype Quiz Referee with lid removed showing the mounting of the component board.

CONSTRUCTION starts here

Most of the components are mounted on a piece of 0·1 inch matrix stripboard having 16 strips by 30 holes, the layout of which is shown in Fig. 3. This drawing also shows the remainder of the wiring to the switches and l.e.d.s.

CASE

The case used in the prototype was a small Verobox type 65-2516G, having overall dimensions of 100 x 50 x 40mm, although any similar size can be used. However it must not be significantly smaller as the components might not fit in.

The l.e.d.s can be simply a tight push fit into their respective holes or standard mounting clips can be used. The battery is fitted to the lid using double sided sticky tape. A small plastic connecting block is screwed to one end of the case facilitating connection to the push switches.

Lettering can be applied using Letraset or similar and finally given a thin coat of protective clear varnish. Ordinary twin bell wire can be used to connect the push switches to the unit. Be sure to identify which is player A and which is player B! Depending on the situation in which it is to be used a length of four metres for each set of switches seems reasonable.

COMPONENTS

See **Shop Talk** page 499

Resistors
R1 10kΩ
R2 330Ω
R3 330Ω
R4 10kΩ
R5 10kΩ
R6 330Ω
All ¼W carbon $\pm$10%

Potentiometers
VR1 500kΩ vertical preset

Capacitor
C1 100μF 10V tantalum

Semiconductors
IC1 CD4001 quad 2-input NAND gate
IC2 CD4013 dual "D" flip flop
D1, 2, 3 TIL209 red light emitting diode (3 off)

Miscellaneous
S1-4 miniature push-to-make release-to-break (4 off)
S5 miniature single pole toggle
B1 9V PP3 battery
Stripboard 0·1 inch matrix, 16 strips by 30 holes; Verobox type 65 2516G, 100 × 50 × 40mm or similar; PP3 battery connector; 14 pin i.c. sockets (2 off); 4-way plastic connecting block; 8 metres thin bell wire; connecting wire.

IN USE

Before finally screwing the lid into place, VR1 will have to be adjusted for the time period required (assuming that a preset is used). Do this by switching on the unit whereupon D1 will light. Press S1 and D1 will go out for the duration of the timing period. Adjust VR1 by trial and error until you obtain the required time interval.

If a panel mounting potentiometer is used then the above process is carried out, but after each time period, a mark is made on a scale around VR1.

After the unit has been calibrated it is ready for use. Switch on by means of S5 and press the START button. The TIME l.e.d. will go out indicating that the timing period is running. If now either S3 or S4 is pressed, the appropriate l.e.d. will light, and will go out at the end of the timing period, whereupon the TIME l.e.d. will come on once more.

If another question is to be asked before the end of the time, the STOP switch is pressed terminating that period, and the START switch pressed to start a new timing period.

If an answer is given after the end of time, no l.e.d.s will come on, indicating to the players that they have failed. The unit is then reset and a new timing period started.

If the timing part of the circuit is not used then the unit becomes a simple precedence detector with a reset switch, S6.

MICROPROCESSOR BASICS

By R. W. Coles

THIS month we complete our look at Instruction Types, and then discuss Addressing Modes.

TRANSFER OF CONTROL GROUP

Most programs are written in the form of "loops". This means that instead of starting at the beginning, working through to the end, and then "dropping-off", at some point control is transferred back to near the start of the program so that the program operations are repeated. Programs also contain many "minor" loops which make more efficient use of program memory than would be possible with in-line code.

Have a look at Fig. 6.1. This is a very simple program to demonstrate the action of loops. It does *not* do anything useful as it stands, but it *is* typical of the structure of other programs which *are* useful.

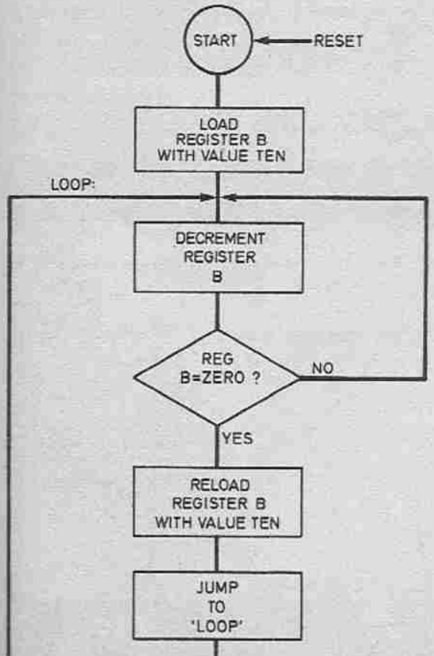


Fig. 6.1. Example of conditional and unconditional jump instructions.

The program is shown in "flowchart" form. This is a useful way to sketch out programs before finally coding them for entry into a micro' system, and is a big help in visualising program operation. This program does nothing more complicated than count down from 9 to 0 in a register I have called register B.

After reset, register B is loaded with the value 9 (decimal) which is 9 (hexadecimal) and 00001001 (binary). After this we enter the main loop and start by decrementing (counting down by one) register B. After the first decrement, register B will contain the value 8, and so on.

Conditioned-jump. Now we come to the important bit, the transfer of control operation, and in this case we have what is known as a "conditional - jump" instruction. When this instruction is carried out, program flow can continue from one of two points depending on the contents of register B.

If register B contains zero then the net instruction in sequence is carried out, but if it contains a number other than zero, then control is transferred back to the location known as LOOP.

In this way, microprocessors can be programmed to take decisions on the basis of data supplied to them, and this is a very important ability indeed. An SC/MP instruction which could be used in this program is:

JNZ (Jump if not zero). Add to the contents of the program counter the data following this instruction *if* the accumulator does not contain zero. (The data can be negative.)

Unconditioned-jump. On nine occasions out of 10, our program will loop. On the tenth pass, the contents of register B will reach zero and when this happens we reload register B with 9 (decimal). Since the program must continue to run, we now need to get back to the start of the loop once more, and so we use an instruction which performs an "unconditional-jump" or in other words "jump-always." An SC/MP instruction to do this is:

JMP Add to the contents of the program counter the data following this instruction. (The data can be negative.)

Notice that the program of Fig. 6.1 will not stop until the "Reset" button is pressed or power is removed. Many control programs operate in this way.

Jump to subroutine. Another very important transfer of control operation which is unfortunately not available on the SC/MP chip is the "jump to subroutine". This is very useful where we have a small program segment, let's say a multiplication routine, which has to be used in several places in our main program. Rather than repeat it each time we need it, the multiplication routine can be entered once and accessed from anywhere in the main program using a "jump to subroutine" instruction.

If you have a look back at the action of the two jumps from the SC/MP instruction set you will see that in each case the contents of the program counter are modified by new data. The old contents are destroyed by this replacement, but not when a "jump to subroutine" is carried out. In this case the previous contents are saved in a special register or RAM area called "the stack", so that they can be retrieved later when required.

Return from subroutine. To complete the picture we need another instruction often called a "return from subroutine", which has the effect of restoring the original program counter contents after the "multiply" has been performed.

The return from subroutine does not cause a jump to a specific address, but to the address which was saved on the stack, whatever it was. This means that our "multiply" can be called from several points in a program, and control will always be passed back to the area from which the call was made.

Nesting. Taking this a stage further, most microprocessors allow subroutines themselves to call other subroutines and so on. This requires a multiple entry "stack" so that control can be passed back from one subroutine to the next until a proper return to the main program is made. This is known as subroutine "nesting", a very powerful and efficient technique.

MISCELLANEOUS GROUP

After removing the instructions which fall neatly into the other groups, there will always be some left over. Since those remaining form a rather rag-tag bunch, it's easiest to call them the "miscellaneous group"! Examples from SC/MP include:

CCL Clear the carry flip-flop to zero.
NOP Don't do anything at all.
DLY Don't proceed until a given delay count has been decremented to zero.

ADDRESSING MODES

Many instructions need access to data in memory. This is not only true of data transfer instructions such as LD, but also of others such as OR and ADD. To provide flexibility, many microprocessors allow a variety of memory addressing formats to be used, in some cases ten or more memory reference modes are available. It is possible to write successful programs using only a few of the available modes, and some of the more exotic combinations certainly won't appear to have obvious applications until you are adept at the programming art!

To make the whole business a bit less complicated I have decided to look only at the more basic modes. Such goodies as "indirect-indexed-addressing" (used by the 6502 microprocessor), can wait until later!

Immediate Addressing. This is easy, the data is stored immediately after the instruction itself. This mode is useful for loading constants.

Direct Addressing. Still easy, the data can be found at the address given after the instruction. For an eight-bit microprocessor direct addressing will usually mean a three-byte instruction, one opcode byte and two address bytes. Any address in memory can be specified, and this mode is ideal for access to variables. This mode is not available with the SC/MP chip.

Indirect Addressing. A bit tricky, the address following the instruction points to a location where the address of the data can be found. The location holding the data address can be in RAM or it can be an on-chip register. This mode is useful for stepping through tables of data in memory, and for "looking up" an entry in a table.

One particular variation on the indirect-addressing theme is that of indexing. In this case special registers called Index Registers are used to hold all or part of the data address, and microprocessors with these facilities are capable of very fast data transfers from one area of memory to another. The SC/MP pointer registers can be used for indexing if required.

Relative Addressing. This mode of addressing is used with transfer of control instructions only. The destination of a jump is specified as a displacement from the current program counter value. This is like the jumps we looked at earlier because what happens is that a displacement value (usually one byte) is added or subtracted from the current program counter-value. The resultant jump is therefore "forwards *n* bytes" or "backwards *n* bytes", rather than to an absolute address.

THAT'S IT

Well, that's all there is to it. All you have to do now is to put the theory into practice by writing some programs of your own. If you really *do* feel inclined to try it, there are a few practical hints on how to set about the job in last month's *Microprofile* feature.

To be continued

JACK PLUG & FAMILY...

BY DOUG BAKER

Simply ahead!

