PRACTICAL

ELECTRONICS

AUGUST 1975

30p

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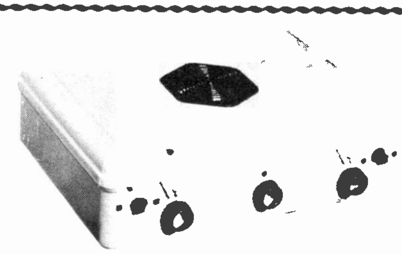

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- Signal Injector
- Transistor Tester NPN —PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio.
- One Transistor Radio
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- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier

Components include:

● 24 Resistors ● 21 Capacitors ● 10 Transistors ● 3½" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc. ● Parts price list and plans 55p (free with parts)

TOTAL BUILDING COSTS

£7·23 P.P. & Ins. 58p (Overseas Seamail P. & P. £3·40)
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WITH VHF INCLUDING AIRCRAFT

Now with free earpiece and switched socket.

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND

Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Chrome plated 6 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in. Easy to follow instructions and diagrams. Parts price list and plans 50p (FREE with parts).

TOTAL BUILDING COSTS £9·50 P.P. & Ins. 65p (Overseas Seamail P. & P. £3·50)
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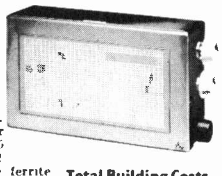
POCKET FIVE



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3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½in × 1¼in × 3½in approx. Plans and parts price list free with parts.

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P.P. & Ins. 38p
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NOW WITH VARIABLE TONE CONTROL

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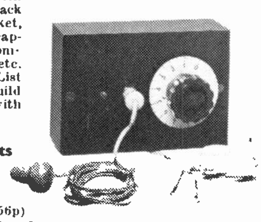

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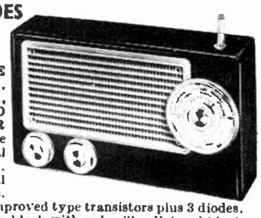
TRANS EIGHT

8 TRANSISTORS AND 3 DIODES



6 TUNABLE WAVEBANDS. MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2¾in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans free with parts.

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POCKET FIVE	☐	EDU-KIT	☐

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PE8

PRACTICAL ELECTRONICS

VOLUME 11 No. 8 AUGUST 1975

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our September issue will be published mid-August, 1975

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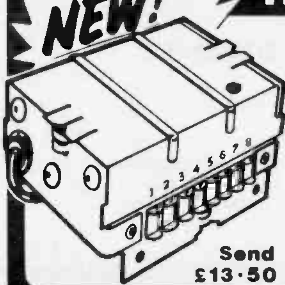

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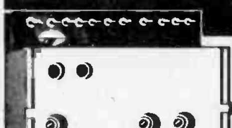

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7404	13	7454	14	74155	95
7405	13	7460	11	74156	71
7406	22	7464	21	74157	71
7407	22	7465	21	74161	95
7408	14	7472	22	74163	1·05
7409	14	7473	26	74164	1·25
7410	11	7474	26	74165	1·25
7411	16	7475	41	74166	1·15
7413	35	7476	26	74173	95
7415	22	7483	70	74175	95
7416	22	7485	80	74176	95
7417	22	7486	24	74177	85
7420	11	7489	1·50	74180	80
7422	22	7490	45	74181	2·50
7423	22	7491	71	74182	80
7425	22	7492	44	74184	1·55
7426	23	7493	44	74185	1·45
7427	22	7494	49	74190	95
7430	12	7495	49	74191	95
7432	22	7496	55	74192	90
7437	25	74100	1·25	74193	85
7438	21	74105	60	74194	95
7440	11	74107	27	74195	80
7441	60	74121	32	74196	1·00
7422	55	74122	50	74197	75
7443	55	74123	55	74198	1·70
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7445	75	74126	50	74200	3·90
7446	85	74141	68		
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74L10	16	74L74	38	74L164	1·53
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74C04	41	74C107	82	74C164	1·92
74C08	41	74C151	1·59	74C173	1·59
74C10	36	74C154	1·92	74C195	1·65
74C20	36	74C157	1·20	80C95	82
74C42	1·18	74C160	1·78	80C97	82
74C73	85	74C161	1·78		

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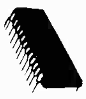

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9 DIGIT LED DISPLAY

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8223	Programmable ROM	2·72

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MM5738	8 DIG 5 funct K & Mem	2·42
MM5739	9 DIG 4 funct (btry sur)	2·92
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MAN 6	.6" high solid seg	3·81
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MCT2	Opto-iso transistor	38

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309K	5V 1A regulator	TO-3	91
310	V Follower Op Amp	TO-5 mDIP	65
311	Hi perf V Comp	mDIP TO-5	58
319	Hi Speed Dual Comp	DIP	71
320	Neg Reg 5.2, 12, 15	TO-3	74
322	Precision Timer	DIP	60
324	Quad Op Amp	DIP	1·07
339	Quad Comparator	DIP	92
340T	Pos Volt Reg (6V-8V-12V-15V-18V-24V)	TO-220	1·07
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372	AF-IF Strip detector	DIP	44
373	AM/FM/SSB Strip	DIP	1·78
376	Pos. V Reg	mDIP	33
377	2w Stereo amp	DIP	1·47
380	2w Audio Amp	DIP	81
380-8	.6w Audio amp	mDIP	69
381	Lo Noise Dual preamp	DIP	98
382	Lo Noise Dual preamp	DIP	98
550	Prec V Reg	DIP	54
555	Timer	mDIP	44
560	Phase Locked Loop	DIP	1·94
562	Phase Locked Loop	DIP	1·94
565	Phase Locked Loop	DIP	1·20
566	Function Gen	mDIP	1·20
567	Tone Decoder	mDIP	1·20
709	Operational AMPL	DIP	27
710	Hi Speed Volt Comp	DIP	21
711	Dual Difference Compar	DIP	44
723	V Reg	DIP	38
739	Dual Hi Perf Op Amp	DIP	65
741	Comp Op AMP	mDIP TO-5	27
747	Dual 741 Op Amp	DIP or TO-5	44
748	Freg Adj 741	mDIP	27
1304	FM Mulpx Stereo Demod	DIP	65
1307	FM Mulpx Stereo Demod	DIP	45
1458	Dual Comp Op Amp	mDIP	38
LH2111	Dual LM 211 V Comp	DIP	1·07
3065	TV-FM Sound System	DIP	38
3075	FM Det-LMTR & Audio preamp	DIP	44
3900	Quad Amplifier	DIP	33
7524	Core Mem Sense AMPL	DIP	1·04
7534	Core Mem Sense Amp	DIP	1·42
8864	9 DIG Led Cath Drvr	DIP	1·37
75451	Dual Perepheral Driver	mDIP	21
75452	Dual Peripheral Driver	mDIP	21
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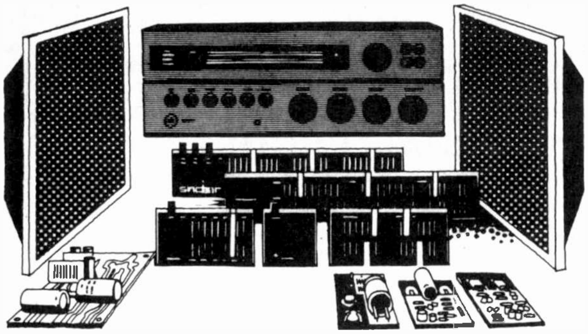

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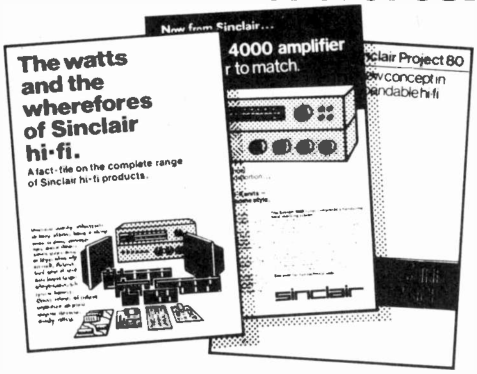

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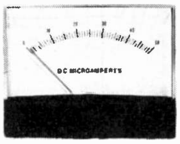

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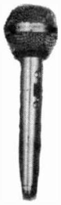

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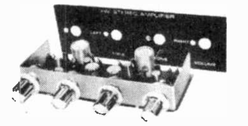

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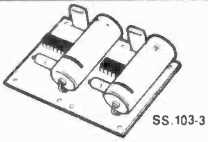

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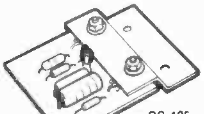

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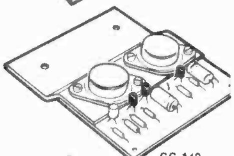

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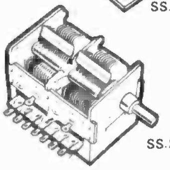

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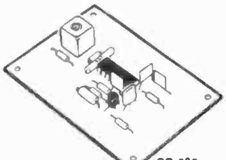

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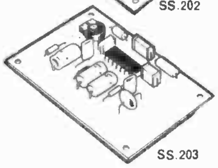

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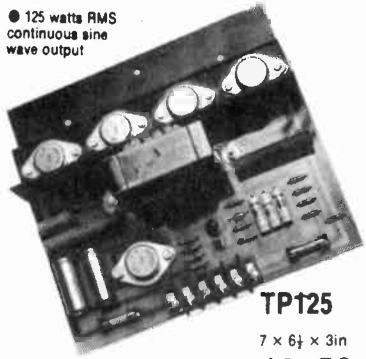

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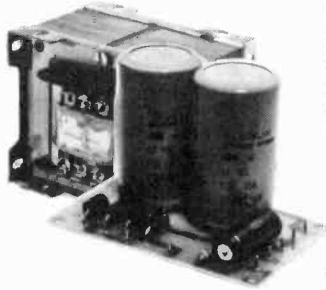

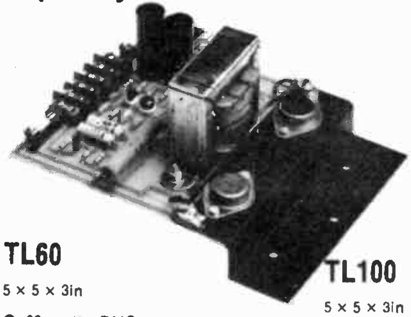

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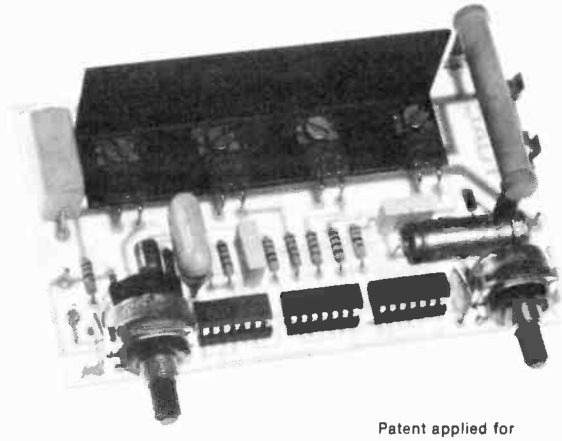

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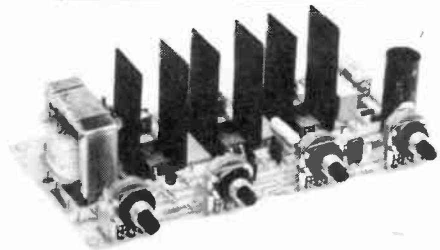

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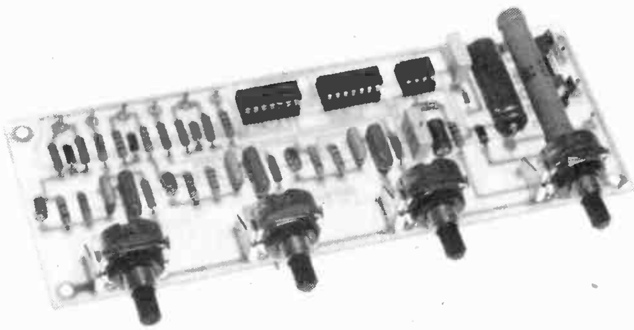

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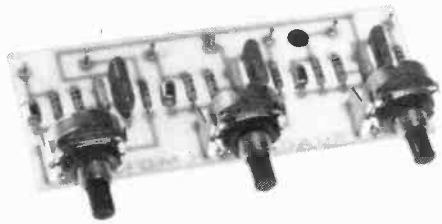

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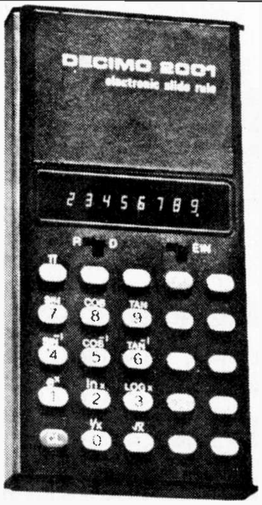

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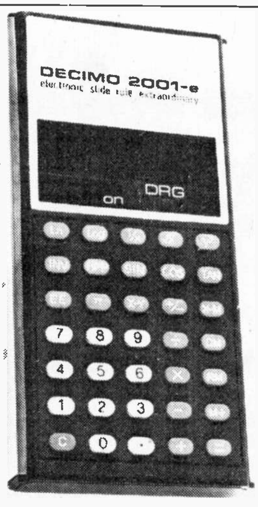

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2N1309	0·47	2N3710	0·15	40411	2·00	BC125	0·16	BCY30	0·80	BF258	0·53	ME0404	0·13	TBA810	1·50
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2N2368	0·25	2N3904	0·27	AC176	0·30	BC157	0·16	BD124	0·67	BFY53	0·18	MP8113	0·47	TIP41A	0·79
2N2369	0·20	2N3906	0·27	AC176K	0·40	BC158	0·16	BD131	0·40	BFY90	0·75	MPF102	0·39	TIP41C	1·40
2N2369	0·20	2N4036	0·67	AC187K	0·35	BC160	0·60	BD132	0·50	BRY39	0·23	MPSA05	0·25	TIP42A	0·90
2N2646	0·55	2N4037	0·42	AC188K	0·40	BC167B	0·15	BD135	0·43	BSX20	0·21	MPSA06	0·31	TIP42C	1·60
2N2647	0·98	2N4058	0·18	ACY18	0·24	BC168B	0·15	BD136	0·49	BSX21	0·29	MPSA12	0·35	TIP49C	0·70
2N2904	0·22	2N4059	0·15	ACY19	0·27	BC168C	0·15	BD137	0·55	BU104	2·00	MPSA55	0·26	TIP53	1·70
2N2904A	0·24	2N4060	0·15	ACY20	0·22	BC169B	0·15	BD138	0·63	BU105	2·25	MPSA56	0·31	TIP2955	0·98
2N2905	0·25	2N4061	0·15	ACY21	0·26	BC169C	0·15	BD139	0·71	C106D	0·65	MPSU05	0·65	TIP3055	0·50
2N2905A	0·26	2N4062	0·15	ACY28	0·20	BC170A	0·15	BD140	0·87	CA3018A	0·85	MPSU06	0·58	TIS43	0·28
2N2906	0·19	2N4126	0·21	ACY30	0·58	BC171	0·16	BD529	0·80	CA3020A	1·80	MPSU55	0·63	ZTX300	0·13
2N2906A	0·21	2N4289	0·34	AD142	0·57	BC172	0·17	BD530	0·80	CA3028A	0·79	MPSU56	0·80	ZTX301	0·13
2N2907	0·22	2N4919	0·95	AD143	0·68	BC177	0·28	BDY20	1·05	CA3035	1·36	NE555V	0·70	ZTX302	0·20
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2N2924	0·20	2N4921	1·83	AD150	1·15	BC179	0·30	BF117	0·55	CA3048	2·11	NE560	4·48	ZTX501	0·13
2N2925	0·20	2N4922	1·00	AD161	0·50	BC182	0·12	BF121	0·35	CA3052	1·62	NE561	4·80	ZTX502	0·18
2N2926		2N4923	1·00	AD162	0·50	BY182L	0·12	BF123	0·35	CA3089E	1·98	NE565A	4·48	ZTX530	0·23
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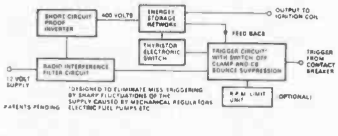

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	SPARKRITE Mk. 2 ready built negative earth at £13·86
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	R.P.M. Limit systems in the above units at £2·42
	Fluorescent light assembly kits at £3·16
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300W (24V)—£22·70 + £1·05 p & p.

All above invertors are in kit form but may be purchased built up and ready for use. Price list sent on receipt of stamped addressed envelope.

P.W. AUTOMATIC EMERGENCY SUPPLY

250V—50Hz—150W invertor with built in battery charger, in event of power failure switches over automatically from battery charging to invertor operation. Cct. as appeared in Dec. 73 *P.W.* Complete kit of parts (excluding meter) £22·50 + £1·10 p & p.

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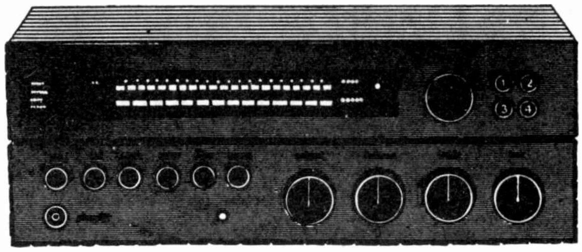
Sinclair System 4000



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RT-VC *

NEW!

VISCOUNT IV STEREO SYSTEM

System 1a. £65.00

The new 20+20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.

The VISCOUNT IV has a comprehensive range of controls — volume, bass, treble, balance, mono/stereo, mode selector, and scratch filter.

Front panel socket for stereo headphones. And a host of sockets at the rear — for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.

SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion @ 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. — 3 millivolts @ 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. — 50 millivolts @ 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. — 140 millivolts @ 50 K ohms (flat frequency response); 5. Microphone — 3 millivolts @ 50 K ohms (flat frequency response).

CONTROLS: Push button ON/OFF, stereo/mono, scratch filter, 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response**: 25 Hz to 25 KHz @ full rated output. **Signal to noise ratio**: better than —50 dB on all inputs. **Tone control range**: Bass ±15 dB @ 50 Hz; Treble ±12 dB @ 10 KHz.
Power requirements: 200-250V A.C. mains @ 60 watts. **Approx. size**: 15¼" × 3" × 10".

MP60 type deck with magnetic cartridge, de luxe plinth and cover.

Two Duo Type IIa matched speakers — Enclosure size approx. 19½" × 10¾" × 7¾" in simulated teak. Drive unit 13" × 8" with 3" tweeter. 15 watts handling. 30 watts peak.

Complete System with these speakers £69.00 +£6.50 p & p.

System 2. £81.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers — Enclosure size approx. 27" × 13" × 11½". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range — 20 Hz to 18,000 Hz.
Complete System with these speakers £85.00 +£7.60 p & p.

PRICES: SYSTEM 1a
Viscount IV R103 amplifier £25.00+£1.90 p & p.
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PRICES: SYSTEM 2
Viscount IV R103 amplifier £25.00+£1.90 p & p.
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20x20 SYSTEM

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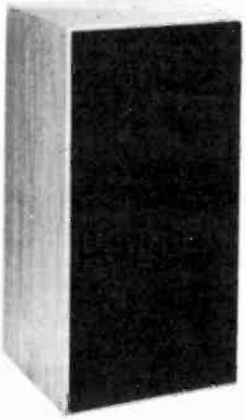
System 1a £1.75 System 2 £3.50



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LE-4 SPEAKERS

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Specification — Size 33"×14"×16" approx. Impedance 8 ohms. Power handling 25W RMS. (Peak 50 watts.) Frequency range 35 Hz–20 KHz.

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EASY TO BUILD SPEAKER KITS

These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" × 8" woofer, 3¼" tweeter and matching crossover.
Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20–20,000 Hz. Size 20" × 11" × 9½" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£22.00 pair complete
+£5.20 p & p. Complete with crossover Components and circuit diagram

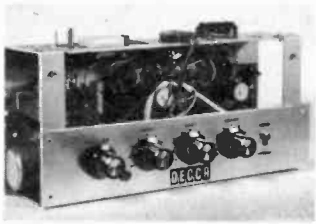
EMI 350 KIT

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

£6.50 +£1.20 p & p.

Complete with crossover Components and circuit diagram

DECCA STEREO AMPLIFIER CHASSIS



Specification: 4+4 watts into 8 ohms. Input Sensitivity 4mV into 47K (for magnetic cartridges). AC Mains only 240V. Controls — volume, bass, treble, on/off, mono/stereo switch. Chassis size 11"×5½"×3¼" approx.

£6.90 +£1.20 p & p.

PUSH BUTTON CAR RADIO KIT – THE TOURIST TT*

NO SOLDERING REQUIRED

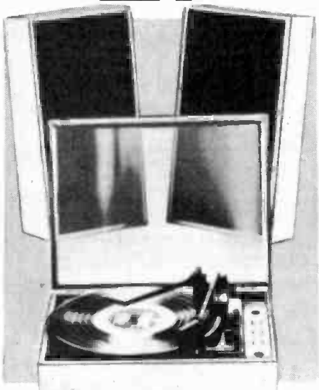
NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board. **TECHNICAL SPECIFICATION:** (1) Output 4 watts RMS output. For 12 volt operation on negative or positive earth. (2) **Integrated circuit** output stage, pre-built three stage IF Module.

Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7″ wide 2″ high and $4\frac{1}{4}$″ deep approx. **£9.50** +£1.05 p & p. Speaker including baffle and fixing strip £2.00 +45p p & p. Car Aerial Recommended — fully retractable £1.60+40p p & p.

The Tourist I Kit For the experienced constructor. If you can solder on a printed circuit board you can build this model. Same technical specification as Tourist TT. **Price £8.20** +£1.05 p & p.

*STEREO 21 QUALITY SOUND FOR LESS THAN £24.00

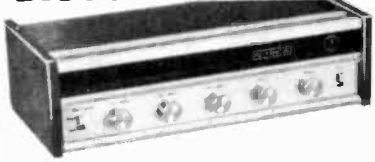


Stereo 21, easy to assemble audio system kit. No soldering required.
The unit is finished in white P.V.C. and the acrylic top presents an unusually interesting variation on the modern deck plinth.
Includes — **BSR 3 speed deck**, automatic, manual facilities together with stereo cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications — For the technically minded:
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs — radio, tape, etc., and outputs for taping discs.
Overall Dimensions. Speakers approx $15\frac{1}{2}$″×8″×4″. Complete deck and cover in closed position approx. $15\frac{1}{2}$″×12″×6″.

Complete only £23.20 +£3.00 p & p.

Extras if required. Optional Diamond Styli £1.60.
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance £5.80.

*DISCO AMPLIFIER



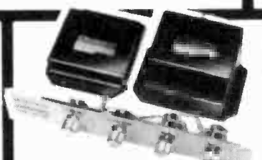
Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Output 20 watts RMS into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls. *Separate bass and treble controls common to all 4 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State circuitry. *Attractive styling.
INPUT SENSITIVITIES — Input — 1). Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity.) — Inputs — 2), 3), 4). Medium output equipment — ceramic cartridge, tuner, tape recorder, organs, etc. — all 250mV sensitivity. AC Mains, 240V operation. Size approx: $12\frac{1}{2}$″×6″×$3\frac{1}{2}$″. **£20.00** +£1.35 p & p.

*8 TRACK HOME CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system. Compatible with Viscount IV system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV. Comparable unit sold elsewhere at £24.00 approx. Yours for only

£16.20 +£1.70 p & p.

BUILD YOUR OWN STEREO AMPLIFIER*

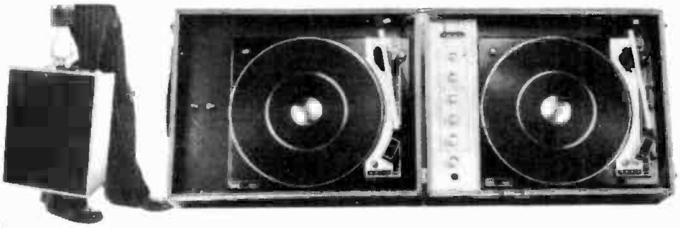


For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

Also available with 2 speakers (7″ x 4″) £10+£1.75 p & p. **£8.95** +£1.05 p & p.

PORTABLE DISCO CONSOLE*

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables. Two B.S.R. MP60 type single play professional series decks, fitted with crystal cartridges.



TECHNICAL SPECIFICATION:
Pre-amp — Output — 200mV. Auxiliary inputs — 200mV and 750mV into 1 meg. Mic input — 6mV into 100K. 240 volt operation. **Turntables capacity** — 7″, 10″ or 12″ records. **Rumble, wow and flutter.** Rumble Better than −35dB. Wow Better than 0.2%. Flutter Better than 0.06% (Gaumont kalee meter).
Finish — Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size —
Unit Closed — $17\frac{1}{4}$″×$13\frac{3}{4}$″×$8\frac{1}{4}$″(app.)
Unit Open — $35\frac{1}{4}$″×$13\frac{3}{4}$″×$4\frac{1}{4}$″ (app.)
This disco console is ideally matched for the **Reliant** IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only £57.00 +£6.50 p & p.

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AC155	18
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AC187	19
AC187K	24
AC188	17
AC188K	26
AD142	45

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AD161	38
AD162	38
AF114	24
AF115	21
AF116	22
AF117	19
AF118	50
AF139	35
AF178	45
AF180	45
AF181	45
AF239	40
AF240	60
BC107	11
BC108	10
BC109	14
BC109C	14
BC113	13
BC116A	19
BC117	14
BC125B	15
BC132	25
BC135	15
BC137	19
BC138	26
BC142	23
BC143	25
BC147	11
BC147A	11
BC148	10
BC149	10
BC153	15
BC154	15
BC157	14
BC158	10
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BF181	32
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BF185	25
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BF195	8
BF196	10
BF197	12
BF198	23
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BY238	25
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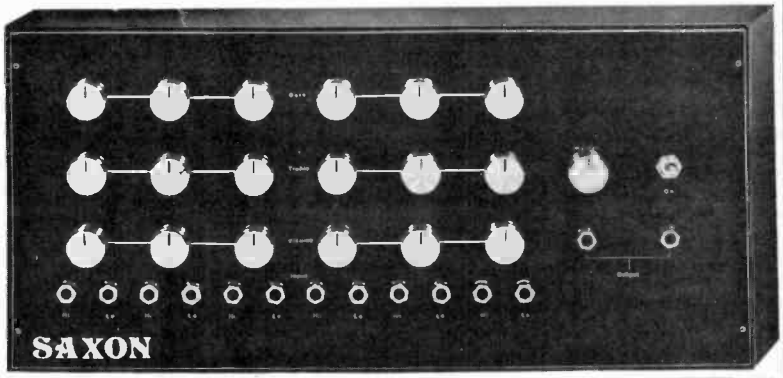

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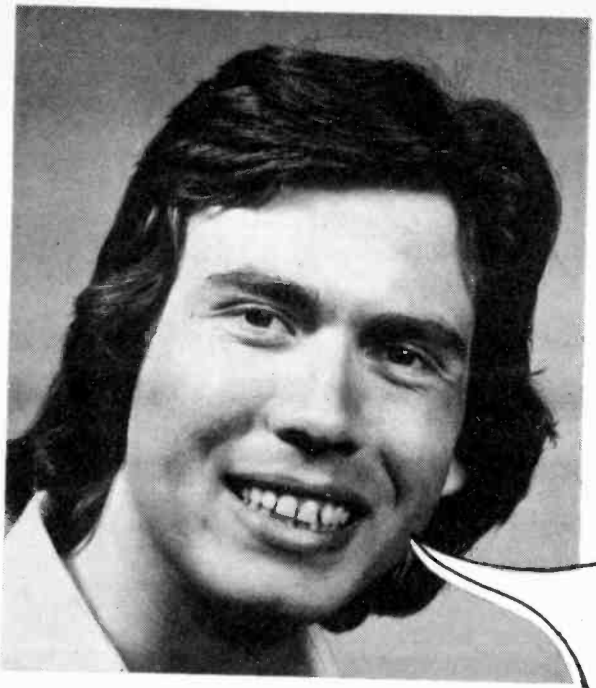

It's the LONG LIFE Catalogue!

You have heard of "Long Life" batteries, milk and beer, so why not a "Long Life" catalogue? The thought struck me the other night when I visited a friend to chat about a joint project we were building. We needed a few bits and pieces, so he went to a drawer and pulled out a catalogue. Yes, it was the famous Home Radio Components catalogue all right, but at first I didn't recognise it. "Gracious! How old is it?" I exclaimed. "Oh," he said, "about 5 or 6 years." Fascinated, I said, "Can you still use it? Surely, it's years out of date?" "No, not really," he said, "you see, many basic things like plugs, sockets, resistors, capacitors, switches, don't change much. Only the prices change, and Home Radio were wise enough to take all prices out of their catalogue many years ago and put them on a separate list. What's more, they were far sighted enough not to change their catalogue numbers, so all I have to do is to write or phone them occasionally and 'hey presto' along comes an up to date price list. Not a penny extra to pay!" "You really believe in getting your money's worth out of a catalogue," I said. "Sure thing," he replied, "but I might have bought four or five catalogues and still not ordered any more goods. These catalogues must cost Home Radio a bomb to produce, so I imagine they are quite pleased if one of their catalogues produces business for say two years or more. However I must admit it's about time I got myself a new one."

This conversation set me thinking, Home Radio Components really do produce a catalogue that will last and last, *and* a service to back it up. So if you are keen to save the pennies, send for a copy today. You may still be using it in 1977. On the other hand, if you really like to keep up with the latest developments, Home Radio will be happy to sell you a new one. Each year they spend at least 5 or 6 months revising it in order to bring the latest trends to your notice. Either way you cannot lose. Especially when you bear in mind, that although the initial cost is 65p plus 33p postage and packing, they enclose 14 vouchers each worth 5p if used as directed. Add to that the fact you could easily make it last two or three years . . . well, to borrow a phrase, "You never had it so good". *Don't wait, send off the coupon today with your cheque or P.O. for 98 pence.*

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PE

VICTIMS OF V.A.T.

An unworkable law is a bad law. On this count—certainly in the light of experience of those involved in retail distribution—the higher V.A.T. rate as applied to many electronic components must be recognised as a bad law. It must be reconsidered by the Government without delay.

On another count, this law is grossly unfair. Its effects are not equally or fairly distributed. One obvious result is the victimisation of the private constructor.

By the recent ruling of H.M. Customs and Excise, the majority of small to medium power general purpose components are subject to the higher rate of V.A.T. So far as set and equipment manufacturers are concerned, any components of this category which they use carry the higher V.A.T. rate if the end product is for home entertainment or is a domestic appliance. But the lower, standard rate applies to all industrial, professional, scientific and commercial type equipments *and to all the individual components from which they are built*, regardless of the latters' standing as *individual* items.

Now consider the position of the private constructor. He faces a 25 per cent V.A.T. charge on the majority of the components he will buy, regardless of the nature of the project in which they are destined to be embodied. This is because the private individual, unlike the set or equipment manufacturer, is not registered for V.A.T. purposes and cannot recover, subsequently, any excess V.A.T. paid on his components.

The unfairness is apparent when one considers the large number of home-built projects that do not come under the headings of home entertainment or domestic appliances. For example: digital clocks, pocket calculators, power controllers, metal locators, gas detectors, car ignition systems, windscreen wiper controllers, electronic games, and test and measuring instruments. As manufactured units, all these items would be subject to the lower rate of V.A.T.

One concession has been won from H.M. Customs and Excise in connection with complete kits of parts for projects of the kind just mentioned (as reported in this issue). But the constructor who buys anything less than a *complete* kit must be charged the higher rate of V.A.T., where applicable. This is tantamount to adding insult to injury, so far as the many thousands of dedicated, bona fide amateur enthusiasts are concerned; for their ranks include designers, experimenters, as well as genuine constructors—as opposed to kit assemblers. And they all buy the vast majority of their components on a piecemeal basis. *They* are are the victims of V.A.T.

Despite this latest imposition, the constructor is at the end of the day still in pocket when one considers the outlay for a comparable commercial product. This is mainly because his own labour carries no V.A.T. charge (as yet!). But this is no justification for unfair treatment. Furthermore, any debilitating effect this higher V.A.T. may have on home constructors could have more far reaching and serious repercussions in the longer term. Our entire electronics industry could be the poorer in future were private constructor activities to be curbed.

We earnestly hope that the Government will heed the representations made by the electronics industry and that the two-tier system of V.A.T. ratings now applicable to electronic components will be abolished. Individual constructors and component suppliers should in their own (and common) interest make their feelings known to their MP.

F.E.B.

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T.V. SOUND SEPARATOR

By D. S. GIBBS & I. M. SHAW* C.Eng., M.I.E.E.

THE standard of sound quality transmitted with 625-line television programmes is equal to that of the v.h.f. f.m. broadcasts and yet it is a sad fact that most TV receivers give a standard of sound reproduction little better than a transistor radio. To most of the public, cabinet styling and picture size are of paramount importance and little thought is given to the sound reproduction of the set. Consequently there is very little market for sets with good sound reproduction and those that exist are very expensive.

*Ferranti Ltd.

METHODS AVAILABLE

The ideal solution for the hi-fi enthusiast would be to feed the TV sound channel through his existing equipment. There are three possible ways this can be done:

(a) By a direct audio feed from the set via an audio isolating transformer.

(b) By building a complete TV sound tuner.

(c) By building a device to pick up the stray 6MHz radiation from the i.f. strip of the TV set.

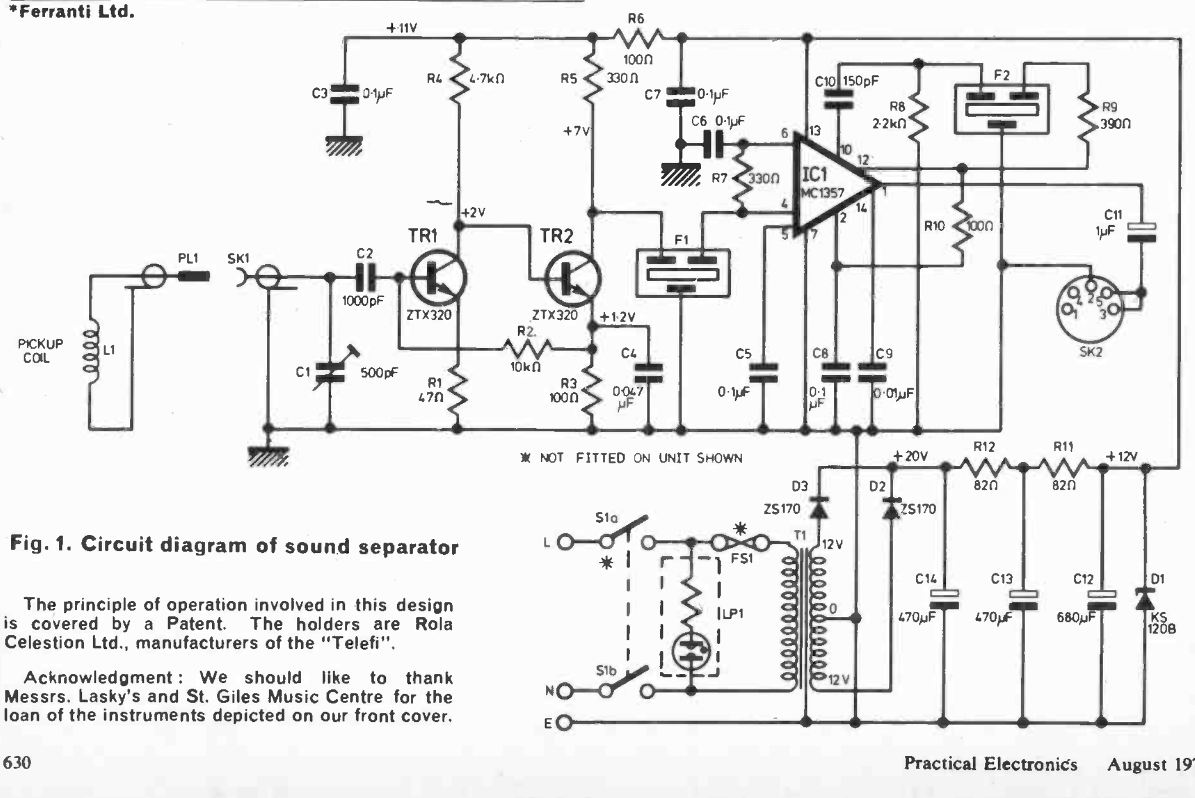
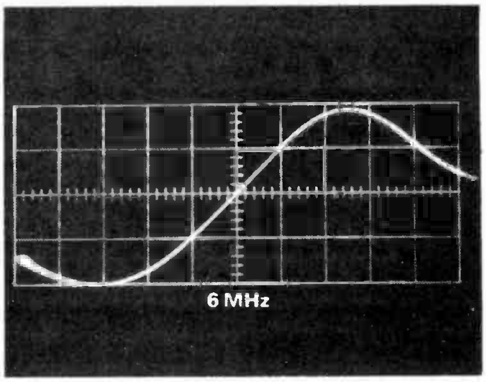


Fig. 1. Circuit diagram of sound separator

The principle of operation involved in this design is covered by a Patent. The holders are Rola Celestion Ltd., manufacturers of the "Telefi".

Acknowledgment: We should like to thank Messrs. Lasky's and St. Giles Music Centre for the loan of the instruments depicted on our front cover.



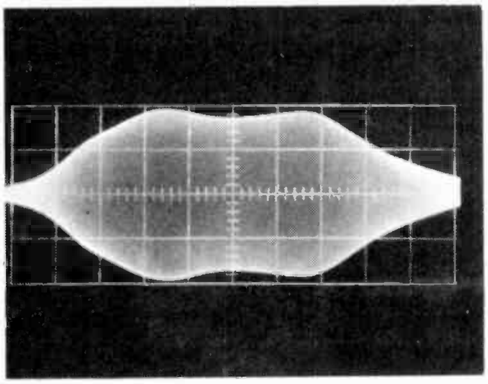


Fig. 2 (left). Response of discriminator. Horizontal scale is approximately 50kHz per division and the output has good linearity over this. (Right) Response of input stage and filter indicating a bandwidth of about 300kHz

Method (a) is probably the simplest—but as it requires modifications to the TV set it cannot be used with rented sets. Also the audio transformer must be capable of withstanding full mains voltage between its windings as there is a possibility of the chassis of the set being "live".

Method (b) is the most complex and expensive as it requires a completely separate tuner and i.f. strip. As these are already present in the TV set it seems a little wasteful to duplicate them—which leads us to method (c). This makes use of the existing tuner and i.f. strip in the TV set by picking up the stray 6MHz radiation from the sound i.f., amplifying and filtering it and then detecting it. This method requires few components, is easy to construct and align, and requires no direct connection to the TV set. Consequently this method was chosen for the unit described here.

CIRCUIT DESCRIPTION

The circuit diagram of the unit is shown in Fig. 1. The pickup coil L1 is tuned to 6MHz and is positioned on the outside of the TV set to pick up the maximum level of 6MHz radiation.

The output signal from the coil is then amplified by TR1 and TR2. These give a voltage gain of about 100 and provide a suitable output impedance to match the ceramic filter F1. This filter has a bandwidth of about 300kHz and provides the main selectivity of the unit. The output of the filter is applied to the MC1357 limiter and discriminator. This gives a high degree of limiting—thus removing noise and a.m. components—and the output of the limiter drives a quadrature detector.

An unusual feature of this circuit is the use of a ceramic filter element in the quadrature detector. The Murata CDA 6·0 MC filter is specially designed for this purpose and the associated component values have been chosen to give the best compromise between linearity and output. The use of a ceramic filter element in the discriminator means that there is virtually no alignment to do other than peak up the pickup coil—and this is very non critical in any case.

The de-emphasis time constant of 75μs is defined by the 0·01μF capacitor connected to pin 14 of the i.c.

COMPONENTS . . .

Resistors

R1	47Ω	R7	330Ω
R2	10kΩ	R8	2·2kΩ
R3	100Ω	R9	390Ω
R4	4·7kΩ	R10	100Ω
R5	330Ω	R11	82Ω
R6	100Ω	R12	82Ω

0·33 watt 5% carbon film

Capacitors

C1	500pF compression trimmer
C2	1,000pF disc ceramic
C3	0·1μF 30V disc ceramic
C4	0·047μF 12V disc ceramic
C5	0·1μF 30V disc ceramic
C6	0·1μF 30V disc ceramic
C7	0·1μF 30V disc ceramic
C8	0·1μF 30V disc ceramic
C9	0·01μF HI-K tubular ceramic
C10	150pF polystyrene
C11	1μF 35V tantalum
C12	680μF 16V electrolytic
C13	470μF 25V electrolytic
C14	470μF 25V electrolytic

Filters

F1 Murata SFE 6·0 MA ceramic filter
F2 Murata CDA 6·0 MC ceramic filter

Semiconductors

TR1	ZTX320 Ferranti	D1	KS120B Ferranti
TR2	ZTX320 Ferranti	D2	ZS170 Ferranti
IC1	MC1357PQ Motorola	D3	ZS170 Ferranti

Coil

L1 Wound as described, see text

Miscellaneous

Case—West Hyde Developments, Samos size S3.
P.c.b. (Davian Electronics.)
T1—R.S. Components 12V 6VA miniature mains transformer (Doram).
NE1—R.S. Components miniature neon lamp.
DIN 5 way socket, Belling Lee coax socket, screws, spacers, grommet, connecting wire, TV 75Ω coax cable.
The printed circuit board, a kit of semiconductors, and the two ceramic filters can be obtained from Davian Electronics, PO Box 38, Oldham, Lancs., OL2 6XJ.