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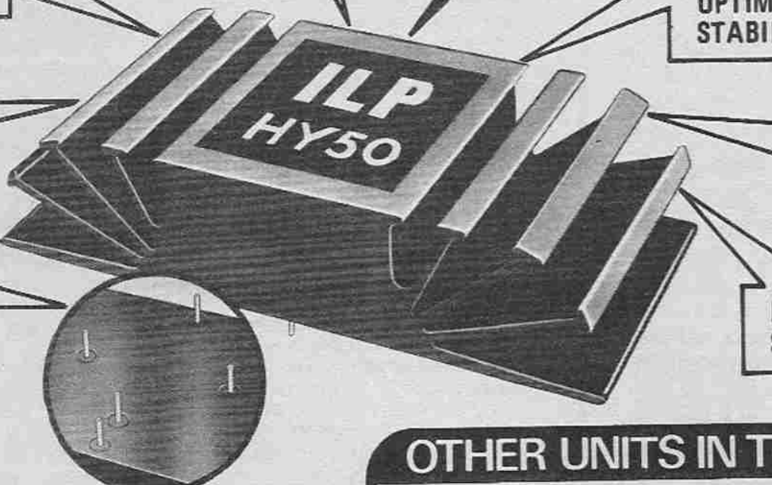

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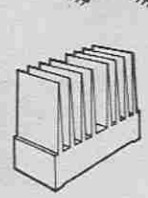

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RUMMAGING AROUND

with Keith Cadbury

MUCH has been written in this magazine and its contemporaries concerning the production of printed circuit boards. It occurs to me that the reason we so often read how easy it is to make our own "one-off" p.c.b.s, is that so many beginners are hesitant to try for themselves. Such was certainly true in my case: over a year elapsed before I ventured to make my first p.c.b. in spite of a well-known lack of reticence!

Those among us who have delayed attempting p.c.b.-making by reason of limitations imposed by a strict budget may find encouragement from various cost-cutting ruses that have helped me.

The basic "ingredients" you will need are: a method of laying an etch-resistant image on to the copper-clad board; etching solution a tray or dish to hold the board and solution; a suitable piece of copper-clad board and something to clean it with; and (for finally preparing the board when etching is complete) a method of drilling 1mm holes in the p.c.b.

Maybe I am biased, having been using Letraset-type of products for graphic design since the days when it involved a gauze frame and water, but I have found that the rub-down transfer method of producing an etch-resistant image by far the best.

A set of suitable transfers can be purchased for about £2, or an extra economy would be to purchase a sheet of various pads, corners, etc., plus a sheet of straight lines.

Graphic designers do not usually use a ball-pen to transfer the image, as a nylon or polythene rubbing-tool is available for a few pence from any decent art shop that stocks rub-down lettering. If you cannot locate such a device (and I do not know of any mail-order electronics supplier that offers it), then use a ball-pen as the only alternative. But to avoid getting the sheet in an awful mess, use an old pen that has run-out of ink.

You will of course have cleaned the copper side of the board thoroughly before laying the image—a sheet of fine abrasive paper, such as "flour-paper" is an easy way.

I have tried producing the circuit image completely freehand, with an etch-resistant pen, and also using rub-down pads and the pen for lines only. Neither to my mind was as satisfactory as the exclusive use of rub-down transfers—the pen lines may be a lot quicker to apply, but are never so clear-cut and well-defined, and I have found that the pen lines are inclined to spread just enough to make checking the finished boards of "tight" circuits a drudge.

Large areas of board that require to remain copper-clad can be covered with plastic tape.

If you are a photographer who makes his own photographic prints, you will own dishes suitable for holding the etching solution, if not, the cost of developing trays from a photographic shop will hasten the selection of an alternative.

A plastic carton from the freezer is ideal—failing which, treat the family to two litres of ice-cream, at a cost of about £1. If you are impatient to use the plastic carton and the family will not oblige by consuming vast amounts of the stuff immediately, I suppose you could transfer it to other suitable receptacles, like jam jars.

I have never attempted to mix etching fluid from anhydrous ferric chloride crystals and water, indeed, my local electronics shop does not stock it. The etching fluid available ready-mixed, in plastic bottles of about a half-pint has sufficed to date, and I hear from some other enthusiasts that mixing the crystals and water is a messy and time-consuming operation.

I have calculated that I etched about 200 square inches of board with one bottle of etching fluid, at which rate it is quite viable to forgo one's own mixing.

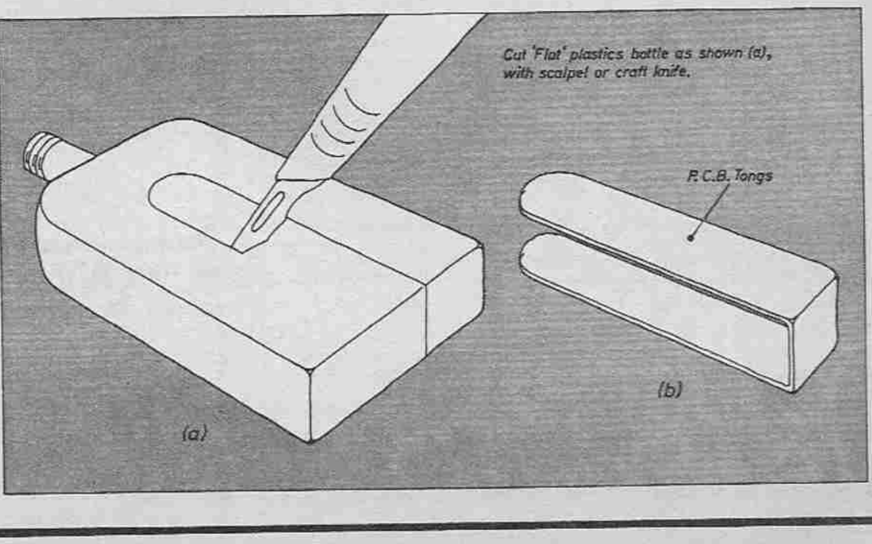
If you feel the need for tongs of some sort, to remove the p.c.b. from the fluid, do not of course use metal ones. Plastic tongs can be made by cutting a plastic bottle, of the type often used to hold indigestion preparations. *See diagram.*

The satisfaction derived from producing your own p.c.b.s, rather than buying a board from a manufacturer (in the case of a published project) is not the only reason for attempting your own etching. The board layout can easily be adapted from the drawings published, to use alternative components, or to incorporate additional circuits.

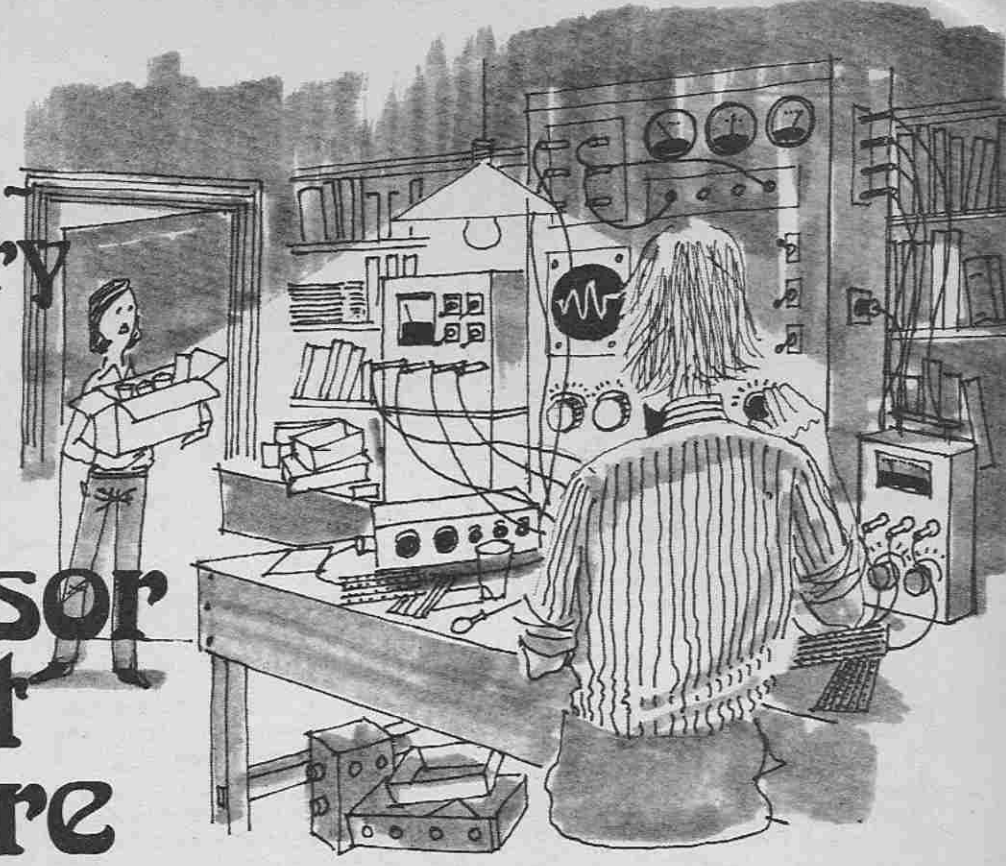
If your design doesn't work you have got a problem, but checking your diagram against the p.c.b. can be an absorbing past-time—it is when things go wrong that my young children learn new words with which to impress the vicar and his wife.

I have not yet found a make of rub-down lettering that is not etch-resistant, so for the cost of a suitable sheet of small lettering, you can also etch your initials, or a name or some other circuit recognition, to make the finished board more professional-looking.

It only remains to drill the p.c.b. before inserting the components, and if you have to date used a hand-drill, or the normal do-it-yourselfer's electric drill, next months RA could be written especially for you.



The Extra-ordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

BOB AND the Prof. have been discussing the various aspects of energy carrying beams. Just at that moment a warning bleep sounded inside the helmet of the Prof's. spacesuit, and a message appeared on a nearby computer viewscreen.

"Time to renew our life-support system, Bob, and as the display indicates that we are expecting visitors, perhaps we'd better take off the space suits and let the robots recharge them."

VISITORS

So it happened that the visitors, Tom and Maurice, were just in time to see Bob and the Prof. stepping out of the airlock of the vacuum chamber still dressed in their amazing space suits. The Prof's experimental robots helped them out of the suits, as Bob's friends Tom and Maurice watched astounded, the robots whisked the suits away for recharging.

"Prof.," whispered Tom, gradually recovering from his surprise, "were those real robots and real spacesuits, or were we dreaming?"

"They were real, Tom," the Prof. assured him, "Bob and I have just been doing some experiments with energy beams in a simulated space environment."

SPACE AGE ROCK

"That's great, Prof.," Maurice broke in, "Tom and I are forming a Space Age Rock Band and the members of the band want to dress up as robots and spacemen and to have all sorts of electronic equipment, amplifiers, sound effects, synthesisers, electronic drums and percussion."