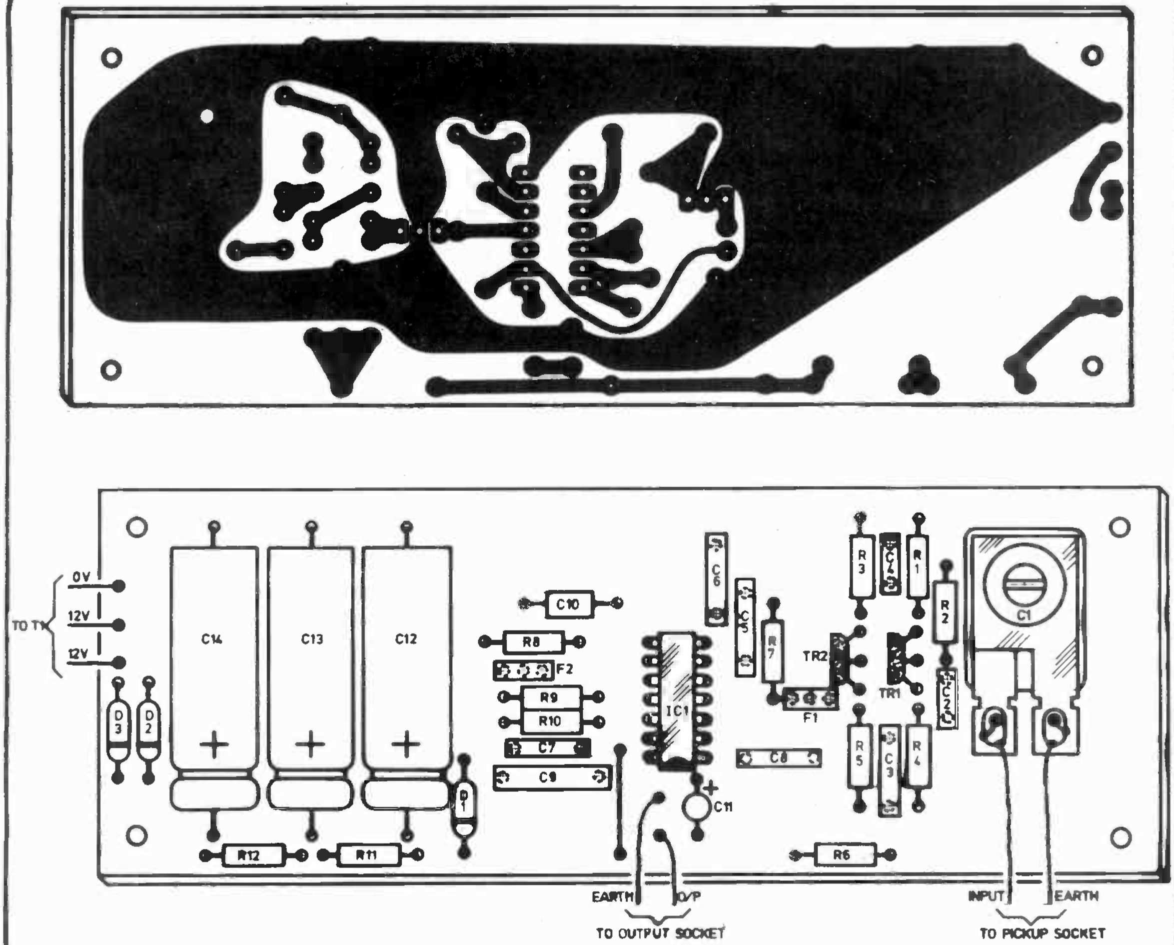
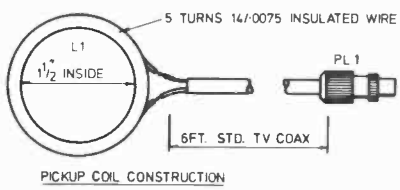


Fig. 3. P.c.b. and component mounting details

Fig. 4. Details of the pick-up coil L1



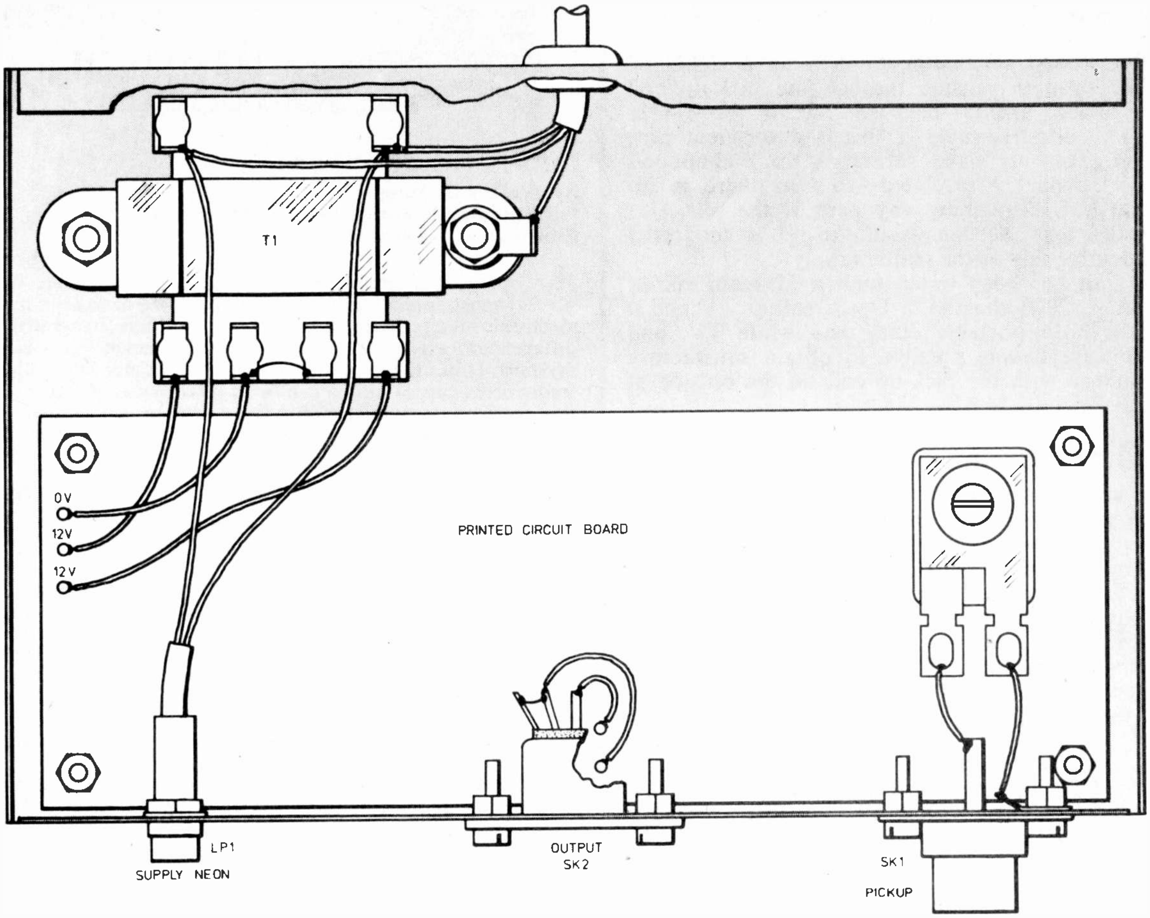


Fig. 5. Assembly details of sound separator

CONSTRUCTION

Most of the components are mounted on the printed circuit board shown in Fig. 3. If you decide to make your own board the copper pattern shown should be followed carefully or stability problems may arise. Do not use Veroboard.

The assembled printed circuit board is a complete module and can be incorporated into your hi-fi system if desired. Alternatively it can be built up as a separate unit as shown in the illustrations.

The prototype unit was built into a West Hyde Developments' Samos case size S3. An assembly diagram for this is given in Fig. 5.

On the latest R.S. Components' 6VA miniature mains transformers the screen tag is at the bottom and it will be necessary to connect a wire to this tag before the transformer is mounted in the box, as this tag is inaccessible afterwards. The assembled printed circuit board is mounted on four ⅜in (9·525mm) spacers, and after this has been fixed in place the coax. socket, DIN socket and the neon lamp can be inserted and the unit wired up.

No mains switch or fuse have been included as many amplifiers have a switched mains output to power auxiliary equipment, but these can easily be added by the constructor if desired.

PICK-UP COIL

The pick-up coil L1 consists of five turns of ordinary connecting wire (14/·0076 insulated wire was used in the prototype) wound around a 1·5in (38·1mm) diameter former. The coil thus formed is soldered to the end of a length of standard Band I/III TV coaxial cable, and the whole assembly is then bound with p.v.c. insulating tape so that the coil and its connections are completely covered. The coax. cable forms part of the tuning capacitance of the coil but the length is not critical and anything up to about 10ft (3·048m) should be satisfactory. A 6ft (1·8288m) length was used with the prototype unit (Fig. 4).

ALIGNMENT

Before switching on check the circuit carefully for errors and make sure that all the semiconductors are connected the right way round.

Connect the output of the unit to an amplifier and switch on. You will probably hear a selection of foreign stations at first but when the pickup coil is placed near to the TV set the TV sound channel should be heard. Move the pick-up coil around over the outside of the TV set until the position giving minimum background noise is found. Then adjust

C1 for best sensitivity and seal it with a blob of adhesive. Once the optimum position for the pick-up coil has been found it can be fixed in position with adhesive tape.

It it is found impossible to pick up a signal of sufficient strength outside the set, the pick-up coil can be placed inside—near to one of the 6MHz sound i.f. coils. However if this is done great care must be taken to make sure that the pickup coil is very thoroughly insulated—so that there is no possibility of it touching any part of the set. Also make sure that the chassis of the set is connected to the neutral side of the mains supply.

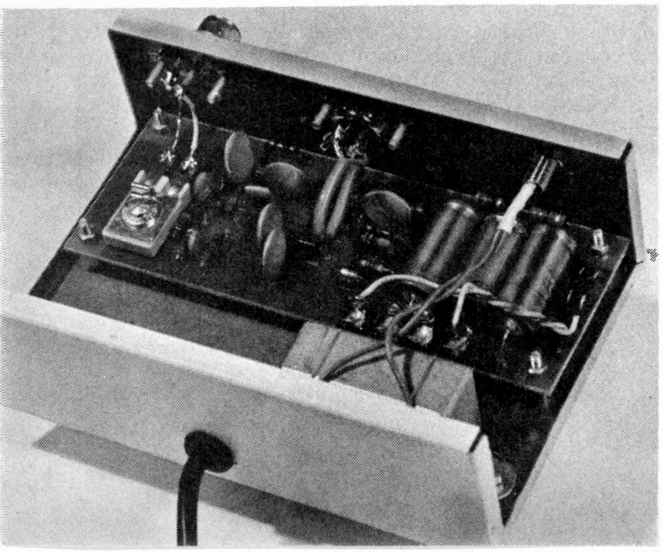
This unit has been tested with a Marconi colour TV (T.C.E. 3000 chassis), a Decca colour TV and a Ferguson 3816 portable black and white TV, and in each case it was possible to obtain satisfactory performance with the pick-up coil on the outside of the set.

USING THE TUNER

It is subjectively rather strange to hear the sound coming from a different direction to the picture—so it will usually be necessary to move one of the loudspeakers so that it is close to the TV set. This should not cause any problems with black and white sets, but colour sets are very sensitive to external magnetic fields and if a loudspeaker is placed too close some interesting effects on the picture may be obtained! In practice it will usually be sufficient to place the loudspeaker a few feet to one side or behind a colour TV.

If a buzz is noticed on the output of the tuner this could be either intercarrier buzz from the TV set or an earth loop. It should be possible to remove the former by a slight adjustment to the tuning or contrast controls of the TV set. An earth loop will be present if both the unit and the amplifier are separately earthed and the cure is to disconnect one of the earths. It is probably best to disconnect the earth to the tuner unit so that it is then earthed via the amplifier.

This unit will not operate with 405-line receivers as these do not have a 6MHz sound i.f.. Also overseas readers should note that in many countries a sound i.f. of 4·5 or 5·5MHz is used. It should be possible to modify the unit to operate at these frequencies by using the appropriate ceramic filters but the necessary experimental work must be left to the constructor. ★



BOOK REVIEWS

IC OP. AMP. COOKBOOK

By Walter G. Jung
Published by Prentice/Hall International
Clothbound. Price £6·60

Of operational amplifiers appearing in this magazine the 741 must surely be the most familiar. We have seen it in electronic music circuits, ramp generators, filters, integrators, differentiators etc. To many this "gain packet" is still a mystery. It has the qualities of a super-transistor but at high frequencies cannot hold a candle to its forebear. Of course, this criticism does not apply to the whole op. amp. family.

Obviously then, although the 741 can provide a fantastic range of audio and d.c. application it still has its limitations.

It follows, that to make the best use of these now standard design tools, one must understand the language of manufacturers' literature for selection and know the basic rules for design.

The book is arranged in three parts: Part I introduces op. amp. basics and the evolution of general purpose and specialised groups. Operating procedures and precautions in use completes this section. Part II covers practical circuit applications: signal generators, regulators, signal processors and audio designs. Some of the more unusual op. amps. are examined at length.

Part III consists of two appendixes of manufacturers' data.

Following the tradition of all good cookbooks this does not stint on the recipes as there are over 250 practical circuit applications.

In all, an instructive reference to anyone interested in op. amp. design techniques.

G.G.

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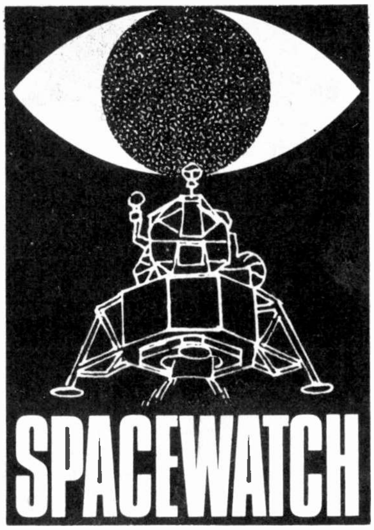


BY FRANK W. HYDE

THREE TIMES A WINNER

Perhaps no space adventure will ever vie with the manned *Appollo 13*, with its explosive panel incident. Then at least there was first hand assistance with the co-operation of crew and ground based control. However, *Mariner 10* has now completed the third fly-past of Mercury and for the second time there were problems close to the time of passing. In September 1974 the teams responsible for the measurement of plasma high energy particles and the magnetic field, gave up their priorities in order that the imaging teams should have maximum value from the second encounter with Mercury.

Naturally the news that *Mariner* might still be out of control at the due pass time, led to considerable apprehension. Once again there was a mixture of unexpected happenings and a brilliant rescue.

At Mission control the spacecraft had been carefully nursed to keep it operational. The nitrogen, for control jets so vital to the final trajectory guidance, had been conserved by using other means of direction. This took the form of using the pressure of light on the solar panels and the high gain antenna.

The spacecraft had been allowed to operate in an uncontrolled mode its position being checked by the background of stars whose images were registered by telemetry. The roll period was some 60 hours.

TROUBLE

The Canopus tracker allowed the calculation of the position from which the locked mode to the star Canopus could be set. It had been decided that the spacecraft should pass over the dark northern hemisphere at 75 degrees at a height of 125 miles. A few days before this encounter it was required that the roll should be stopped and the star tracker orient the position of *Mariner*.

It was at this point that trouble appeared. During the short period needed to recognise the star Canopus a bright particle passed through the field of view, the tracker mistook this for the star and the spacecraft was commanded to roll in the wrong direction. Instead of the high gain antenna being directed to Earth the vehicle rolled to a null point with the low gain antenna towards Earth and communication was lost.

For some months the stellar magnitude channel had been inoperative, making recognition difficult. The craft could not be controlled from the smaller antennas on the ground. It seemed that the fly-past would be perfect but in silence.

An attempt was made to command from the Goldstone large antenna. This was not successful. The next possibility was Canberra, but with the German spaceprobe *Helios* approaching a critical phase in its mission, this antenna was fully committed.

However, at great risk to this critical point in their programme, the West German control gave up one of the antennas for a short time. This allowed the Madrid station to command the *Mariner* to its correct position. This was accomplished on the day before the encounter was due.

MERCURY FLY-PAST

The pass was highly successful but with some problems in imaging. All the data required by the non-imaging teams was acquired. The data proved that the magnetic field of the planet was intrinsic and not due to the solar wind and its interaction. The magnetic field experiment was confirmed and the results of the first pass extended. The predictions made using the data from the first pass, were very close to those obtained on the third encounter.

The results from the magnetic field, the relativistic particle experiments and the electron component of the solar wind indicate without doubt that Mercury is one of the few magnetised planets in the Solar System.

The question of origin of the magnetism is still not established. Whether it is due to magnetised crust or to a dynamo mechanism of a fluid core is not known for certain. The people operating the *Mariner* experiments lean towards the dynamo hypothesis. One result that emerges from the experiments is that planets do not have to be rapidly rotating to produce a magnetic field. Mercury's rotation period is 58·5 days.

The low energy solar wind electrons were observed and these suggest that the magnetosphere is like a scaled down version of the Earth's own magnetosphere. The same tadpole like effect appears.

There were intensive bursts of electrons and protons. This indicates, from the rapid but short duration of the bursts, that the controlling magnetic fields must be subject to cancellation. The spiral radius of particles along the field lines of Mercury's orbit is almost the same as the planets radius.

This fly-by has also provided evidence that there is a continual solar emission of hydrogen and helium nuclei from active centres. These may be due to hot calcium plages where sunspots appear.

ANOTHER X-RAY NOVA

Following the success of the *Ariel 5* discovery of the Cen-Xmas X-ray binary and the nova at the centre of the galaxy, noted in last month's Spacewatch, the teams have now made a further addition. This is the new X-ray nova near the Crab Nebula.

The discovery was made when the standard calibration task was being performed. The basis of comparison for the X-ray measurements is the X-ray source in the Crab itself. The field of vision of the X-ray detector is some 17 degree and therefore covers a considerable area of sky.

On April 21 it was noticed that there was an X-ray source near the Crab which was not there in the previous survey. As it is some four degrees from the Crab it cannot be an appendage to it. When first observed the new source was about 7 per cent of the brightness of the Crab source. On the next observation ten days after the discovery the new source had become twice as bright as the Crab source, which itself is the second brightest X-ray source. As the pointing accuracy is extremely high, one minute of arc, there can be no doubt that it is new.

The teams have a right to be excited for this could be another binary system. After the previous discovery it is natural that these should be sought, for the period is important to the physics of these sources. Also there is the possibility that it could be an artefact for there is the chance that the periodicity could be 104 seconds.

A preliminary survey by both optical and radio astronomy has not yet revealed a visual or radio counterpart of the source.

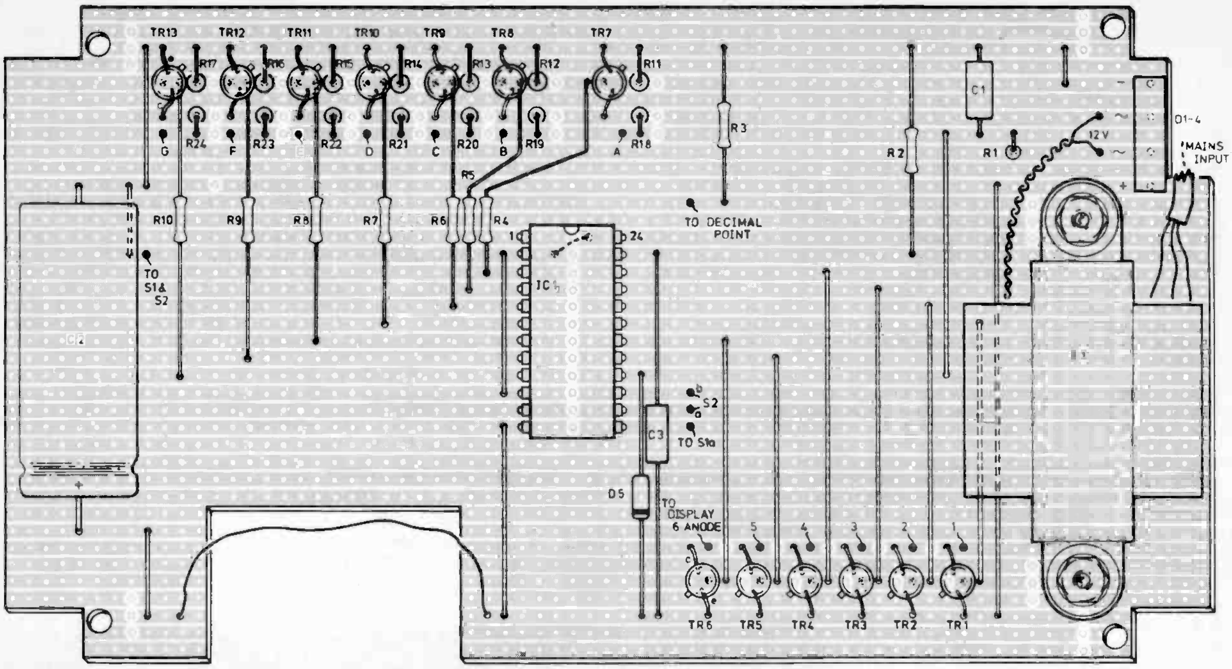


Fig. 2 The main component board mounted in the case. Note the cut-out for access to the Hold and Slow/Fast switches. The display board is mounted on the case lid

CONSTRUCTION

Construction should start with the main clock board. If the recommended board is purchased it will economically furnish both the clock board and the board for the display.

Commence by making all the breaks shown on the board layout. If the clock is to be built into the suggested case then the cut-outs at the corners and the cut-out for the time setting switches should be made at this stage. The cut-outs at the corners of the clock board enable the board to fit snugly into the suggested case. The board will be fitted to the case with the screws supplied.

After the breaks in the copper rails have been made, fit the 22 s.w.g. copper links exactly as shown in the layout, taking care to see that each link is perfectly straight. If the links are kept straight and tidy there is no need to sleeve them and the fitting of the links should present no difficulty.

The holes for fixing the board into the case, and the two holes for fixing the transformer should be drilled with a number 27 drill or a little larger for good clearance.

The author used nylon 4BA screws and nuts for fixing the transformer as there is then no danger of shorting adjacent copper rails. If ordinary nuts and screws are used the copper rails should be insulated with mica washers or similar. Coloured wires are brought out from the board as this method enables the wires to be easily identified when connecting the display board to the clock board. The following colours were used in the prototypes:

Brown — Hours × 10	Brown — Cathodes A
Red — Hours × 1	Red — Cathodes B
Orange — Mins × 10	Orange — Cathodes C
Yellow — Mins × 1	Yellow — Cathodes D
Green — Secs × 10	Green — Cathodes E
Blue — Secs × 1	Blue — Cathodes F
	Mauve — Cathodes G

COMPONENTS . . .

Resistors

R1–R2	100kΩ (2 off)
R3	560Ω
R4–R10	2·2kΩ (7 off)
R11–R17	10kΩ (7 off)
R18–R24	270Ω (7 off)

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

Capacitors

C1	0·01μF plastic or paper
C2	2,200μF >25V
C3	0·022μF

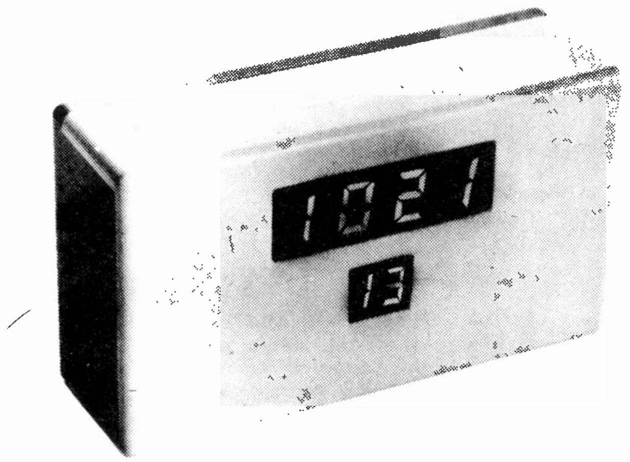
Semiconductors

*TR1–TR6	BC478
TR7–TR13	BC108
IC1	MM5314N
D1–D4	Rec 63 (Bridge rectifier)
D5	IN914 (IN4148)
* L.E.D. Displays 1–4	DL747
5–6	DL707

Miscellaneous

Case, Vero Electronics (order code 65-25224) (Approx. dimensions 180mm × 55mm × 100mm). S1 switch, S.P.D.T. or S.P.S.T. S2 switch, S.P.D.T. bias to centre OFF. Veroboard 0·1in matrix $11\frac{1}{2}$in × $3\frac{3}{4}$in. T1 transformer, Min. Trans 12V (6VA). (RS Components, Doram).

* Note. For 4-digit version delete transistors TR5 and TR6 and the two l.e.d. displays type DL707.



It should be obvious that the group of six transistors are for the digit enable outputs, while the group of seven transistors are the seven-segment outputs. Fig. 2 shows the layout of the clock board viewed from the plain (component) side.

Viewed from the component side of the board, a wire is taken from each hole to the right of each collector connection. These wires should be, from left to right, Brown, Red, Orange, Yellow, Green and Blue. They are the digit enable connections, and will connect to the anode on each l.e.d. package.

The emitters of the seven driver transistors for the seven segments, type BC108, are taken to earth. From the lefthand side of resistors R19 to R24, a coloured wire is taken. The order, right to left is: Brown, Red, Orange, Yellow, Green, Blue, Mauve. These are the cathode connections for the l.e.d.s, Brown being Cathode A, Red being Cathode B, etc. (Fig. 3).

POSSIBLE VERSIONS

Before going further is must be decided which version of the clock is required. The clock board in Fig. 1 is for a six digit, twelve-hour clock operating from 50Hz. If a 24-hour clock is required the link between pins 2 and 10 adjacent to the i.c. should be omitted. Also, if a four-digit clock is desired the link between pin 24 of the i.c. and the negative rail should be omitted. If the clock is to be used on a supply having a frequency of 60Hz, pin 11 of the i.c. should be connected to the negative rail. Thus it is simple to programme the clock to suit one is requirements.

One last tip before we leave the clock board on one side. Do not apply the soldering iron to the pins of the clock i.c. for longer than necessary or damage will result. A socket for the package was not used in the prototype for reasons of economy, but a 24-pin dual in line socket can be used.

L.E.D. DISPLAYS

Before commencing the construction of the display board, it might be as well to make ourselves familiar with the l.e.d. displays. Two types are used for the six digit version of the clock. Four are type DL747 having a character height of 0·6in and pins numbered 1 to 18. The DL747 packages are for the hours and minutes display. The other two displays, for the seconds readout, are type DL707. These have a character height of 0·3in. They are smaller than the other dosplays for reasons of economy and current saving. Although not as large as the DL747, the DL707 is of equal brightness. It will soon be obvious, when looking at the

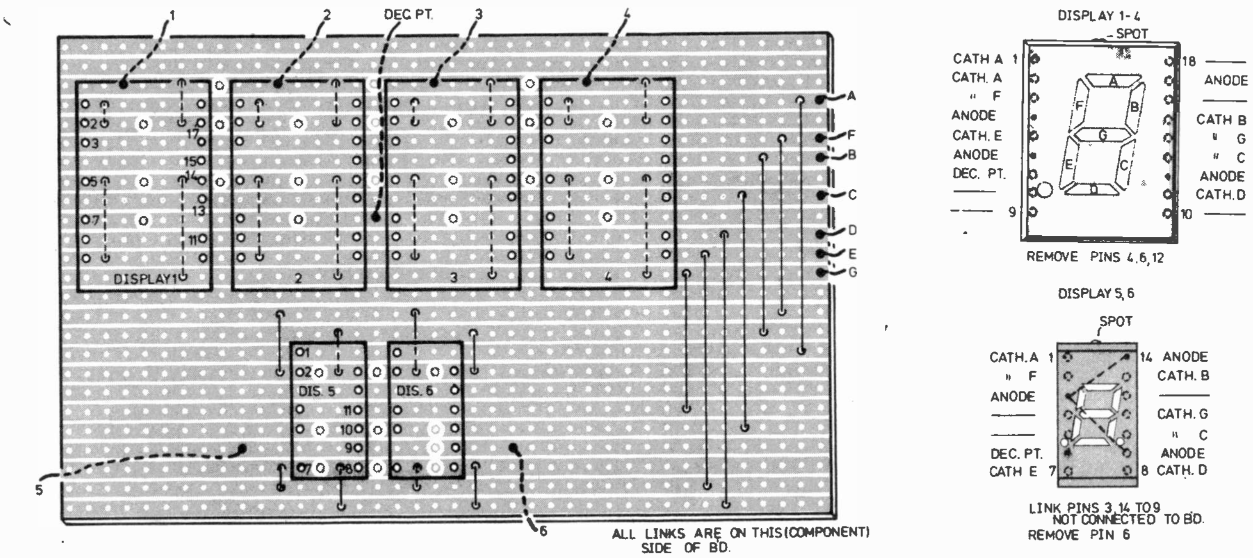
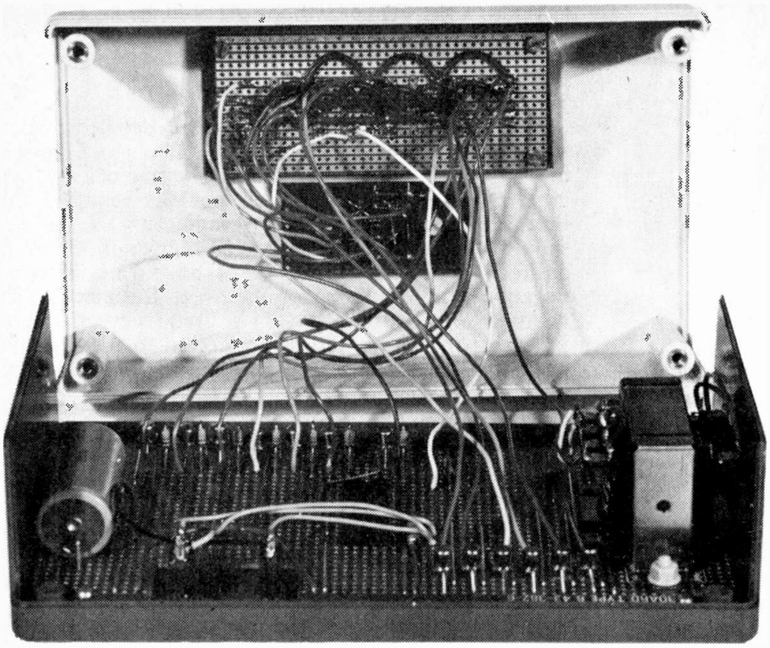


Fig. 3. Display board and l.e.d. display details



displays it will be necessary to very carefully take a little off the rear edge of the sides of these displays in order for them to fit close together on the board without any gaps between them.

The smaller display packages can be soldered slightly proud of the display board to bring their faces up to the same height as the four larger displays. The stand-off strips should be just high enough to make the display surfaces flush with the front face of the case. They should be drilled and tapped to suit 6BA screws.

It will be obvious from the positioning of the cutout in the clock board where the time setting switches are placed. No details for drilling the holes for the time setting switches are given. The space allowed gives ample scope in the placing of the switches, the toggles of which stand out from the rear of the case.

two display devices, that neither is carrying its full complement of pins. The smaller DL707 has pins 4, 5 and 12 missing, while the larger DL747 has pins 1, 8, 9, 10, 16 and 18 missing.

DISPLAY BOARD ASSEMBLY

The type of construction employed for the display board eliminates the interconnecting of similar pins which would otherwise have to be done. This method of construction saves a lot of wires and generally helps keep the whole of the display board tidy. It also means less confusion, as there are less actual connections to be made. However, it does mean that we have to modify the display packages a little. This must be done with meticulous care so as not to spoil a display i.c.

Taking the smaller DL707 first, pins 14, 3 and 9 must be linked with sleeved light gauge tinned copper wire. 10 amp fuse wire will do the job. It will be seen that the pins referred to are the anode connections which, on this package, are not common and must therefore be joined together. The three pins should be joined with the wire which must be soldered as close to the rear of the package as possible. Now remove, with small side cutters, pins 3, 6 and 14 so that they cannot protrude through the board. There are no pins to be linked on the larger DL747, but carefully remove pins 4, 6 and 12.

The display packages can now be laid aside while the construction of the display board takes place. Veroboard is again used and the layout as viewed from the plain side can be seen in Fig. 3.

Four 6BA holes should then be drilled out as shown to enable the board to be fixed to standoff strips which are glued in position inside the case. Now the display packages can be fitted to the plain side of the board. In the case of the larger DL747

VENTILATION

In a confined space without ventilation the transformer can run uncomfortably warm, but the temperature rise can be kept minimal by the drilling of as many holes as possible below and to the rear of the transformer. The holes should be not less than $\frac{3}{16}$in diameter.

SETTING THE CLOCK

Time setting is easy and reasonably fast. When the clock is connected to the mains, hold the "Fast/Slow" switch in the fast position. The clock will change its readout one hour every second.

Let us assume the time is actually seven minutes past eight. With the clock running in the FAST position it is best to release the switch soon after it has changed to the seventh hour. Now hold the switch in the slow position and it will alter one minute each second. The time as shown by the clock can now be conveniently brought to the right time (8.07), when the switch should be released. It will now count normally.

If one is fastidious enough to want the seconds to count down correctly, bring the clock to a time just in advance of the actual time—say eight o'clock. As soon as the clock changes over to eight, operate the hold switch. If this is done promptly the clock will now display 8.00 and 00 secs. Now telephone for the correct time, waiting for the time signal for 8.00, then operate or relase the hold switch and the clock will run with the correct seconds count being displayed. It all actually takes less time to set up than it takes to read the notes on the procedure.

The clock can be mounted in any case, always ensuring adequate ventilation, but the case used by the author makes the clock presentable and modern in appearance, fitting in well with any decor. ★

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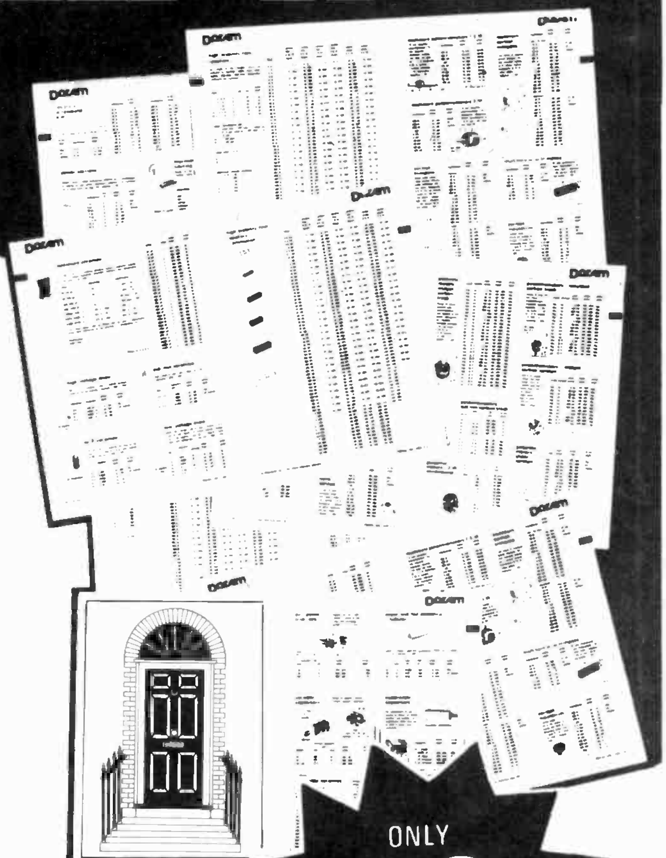

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OC203	0·55
OC204	0·65
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7474	0·42
7475	0·59
7476	0·45
7480	0·60
7482	0·87
7483	1·10
7484	1·00
7486	0·47
7490	0·55
7491AN	1·00
7492	0·70
7493	0·70
7494	0·80
7495	0·80
7496	0·95
7497	3·87
74100	1·89
74107	0·45
74110	0·58
74111	0·86
74118	0·90
74119	1·68
74121	0·50
74122	0·70
74123	1·00
74141	0·90
74145	1·26
74150	1·75
74151	1·00
74154	2·00
74155	1·00
74156	1·00
74157	0·95
74170	2·52
74174	1·57
74175	1·10
74176	1·26
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Strictly Instrumental

by K. Lenton-Smith

THE swingeing increase in VAT earlier this year provides an incentive to build an electronic musical instrument rather than buy the commercial variety. Most constructors spend a great deal of thought on circuitry—rightly so—and will want to get a quart out of a pint pot more than ever before. It could be that exact imitation of the acoustic counterpart is the ideal, if so, there are problems to contend with.

JOANNA

Alan Boothman's second-generation piano is an excellent little instrument and was particularly well received when demonstrated to meetings of The Electronic Organ Constructors' Society at the time the articles in this magazine commenced; a number of readers will have been at these meetings and heard for themselves. Members of the E.O.C.S. are a critical bunch (in the strictly musical sense!), so "Joanna's" reception was praise indeed. Whatever one's musical tastes, this instrument can cope both expressively and accurately.

When the physical characteristics of an acoustic piano are considered, the electric piano's realism is moderately surprising. The grand piano's "loud pedal" lifts all the dampers so that on playing any note, harmonics of those strings also sound by sympathetic resonance. Hammers strike the strings at approximately the same distance from the bridge irrespective of the length of the string, so the harmonic content varies across the spectrum of the keyboard. In the electronic counterpart, filtering can take care of the last point to some extent but sympathetic resonance is almost impossible to reproduce by electronic means.

CHORUS

The majority of keys in the acoustic piano's compass employs three strings and, though each of the strings may be in perfect tune with each other and with the equally-tempered scale, they will not necessarily vibrate in phase; the chorus effect so produced adds to the richness of sound. Yet nearly all electric pianos, including "Joanna", are divider instruments which lack chorus effect due to the single octave tone source and strict phase relationship between octaves.

The electric piano is accepted as realistic because careful design results in attack/decay characteristics which closely match those of the hammer and string. With organs, the listener automatically expects to hear a "mighty Wurlitzer" emerge from what is only too often a fairly small speaker because he identifies organs with Blackpool, a church or concert hall!

ECONOMY

This "grand sound" is asking a great deal from the divider generators of the average home organ. As with electric pianos, dividers score on grounds of both cost and weight. Manufacturers mainly use i.c. dividers (such as SAJ110) because of their reliability and simplicity where wiring is concerned.

Separately tuned master-oscillators (Hartley, Colpitts or multivibrators) normally precede each divider string, but the relatively high tuning accuracy of the single-master-oscillator i.c. has made for further economies in recent years.

IMPROVEMENTS

By careful mixing and filtering, the noticeably hollow tone of square waves can be overcome. Staircasing may be achieved by adding small amounts of super-octaves to the fundamental tones.

A reverberation unit will produce signals in jumbled phase and gives some semblance of chorus when mixed with the main signal, using separate speaker systems. A chorale (slowly rotating) speaker produces phase differences with the main unit, though some listeners find the effect somewhat monotonous. Even so, these devices improve a simple divider organ considerably.

Some years ago, the Baldwin Piano Co. used a completely different approach to this problem in their Choratone Projector. In this case, the main audio signal was amplified and passed through a phase splitting network to produce three signals with 120 degree differences. Each of these were fed to four three-stage phase-shift oscillators operating at 1, 2, 4 and 8Hz with bandpass filters in their outputs.

Incoming signals at about 400Hz were frequency-modulated at 1Hz, 800Hz modulated at 2Hz and so on, up to 8Hz modulation for the highest frequencies. Each of the four broad frequency bands, slowly modulated at appropriate rates, were mixed with the main signal to produce a "cathedral effect" from lowly divider generators!

THE ULTIMATE

No amount of electronic trickery can disguise the fact that a single set of dividers is inadequate—to the critical ear. A good example of a multiple-generator instrument is the "Magic Organ", featured by Harry Stoneham on EMI's stereo LP OU 2068.

Designed by Jaap Keizerwaard, a Dutchman, this organ has no less than 24 sets of generators. Four of these are allotted to the first manual, eleven to the second manual (six for individual voices and five for its excellent string tones), five to the third manual and four to the pedals.

The designer apparently is willing to build another "Magic Organ" for a mere £35,000 (not forgetting the Chancellor's share), delivery time being five years!

PLAY ON

Finally, Mr P. D. Scargill (his letter in the June issue) may be assured that this column does not "scoff at the younger generation". There are plenty of examples of skilfully performed pop music but, like all Art forms, a consistently high standard cannot exist. Electronic gimmickry substituted for sheer musical ability is not uncommon, and it is this aspect that gives the impression I mentioned to musicians of any age group.

SEMICONDUCTOR UPDATE...

By R.W. COLES

TRI-STATE LAMP

The **MV5491** is a new device from Monsanto which looks as though it may prove to be a big success. Like all good ideas, this new device is essentially very simple, consisting as it does of a standard "match-head" light emitting diode package, containing not *one* l.e.d. but *two*, one red and the other green, sharing a common lense. These two l.e.d. chips are not intended to be "ON" at the same time, and this is ensured by the connection of the two diodes in "inverse parallel" inside the package, making the MV5491 a two-terminal assembly.

The operation of this novel device is elegantly simple—bias it one way and it glows RED, bias it the other way and it glows GREEN; if you don't bias it at all, of course, no light is emitted, making the MV5491 a three-state indicator. This TRI-STATE capability adds a whole new dimension to applications such as tuning indicators, logic probes, voltage polarity sensors and a host of others.

Incorporation into practical circuits is easy. To build a simple polarity indicator, all that would be required in addition to the MV5491 is a single current limiting resistor connected in series in standard l.e.d. fashion. This simple arrangement does not allow for the difference in brightness between the GaAsP (RED) l.e.d., and the GaP (GREEN) l.e.d., but to add compensation for this difference requires only one extra resistor and a silicon diode.

HOME GROWN

"Support your local i.c. manufacturer" could well be the sales maxim of Ferranti Ltd. since their CDI (Collector Diffusion Isolation) process is about the only original British developed process around, and it certainly *is* refreshingly different. Remember the ZN414, the radio in a TO18 can used in the P.E. Triffid receiver? Well, that was one of the early examples of what this home-grown technology could produce.

CDI has come of age since then, with a wide range of interesting circuits, both linear and digital, many of them "custom" specials for equipment manufacturers.