"Yes!" said Tom, "a real show-band offering comprehensive entertainment with as many weird and unusual musical instruments and effects as possible, unusual lightshows, strange sounds, anything we can manage to get on stage, almost to give an image of modern and futuristic technology along with the basic instruments and equipment to produce good music!"

"Trouble is," said Maurice, "we've got much more enthusiasm than 'know how' and we're starting almost from scratch. Also as we'll be playing mainly for charities, with only a few paid bookings, we can't afford anything expensive. Some of our friends in more well-to-do bands have let us have their old equipment, but most of it is in need of repairs.

"We're hoping that your knowledge of real robots, spacesuits and gadgets can be brought to a more down-to-earth use and that you will be able to help us with some technical advice on equipment for the Band!"

"I see," said the Prof., "it seems that you would like me to advise and help you with almost all the technical aspects of the equipment of a band, right from the beginning! Rather interesting, as your band seems to have some special requirements."

WAH WAH

"I'm keen to help with this too," Bob remarked, "It will be good practice for me and I'd like to learn a lot more about Band equipment and electronics! By putting in some work on repairs, and construction of new equipment, I'll gain experience, and by saving the band some money, this will help the charities they work for!"

Maurice dug into his huge duffle-bag and brought out a variety of small items of band equipment, a fuzz box, wah wah, reverberation unit, microphones, and amplifier.

"Your duffle bag seems bottomless!" the Prof. was amazed at the quantity and variety of bits and pieces which Maurice was in the habit of carrying around.

"These are some of the things we got as the result of a charity appeal for the band. The reverberation unit doesn't work," Maurice held up the offending item, which rattled ominously.

"The wah wah works but it isn't very effective. The amplifier gets hot and stops working after a few minutes use."

"How does a wah wah work, Prof?" Bob asked.

"It is a selective audio filter which boosts a narrow band of audio frequencies at the expense of others. The boosted band of frequencies can be moved gradually from treble boost through mid-range boost to bass boost. This is usually done by moving a hinged foot control, but some wah wah units work automatically, sweeping up and down at a rate which can be determined by a speed control.

"Some others are triggered by the attack as each sting of a guitar is plucked, and automatically produce 'wah wah' effects in time with the player."

The Prof. picked up the wah wah which Maurice had brought. It was of the pedal variety and when he plugged it into the audio amplifier and fed white noise into the input of the wah wah, he noticed that when the pedal was moved, the effect on the sound from the speakers was not very great.

IMPROVED CIRCUIT

The Prof. opened up the wah wah unit and removed a 470 ohm resistor, which he replaced with a 470 ohm miniature preset resistor, as he adjusted this, the quality of the sound from the loudspeakers became altered dramatically, the effectiveness of the wah wah circuit improved greatly until a point was reached where a loud howl was heard from the speakers. The Prof. then adjusted the preset to a slightly higher resistance so that the oscillation howl was not produced at any position of the foot pedal.

However, as he moved the foot pedal, the effect on the sound was now very much greater than before.

"You've made the old wah wah sound better than a new one, Prof. with only a few minutes' work!" They were all delighted and very surprised.

The Prof. sketched out a circuit diagram, Fig. 1, and began to explain to Bob.

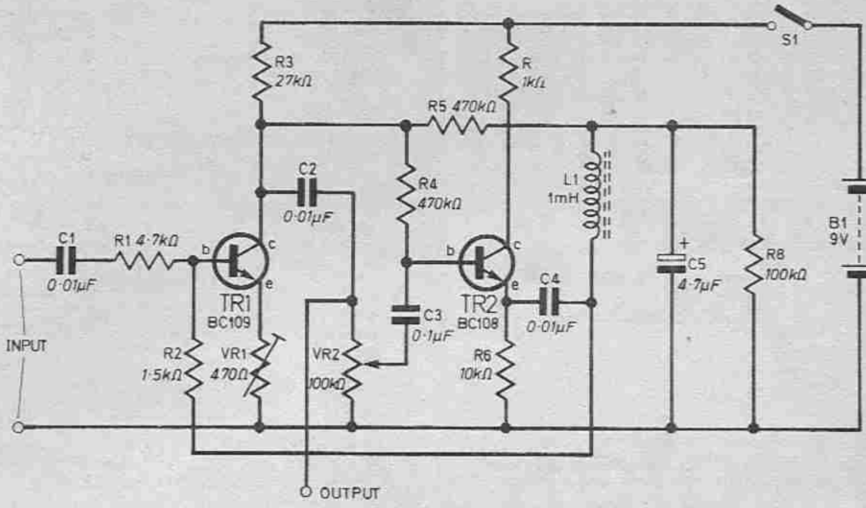


Fig. 1. The Prof's improved wah wah circuit.

"Here is a circuit which is used in most of the commercially produced wah wah units, and the alteration which I have just done can be used to improve almost any wah wah unit which has this type of circuit. The 470 ohm resistor in the emitter circuit of TR1 is used to define the sharpness of the filtering effect of the wah wah, so it has a critical effect on the circuit. By replacing it with a preset, the effectiveness of the wah wah can usually be greatly improved with no detrimental effects.

"However, if the resistance is decreased below a certain value, which is different for each individual circuit, oscillation begins at the filter frequency, which can be varied by means of the foot-controlled 100 kilohm potentiometer."

SPOOKY SOUNDS

The Prof. demonstrated. As he reduced the resistance of the 470 ohm preset, the circuit once more broke into a strange and eerie howling sound whose pitch varied in a striking manner as he manipulated the foot control.

"That's really spooky!" cried out Tom, "we could use that sound on stage, it would sound great through an echo chamber!"

"I think I'll fit an extra foot-switch to this wah wah," remarked Maurice, "then by pressing it we could 'short out' the 470 ohm preset and cause the wah wah to oscillate whenever we want. By playing an instrument through it whilst it is oscillating, we should hear some very strange and interesting sound-effects!"

To be continued

PLEASE TAKE NOTE

SHAVER INVERTER *(April 1979)*
Transformer T1 should be a 0-20V, 0-20V type, not as stated in the components list. The circuit is correct.

POCKET RADIO *(June 1979)*
Diodes D1 and D2, both in the circuit diagram and layout are shown incorrectly orientated. The cathode ends should be connected to the negative line.

LOW COST METAL LOCATOR *(June 1979)*
Resistor R5 has been omitted from the components list and should be 390 ohms.

Crossword No. 18—Solution

1D	A	2M	P	3I	N	G			4S	W	5I	T	6C	H
I		B		N					H		O		O	
7S	L	E	E	V	E		8P		A		N		D	
T				E		9L	O	A	D	L	I	N	E	
O		10S	O	R	R	O	W		O		S			
R		T		T		11W	E		W		E			12A
13T	R	A	N	S	F	E	R		14S	Y	S	15T	E	M
I		F				R		16M				A		P
17O	F	F	18S	E	19T		20A	I	S	21E	T	I	M	E
N			H		R		22O	N		L		L		R
			O		I		23B	O	R	E	R	S		E
	24D	I	R	E	C	T	O	R		C				H
	O		T		K		T		25S	T	E	26R	E	O
	D		E		L					R		A		U
27B	O	U	N	C	E			28C	H	O	P	P	E	R

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.

EX GPO TELEPHONES
Normal black desk instrument with dial and internal bell, latest type **£8·85** each, preceeding type **£4·05** each.

TELEPHONE SWITCHES
Desk mounting. These are the older, winking eye type almost becoming museum pieces. Prices depend on condition starting at **£15** +£1·20 plus carriage at cost.

BLOWER BARGAIN
Smith's Industries—mains operated blower/fan—a real air mover that takes up very little space as it's balanced four pole motor is let into the air turbulator—overall size approx 7" diameter by 2½" thick. Suitable for drying—blowing extraction, air circulating etc etc only **£4.**

THREE MORE TRANSFORMERS are added to our list this month. TM54 This is an upright mounting—varnish impregnated, it has a main secondary of 200v 500mA and another of 6·3v 1amp price **£4·50** +34p post **£1.**
TM55 Again upright mounting and impregnated, this one has two secondary windings both 12v 5amp so it can be used as 12v 10amp—24v 5amp or 12—0—12 @ 5amp, price **£4·95** +40p post **£1·25.**
TM56 One secondary of 4v 2½amp — this is quite a small transformer and could also be used as a 60—1 matching transformer for microphone etc. price **£1·50** +12p

TANGENTIAL BLOWER
Metal bladed Smiths made super silent unit with dozens of applications, cooker hoods—fume extractor—blower heater—fresh air impeller etc. Air outlet is rectangular size approx 10½" × 2½" **£3·95.**

WANT LOW VOLTAGE MAINS AND ISOLATION
A 10 watt **£2·10**, 38 watt at **£4.** Larger sizes on request.

MODEL MOTORS
We have at least 150,000 small battery operated motors in stock, mostly Japanese made and good quality, all will work on 3 volts upwards, some will work from single 1½ volts cell, some are very small and the smallest requires no on/off switch as it won't start until it is spun and when it stops it will get into a no current position if possible. The largest is powerful enough to operate a hand drill. We have a leaflet which briefly describes these but if you're contemplating making a toy or a novelty needing a motor then send **£2·50** for our assortment of 8 motors—find the right one for your project—we will supply this at a special quantity discount.

NOW SOME BIGGER 12 VOLT MOTORS

12v MOTOR BY CROUZET— a powerful motor virtually impossible to stop by hand, size approx 2½" long and 2½" dia, this is a permanent magnet field type so is reversible simply by changing polarity and has a relatively constant speed with or without load. Fitted with a splined shaft which could directly engage a toothed gear wheel or to which a pulley could be attached. Ideal for large models, or small machines etc. Price **£4·25.**

12 VOLT MOTOR BY SMITHS INDUSTRIAL
Made for use in cars these are series wound and become more powerful as load increases—they will in fact burn themselves out if over loaded to stopping point—reversible by rewiring. Being series wound they will also work off a.c. mains through a step down transformer and if you use a variable voltage type then the motor speed can be varied by the voltage.
Size approx 3½" long by 3" dia these have a good length of ¼" dia spindle—price **£3** + 24p. Ditto but double ended **£3·95.**

MAINS OPERATED LOW SPEED MOTORS
Type as fitted into time switches etc—we have a good selection and can offer the following final speeds:
1 r 24 hrs—1 r 8 hrs—1 r 4 h—1 r h—2 r h—er h—4 r h—12 r h—20 r h—30 r h—1 r min—2 r m—4 r m—8 r m—15 r m—25 r m—30 r m—200 r m, all at **£2·85** each.