Naturally, some examples of "general purpose" CDI goodies, such as the ZN414, continue to find their way through to wider sales horizons, and one such interesting new device just announced by Ferranti, is the **ZN1040E**, universal count and display circuit.

Primarily a digital design, the ZN1040E is an all-singing, all-dancing, counter circuit which will not only count up or down over four decades at 5MHz, but will also store a previous count and feed it out for display in a ready decoded seven-segment format as well as b.c.d. Display electronics include automatic leading zero blanking, a display multiplexer and an on-chip display clock.

This versatile device will drive many kinds of display directly, including seven-segment l.e.d.s, resulting in a very low component count in typical applications such as frequency counters, timers, and dual-slope voltmeters. The ZN1040E comes in a 28-pin plastic package, runs from a single five-volt supply, and costs about £7·50 100 up.

NEGATIVE THINKING

Anyone who has sampled the delights of using the new "fixed-voltage" regulator i.c.s such as the Motorola 7800C series, will welcome a new range of devices from the same company. The 7800C series (and equivalents from other manufacturers) are a blessing wherever a fixed positive regulated supply is required, and are available in a range of voltages including all the favourites such as 5, 6, 12, and 15. Their great advantage over more traditional variable voltage types, is that very few discrete components are required to ensure correct operation, making circuitry quite simple.

Until now, however, producing a negative regulator circuit was rather unsatisfactory since it meant using one of the positive regulator i.c.s in the earthy side of the negative voltage supply. The new **7900C series** from Motorola overcomes this problem because it introduces a range of "dedicated" negative regulators which complement the 7800C series.

The 7900C devices are available in the same voltage increments as their positive counterparts, making it a simple matter to construct a complementary supply, such as the plus and minus 15 volts often required by operational amplifiers like the 741.

POWER TO THE PEOPLE

In general, monolithic audio amplifiers are not popular with hi-fi, or even mid-fi designers who prefer to have the greater control over circuit operation afforded by a discrete design. An interesting carrot is now being dangled to tempt these reluctant designers into the monolithic fold, in the shape of the **TDA1410** and **TDA1420** devices from SGS/ATES

These two i.c.s are set fair to succeed where others have failed, because they integrate only the parts of a power amplifier which stand to benefit most from the close thermal tracking and parameter matching obtainable with a monolithic approach, i.e. the final output stage. This novel new answer to audio designers' criticisms of previous monolithic amplifiers leaves the designer to concentrate on the low level stages which may be better implemented with discretes.

These devices are a compromise between "Power-Darlingtons" and a fully integrated amplifier.

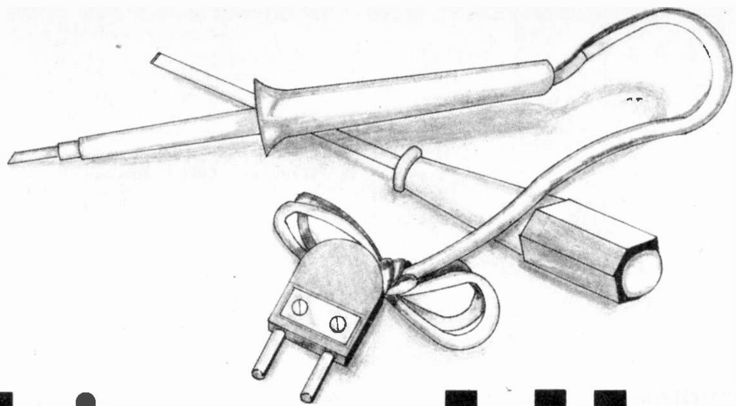
FASTER STILL, AND FASTER

Finally, the **CA3100**, an interesting new RCA operational amplifier is now becoming available in Britain at a realistic price. This device takes OP-AMP technology a step further by using a combination of bi-polar and *p-mos* devices on the same chip to give a bandwidth extending to 38MHz and a 70V/microsecond slew rate, alongside the now expected low drift d.c. performance.

If you are tempted to say, "so what?" contrast that 70V/microsecond slew rate with the typical figure of 0·5V/microsecond for the ubiquitous 741, and you will see what kind of advance the CA3100 represents.

This fast amplifier comes in a TO5 can, with optional lead forming to make it pin compatible with the eight-pin plastic "Mini-DIP". As an added bonus, pin assignments are identical with its famous predecessors such as the 748 and the 741, making it possible to use it as a plug-in replacement to increase the bandwidth and risetime of existing amplifiers. Compensation (when needed) is by means of a single capacitor, and voltage offsets can be nulled in standard 741 fashion with a 10kΩ pot.

The CA3100 brings speed and bandwidth to the people, because, while it was possible to obtain devices with these desirable characteristics before the CA3100 showed up, it was an expensive business and a substantial premium had to be paid. The price of the CA3100?, about £3, 1 off.



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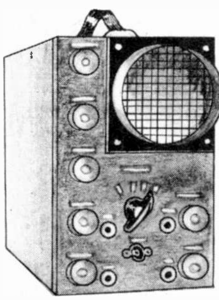

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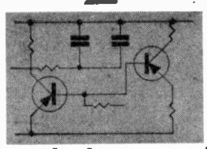

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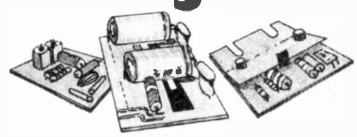

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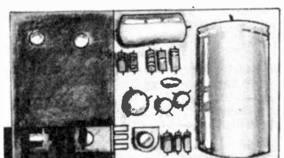

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4·0μF	40V	7p	100μF	63V	17p
4·7μF	63V	7p	150μF	16V	7p
6·8μF	63V	7p	150μF	63V	17p
8·0μF	40V	7p	220μF	6·4V	7p
10μF	16V	7p	220μF	10V	7p
10μF	25V	7p	220μF	16V	8p
10μF	63V	7p	220μF	63V	21p
15μF	16V	7p	330μF	16V	8p
15μF	63V	7p	330μF	63V	25p
16μF	40V	7p	470μF	6·4	14p
22μF	25V	7p	470μF	40V	26p
22μF	63V	7p	680μF	16V	8p
32μF	10V	7p	680μF	40V	25p
33μF	16V	7p	1000μF	16V	17p
33μF	40V	7p	1000μF	25V	28p
32μF	63V	7p	1500μF	6·4V	25p
47μF	10V	7p	1500μF	16V	28p
47μF	25V	7p	2200μF	10V	17p
47μF	63V	8p	3300μF	6 4V	28p

VEROBOARD	0·1	0·15
2½ x 5"	36p	36p
2½ x 3¾"	33p	25p
3¾ x 5"	42p	46p
3¾ x 3¾"	36p	36p
2½ x 1"	10p	9p
2½ x 5" (Plain)	—	19p
2½ x 3¾" (Plain)	—	16p
5 x 3¾" (Plain)	—	29p
Insertion tool	73p	73p
Track Cutter	56p	56p
Pins, Pkt. 25	22p	22p

TRANSISTORS

AC127	21p	BC212L	13p
AC128	22p	BC213L	13p
BC107	12p	BC214L	18p
BC108	12p	OC44	19p
BC109	13p	OC71	13p
BC148	13p	OC81	17p
BC149	13p	OC170	29p
BC182L	13p	TIS43	34p
BC183L	13p	2N2926	13p
BC184L	14p	2N3702	14p

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Carbon Track 5K Ω to 2M Ω, log or lin (and 1K lin). Single, 17½p Dual Gang 48p. Log single with switch 28p. Slider Pots. 10K, 100K, 500K, semi log 30mm, 34p. 45mm, 47p. 60mm, 55p.

DIODES		PLUGS	
IN4001	6½p	Din 2 Pin	12p
IN402	7½p	3 Pin	13p
IN4003	9p	5 Pin 180°	16p
IN4400	9p	Std. Jack	20p
IN4005	12p	2·5mm jack	13p
IN4006	14p	Phono	7p
IN914	7p	**SOCKETS**	
IN916	7p	Din 2 Pin	10p
BA100	10p	3 Pin	10p
OAS	42p	5 Pin 180°	12p
OA47	9p	Std. Jack	18p
OA81	11p	2·5mm Jack	13p
OA200	8p	Phono	7p

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[illegible] F.S.D.
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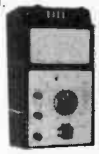
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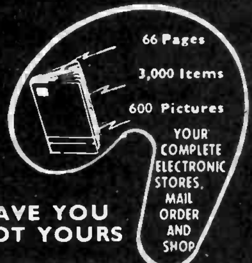

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TRANSDUCERS

PART 5 Piezoelectric Devices

By P.R. ALLCOCK*

PIEZOELECTRICITY is the name given to the phenomenon whereby electric charge dipoles are generated in certain crystals when they are subjected to mechanical stress. The effect was discovered in 1880 by Jacques and Pierre Curie and is reversible in that these materials suffer dimensional changes when under the influence of an electric field.

Natural crystals such as quartz, tormaline and Rochell salt are traditional piezoelectric materials and have been used as transducers, for converting electrical energy into mechanical energy and vice versa, for many years. More recently ceramic piezoelectric materials have been produced and these have the advantage that they can be given almost any shape or size with direction of electric polarization freely chosen during manufacture. Physically, ceramic piezoelectric materials are hard and brittle with general mechanical properties resembling those of insulator-type ceramics and they are manufactured by much the same process.

By changing the chemical composition of the materials it is possible to emphasise one or more specific properties so that the requirements of a particular application can be met. Several grades of piezo ceramic are now available and some of the possible applications are listed in Table 5.1. Some grades are produced under the code name PXE and the charge dipoles in these materials are produced during manufacture by the application of a high electric field during a high temperature phase of the process.

The dipoles are aligned by this technique in one specific direction known as the poling direction. If the material is subjected to an external electrical field which acts in the same direction as the poling direction, the material will expand, or contract, depending on the sense of applied field. If an alternating field is applied the ceramic will vibrate and the amplitude of vibration will be greatest at the resonant frequency.

To ensure adequate coupling between the material and its environment (air, gas or liquid) a compliant structure is needed. A plate or diaphragm is one such structure that operates by "flexing" and can be realised as a bimorph plate or composite transducer.

THE BIMORPH

The bimorph plate principle is illustrated in Fig. 5.1. The bimorph is made up as a sandwich of two thin plates of PXE piezoelectric ceramic, cemented back-to-back so that their respective poling directions are in opposition. Electrical connections are made to the top and bottom silvered faces and the application

Table 5.1: Some Applications of Piezo-electric Materials

1. High voltage (impulse) generation	Gas ignition, cigarette lighters.
2. High power ultrasonics	Sonar, ultrasonic cleaning, soldering and drilling, fish location.
3. Sound and ultrasound in air	Microphones, intruder alarms, tweeters, earphones.
4. Sensors and Pick-ups	Accelerometers, record players, vibration pick-ups.
5. Filters	Remote control, I.F. circuits in radio and TV.
6. Delay lines	Computers and colour TV, acoustic wave devices.
7. Keyboards	Telephones, calculators.

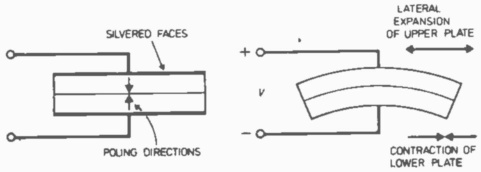

Fig. 5.1. The PXE bimorph plate principle

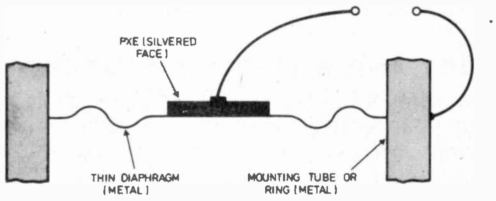

Fig. 5.2 Composite PXE metal transducer. Connection to the lower face is via frame, diaphragm and bonding

* North Staffordshire Polytechnic

of a voltage between these faces causes the bimorph to flex. The bending action arises due to the contraction of the upper plate (along the poling axis) producing a lateral expansion of this plate whereas the opposite effect, a lateral contraction, appear in the lower plate. Because the plates are cemented together this differential expansion causes the bimorph to flex as shown.

To minimise damping of the plate, careful mounting of the bimorph is necessary and techniques sometimes used include knife edges and taut suspension wires. To maximise the acoustic output from a plate it may be necessary to screen part of the bimorph so that portions of the plate moving in antiphase cannot cause cancellation of sound.

Flexure transducers may also be produced by bonding a single disc of piezoelectric ceramic material to a metal plate or diaphragm as shown in Fig. 5.2. Flexing of the plate is similar to that of the bimorph except that the differential expansion is now the relative lateral expansion between the ceramic and the metal sheet. The bond to the metal plate must allow an electrical connection to the lower face of the PXE materials and this can be achieved due to the surface "roughness", providing the adhesive layer is thin and bonding is done under pressure. Alternatively a conducting adhesive can be used.

The frequency at which a composite transducer will resonate can be controlled by changing the dimensions of the metal plate or diaphragm. The resonant frequency is inverseley proportional to the square of the plate diameter and proportional to the plate thickness.

EQUIVALENT CIRCUIT

The electrical equivalent of a piezoelectric air transducer is shown in Fig. 5.3 and will be seen to be the familiar series—parallel arrangement that is commonly used to model the behaviour of a quartz crystal. The impedance of the transducer will be relatively low when the series arm resonates, but at a slightly higher frequency a maximum impedance condition arises due to the parallel resonance between the short capacitance and the effective inductance of the series arm above its own resonant point.

A typical impedance variation is shown in the curve in Fig. 5.3. Transducers of this type can be operated at any frequency in the region of resonance and since manufacturing tolerances, temperature and circuit loading cause variation of operating frequency, the associated circuits must be designed to accommodate variations of, say, 5 per cent. For this reason, a narrow band amplifier may be desirable and circuits that allow the transducer to "dictate" the operating frequency are sometimes used.

DIRECT AND REFLECTING SYSTEMS

Ultrasonic transducers can be arranged as transmitter and receiver elements, in either direct or reflecting systems. In the direct system the transmitter and receiver are separated and the beam of ultrasound is interrupted in some way by, say, objects (to be counted) on a conveyor belt. This system is illustrated in Fig. 5.4 and gives reliable operation since most objects strongly attenuate the ultrasound when they block the beam.

In the reflected sound system the transmitter and receiver can be positioned side by side but difficulties sometimes arise due to reflections from other

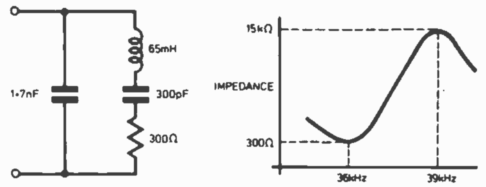

Fig. 5.3. Typical impedance variation and equivalent circuit. The values are typical for Mullard MB4015 transducer

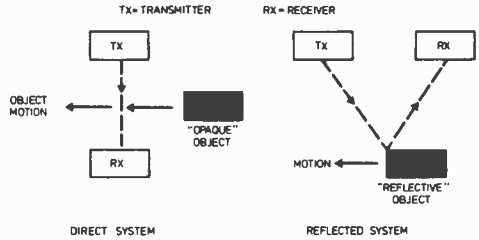

Fig. 5.4. Ultrasonic detection using the direct and reflecting systems

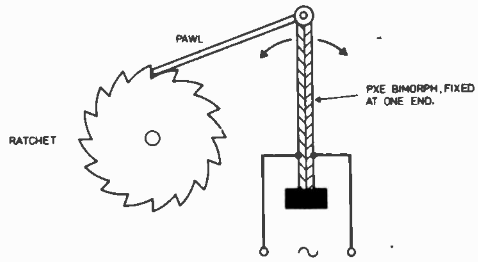

Fig. 5.5. An electric clock motor using the PXE bimorph principle

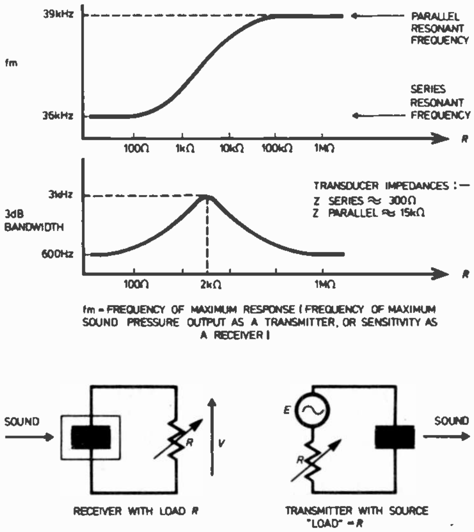

Fig. 5.6. Variation of characteristics with loading resistance

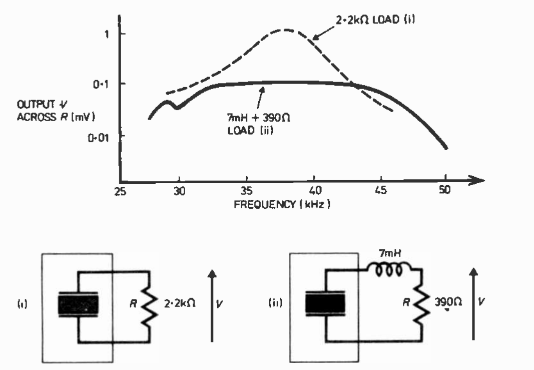

Fig. 5.7. Response with inductive loading added

than the wanted objects. Further, some objects do not give a strong sound reflection and acoustic screening is sometimes necessary between transmitter and receiver to improve the reflected signal/background "noise" ratio.

PIEZOELECTRIC MOTOR

An interesting example of one application of a PXE bimorph is as an electric clock motor. In this system the bimorph is made to flex and the movement is converted to rotary motion by a ratchet and pawl arrangement as shown in Fig 5.5. In a practical realisation using this principle a virtually silent clock mechanism was constructed using a 500-tooth ratchet wheel and fine wire loop as a pawl. The power consumption was about 1mW.

LOADING RESISTANCE

It has already been mentioned that the characteristics of an air transducer are very dependent on the electrical loading. When used as a receiver transducer the input resistance of the amplifier loads the element, whereas for transmitter applications the output resistance of the generator circuit represents the loading resistance. The frequency of maximum response and the 3dB bandwidth both vary with the loading resistance and typical variations are shown in Fig. 5.6.

When the loading is less than the impedance at the series resonant frequency, or greater than the impedance at the parallel resonant frequency, the bandwidth tends to a maximum value of about 600Hz. At an intermediate loading value the bandwidth reaches a maximum of about 3kHz. Notice that the maximum response frequency rises from the value of the series resonant frequency to the value of the parallel resonant frequency as the load resistance is raised.

Over the range of values for R from 100Ω to 50kΩ the efficiency of the typical air transducer remains fairly constant. When used as a receiver (microphone) the frequency response can be made uniform over a band of 10 to 15kHz by employing inductance in series on parallel with load resistance R. This effect is illustrated in Fig. 5.7.

ATTENUATION

Since air attenuates the ultrasound emitted by a piezoelectric transducer and this loss increases as the frequency is raised, most simple low cost air transducers operate well below 100kHz. Specialised devices, operating at frequencies of several megahertz, are however used in applications involving liquids such as water and oil as the medium.

Applications are many and varied, ranging from high power Sonar and echo sounding to specialised devices for blood flow measurements and other medical investigations. The interested reader is referred to the literature for further information on these areas.

ELECTRET MICROPHONE

Capacitance variation has already been mentioned in this series as a well-known example of this principle is the capacitor (or electrostatic) microphone. One disadvantage of these microphones is the need for a polarising source to energise the capacitor circuit so that current fluctuations will occur when the capacitance is varied. Since the wanted output signal from such a microphone is small the hum and noise introduced by the power supply must be kept very low if reasonable signal-noise ratios are to be achieved.

A fairly recent development in this area is the so-called electret microphone due to Sesslen and West of the Bell Telephone Laboratories, in which the need for a power supply is removed. The diaphragm is made from a foil electret which is simply a special dielectric film which has been permanently polarised during manufacture. The film thus provides its own voltage source and can be used to make very small microphone capsules which are to be found in some makes of cassette recorders as well as being used as the basis for wide frequency response individual units.

As with the normal capacitor microphone, the output is very small and a high-impedance input preamplifier is often incorporated in the same housing as the microphone capsule to increase the available signal level to about 1mV in normal use. It should, perhaps be mentioned that the electrostatic principle has also been applied, very successfully, to the production of wide frequency response loudspeakers and high frequency tweeter units where advantage is taken of the low mass of the moving parts of the transducer.

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THERE are two basic sets of Voice Filters, one set covers the Piano tone, whilst the other set produces the Harpsichord effect. The Honky-Tonk sound is produced by mixing the two voices together. The full set of filters is shown in schematic form in Fig. 4.1. The bottom two octave outputs from the Envelope Board are connected to the low (L) input, the middle two octaves to the (M) input, and the top octave to the (H) input. The voice circuits make wide use of passive low and high pass filters, but the main response is obtained from the use of adjustable band pass amplifiers based on the integrated circuit operational amplifier type 741.

FREQUENCY RESPONSE

The overall frequency response of the Piano and Harpsichord filters are shown in Fig. 4.2. Referring to the Piano filter response curves it can be seen that the three filters are set up centred on different frequencies of approximately 420Hz, 550Hz, and 700Hz. This makes the bottom three octaves rich in at least the second harmonic, with a lower harmonic content for the top two octaves. The range of fundamental frequencies applied to each filter is indicated above the graph.

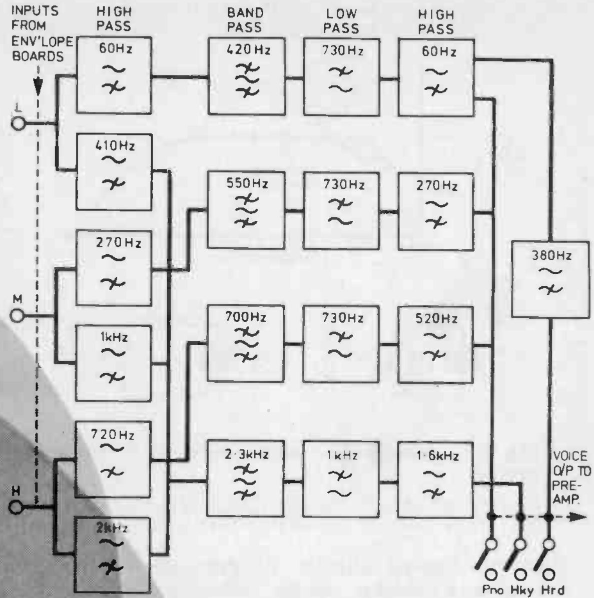


Fig. 4.1. Voicing filters for the Joanna

PE JOANNA PART 4

By A.J. BOOTHMAN B.Sc.

The Harpischord filters have a very sharp bass cut response, with some variation between (L), (M) and (H) inputs. Consequently the second and higher harmonics are strongly emphasised, with the fundamental being well attenuated. A high frequency roll off is necessary in order to reduce the effect of beehive breakthrough. From both Fig. 4.1 and Fig. 4.2 it can be seen that a high degree of low frequency cut is used on the mid and high range Piano inputs. This controls the attack "thump" in these registers to a realistic degree, and further high pass filtering on the low range input reduces the bass response when the Honky-Tonk voice is selected.

OUTPUT WAVEFORMS

Sample waveforms are shown in Fig. 4.3, for each of the C notes on the Piano voice setting, and middle C on Honky-Tonk and Harpsichord voice settings. On the Piano voice waveforms the variation in harmonic content across the compass is clearly demonstrated, with predictable modifications to the waveform for the other two voices.

VOICE FILTER CIRCUITS

The Voice Filter circuitry is shown in Fig. 4.4. The low, medium, and high inputs are controlled by I.C. 8, 9 and 10 respectively whilst the main Harpsichord filter is built around IC7. The Q of these twin-T band-pass amplifiers can be adjusted by the associated preset potentiometers, and the voice selection is achieved by opening the correct voice switch which is normally shorting its signal to ground.

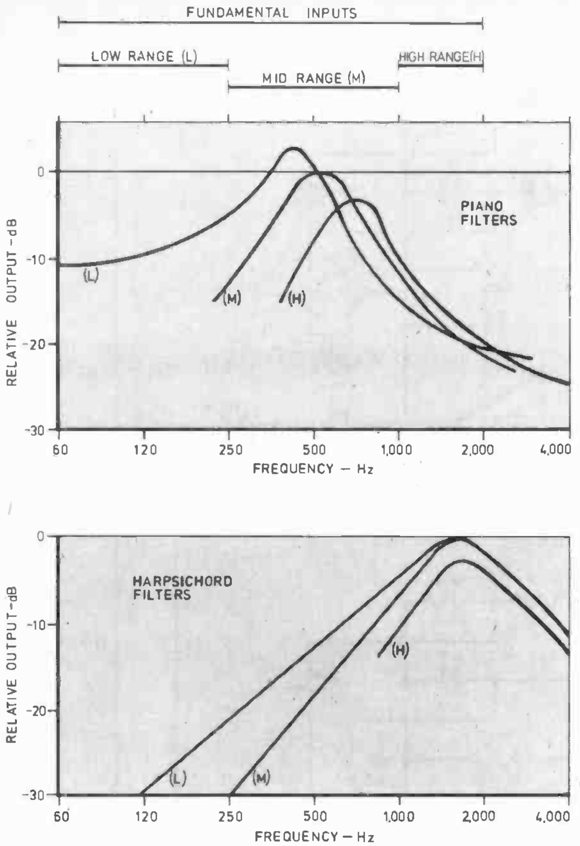


Fig. 4.2. Frequency responses for the Piano and Harpsichord filters

PREAMPLIFIER

The Voice Filter outputs are mixed into a 741 preamplifier, which has a voltage controlled amplifier type MFC6040 in a feedback loop. This i.c. can handle up to 500mV r.m.s. at pin 3 and therefore requires a voltage sharing resistor network on its input as shown in Fig. 4.5. Since the amplifier is an invertor its output is fed into the non inverting input of the 741 to give negative feedback. The overall gain of the preamplifier is controlled by a d.c. input line to pin 2 of the MFC6040 the voltage of which is set by preset potentiometer VR9, and is further adjusted by the Soft Pedal switch and Tremolo Generator.

HEADPHONE AMPLIFIER

The circuit for the headphone amplifier is also shown in Fig. 4.5, and uses a low power (250mW) Class B integrated circuit type MFC4000B. This amplifier will drive approximately 40mW into standard stereo headphones, which when connected in parallel have an impedance of approximately 4 ohms. The MFC4000B is powered by a 10 volt rail taken from the power supply unit on the input to the 5 volt regulator.

TREMOLO GENERATOR

A phase shift oscillator can be operated at two alternative frequencies to generate slow and fast tremolo effects, TR22 amplifies the sinewave output from the oscillator and modulates the d.c. control voltage to the MFC6040.

SUPPLY LINES AND SUSTAIN PEDAL CIRCUITS

In order to simplify Figs. 4.4 and 4.5, the power supply lines and components have been omitted and are shown in Figs. 4.6 and 4.7. The Sustain Pedal

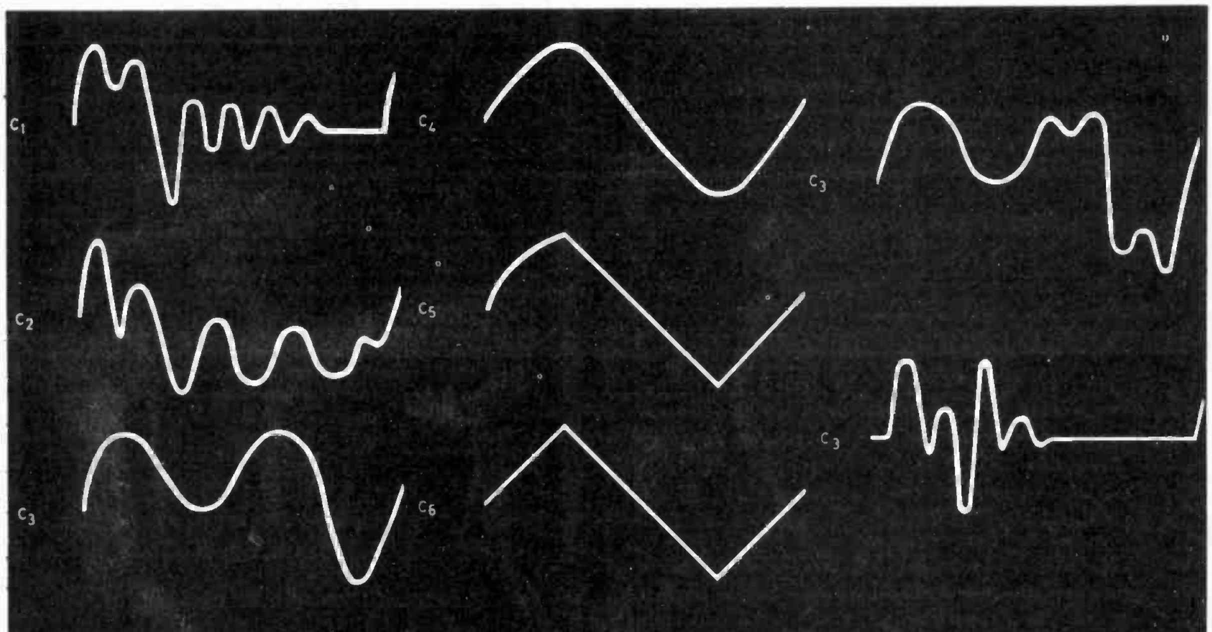


Fig. 4.3 Sample output waveforms for the three voice settings. C_1 to C_6 are for each of the Piano voice C notes. C_3 upper right and C_3 lower are for the Honky-Tonk and Harpsichord voice settings

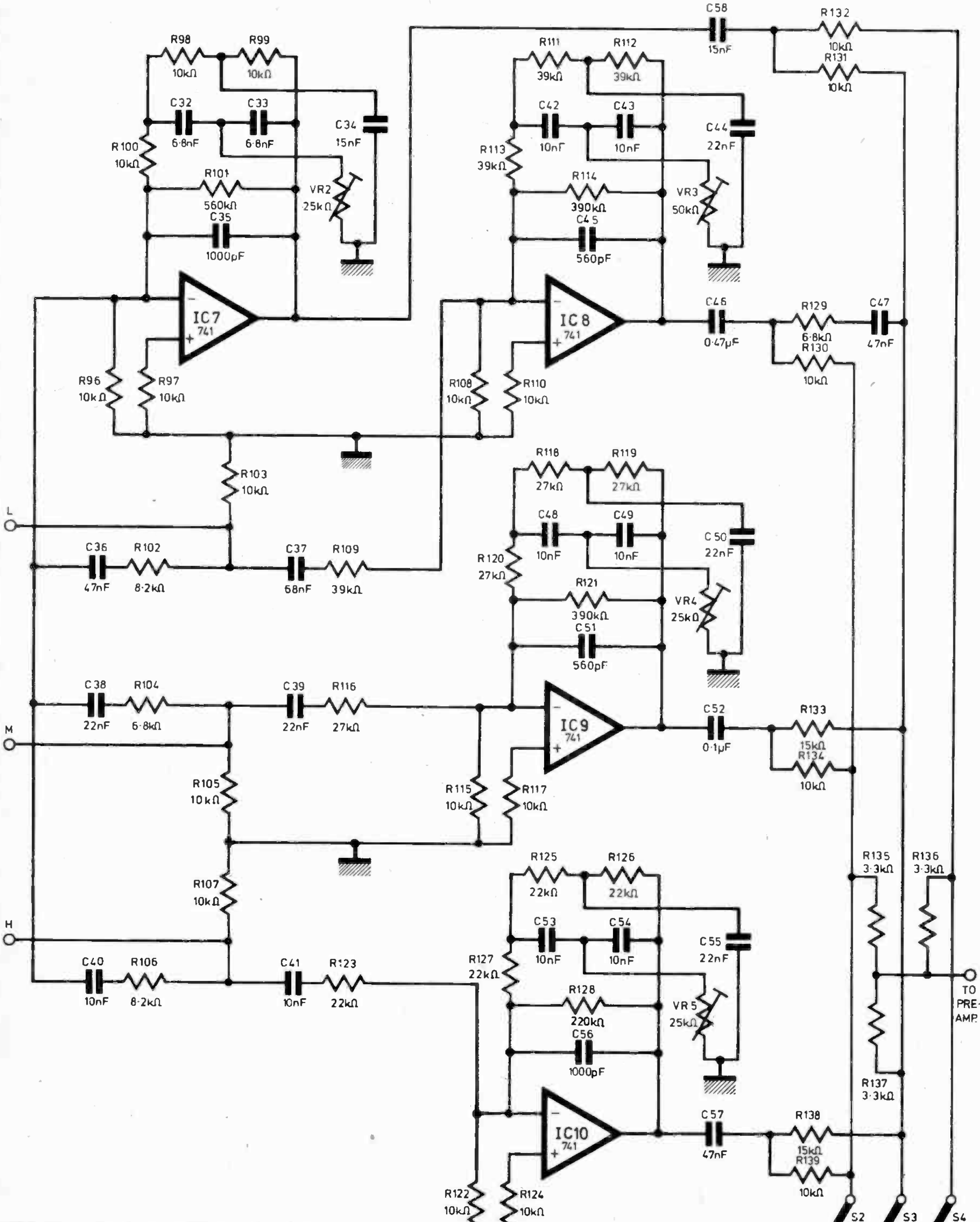


Fig. 4.4. The Voice Filter circuitry

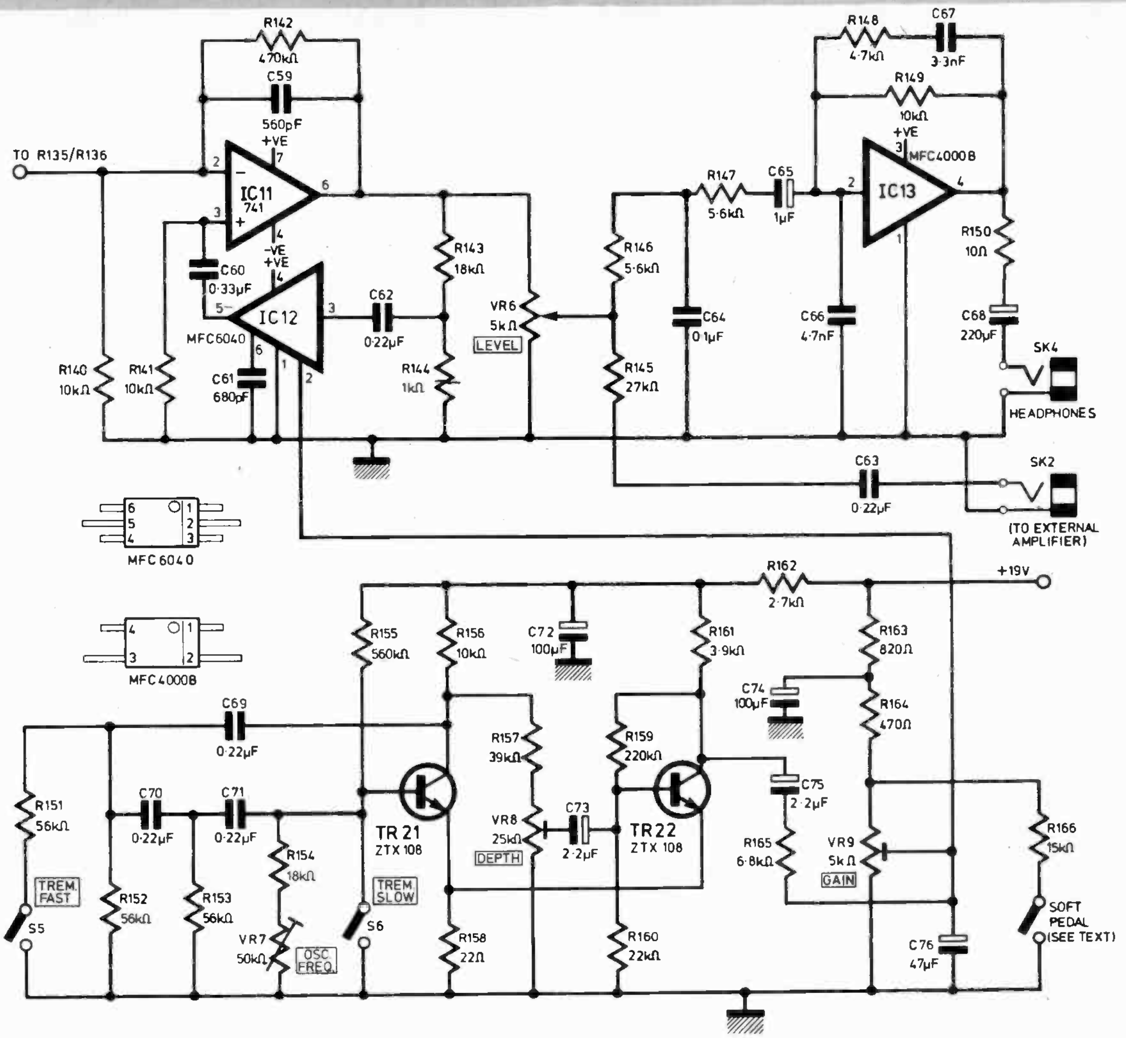


Fig. 4.5. Circuits for the Preamplifier, Headphone Amplifier, Tremolo Generator and Soft Pedal action

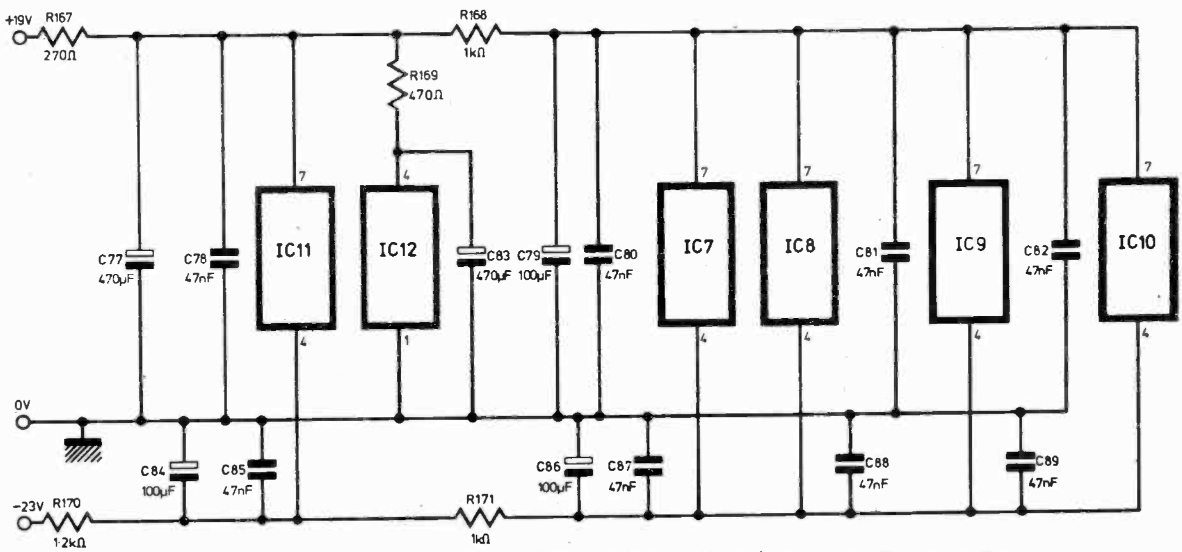


Fig. 4.6. Power supply line components for the Voice circuits and Preamplifiers

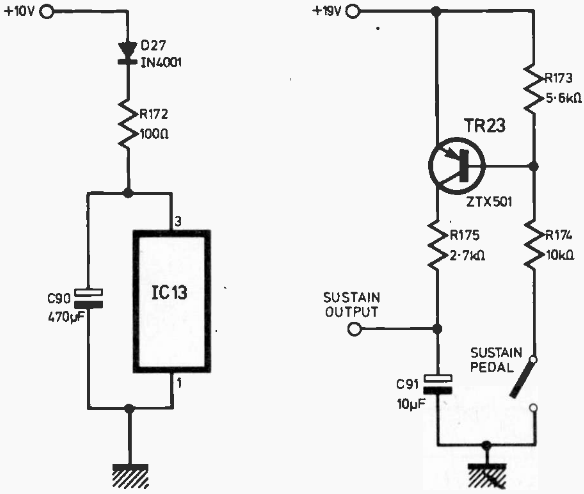


Fig. 4.7. Power supply components for Headphone Amplifier and the Sustain Pedal circuit

circuit is also shown which uses a *pnp* transistor, normally in the off condition. When the pedal is depressed, the transistor is switched on, and the output rises from ground potential to approximately 9 volts (see Fig. 4.7).

VOICE/PREAMPLIFIER BOARD

The Voice Filters, Preamplifier, Headphone Amplifier, Tremolo circuitry, Soft and Sustain Pedal circuitry are all mounted on a single printed circuit board, the etching and drilling details for which are given in Fig. 4.8, with component mounting details.

The component density on this board is very high, and some extra care will be necessary in construction to ensure that the components used can be accommodated on the board. Terminal pins and presets should first be assembled on the board, followed by resistors, small capacitors, transistors, and integrated circuits. The larger capacitors should be assembled last, and will in some cases be positioned at a distance from the board surface to clear small components which will lie underneath them. Care should be taken to ensure that the transistors and integrated circuits are inserted in the correct orientation, corresponding with the assembly details given in Fig. 4.8, and that the electrolytics are inserted with the correct polarity.

VOICE CIRCUIT ADJUSTMENT

The overall gain of the Preamplifier is first set by adjustment of VR9 to a level which does not distort the output when two heavy chords are played together at maximum weight, with the output level control VR6 set at maximum. The tone/colour of the Piano sound is set by VR3, VR4 and VR5, for the lower two octaves, middle two octaves and top octaves respectively. These should be individually adjusted, with S3 and S4 closed, to suit the ear of the constructor. VR2 controls the Harpsichord and should be adjusted with S2 and S3 closed, to the point of minimum background breakthrough.

COMPONENTS . . .