SPIT MOTORS
These are powerful mains operated induction motors with gear box attached. Shaft is a ¼" rod with square hole, final speed is approx 5 revs per min, price **£5·25**—similar motor but with final speed 110 rpm **£5·15**, 80 rpm same price.

SUB MINI MICROPHONE
Size only ¼" × ⅜" × $\frac{3}{16}$" so small enough for a bugging device ex hearing aids but guaranteed. Price **£1·50.**

SUB MINI MICRO SWITCH
American make size approx ⅜" × ¼" × $\frac{3}{16}$" changeover contacts—three types in stock, button operated **35p**, lever **40p** + 3p.

MEDIUM AND LARGE MICRO SWITCHES
We have over 100,000 of them in stock at prices from 10p each—may we have your enquiries please with a sample if possible.

DP DT TOGGLE SWITCH
Normal size, normal fixing bright plated toggle and fixing nuts—by NSF. 3amp 250v price **49p** each. **£35** + **£2·40** per 100.

SP DT TOGGLE SWITCH
13amp at 250v—bakelite body flat toggle—bright plated fixing nut **33p. £22** per hundred.

WAVE CHANGE SWITCHES
We have mini types @ **40p** + 5p available in the following combinations 4 pole 3 way, 3 pole 4 way, 2 pole 6 way and 1 pole 12 way.

STANDARD TYPES
1½" wafer made to your specification at **£1** + 12p per wafer plus **50p** + 6p for clicker mechanism and spindle. Wafers stock are 1 pole 12 way, 1 pole 10 way, 2 pole 9 way, 2 pole 8 way, 2 pole 6 way, 3 pole 5 way, 4 pole 4 way, 6 pole 3 way, and 8 pole 2 way. We can stack up to 10 wafers so could make say 10 pole 12 way or 80 pole.

INSTRUMENT SWITCHES
These use a smaller moulded wafer size approx ⅞" dia—available in some combinations as standard switches price **£1·50** + 19p for each wafer and **75p** + 5p for clicker and spindle.

WALL MOUNTING THERMOSTAT
By Danfoss in a really pretty two tone grey case with scale and dial. Setting temperature from 0—30c—13amp 250v contacts. Price **£4·32.**

UP TO 5 MINUTE TIMER
Mains motorised, the dial of this is calibrated in 1/10th of a minute up to 5 minutes—slipping clutch motor takes preset time to travel to its stop, then it slips until switched off. Fitted micro switch operates at the stop. Micro switch could be used to make the timer repeat, switch off etc. American made—ex equipment—believed unused. Price **£3·25.**

MAINS STEPPER is a 24 way stud switch controlled by two solenoids. One ratchets the switch arm round one stud per impulse—the second solenoid returns the switch arm on a metal chassis size approx 4½" × 3" **£4·86.**

MINIATURE MAGNETIC CIRCUIT BREAKERS
will trip faster than a fuse can blow, use to control your service bench etc will save you the trouble of renewing fuses, or replace your fuse box with a line of these. Available as follows: 1amp—2amp—5amp—10amp—15amp—25amp. All same price **£2·25** each.

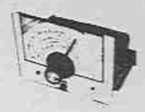
CASSETTE MECHANISMS
with record and playback heads, all electronics, switches and speakers. Price **£9·95** (Surely this must be the bargain of the year). Stereo with heads but not electronics **£14·95.**

JUNCTION BOXES
Ideal for ring main or lighting installations. Brown bakelite base and cover, **25p** each or box of 12 for **£2.**

24 HOUR TIMERS VENNER

As illustrated with sun correction made for G.P.O. phone boxes used perfect **£2·95.** 20 amp switching contacts.

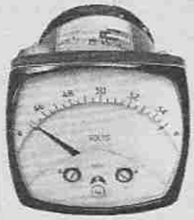
SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

12v SIREN/BLEEPER

Makes a sound very similar to the Black & Decker smoke alarm. 6-12ac or 12-14v 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.



ELECTRONIC VOLTMETER/ SENSITIVE RELAY

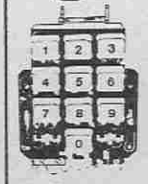
Consists of a large, extremely readable, 4½" square drop through panel volt meter, 0/0-1 fsd. Built into the front of the meter are two screw adjusters which move two separate pointers one red and one green, up and down the scale, the purpose being to set a minimum and maximum level so that when the 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.

BURGLAR ALARM ITEMS

(Circuit free on application)	
Trigger mats 24in × 18in	£2·45
13in × 10in	£1·95
Relay 24 volt	95p
9-12 volt	95p
Alarm Bell 24 volt	£7·50
9-12 volt	£2·25
Mains	on application
Reset, switch, ordinary	45p
Secret type with key	95p
Wire—100 metres	£1·50
24v Power unit mains operated	£5·35

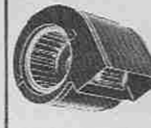
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45.**



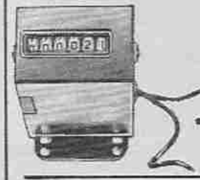
SWITCH PAD

Made for the GPO for incorporation, we understand, in push-button dialling units, this has the usual 10 digits, each of which when depressed operates a two pole switch. Really beautifully made, size approx 4" square. Price **£2·95.**



MAINS BLOWER

The Torrin—quiet but powerful outlet size 2½ × 1⅞ for cooling equipment etc. will extract if outlet is blowing outwards price **£5·50.**
Other models from £2·00.



6 DIGIT COUNTER

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

TERMS: Cash with order—but orders under **£6** must add **50p** to offset packing etc
BULK ENQUIRIES INVITED PHONE 01-688 1833
ACCESS & BARCLAYCARD ACCEPTED

J. BULL (ELECTRICAL) LTD
(Dept. E. E.), 103 TAMWORTH RD., CROYDON CR8 1SG

BUS BARS FOR PUSH ON TAGS Type 1
as used in cookers etc is a panel approx 3" × 2" with two hefty cable trap terminals, amrked N & L and bus bars will take 12 push on tags each—useful on work bench or would help in construction of most electrical heaters etc. Price **44p.** Type 2

CONNECTOR STRIPS
Normal 12 screw down in polythene base, 3-5 amp 10 for **£2**, 15amp 10 for **£3**, 25 amp 10 for **£4.**

NUMBERED CONNECTION STRIP
For 25amp cables this is very compact only 3½" long, ⅜" wide. The body is not polythene but a harder material probably nylon. The contacts are numbered 1-12, useful for intercom, and similar installations. Price 10 for **£4·50.**

PLUG-IN-ABLE CONNECTOR STRIP
Female usual screw downs on one side, but sprung holes on other. Male has screw downs one side and plugs on the other. The plugs are tightly gripped by the sprung holes. Female portion is available in strips of 3 connectors **16p** or 12 connectors **50p.** Male portion only in strips of 3 connectors price **25p.**

600 OHM WIRE WOUND RESISTOR
15 Watt type, 10 for **£1.**

SPRING FIXINGS FOR 15 WATT RESISTORS
Specially shaped spring clip pushes into resistor, 20 for **£1.**

FUSE HOLDERS
For 20mm fuse. Chassis mounting, polythene base with hole for fixing. Strips of 10. Price **54p.**

THYRISTOR TRIGGER MODULE
By Mullard their ref MY5001, brand new in maker's sealed packing. Price **£6·50.**

NOVEL 50Hz FREQUENCY CHECKER
for checking frequency of invertors etc, is a frequency controlled motor with reduction gear box—simply fit a cardboard disc to spindle, connect direct to the unknown supply—if 200-250v if not use a transformer—if the disc revolves at 16 r.p.m. then supply is correct frequency if less than 16 r.p.m. it is slow, if more then it is fast. Price **£1·50** + 12p.

SERVICEMAN'S LEAD ASSORTMENT
More and more appliances, we have tags and to quickly hook these up you need female ended leads: we offer an assortment of twenty leads ending with push on connectors, all for **£1·08** will save their cost in no time.

KETTLE LEAD AND PLUG
Fits all normal kettles: a robust plug with a good length of heavy duty three core lead. Price **85p**, 10 for **£8.**

HEAVY DUTY RELAY
With twin 20amp changeover contacts, coil voltage is 24 volts D.C. or 50 volts A.C. Four of these with coils in series could be used to switch lighting etc. Price **88p.**

MAINS OPERATED CONTACTOR
Beautifully made in West Germany, this has 3 poles switching on, and a fourth pole with changeover, all contacts look big enough for 10-15amps and the closing coil is mains operated. Normal bakelite upright mounting, size approx 3" × 2½" × 3⅜" high, Price **£4·50.**

6 VOLT RELAY
Standard open single screw fixing with 3 pairs 10amp C/O contacts. Price **£1·08.**

MAINS SOLENOID WATER VALVES
Made by Asco. Two models available both suitable for water and non corrosive liquids, both for normal mains operation. Ref V1 for ⅛" pipes and low pressure operation, V2 is for ¼" pipe and high pressure operation. Only **£4·32** either type.

MINIATURE 24 HOUR TIME SWITCHES
Superb piece of precision engineering: measures only 2" × 2" × 2". Standard mains operation, with provision for up to 36 independent on/offs, massive 16amp contacts enable many switching applications Brand new with one set of on/off triggers at **£7·25.** Additional on/off triggers **£1** a pair.

INTEL 4004
4 bit MPU, this is the forerunner of the 8008 MPU chip and is ideal for breadboarding etc. to control keyboards, CRT's, memories etc. etc. supplied with complete data showing 40+ instruction set and as there is a great amount of established software available this is a tremendous offer at only **£3·47** + 28p.

SPERRY-UNIVAC
Servo Driven Tape Cassette System. This superb unit consists of an attractive desk standing console with twin servo driven cassette drives and all TTL electronics. Facilities such as "block transfer" "data transfer" "electronic *LED* tape position locator" are inbuilt. No data is presently available for these units but they seem to be selling very fast. As we only have a few left we must restrict this snip to callers only. Price **£75.** Standard 240 volt operation.

SPERRY UNIVAC UNISCOPE 300
As described in our previous newsletter we still have a few left of these VDU, Keyboard, PSU controller systems available. They are not in as good a condition as previously mentioned, therefore warrant a reduced price of **£75** "as seen". Callers only.

TAPE READERS AND PUNCHES
The cheapest way of non volatile memory-programmes is via mag. tape or paper tape. We have a few Viatron tape decks, **£125** each also Burroughs high speed optical tape readers **£50** and High speed tape punches **£45.** Still avilable 8 bit NCR tape punch at **£18·50.**

RACAL C10 SUPERGRADE CASSETTES
Supergrade 10 minute cassettes complete with library cases, top quality made for data storage, 2 for **£1**, 10 for **£4·50.** Self adhesive die cut labels 20 for **£1.**

VERBATIM MINI DISCS
Soft Sectored, ideal for Tandy TRS 80 Disc System etc. **£3·50** each or 10 for **£35.** FREE LIBRARY CASE INCLUDED ON PURCHASE OF 10.

PHILIPS 9 TRACK DIGITAL TAPEDECKS
Just arrived for personal callers are these small 9 track tape decks, measuring only 15" × 12" × 12" they are complete with all T.T.L. controllers and P.S.U. 110 volt operation, auto transformers available **£95** each.

PHILIPS QWERTY KEYBOARDS
Uncoded keyboards with standard typewriter keyboard, mounted on PCB, complete with cover and inbuilt 8 bit optical tape reader **£25·00.**

MINIATURE UNISELECTOR
12 pole 8 way, this has 4 wiper arms coming out so it could be used for continuous motoring, the speed of which can be varied by using our time delay module and a pot. Made for the GPO, these are new and unused, very compact all the connections coming out of the bottom. Thousands of switching combinations are possible . Price **£8·50.**

IMPULSE CLOCKS
10" dia, white face and a large clear hands. Require two impulses per min to give correct time but they are also useful educationally as they can be set to any time very quickly. Really beautiful clock, price only **£6·50.**

REGULATED POWER SUPPLIES
Precision built on stout metal chassis using only top class components, normal mains input. Six different models are available. Simply order by output specification.

100v—225mA
150v—200mA
200v—200mA
175v+225v—150mA
225v+275v—150mA

all **£13·00** each.

GMT ELECTRONICS

(A DIVISION OF GOTHIC ELECTRONIC COMPONENTS LTD)
PO Box 290
8 Hampton Street
Birmingham B19 3JR

TELEPHONE: 021·233·2400

CALLERS BY APPOINTMENT

ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

CAPACITORS

Electrolytic Axial Leads — Order Code Cap 015 + µF + V d.c.
−10% to +50% Tol

µF	V d.c.	16	25	40	63
1.0					8
1.5					8
2.2					8
3.3					8
4.7					8
6.8				8	9
10			7		9
15		7		8	10
22			7		12
33		7		8	
47			7	10	12
68		8			
100			8	12	
150		8	9		29
220		12		24	34
330				28	37
470			21	30	44
680		19	28	38	50
1000		23	28	55	
1500		32	36		
2200		39			

Tantalum Bead — Order Code Cap PR + µF + Volts
·20% Tol.

µF	V d.c.	3.15	6.3	10	16	25	35
0.1							9
0.15							9
0.22							9
0.33							9
0.47							9
0.68							9
1							9
1.5							10
2.2					9		11
3.3					9	11	14
4.7					10	14	15
6.8			9		11	15	16
10			10	11	14	16	20
15			11	14	15	20	
22		11	14		16		
33			15	16	20		
47			16	20			
68		16	20				
100		20					

Electrolytic Can Type — Order Code Cap HR + µF + Volts
High Ripple, IEC Grade 1, Low E.S.R.
Supplied complete with Vertical Fixing Clip

µF	V	Ripple 1A @ 85°C	1.4A @ 50°C	
2200µF	16V			166
4700µF	16V	2.6A	3.6A	184
10000µF	16V	5.8A	8.1A	222
22000µF	16V	9.8A	13.7A	346
2200µF	25V	1.3A	1.8A	175
4700µF	25V	4.6A	6.4A	201
10000µF	25V	8.0A	11.2A	264
22000µF	25V	12.8A	17.9A	438
1000µF	40V	0.9A	1.2A	168
2200µF	40V	2.4A	3.3A	188
4700µF	40V	5.6A	7.8A	231
10000µF	40V	9.2A	12.8A	367
1000µF	70V	1.8A	2.5A	190
2200µF	70V	4.0A	5.6A	235
4700µF	70V	7.5A	10.5A	376
1000µF	100V	4.0A	5.6A	222
2200µF	100V	7.8A	10.9A	346

Electrolytic Radial Leads — Order Code Cap 034 + µF + Volts
−10% to +50% Tol.

µF	V d.c.	6.3	10	16	25	35	40	50	63
.47									6
.68									6
1.0									6
1.5									6
2.2									6
3.3									6
4.7							6		7
6.8					6			7	8
10				6			7		8
15				6	7			8	10
22			6	7			8	10	
33				7	8		10		
47			7	8		10			
68				8	10				
100			8	10					
150			10						
220		10							

Trimmers

250V D.C. Wkg. Film Dielectric, Miniature

		Order Code
1.4 – 4.1pF	19	Cap 808 A
2 – 8pF	19	Cap 808 B
2 – 20pF	21	Cap 808 C
5.5 – 59.5pF	29	Cap 808 D

500V D.C. Wkg. C004 EA Tubular Type

		Order Code
.8 – 3.8pF	46	Cap 802 3
.8 – 6.8pF	48	Cap 802 6
1 – 13pF	61	Cap 802 12
1.7 – 19.7	62	Cap 802 18

Miniature Low Value — Order Code

Polystyrene, Axial, ±1% Tol., ≥ 63V D.C. Wkg — Cap 424
Ceramic Plate, Radial, Low K, 1.8pF–8.2pF ±.25pF Tol, 10-330pF ±2% Tol, 100V D.C. Wkg — Cap 632
Ceramic Plate, Radial, Med K, ±10% Tol, 100V D.C. Wkg — Cap 630
Ceramic Plate, Radial, High K, −20% to +80% Tol, 63V D.C. Wkg — Cap 629
+ Value

pF	424	632	630	629
1				
1.2				
1.5				
1.8		6		
2.2		5		
2.7		5		
3.3		5		
3.9		5		
4.7		5		
5.6		5		
6.8		5		
8.2		5		
10		5		
12		5		
15		5		
18		5		
22		5		
27		5		
33		5		
39		5		
47		5		
56		6		
68		6		
82		6		

pF	424	632	630	629
100	16	6		
120	16	8		
150	16	8		
180	16	6		
220	16	6		
270	18	8		
330	18	8		
390	18		5	
470	18		5	
560	16		5	
680	16		5	
820	16		5	
1000	18		5	5
1200	16		5	
1500	18		6	
1800	18		6	
2200	18		6	6
2700	18		6	
3300	18		6	
3900	18		6	
4700	23		7	6
5600	23			
6800	23			
8200	23			

nF	424	632	630	629
10	25			6
12	26			
15	26			
18	27			
22	28			6
27	38			
33	41			
39	43			

Polyester Radial Leads — Order Code

Dipped Type, ±20% Tol, > 250V D.C. Wkg. C280/352 Style — Cap 352
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 10.2mm Pitch Centres — Cap 360
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 7.6mm Pitch Centres — Cap PHE280
+ Value

µF	352	360	PHE280
.001		5	6
.0015		5	6
.0022	5	6	7
.0033	5	6	7
.0047	5	6	7
.0068	5	6	7
.01	5	6	7
.015	5	7	8
.022	5	7	8
.033	5	7	8
.047	5	7	8
.068	6	8	9

µF	352	360	PHE280
.1	6	8	9
.15	7	9	
.22	8	10	
.33	10		
.47	12		
.68	15		
1.0	19		
1.5	27		
2.2	32		

CASES

Small Desk Console — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	186	Case BIM1005 OR
W215, D130, H47 (73)	268	Case BIM1006 OR

Plastic Boxes — Boss Industrial Mouldings
Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	87	Case BIM2003 OR
L150 W80 D50	115	Case BIM2005 OR
L190 W110 D60	195	Case BIM2006 OR

Instrument Case — Boss Industrial Mouldings
Covers Manufactured from 14SWG Aluminium
Chassis Manufactured from 18SWG Mild Steel
Covers Finished Orange
Chassis Finished Matt Black

		Order Code
W250 D167.5 H 68.5 (Chassis 153mm Deep)	1480	Case BIM3000 OR

Plastic Boxes with Metal Lids — Boss Industrial Mouldings
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	97	Case BIM4003 OR
L111 W71 D42	130	Case BIM4004 OR
L161 W96 D53	182	Case BIM4005 OR

Diecast Boxes — Boss Industrial Mouldings
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Orrler Code
L113 W63 D31	104	Case BIM5003 NA
L152 W82 D50	181	Case BIM5005 NA
L192 W113 D61	290	Case BIM5006 NA

VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	59	VERO 21069J
3.75" x 5" .1" pitch Veroboard	66	VERO 21072D
2.5" x 1" .1" pitch Veroboard (5)	70/Pack	VERO 21076C
3.75" x 5" .1" pitch Plain Board	56	VERO 21078E
5.82" x 2.9" .1" pitch V-Q DIP Board	111	VERO 21084E
Spot Face Cutter	89	VERO 21013A
Pin Insertion Tool for .040 type pin	122	VERO 21015F
DS Pins .040 (100)	38/Pack	VERO 21087G
SS Pins .040 (100)	38/Pack	VERO 21017B
6mm Board Standoff (100)	181/Pack	VERO 21321K
15mm Board Standoff (100)	215/Pack	VERO 21322G
19mm Board Standoff (100)	226/Pack	VERO 21323D
Verowire Kit (1-pen, 2-wire, 25-comb)	375/Kit	VERO 21341D
Verowire Combs (100)	407/Pack	VERO 21339F
Verowire Wire (4)	228/Pack	VERO 21340G
Flip Top Box, Small, Black	192	VERO 21317D
Flip Top Box, Large, Black	250	VERO 21319J

Small Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	206	Case BIM6005 OR
W170 D143 H32 (56)	271	Case BIM6006 OR
W170 D214 H32 (82)	375	Case BIM6007 OR

All Metal Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
Two Piece All Aluminium Construction
Ventilation Slots In Rear and Base
Choice of 15° or 30° Sloping Front
Off White Top Panel, Blue Base

		Order Code
W102 D140 H28 (51) 15° slope	1018	Case BIM7151A
W165 D211 H33 (76) 15° slope	1350	Case BIM7154A
W254 D267 H33 (76) 15° slope	1572	Case BIM7156A
W356 D267 H33 (76) 15° slope	1823	Case BIM7158A
W102 D140 H28 (76) 30° slope	1018	Case BIM7301A
W165 D183 H28 (102) 30° slope	1202	Case BIM7303A
W254 D259 H28 (102) 30° slope	1572	Case BIM7306A
W356 D259 H28 (102) 30° slope	1823	Case BIM7308A

Eurocard Size Desk Console — Boss Industrial Mouldings
Slope Front Console
ABS Case, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel, Finished Grey

		Order Code
W169 D127 H45 (70)	375	Case BIM8006 OR

HARDWARE

D.I.L. Sockets

		Order Code
8 Pin Low Profile Socket Tin	11	DIL SKT 8
14 Pin Low Profile Socket Tin	13	DIL SKT 14
16 Pin Low Profile Socket Tin	14	DIL SKT 16
24 Pin Low Profile Socket Gold	66	DIL SKT 24
28 Pin Low Profile Socket Gold	78	DIL SKT 28
40 Pin Low Profile Socket Gold	127	DIL SKT 40

Heatsinks

Individual Type for 1 x T05 50°C/W	10	Sink 5F
Individual Type for 1 x T066 10.5°C/W	26	Sink TV2
Individual Type for 1 x T03 7.2°C/W	24	Sink TV3
Individual Type for 1 x T0126 17°C/W	23	Sink TV4
Individual Type for 1 x T0220 17°C/W	23	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	92	Pen 33PC

Fuseholders

Suit 20mm x 5mm fuses.