VOICE/PREAMPLIFIER BOARD

Resistors

R96–100	10kΩ	R128	220kΩ	R157	39kΩ
R101	560kΩ	R129	6·8kΩ	R158	22Ω
R102	8·2kΩ	R130–132	10kΩ	R159	220kΩ
R103	10kΩ	R133	15kΩ	R160	22kΩ
R104	6·8kΩ	R134	10kΩ	R161	3·9kΩ
R105	10kΩ	R135–137	3·3kΩ	R162	2·7kΩ
R106	8·2kΩ	R138	15kΩ	R163	820Ω
R107–108	10kΩ	R139	10kΩ	R164	470Ω
R109	39kΩ	R140–141	10kΩ	R165	6·8kΩ
R110	10kΩ	R142	470kΩ	R166	15kΩ
R111–113	39kΩ	R143	18kΩ	R167	270Ω
R114	390kΩ	R144	1kΩ	R168	1kΩ
R115	10kΩ	R145	27kΩ	R169	470Ω
R116	27kΩ	R146–147	5·6kΩ	R170	1·2kΩ
R117	10kΩ	R148	4·7kΩ	R171	1kΩ
R118–120	27kΩ	R149	10kΩ	R172	100Ω
R121	390kΩ	R150	10Ω	R173	5·6kΩ
R122	10kΩ	R151–153	56kΩ	R174	10kΩ
R123	22kΩ	R154	18kΩ	R175	2·7kΩ
R124	10kΩ	R155	560kΩ		
R125–127	22kΩ	R156	10kΩ		

All $\frac{1}{3}$ watt, 5% tolerance.

Capacitors

C32–33	6·8nF	C62–63	0·22µF
C34	15nF	C64	0·1µF
C35	1,000pF	C65	1µF 16V elect.
C36	47nF	C66	4·7nF
C37	68nF	C67	3·3nF
C38–39	22nF	C68	220µF 10V
C40–43	10nF	C69–71	0·22µF
C44	22nF	C72	100µF 16V elect.
C45	560pF	C73	2·2µF 16V elect.
C46	0·47µF	C74	100µF 16V elect.
C47	47nF	C75	2·2µF 16V elect.
C48–49	10nF	C76	47µF 16V elect.
C50	22nF	C77	470µF 16V elect.
C51	560pF	C78	47nF
C52	0·1µF	C79	100µF 16V elect.
C53–54	10nF	C80–82	47nF
C55	22nF	C83	470µF 16V elect.
C56	1,000pF	C84	100µF 16V elect.
C57	47nF	C85	47nF
C58	15nF	C86	100µF 16V elect.
C59	560p	C87–89	47nF
C60	0·33µF	C90	470µF 10V elect.
C61	680pF	C91	10µF 16V elect.

Diode
D27 1N4001

Transistors
TR21–22 ZTX108 TR23 ZTX501

Integrated Circuits
IC7–11 741 IC12 MFC6040 IC13 MFC4000B

Potentiometers
VR2 25kΩ horiz preset
VR3 50kΩ preset
VR4 5–25kΩ preset
VR6 5kΩ 1in pot. with switch
VR7 50kΩ horiz preset
VR8 22kΩ horiz preset
VR9 5kΩ horiz preset

Miscellaneous
S2–6 Single pole on-off switch
Terminal pins (27 off)

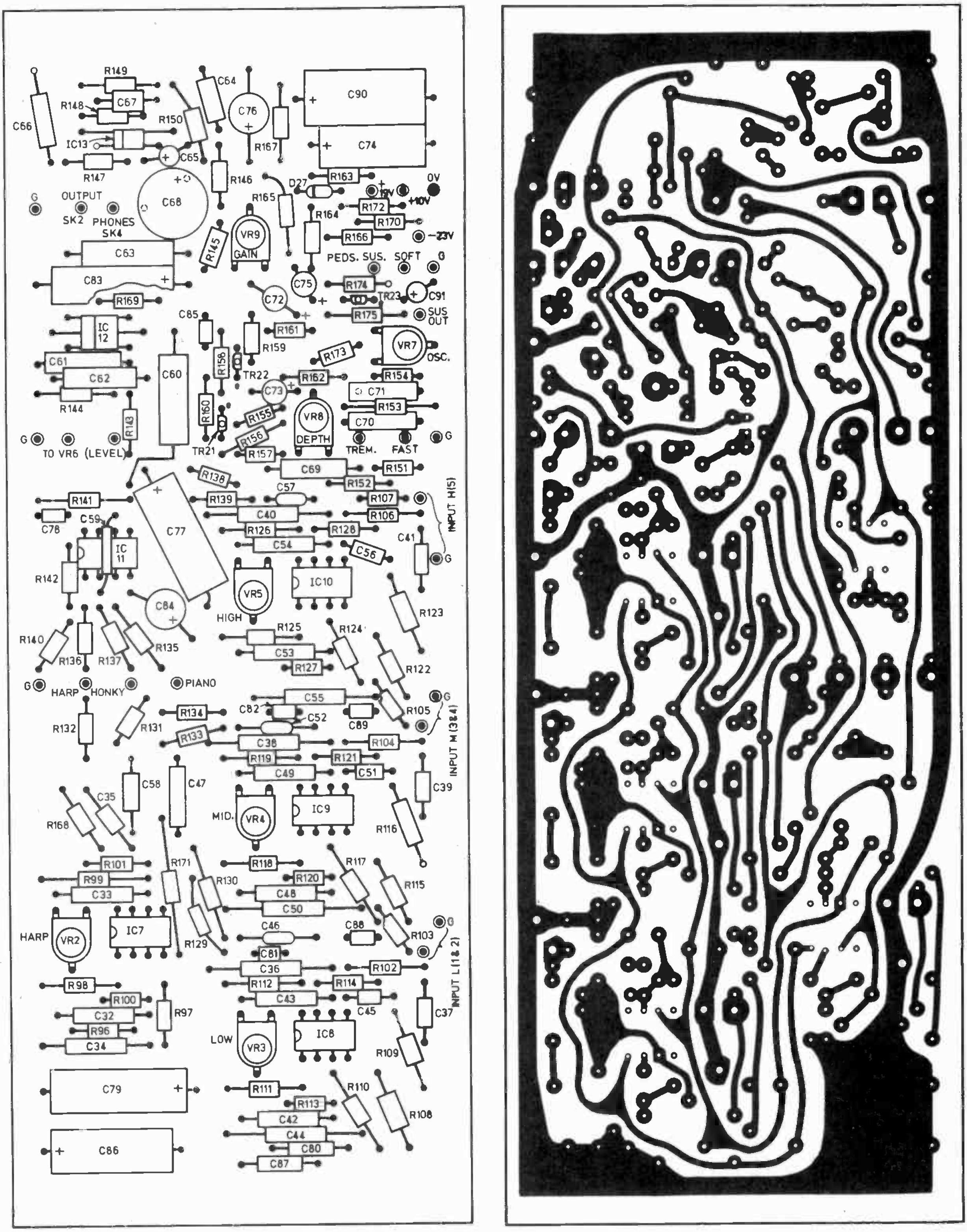


Fig. 4.8. Component mounting and p.c.b. etching details

TREMOLO ADJUSTMENT

With S6 open the Tremolo Generator may or may not oscillate immediately which can be determined by setting VR8 approximately at the centre of its travel. If oscillation does not occur, VR7 should be adjusted until oscillation commences. VR8 should then be adjusted until a good level of tremolo is obtained with minimum breakthrough sound in the speaker when a note is not being played. S6 should be switched on and off to ensure that the generator starts reliably every time, and VR7 slightly re-adjusted until a consistent start is obtained. With S5 closed the fast tremelo should work. If the background tremolo breakthrough increases on this setting, VR8 should be adjusted.

OVERALL TONE VARIATION

Some variation in overall tone may occur depending on the power amplifier and speaker combination used with the Piano. Further top cut may be obtained if required by increasing the value of C59.

PEDAL SWITCHES

The switches associated with the pedals have a very simple single pole on/off action, the mechanical arrangement of which will be described on the last part of the series. Pedal action occurs in both cases when the relevant switch is closed to ground, and can be simulated for test purposes by shorting straps on the board from the relevant pin to ground.

In the case of the Soft Pedal, the degree of attenuation is controlled by R166. The individual characteristics of each MFC6040 can effect the attenuated level, and it may in some cases be necessary to change the value of R166 to suit. A lower value should be used for increased attenuation.

It should be noted that patents are pending for the envelope generation system.

Next month: Case assembly, amplifier and tuning details.

V.A.T. AND COMPONENTS

For the benefit of our readers and advertisers we publish, in full, a press announcement by Customs and Excise and the Electronic Components Board. This explains how the new V.A.T. regulations are being interpreted in respect to circuit components (see opposite page).

The following additional information helps clarify the V.A.T. situation as it affects home constructors. The details were obtained in the course of direct consultations with the headquarters of H.M Customs & Excise.

Readers having particular problems are advised to contact their local H.M. Customs & Excise V.A.T Office.

HOME CONSTRUCTOR KITS

A concession has been made in respect of *Complete Kits* for making goods or equipment of a kind that are subject to the lower (standard) rate of V.A.T. (for examples see below). Where less than one third (by value) of the components included in the kit are rated, individually, at 25 per cent, the whole kit is chargeable at 8 per cent.

GENERAL PURPOSE MATERIALS

All Veroboard, blank s.r.b.p., and other general purpose building materials are chargeable at 8 per cent. Printed Circuit Boards, being designed for specific uses, are chargeable according to the rate appropriate to the finished equipment.

COMPLETE EQUIPMENTS

Subject to the Higher Rate of V.A.T.

Includes: Radio, television and audio equipment, electronic musical instruments, and most electrically operated domestic (and gardening) appliances, photographic aids, d.c./a.c. inverters, and power supplies.

Subject to the Standard Rate of V.A.T.

Includes: Digital clocks, pocket calculators, automobile devices (not for in-car entertainment), most kinds of electronic test equipment, e.g. electronic test meters, signal generators and c.r.o.'s, Geiger counters, gas detectors, metal locators, light dimmers, thermometer controllers, electronic games.

MAIL BAG

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

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

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

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

V.A.T.

JOINT PRESS ANNOUNCEMENT BY CUSTOMS AND EXCISE AND THE ELECTRONIC COMPONENTS BOARD

The Electronic Components Board have made representations to the Government that the Finance Bill should be amended to exclude the application of the 25 per cent rate of VAT to electronic components. These representations are being considered, but meanwhile the Electronic Components Board and the Department of Customs and Excise have been in consultation in order to establish means of interpreting the law as it stands at present in such a way to give rise to a reasonable minimum of difficulty.

The Electronic Components Board and Customs and Excise have agreed upon the following recommendations to traders:

1. *Product categories to be charged at 25 per cent VAT*
   - *a.* TV cathode ray tubes.
   - *b.* TV tuners including tuners featuring touch button controls and/or remote control units.
   - *c.* TV delay lines.
   - *d.* TV, radio and audio loudspeakers (except loudspeakers suitable only for public address purposes).
   - *e.* TV and radio wound assemblies (deflection coils, colour correction coils, line output transformers, switched mode inductors, wound aerial rods, r.f. and i.f. wound assemblies).
   - *f.* All receiving valves for domestic use.
   - *g.* All voltage multipliers for domestic use (triplers, etc)
   - *h.* Modules for domestic appliances.
   - *i.* Consumer modules for TV, radio and audio equipment.
   - *j.* Linear integrated circuits suitable for use in TV, radio and audio equipment.
   - *k.* Discrete Semiconductors:
     - i Transistors, triacs and thyristors, plastic encapsulated and less than 3 amps rating.
     - ii Power transistors for TV deflection applications.
     - iii All plastic diodes of less than 1 amp rating, excepting 2*f*.
     - iv All plastic encapsulated Zener diodes of power rating less than 3 watts.
     - v Rectifiers of a kind suitable for use in low voltage battery charger equipment having a current rating of less than 5 amps.
   - *l.* Capacitors (excluding those types indicated in 2*m*).
   - *m.* Resistors (excluding those types indicated in 2*n*).
   - *n.* Switches having a rating of less than 5 amps and user controls (variable resistors, etc) of less than 2 watts max. dissipation of a kind suitable for use in TV, radio and audio equipment.

2. *Product categories to be charged at 8 per cent VAT*
   - *a.* Professional assemblies.
   - *b.* Storage systems.
   - *c.* Matrix stacks.
   - *d.* Industrial assemblies (Norbit logic elements, etc).
   - *e.* Automobile assemblies (excluding those products used for in-car entertainment equipment—radio, stereo, etc).
   - *f.* Microwave products (tube, solid state or passive networks).
   - *g.* Professional deflection assemblies.
   - *h.* All professional tubes.
   - *i.* Infra red devices.
   - *j.* Integrated circuits (excluding items indicated in 1*j*).
   - *k.* Ferrites and wound ferrites (excluding items indicated in 1e).
   - *l.* All discrete semiconductors (excluding those items indicated in 1*k*).
   - *m.* Capacitors:
     - i Paper capacitors of greater than 0·5 microfarad and/or metal cased.
     - ii Sintered Tantalum capacitors of greater than 300 microfarad and/or metal cased.
     - iii Film capacitors meeting IEC specification 68·2 or equivalent (21 day humidity rating) and/or metal cased.
     - iv Electrolytic capacitors meeting IEC specification 103 Type I—85 C or equivalent specification or operating in excess of 200 V.a.c.
     - v Mica capacitors.
     - vi Vacuum and pressure gas capacitors.
   - *n.* Resistors:
     - i Metal film with a stability better than 1 per cent over 1,000 hours.
     - ii Wirewound resistors (except main ballast resistors of a kind suitable for use in TV, radio or audio equipment).
   - *o.* Edge Connectors and connectors for more than 8 ways.
   - *p.* Electro mechanical components—excluding switches having a rating of less than 5 amps and users controls (variable resistors, etc) of less than 2 watts max. dissipation of a kind suitable for use in TV, radio and audio equipment.
   - *q.* Magnets.
   - *r.* Printed circuits for the assemblies described in items 2*a*, 2*d* and 2*e*.

It is recognised that there may be some individual products to which the application of these definitions is not entirely straightforward. If a firm finds one of its products is described above as chargeable at 25 per cent but, in its view, the product is not suitable for use as a part of goods within the Higher Rate Schedule, it may report the facts to the Electronic Components Board which will, if necessary, take the matter up with Customs and Excise, when an individual ruling will be given. The recommendations above will, in any case, be kept under review in the light of experience.

See also notes on page 656.

RECMF

London Electronic Component Show

DESPITE the current economic climate, a much reduced volume of exhibitors and a general atmosphere of depression in the industry, the 1975 London Electronic Component Show was still well attended by both the trade and non-professional visitors. Indeed, for the first time in years it was almost possible to get round, in a very sketchy manner, in a day, rather than being faced with the very necessary two or three day effort the larger past events have demanded.

Clearly, the days of the Honeywell Girl and bikini-clad beauties draped over oscilloscopes or resistors are, almost, things of the past—a good or a bad thing dependent on your viewpoint. But the absence has not in any way detracted from the interest level of the show because, with a scope extending from simple resistors and capacitors right through to manufacturing plant and instrumentation, there was lots for all to see. The more so with the growing application of i.c.s to all walks of life.

TRAINS AND

In this context all the main names appeared to be on show and one of the more eye-catching exhibits was, of all things, a model railway on the GEC Semiconductors' stand. To be honest, the railway was only being used to illustrate the operation of a sorting system under the control of a microprocessor. In fact the demonstration was very effective, consisting of shunting a large number of small carriages, each with a letter of the alphabet on its roof, until they made up a sentence which could be read.

Data input to the system to instruct what was to be "printed" was through a keyboard-input visual display unit and the actual sorting from a jumble of letters to a sensible set of words took only a matter of minutes. Indeed, the speed of the system was very obviously limited by the operational speed of the trains rather than the microprocessor.

From the comments of bystanders it is very obvious that this area of semiconductory is now well to the forefront of the development wave. It has obvious application areas in things like business machines, complex desk calculators, teaching machines and all sorts of data handling areas from industry to commerce.

The train system was demonstrated by GEC Semiconductors and used the Intel 8080 microprocessor chip. This is a new device which is fast proving itself out in the British market.

The same manufacturers now sell a simpler device, the 4040, which is capable of many applications such as badge reading, automotive control, multi-function calculator applications and so on, for a mere £13·97 one-off.

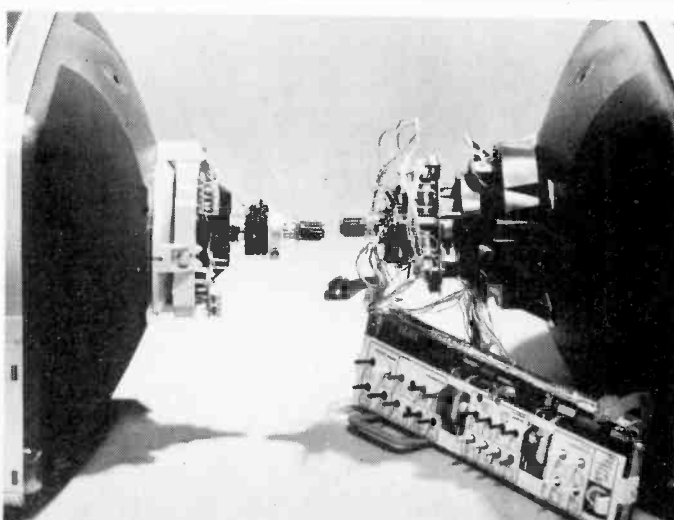
Clearly this type of product is finding its way into the low cost experimental areas.

SETS AND

Semiconductors are not the only area where more is being supplied in one package. On the television front it is not unusual to see tubes supplied ready equipped with yokes and other associated parts as a preassembled unit. Thus Thorn Colour Tubes now supply setmakers with their P.I. (Precision In-line) colour tubes as an assembly including scanning coils and beam bender units. In this way all the dynamic and static convergence and purity adjustments are precision set prior to the units leaving the factory.

Such sophistication allows the new tubes to be plugged into a

The Weller DS100 soldering and desoldering station



Thorn precision in-line 110° colour tube compared with a conventional 110° tube colour set with much the same ease as a black-and-white tube.

TOOLS AND

Staying for a moment with the mechanical side of electronics, for the more wealthy amongst us Weller have produced a smart soldering and desoldering station specifically designed with the printed circuit man in mind. Incorporated are a soldering iron and a selection of bits, holder, low voltage transformer, desoldering tool in the shape of a further iron and suction equipment with a foot switch for "hands-free" actuation, and a nice "see-through" solder collector.

It is surprising just how many people were showing a very active interest in the British Central Electrical E-Z-Hook products, those tiny and not-so-tiny test terminals with projecting/sliding hooks which lend themselves to latching on to wires on a p.c.b. or in similar inaccessible places.

Their latest brainchild is the Micro-Hook, a version designed to cope with multi-legged i.c.s so as to get signals in to or out from chips without removal or shorting.

MEASUREMENT

Instruments always attract a lot of interest at any electronic exhibition and this year probably one of the more interesting products was a tiny oscilloscope from the now renowned firm of Scopex.

Called the 1S 10, the new instrument only measures 135 × 196 × 60mm and has the surprising bandwidth of d.c. to 10MHz at 500mV/div. This drops to 1MHz at 10mV/div.

Horizontal sweep speeds are from 1µs to 1s/div and the trigger can be positive or negative and will free run when without a signal.

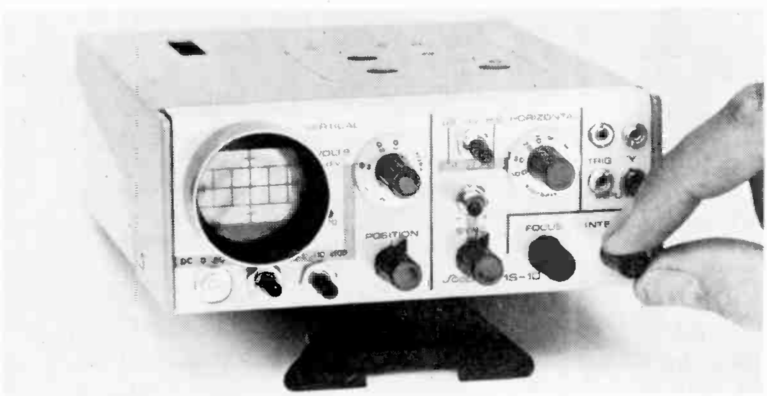
As a battery portable instrument priced at £198, this is quite something for the engineers briefcase, to go with his Sinclair Cambridge 300 and pocket tape recorder. For the rest of us the normal Scopex 10MHz beast will presumably suffice quite well!

Still on the instruments front there were some interesting developments from J. J. Lloyd with a series of low-cost chart recorders which started at £110 for a single-channel version known as the CR500. This is a real down-to-earth instrument without any frills designed to meet most educational and quite a few industrial applications. It is a 1 per cent instrument with five ranges from 10mV or 10µA up to 100V f.s.d., 2 per cent linearity and 0·5 per cent repeatability. Not at all bad for the price.

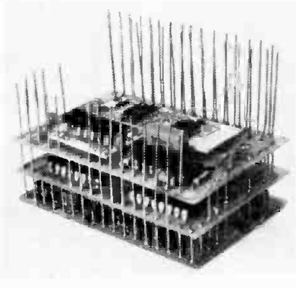
A three-channel version, the CR503, is also available.