P.C.B. Mounting, Open Type	8	Fuse/H20B
Chassis Mounting, Open Type	17	Fuse/H20C
Panel Mounting, Screwdriver Slot	77	Fuse/H20PT
Panel Mounting, Finger Release	56	Fuse/H20P

Fuses

20mm x 5mm Glass.

Quick Blow, Range 100mA–5A	8	Fuse 20
Slow Blow, Range 250mA–5A	22	A/S Fuse 20
		+ Rating

Lampholders, Panel Mounting

Similar in Style to Fuse/H 20P
Low Voltage Type Suits LES and M/F Bulbs.

Low Voltage, Red, Amber or Green	75	Lamp LV
Internal Neon 200/240V Red or Amber	95	Lamp N
		+ Colour

Bulbs, Low Voltage, L.E.S.

6V, 0.36W; 6.5V, 1W; 14V, 0.75W.	22	Bulb LES
		+ Voltage

RESISTORS

Carbon Film, Fixed

				Order Code
0.25W, E24 Values 1R0-10M, 5% Tol.	1.5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	2 ea.	1.25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD½
				+ Value

Metal Film, Fixed

0.5W, E24 Values, 5R1-1M, 2% Tol.	6 ea.	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	Res MR30
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.90/100 (Mult 10/Value)		Res PR52
				+ Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)	Res VR37 + Value

Skeleton Presets, Miniature

		Order Code
0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	7	Min Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mounting	7	Min Preset H
		+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10	Std Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10	Std Preset H
		+ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	34	Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	34	Pot Log
		+ Value

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GMT ELECTRONICS Freepost Birmingham B19 1BR

DIGITAL INTEGRATED CIRCUITS

4000 Buffered C-MOS – High Speed

5–15V 'B' Series, Up to 20MHz

HEF4000	14	HEF4046	100	HEF4514	250
HEF4001	14	HEF4047	87	HEF4515	299
HEF4002	14	HEF4049	28	HEF4516	90
HEF4006	95	HEF4050	28	HEF4517	382
HEF4007	14	HEF4051	69	HEF4518	69
HEF4008	80	HEF4052	72	HEF4519	55
HEF4011	14	HEF4053	72	HEF4520	65
HEF4012	14	HEF4066	37	HEF4521	188
HEF4013	32	HEF4067	390	HEF4528	99
HEF4014	84	HEF4068	14	HEF4532	120
HEF4015	60	HEF4069	14	HEF4534	510
HEF4016	35	HEF4070	14	HEF4539	110
HEF4017	55	HEF4071	14	HEF4543	155
HEF4018	65	HEF4072	16	HEF4555	78
HEF4019	46	HEF4073	16	HEF4556	78
HEF4020	88	HEF4075	16	HEF4557	386
HEF4021	85	HEF4076	85	HEF4585	97
HEF4022	82	HEF4077	14	HEF4724	171
HEF4023	14	HEF4078	16	HEF40097	90
HEF4024	45	HEF4081	16	HEF40098	73
HEF4025	14	HEF4082	16	HEF40106	62
HEF4027	32	HEF4085	64	HEF40160	119
HEF4028	52	HEF4086	64	HEF40161	119
HEF4029	80	HEF4093	50	HEF40162	119
HEF4030	48	HEF4094	175	HEF40163	119
HEF4031	200	HEF4104	166	HEF40174	119
HEF4035	110	HEF4502	91	HEF40175	119
HEF4040	88	HEF4505	571	HEF40192	140
HEF4041	75	HEF4508	151	HEF40193	140
HEF4042	54	HEF4510	70	HEF40194	119
HEF4043	79	HEF4511	110	HEF40195	117
HEF4044	84	HEF4512	98		

7400 T.T.L.

N7400N	9	N7444N	83	N74122N	39	N74190N	60
N7401N	11	N7445N	65	N74123N	37	N74194N	80
N7402N	11	N7446AN	62	N74125N	32	N74195N	79
N7403N	11	N7447AN	51	N74126N	32	N74198N	120
N7404N	12	N7448AN	44	N74128N	74	N74199N	139
N7405N	12	N7450N	13	N74132N	46	N74221N	160
N7406N	25	N7451N	13	N74145N	60	N74279N	116
N7407N	27	N7453N	15	N74147N	125	N74298N	200
N7408N	13	N7454N	13	N74148N	83	N74365N	150
N7409N	13	N7460N	13	N74150N	65	N74366N	150
N7410N	11	N7470N	26	N74151N	46	N74367N	120
N7411N	16	N7472N	22	N74153N	55	N74368N	150
N7412N	17	N7473N	23	N74154N	96		
N7413N	23	N7474N	23	N74155N	53		
N7414N	46	N7475N	28	N74156N	48	**74LS**	
N7416N	22	N7476N	26	N74157N	49	N74LS00N	15
N7417N	23	N7480N	43	N74158N	54	N74LS01N	16
N7420N	11	N7483N	63	N74160N	74	N74LS02N	16
N7421N	26	N7485N	65	N74161N	74	N74LS03N	16
N7425N	27	N7486N	23	N74162N	74	N74LS04N	16
N7426N	22	N7490N	30	N74163N	74	N74LS05N	23
N7427N	22	N7491AN	60	N74164N	65	N74LS08N	16
N7428N	30	N7492N	33	N74165N	65	N74LS09N	22
N7430N	11	N7493N	31	N74166N	93	N74LS10N	16
N7432N	21	N7494N	74	N74170N	134	N74LS11N	22
N7433N	30	N7495AN	48	N74173N	111	N74LS12N	23
N7437N	21	N7496N	46	N74174N	63	N74LS13N	38
N7438N	21	N74100N	88	N74175N	62	N74LS14N	74
N7439N	60	N74107N	25	N74180N	80	N74LS15N	24
N7440N	12	N74109N	42	N74181N	165	N74LS20N	16
N7442N	40	N74116N	148	N74182N	69	N74LS21N	22
N7443N	79	N74121N	23	N74192N	65	N74LS22N	24

N74LS28N	32	N74LS138N	85	N74LS253N	105
N74LS30N	16	N74LS139N	85	N74LS257N	104
N74LS32N	24	N74LS153N	76	N74LS258N	107
N74LS33N	32	N74LS154N	122	N74LS260N	26
N74LS37N	24	N74LS155N	80	N74LS261N	300
N74LS38N	24	N74LS156N	80	N74LS266N	40
N74LS40N	22	N74LS157N	54	N74LS273N	130
N74LS42N	53	N74LS158N	60	N74LS283N	116
N74LS51N	22	N74LS160N	120	N74LS290N	90
N74LS54N	16	N74LS161N	78	N74LS293N	100
N74LS55N	22	N74LS162N	130	N74LS298N	100
N74LS73N	29	N74LS163N	78	N74LS324N	170
N74LS75N	40	N74LS164N	90	N74LS365N	105
N74LS76N	33	N74LS170N	200	N74LS366N	105
N74LS78N	33	N74LS173N	100	N74LS367N	105
N74LS83AN	97	N74LS174N	100	N74LS368N	105
N74LS85N	70	N74LS175N	100	N74LS373N	150
N74LS86N	33	N74LS181N	320	N74LS374N	150
N74LS90N	45	N74LS190N	91	N74LS375N	100
N74LS92N	70	N74LS191N	95	N74LS378N	160
N74LS93N	45	N74LS192N	128	N74LS386N	35
N74LS95BN	65	N74LS193N	130	N74LS390N	170
N74LS96N	116	N74LS194N	150	N74LS393N	170
N74LS107N	38	N74LS195AN	120	N74LS395N	180
N74LS109N	38	N74LS196N	80	N74LS490N	130
N74LS112N	40	N74LS197N	110	N74LS670N	170
N74LS113N	38	N74LS240N	160		
N74LS114N	38	N74LS241N	160		
N74LS125N	40	N74LS242N	160		
N74LS126N	40	N74LS243N	160		
N74LS132N	60	N74LS244N	160		
N74LS136N	37	N74LS251N	90		

LINEAR INTEGRATED CIRCUITS

CA3011	92	NE592K	162
CA3018	75	RC4136	130
CA3020	191	TBA120S	79
CA3028A	86	TCA580	346
CA3046	76	TCA730	450
CA3048	245	TCA740	450
CA3080E	70	TDA1008	326
CA3089E	253	TDA1022	648
CA3130E	90	TDA1028	338
CA3140E	38	TDA1029	338
CA3189E	266	TDA1034B	217
LM301AN	30	TDA2581	266
LM308N	95	TDA2640	292
LM318N	200	TL081CP	76
LM319N	216	TL084CN	140
LM324N	70	UA709CT	46
LM339N	71	UA709CN	40
LM381N	110	UA710CN	41
LM381AN	180	UA711CN	65
LM382	120	UA741CT	47
		UA741CN	18
		UA747CN	50
		UA748CN	35
MC1458N	35		
MC1496N	97	**Voltage Regulators**	
NE531	119	LM309DA (K)	108
NE536T	216	UA723CN	38
NE540	225	UA7805CU	65
NE555N	25	UA7812CU	65
NE556N	60	UA7815CU	65
NE560N	351	UA7905CU	86
NE561N	427	UA7912CU	86
NE562N	461	UA7915CU	86
NE565N	120	UA78L05CS	32
NE566N	155	UA78L06CS	32
NE567N	170	UA78L12CS	32
NE570N	405	UA78L15CS	32
NE571N	459		

OPTO ELECTRONICS

			Order Code
Light Emitting Diodes, Individual			
.125" (3mm)	Red	14	CQY54
	Green	17	CQY95
	Yellow	19	CQY97
Panel Mounting Clip to suit.		3	LED3 Clip
.2" (5mm)	Red	15	CQY24A
	Green	17	CQY94
	Yellow	19	CQY96
Panel Mounting Clip to suit.		5	LED5 Clip
Light Emitting Diodes – 7 Segment Display			
.3" (7.6mm)	C. Anode R.H. Decimal Pt. Red	160	XAN3061
	C. Anode R.H. Decimal Pt. Green	199	XAN3051
	C. Cathode R.H. Decimal Pt. Red, Low current drain	160	XAN3074
.6" (15.2mm)	C. Anode L.H. Decimal Pt. Red	230	XAN6620
	C. Anode L.H. Decimal Pt. Green	230	XAN6520
	C. Cathode L.H. Decimal Pt. Red	230	XAN6640
Photoresistors			
ORP12		90	ORP12
ORP61		90	ORP61
Phototransistors			
OCP71		180	OCP71
BPX25		175	BPX25
BPX29		175	BPX29
Photocoupler			
FCD820		150	FCD820

SWITCHES

				Order Code
Miniature Toggle – Honeywell				
SPDT		2A/250V A.C., 5A/28V D.C.	58	SW BA1011
SPDT	C/Off		67	SW BA1021
SPDT	Double Bias To Centre		76	SW BA1041
SPDT	Single Bias To Centre		75	SW BA1051
SPDT	Bias		70	SW BA1061
DPDT			86	SW BA2011
DPDT	C/Off		92	SW BA2021
DPDT	Double Bias To Centre		102	SW BA2041
DPDT	Single Bias To Centre		102	SW BA2051
DPDT	Bias		96	SW BA2061
Miniature Push – C & K				
SP	Push To Make, Momentary	0.5A/250V A.C., 1A/28V D.C.	54	SW 8531
SP	Push To Break, Momentary		54	SW 8533
Slide – Switchcraft				
DPDT	Standard Actuator		36	SW 46206
DPDT	Slot Actuator, Voltage Change, Marked 110/240		43	SW 46206F

SEMICONDUCTORS

Diodes

IN827	193	IN4006	7	BB110G	61	OA202	9
IN914	4	IN4007	8	BY127	15		
IN916	5	IN4148	3	BY206	34		
IN4001	4	IN5402	15	BY110	19	**Microwave**	
IN4002	4	IN5404	16	OA47	10		
IN4003	6	BAX13	5	OA90	7	BAW95D	1091
IN4004	6	BAY38	27	OA91	7	CL8960	2592
IN4005	7	BB106(4)	122	OA200	9	CXY11C	1280

Zener Diodes

400mW C4V7-C33 BZY88/BZX79 + Voltage 8 — 1.3W C7V5-C75 BZX61 + Voltage 16

Transistors

2N929	37	2N4427	206	BC478	24	BSX88	18
2N1893	30	2N4856	158	BC547	12	MJE340	48
2N2218A	28	2N4858	134	BC548	10	MPF102	32
2N2222	21	2N4860	122	BC548B	15	OC28	107
2N2369	19	2N5294	43	BC549	12	OC35	95
2N2369A	20	2N5416	108	BC549B	20	OC45	82
2N2646	42	2N5457	35	BC557	14	OCP71	180
2N2894	49	2N5458	30	BC558	14	TIP29A	41
2N2895	28	2N5459	32	BC559	17	TIP29C	53
2N2904	24	2N6258	432	BCY34	97	TIP30A	44
2N2904A	24	40673	80	BCY70	14	TIP30C	57
2N2905	22	AC188	22	BCY71	14	TIP31A	43
2N2905A	24	AD161	38	BCY72	15	TIP31C	58
2N2906	19	AD162	38	BD131	35	TIP32A	49
2N2907	22	BC107	10	BD132	35	TIP32C	63
2N2907A	25	BC107B	14	BD135	38	TIP41A	59
2N2918	330	BC108	10	BD136	37	TIP41C	69
2N2926G	11	BC108B	14	BD137	38	TIP42A	59
2N3053	17	BC108C	16	BD138	39	TIP42C	69
2N3054	50	BC109	10	BD139	35	TIP2955	68
		BC109B	17	BD140	35	TIP3055	54
2N3055	50	BC109C	18	BF115	28	TIS43	32
2N3055 Full ISB Test	86	BC147	7	BF180	37	ZTX109C	14
2N3340	30	BC148	8	BF181	37		
2N3442	141	BC149	8	BF257	35		
2N3702	8	BC157	10	BF258	32		
2N3703	11	BC158	9	BF259	36		
2N3704	8	BC159	11	BFR90	303		
2N3705	9	BC177	15	BFS21	428		
2N3706	9	BC178	15	BFX13	23		
2N3707	9	BC179	18	BFX84	26		
2N3708	9	BC182	10	BFX85	26		
2N3709	11	BC182L	11	BFX86	30		
2N3773	270	BC183	10	BFX87	22		
2N3819	20	BC183L	11	BFX88	26		
2N3820	39	BC184	10	BFY50	15		
2N3866	97	BC184L	11	BFY51	15		
2N3900	20	BC212	10	BFY52	18		
2N3904	8	BC212L	11	BFY90	97		
2N3905	12	BC213	10	BLX65	238		
2N3906	12	BC213L	11	BLY35	1889		
2N3962	95	BC214	10	BLY93A	2706		
2N4347	227	BC214L	11	BPX25	175		
2N4401	20	BC327	17	BPX29	175		
2N4403	20	BC328	15	BRY39	45		
2N4416	86	BC337	16	BSW69	33		
		BC338	14	BSX20	19		

SEMICONDUCTORS

Rectifier Bridges		Order Code
1A 400V S.I.L.	93	BY179
1.4A 60V S.I.L.	84	BY164
1.5A 100V D.I.L.	33	VM18
1.5A 400V D.I.L.	39	VM48
1.5A 100V	45	W01
1.5A 400V	52	W04
2A 100V	89	VS148
2A 400V	109	VS448
6A 100V	143	VH148
6A 400V	183	VH448
10A 100V	172	VJ148
10A 400V	201	VJ448
15A 100V	215	VL148
15A 400V	226	VL448
30A 100V	242	VK148
30A 400V	260	VK448
S.C.R.'s		
4A 400V	54	C106D
12A 400V	108	TIC126D
Triacs		
10A 500V	124	BT138-500
15A 500V	177	BT139-500
23A 500V	492	BTW41-500

MAINS TRANSFORMERS

Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA – Clamp Type Construction
Approx. 18% Regulation. F.C. 54, H36, W35

		Order Code	
0-4.5V, 0-4.5V Secondaries	220	Trans 6VA	45
0-6V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200

20VA – Clamp Type Construction
Approx. 16% Regulation F.C. 70, H48, W46

		Order Code	
0-4.5V, 0-4.5V Secondaries	335	Trans 20VA	45
0-6V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-17.5V, 0-17.5V			175
0-20V, 0-20V			200

55VA – Clamp Type Construction
Approx. 10% Regulation F.C. 92, H64, W57

		Order Code	
0-6V, 0-6V Secondaries	540	Trans 55VA	60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200
0-30V, 0-30V			300

100VA – Frame Type Construction
Approx. 6% Regulation H87, W74, D64

		Order Code	
0-25V, 0-25V Secondaries	825	Trans 100VA	250
0-40V, 0-40V			400

COMMUNICATIONS INTEGRATED CIRCUITS – PLESSEY

SL360C	242	SL641C	384										
SL362C	302	SL650C	855										
SL610	230	SL651C	786										
SL611C	230	SL652C	329										
SL612C	230	SL680C	230										
SL613C	394	SL701C	220										
SL620C	347												
SL621C	347	SL1610C	166	SL1623C	251	SL1680C	170	SP8629	446	SP8690	907		
SL622C	854	SL1611C	166	SL1625C	225	SL6600C	890	SP8630B	1361	SP8760B	680		
SL623C	629	SL1612C	166	SL1626C	251	SL6640C	401	SP8655B	1058	SP8790B	454		
SL624C	321	SL1613C	193	SL1630C	166	SL6650C	378	SP8657B	1058	SP8794B	454		
SL630C	218	SL1620C	225	SL1640C	193			SP8659B	907				
SL640C	384	SL1621C	225	SL1641C	193			SP8660B	907				

TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK

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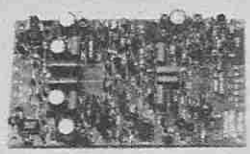
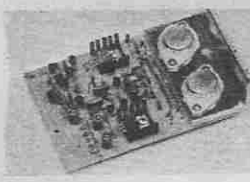
STEREO PRE-AMPLIFIER



CPR

POWER AMPLIFIER



CPR 1—THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3·5mV; distortion < 005% at 30dB overload 20kHz.
Following this stage is the flat gain/balance stage to bring tape, tuner, etc., up to power amp. signal levels. Signal to noise ration 85db; slew-rate 3V/uS; T.H.D. 20Hz—20kHz < ·008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138 × 80 × 20mm. Supply to be ±15 volts.

MC 1—PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3·5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

REG 1—POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

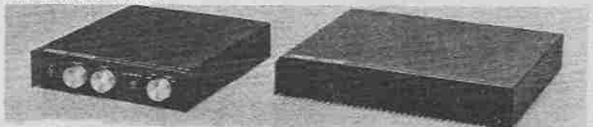
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc., who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically 01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, —8dB; stability unconditional; protection—drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 × 80 × 25mm.

POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120—240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.



PRE-AMPLIFIER KIT

This includes all metalwork, pots, knobs, etc., to make a complete pre-amp with the CPR 1(S) module and the MC 1(S) if required.

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CE 1008 100W/8 ohms 45-0-45v £24·38
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POWER AMP KIT ...... £32·90

PRE-AMPS:
These are available in two versions—one uses standard components, and the other (the S) uses MO resistors where necessary and tantalum capacitors.
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CPRIS .... £39·98
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MCIS...... £32·44
Pre-amp kit £37·24

POWER SUPPLY
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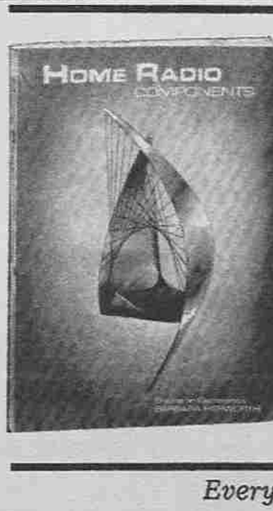

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KTW62	1·97
KTW63	1·97
MU14	1·13

N78	10·13
OA2	2·16
OB2	1·35
OC3	2·07
OD3	2·07
OZ4	1·80
PC86	1·58
PC88	1·58
PC97	1·35
PC900	1·35
PCC84	1·13
PCC88	1·35
PCC89	1·53
PCC189	1·58
PCF80	1·13
PCF82	1·13
PCF86	1·80
PCF87	1·80
PCF200	2·77
PCF201	2·40
PCF801	1·80
PCF802	1·78
PCF805	1·80
PCF806	1·80
PCF808	1·80
PCL82	1·13
PCL83	1·78
PCL84	1·13
PCL85	1·22
PCL86	1·22
PCL805/85	1·22
PD500	4·05
PFL200	2·03
PL36	1·35
PL81	1·35
PL81A	1·35

PL82	1·35
PL83	2·50
PL84	1·22
PL504/500	1·58
PL508	2·03
PL509	3·38
PL519	3·65
PL801	1·24
PL802	3·33
PY33	1·24
PY81	0·95
PY82	0·90
PY83	0·79
PY88	0·95
PY500A	2·03
PY800	0·95
PY801	0·95
QQV02-6	11·23
QQV03-10	5·11
QQV03-20A	18·90
QQV06-40A	18·90
R17	1·88
R19	1·35
R20	1·62
U18-20	2·81
U25	1·31
U26	1·62
UABC80	1·41
UAF42	1·41
UB41	1·41
UBC41	1·69
UBF89	1·35

UCC84	1·24
UCC85	1·35
UCF80	1·29
UCH42	1·35
UCH81	2·61
UCL82	1·17
UCL83	1·62
UF41	1·13
UF80	1·62
UF85	1·62
UF89	1·62
UL41	1·82
UL84	1·35
UM80	1·13
UY41	1·41
UY85	1·17
Z803U	8·53
1B3GT	2·44
1R5	1·18
1S5	0·45
1T4	0·45
2AS15	10·80
2D21	2·76
3A5	1·46
3CX100A5	21·60
3S4	1·24
4CX250B	26·79
5R4GY	2·25
5U4G	4·25
5U4GB	2·54
5V4G	1·71
5Y3GT	0·96
5Z3	1·69
5Z4G	1·71
5Z4GT	1·69

6-30L2	1·76
6AB7	1·69
6AC7	1·58
6AF4A	1·80
6AG7	2·25
6AH6	5·40
6AK5	3·89
6AK6	2·75
6AL5	0·99
6AM4	2·59
6AM5	4·29
6AM6	2·03
6AN5	5·99
6AN8A	4·66
6AQ5	1·08
6AR5	1·80
6AS6	6·28
6AS7GA	7·29
6AT6	0·96
6AU5G7	4·70
6AU6	1·22
6AV5GA	4·25
6AV6	0·96
6AX5GT	3·49
6B7	1·69
6B8	1·97
6BA6	1·13
6BA7	5·76
6BA8A	4·22
6BC4	4·17
6BE6	1·22
6BH6	1·71
6BJ6	1·22
6BK4	4·74
6BL6	91·80
6BL7GT	4·34
6BN6	1·86

6BQ7A	4·05
6BR7	4·50
6BR8	1·97
6BS7	4·50
6BW6	4·50
6BW7	1·71
6BX7GT	5·58
6BZ6	2·57
6C4	0·99
6CB6A	2·70
6CD6GA	5·51
6CG7	2·50
6CH6	7·31
6CL6	4·03
6CW4	8·15
6D2	0·99
6DK6	2·53
6DQ6B	4·39
6EA8	3·24
6EB8	2·39
6EW6	1·69
6F6	1·99
6F23	1·80
6F28	1·31
6H2N	1°18
6H3N	1·18
6H6	1·69
6J4	5·96
6J6	3·51
6J7	8·84
6K4N	1·41
6K6GT	1·46
6K7	1·69
6K8	1·97
6KD6	6·93
6L6G	2·81
6L6GA	1·69

6L6GT	0·96
6L6GC	2·19
6L7	2·25
6N2P	1·18
6N3P	1·18
6N7	1·69
6P25	4·05
6Q7	2·48
6R7	2·03
6SA7	1·63
6SC7	1·69
6SF7	1·80
6SH7	1·69
6SJ7	1·80
6SK7	1·46
6SL7QT	3·02
6SNG7	1·80
6SQ7	1·47
6SR7	1·69
6SS7	2·03
6U5G	2·25
6U8	0·90
6U8A	3·17
6V6GT	1·80
6X4	1·35
6X5GT	0·96
7B7	1·91
7C5	1·97
7C6	1·41
7H7	2·25
7R7	1·69
7S7	2·53
7Y4	1·80
7Z4	2·08
12AT6	1·35
12At7	0·99
12AU6	2·77

12AU7	0·81
12AV6	2·25
12AV7	3·89
12AX7	0·99
12AY7	5·13
12B4A	3·42
12BA6	2·36
12BE6	2·50
12BH7	1·26
12BY17	2·95
12E1	7·67
19H4	27·00
30C15	1·80
30C17	1·80
30C18	1·80
30F5	1·89
30FL1/2	1·26
30FL12	2·03
30FL14	1·80
30L1	1·13
30L15	2·03
30L17	2·03
30P4	1·04
30P19	1·35
30PL1	1·49
30PL13	2·03
30PL14	1·89
30PL15	2·03
35W4	0·68
50C5	0·79
85A2	2·00
90AG	8·60
90AV	8·60
90C1	1·94
90CG	14·77
90CV	14·36
92AG	8·60

92AV	8·60
95A1	5·24
150B2	2·32
150B3	4·21
150C2	1·62
150C4	1·89
211	6·48
723AB	37·80
807	3·89
811A	9·18
812A	9·02
813	34·56
833A	81·00
866A	6·21
872A	14·85
931A	13·22
2050	7·52
5642	5·68
5654	3·80
5651	1·94
5670	4·97
5814A	4·51
6080	7·40
6146A	5·53
6146B	6·03
6159	8·62
6973	3·96
7586	12·80
7587	22·05
7868	4·43
8068	6·19
8136	2·75
4CX 250B	5·40

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7400	0·17
7401	0·17
7402	0·17
7403	0·17
7404	0·18
7405	0·17
7406	0·43
7407	0·43
7408	0·22
7409	0·22
7410	0·17

7412	0·28
7413	0·35
7416	0·35
7417	0·35
7420	0·18
7422	0·22
7423	0·35
7425	0·32
7427	0·32
7428	0·46
7430	0·18

7432	0·32
7433	0·39
7437	0·35
7438	0·35
7440	0·19
7441AN	0·92
7442	0·78
7447AN	0·97
7450	0·19
7451	0·19
7453	0·19

7454	0·19
7460	0·19
7470	0·38
7472	0·36
7473	0·39
7474	0·43
7475	0·58
7476	0·43
7480	0·59
7482	0·81
7483	0·97
7484	1·08
7486	0·38
7490	0·56

7491	0·86
7492	0·65
7493	0·65
7494	0·86
7495	0·78
7496	0·86
7497	3·24
74100	1·62
74107	0·49
74109	0·76
74110	0·54
74111	0·76
74116	1·89

74118	1·08
74119	1·62
74120	0·90
74121	0·43
74122	0·65
74123	1·08
74125	0·59
74126	0·59
74128	0·65
74132	0·76
74136	0·59
74141	0·86
74142	2·48
74143	2·70

74144	2·70
74145	0·97
74147	2·16
74148	1·89
74150	1·73
74151	0·92
74154	1·89
74155	0·92
74156	0·92
74157	0·81
74159	2·27
74170	2·48
74172	4·75

74173	1·51
74174	1·62
74175	0·97
74176	1·19
74178	1·35
74179	1·35
74180	1·25
74190	1·62
74191	1·62
74192	1·46
74193	1·46
74194	1·35
74195	1·08

74196	1·30
74197	1·19
74198	2·43
74199	2·43
76013N	1·97
LM309K	1·62
TAA570	2·59
TAA630S	3·94
TAA700	4·22
TBA480Q	2·07
TBA20Q	2·59

TBA530	2·23
TBA540Q	2·59
TBA550Q	3·62
TBA560CQ	3·62
TBA673	2·46
TBA700	1·71
TBA720Q	2·59
TBA750Q	2·33
TBA800	1·30

TBA920	3·13
TBA920Q	3·36
TBA990Q	3·36
TCA270Q	3·36
TCA760A	1·55

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14 PIN	0·16
16 PIN	0·18

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B7G skirted	0·32
B9A unskirted	0·16
B9A skirted	0·32
NUVISTOR	0·59
Int Octal	0·22
Loctal	0·59
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14 pin DIL	0·16
16 pin DIL	0·18
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2BP1*	9·72
3BP1	8·64
3DP1*	5·40
3EG1*	7·56
3FP7	6·48
3GPI	6·48
3JPI*	8·64
3JP2*	8·64
3JP7*	10·80
3KPI*	16·20
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5BPI*	10·80
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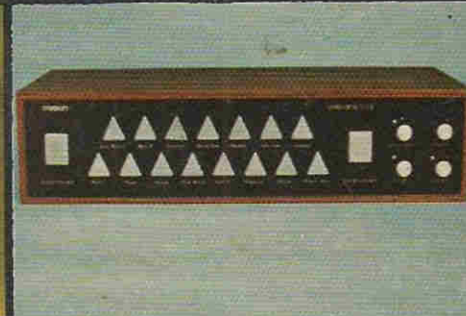

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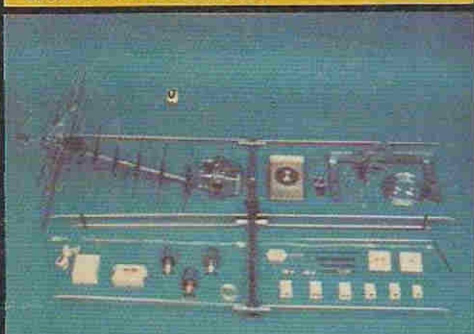

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