Just to round off the instruments, there were quite a few overseas sourced items including complex automatic test gear. Some, indeed, seems to go beyond the needs of British customers since one manufacturer was showing telephone dial test equipment capable of coping with touch-dial machines.

Slowly it is dawning on many people that whilst touch dialling will be available here some time in the future it will not utilise the full speed of the system as each telephone will have to be fitted with a memory which will accept the mechanically inputted information and release it slowly enough for the telephone system equipment to cope with it.

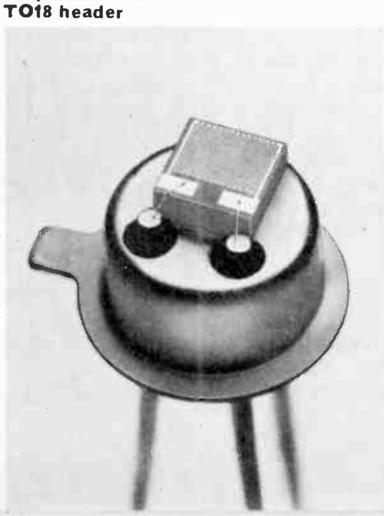


The miniature Scopex 1S 10 10MHz oscilloscope



The high component density obtainable with hybrid circuits

A planar resistor mounted on a TO18 header



MINIATURISATION

So much for high speed test gear!

Whatever direction one moves in, miniaturisation seems to appear on all sides. Resistors and capacitors get constantly smaller or are uprated, which amounts to the same thing, and hybridisation or other methods of construction allow yet further reduction in size. Typical items appeared on the Welwyn stand where hybridisation was displayed together with some rather interesting layer-built applications of the principle.

On the same stand were some applications of planar resistors, truly precision devices mounted on TO18 or slightly larger headers. With a wide value range available capable of achieving down to ±0·005 per cent this product is ideally suited to precision resistor networks.

THE TRANSISTOR AS A ZENER

By I. D. EVANS

To control the voltage applied to a circuit it is necessary to have a reference voltage which, typically, is obtained by the use of a Zener diode.

However, it is a well-known—if little used, fact that when a transistor is in operation the voltage between the base and emitter, V_{be}, is affected little by large changes in base current, I_b, assuming a value close to 0·2V for germanium transistors, and close to 0·6V for silicon transistors. Similarly, I_b is almost zero unless V_{be} exceeds a minimum value equal to roughly 0·1V and 0·5V for germanium and silicon transistors respectively.

This article explores a number of possible applications for this "built-in" reference voltage. It must be noted here that because of the relatively large fractional changes that occur in V_{be} with germanium transistors, the initial increase in base current with increasing base-emitter voltage is rather slower than for comparable silicon transistors and thus, for most of the uses discussed, silicon transistors operate more effectively than germanium transistors.

ZENER DIODE CIRCUITS

Fig. 1 shows a simple circuit which can perform the function of a Zener diode, switching from a low to a high conductance state over a fairly narrow voltage range in the region of a voltage determined by the relative values of R1 and R2. When V is low, V_{be} is determined solely by the R1/R2 potential divider since there will be no base current and hence all the current through R1 must flow through R2. This will apply until V_{be} reaches the critical value referred to above, the corresponding value of V in volts being approximately $\frac{R1+R2}{10\times R2}$ and $\frac{R1+R2}{2\times R2}$ for germanium and silicon transistors respectively. As V increases above this value, I_b, and with it I_c start to increase in such a way that V_{be} remains nearly constant. The dynamic resistance of the circuit can be shown to be approximately equal to R1 divided by β, the common emitter current gain of TR1.

Thus the circuit behaves like a Zener diode with a Zener voltage and dynamic resistance as given above. One important difference, however, is that the Zener voltage can readily be adjusted over a wide range by using a combination of variable and fixed resistors in place of R1 and R2. Variation of R2 alone is advised since this will have no effect on the dynamic resistance of the circuit when in the "on" state and little effect on the resistance of the device in the "off" state resulting from the finite values of R1 and R2.

ACTUAL VALUES

It may be helpful, or at least of interest, to include comparisons between theory and the actual behaviour of selected transistors when used in the circuit of Fig. 1. Relevant information is presented in the form of Tables 1 and 2.

In Table 1, information is given describing the behaviour of two BC109s and two OC81s, the theoretical values being calculated assuming switch-on voltages of 0·55V and 0·09V for the BC109 and OC81 transistors respectively.

The Zener voltages recorded here were obtained by extrapolating the roughly linear, low resistance part of the I/V characteristics to obtain an intersection with the V-axis.

This can be done quite easily with silicon transistors, but is much harder with germanium transistors for the reason noted earlier, the values recorded for the OC81s thus suffering from considerable uncertainty.

Table 2 compares the behaviour of a number of silicon and germanium transistors (two of each type were used). The Zener voltages recorded are "apparent" bcause they were obtained simply by recording the voltage across the circuit of Fig. 1

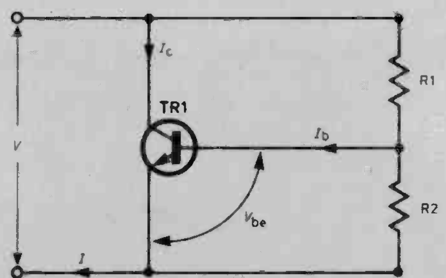


Fig. 1. Basic "Zener Transistor" circuit

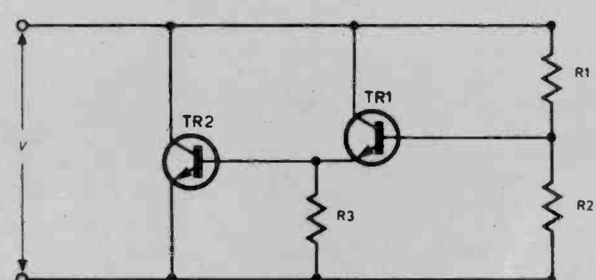


Fig. 2. A high version of the circuit of Fig. 1

when a current of approximately 0·25mA was flowing through the transistor.

This measurement can be made by connecting a 68kΩ resistor in series with the circuit of Fig. 1, applying 20V across the combination and measuring the collector-emitter voltage with a voltmeter having a resistance of 100kΩ or more (thus a 10kΩ/V, 10V f.s.d. instrument is quite satisfactory for the purpose).

The Zener voltages predicted here, assuming switch-on voltages of 0·55V and 0·09V for all the silicon and germanium transistors respectively, are 4·3V and 2·9V for the circuits using silicon and germanium transistors respectively.

A useful modification of this basic circuit is shown in Fig. 2. Here, two transistors are coupled in such a way that the combined gain is approximately equal to the product of the common emitter current gains of the two transistors. As a result of the very high effective β one can achieve a very low value for the dynamic resistance in the on state and/or a very low value for leakage current flowing through R1 and R2 in the off state.

R3, a suitable value for which will be in the range from 10kΩ to 1MΩ, helps reduce the effects of leakage current through TR1 which would be amplified by TR2. R3 is thus most important when germanium transistors are being used since these often have relatively high leakage currents; however it also helps circuit performance with silicon transistors.

Table 1. Practical (a) and theoretical (b) Zener voltages (R2 fixed at 10kΩ for the BC109's, or 2·2kΩ for the OC81's)

R1	BC109		OC81	
	a (volts)	b (volts)	a (volts)	b (volts)
10kΩ	1·1, 1·1	1·1	0·45, 0·5	0·5
47kΩ	3·2, 3·3	3·15	1·9, 2·1	2·0
68kΩ	4·3, 4·4	4·3	2·7, 3·0	2·9
100kΩ	6·2, 6·2	6·05	4·4, 4·8	5·0
150kΩ	8·9, 9·1	8·8	6·0, 6·5	6·2
220kΩ	11·8, 12·0	12·65	8·7, 9·5	9·1

Table 2. Apparent Zener voltages (see text) of a range of transistors in the circuit of Fig. 1 with R1 fixed at 68kΩ, and R2 fixed at 2·2kΩ or 10kΩ for germanium or silicon transistors

Type	- Description	Apparent Zener voltage
2N2926	*npn*, silicon	4·4, 4·4
2N4059	*pnp*, silicon	4·4, 4·5
2N4062	*pnp*, silicon	4·3, 4·4
BC109	*npn*, silicon	4·4, 4·5
BC168	*npn*, silicon	4·5, 4·6
BC258	*pnp*, silicon	4·3, 4·4
OC44	*pnp*, germanium	2·7, 2·9
OC71	*pnp*, germanium	3·2, 3·3
OC81	*pnp*, germanium	2·8, 3·0

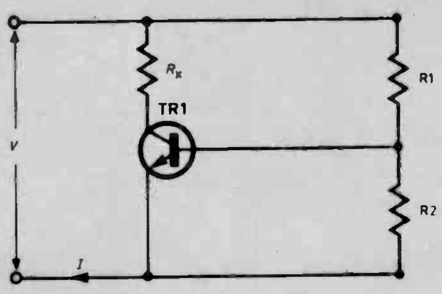


Fig. 3. Current limiting or load resistance circuit

Because of the two base-emitter junctions the Zener voltage is given approximately by $\frac{R1+R2}{5\times R2}$ V and $\frac{R1+R2}{R2}$ for germanium and silicon transistors respectively, the value of R3 having little effect on this.

CIRCUIT VARIATIONS

Fig. 3 shows another variation of the basic circuit, the resultant circuit diagram being identical to that for the potential-divider biased common emitter amplifier stage. R_x here can serve two roles, either it can be a current-limiting device or it can be a load resistor or circuit.

In the first case the behaviour of the circuit, in terms of both the Zener voltage and the dynamic resistance, will be very little affected if R_x is less than $\frac{R1}{\beta}$. If R_x is greater than $\frac{R1}{\beta}$, then, as I increases, R_x will take an increasing fraction of the voltage applied to the circuit and will limit the potentially damaging rapid initial increase in I and will thus serve to protect the device without increasing the initial dynamic resistance, as would be the case when a resistor is connected in series with a Zener diode.

Instead of being a current-limiting resistor, R_x may represent a component or circuit to which one wants to supply voltage in a controlled way.

If R_x is large compared to $\frac{R1}{\beta}$, then, almost as soon as the transistor starts to conduct, the whole of V is dropped across R_x, little power being dissipated at TR1, and thus this circuit could, for instance, be used instead of a thyristor in controlling the power supplied to a circuit, when V might be the output of a transformer-rectifier bridge network.

IMPORTANT DIFFERENCES

Two important differences between the functioning of this circuit and a thyristor are that this circuit switches at a point determined by the value of V rather than by a phase shift network, thus making its operation essentially frequency independent, and, that the current through this circuit does not have to be reduced to zero for the device to revert to the off state, reduction of V below the critical value being sufficient.

NEGATIVE RESISTANCE CIRCUITS

It is a simple matter to use the circuit of Fig. 1 to achieve effectively the reverse of the function which the circuit performs. Thus, the circuit of Fig. 4 conducts current well up to a certain voltage—which is approximately equal to $\frac{R1+R2}{10\times R2}$ and $\frac{R1+R2}{2\times R2}$ for germanium and silicon transistors respectively, at which the current through R_X decreases over a fairly narrow voltage range to almost zero and stays very low while V increases further.

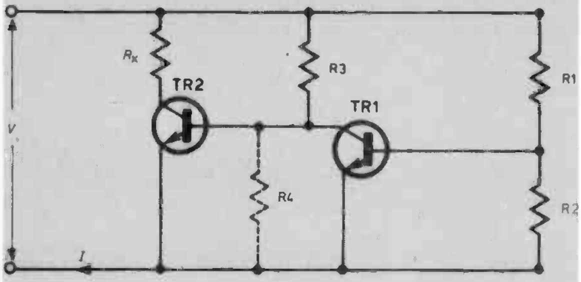


Fig. 4. Negative resistance circuit

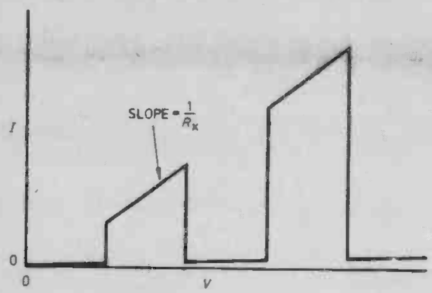


Fig. 5. Connecting a number of the elements of Fig. 4 in series can give a voltage/current relationship of this form

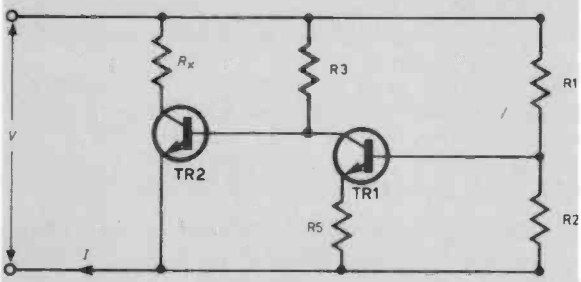


Fig. 6. An improved negative resistance circuit

I, the total current entering the circuit, behaves in a similar way though it never decreases to quite such a low value and also, as one increases V, starts to increase again slowly after the rapid decrease.

If one also includes a resistor R4, as shown dotted in Fig. 4, then the circuit possesses both a switch-on voltage, determined by R3 and R4, as well as a switch-off voltage, determined by R1 and R2. Indeed (although the author can at present think of no practical reason for doing so) one can connect a number of these stages together, six being so far the maximum number attempted by the author, in such a way that, as the voltage applied is progressively increased, current through R_x is alternately switched on and off, yielding current/voltage characteristics of the type shown in Fig. 5.

If one considers the functioning of the circuit shown in Fig. 4, it is clear that, in the voltage range over which I is reduced from a high to a low value, the circuit possesses negative resistance characteristics, I decreasing while V is increasing. To be useful in practice, however, as a negative resistance device, a much wider range for the "negative resistance" is highly desirable.

ALTERNATIVES

To achieve this, several alternatives have been investigated. Firstly, by virtue of the fact noted at the end of the introductory section, germanium transistors perform the switching-off over a much wider range of values of V than a comparable silicon transistor.

Secondly, one can extend the negative resistance range by using a larger value for R1 and/or a TR1 with a lower β; in doing so, however, one must ensure that the effective resistance of TR1 can attain a low enough value to switch off TR2.

Thirdly, one can incorporate an extra resistor R5 as shown in Fig. 6, of such a value (of the order of 10kΩ) that, whilst allowing the switch-on of TR1 to switch off TR2, V_{be} for TR1 increases relatively slowly with V because of the voltage across R5 accompanying the collector current flowing through TR1. In this last case, it is of interest to note that the circuit will again revert to a low conductance state when V is increased to a sufficiently high value, determined, assuming the effective resistance of TR1 is then very much less than R5, by the relative values of R5 and R3. ★

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8 CHANNEL LOGIC TRACE MULTIPLIER

By A.C. Ainslie

During the design of logic systems of any complexity a timing or sequence diagram is usually drawn to show the order in which operations or sequences start and finish in relation to one another. Should any difficulties arise in the development or testing stage, as they invariably do, it is very useful to display part or all of the timing diagram on an oscilloscope in order that the trouble may be traced.

Most scopes nowadays are double beam, with a few models having provision for a 4-channel plug-in. The design to be described enables up to eight logic channels to be displayed on a single beam oscilloscope. Dual trace scopes, therefore, will be able to display a single analogue signal (perhaps the output of a transducer feeding the logic) as well as a maximum of eight channels of logic.

The eight channels are obtained by a system of multiplexing and are in the correct timing relationship as viewed on the scope. The unit is capable of displaying two, four or eight channels and each channel gives a loading to the circuit under test of one TTL load.

In some systems a timing pulse may be very short (as little as 10ns or 20ns) in relation to the operating cycle which may be several seconds for an industrial control application. Clearly the short timing pulse would not show as it is so narrow. The unit therefore incorporates a "stretch" circuit so that the position of the timing pulse can be made visible in relation to the rest of the display. Provision has to be made to trigger the stretch circuit from both positive and negative going pulses.

SPECIFICATION . . .

Input Signals
One standard TTL load (i.e. logic 1 is between 2·4V to 5V, logic 0 is between 0V and 0·8V. A signal at logic 1 must supply a current of 40μA, and at logic 0 must be able to sink 1·6mA, whilst preserving the aforesaid voltages). There is also capacitive loading due to the connecting cable which should be as short as possible in high speed systems.

Frequency Response
Bit rates from d.c. to 5MHz.

Pulse Stretch
Will detect a pulse of 15ns and stretch to a length of between 2μs and 50ms in 3 ranges (Channel 8 only).

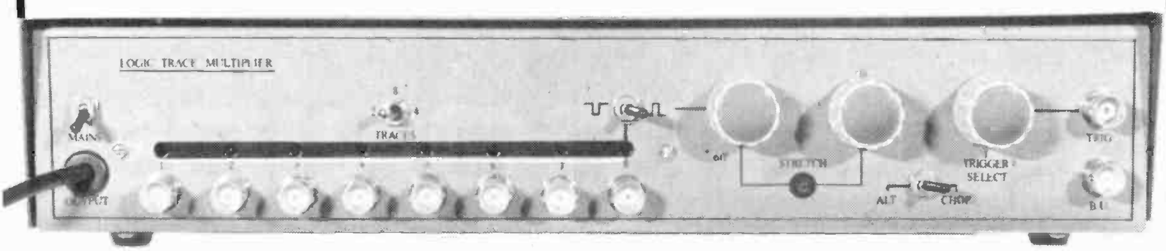
Mode
Chop or Alternate 2, 4 or 8 traces.

Chop Rate
Approximately 250kHz.

Trigger Section
The switch selects one of the 8 inputs for transfer to the Trig O/P socket.

Scope Timebase Gate Input
Handles a signal of from 2V to 50V pk, positive during scan.

Bright Up Output
15V pulse positive to cut-off trace. Output impedance <1kΩ.



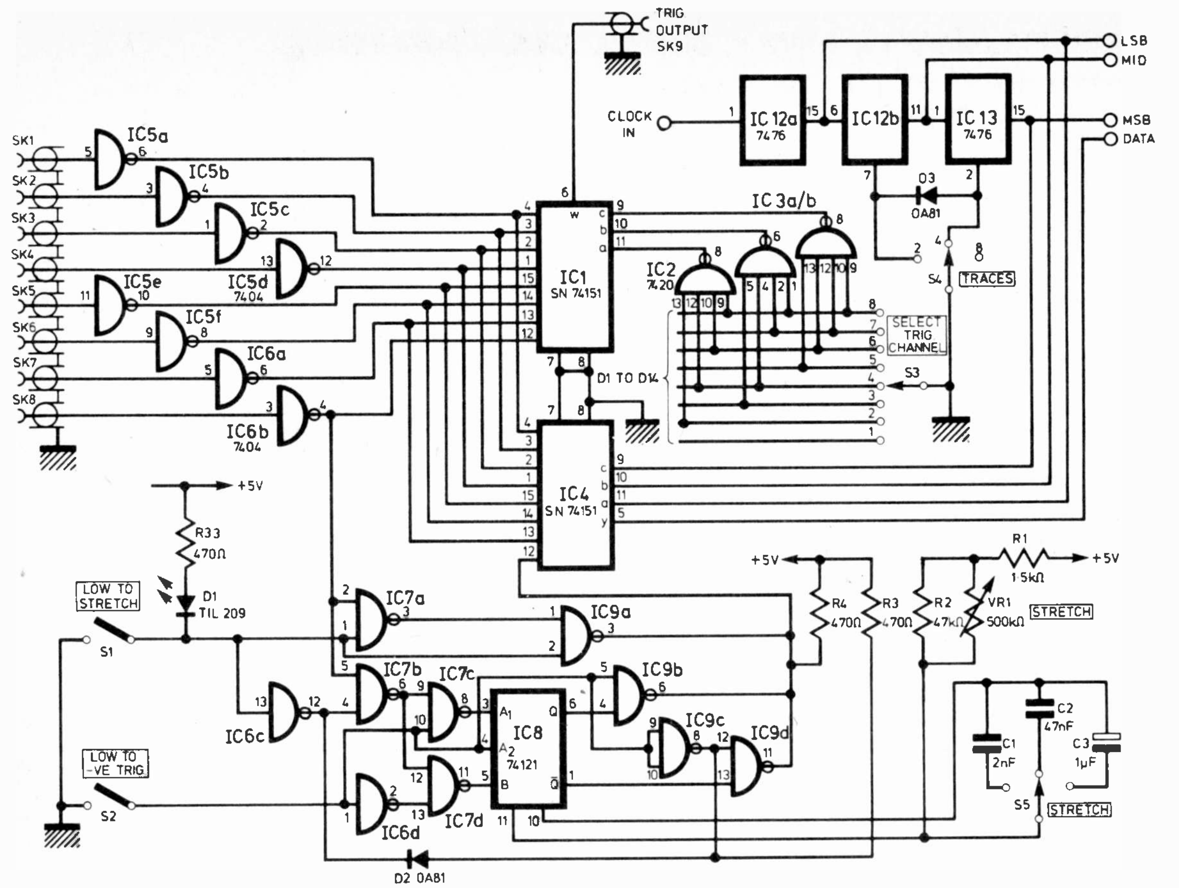


Fig. 1. Main circuitry of the trace multiplier showing the input multiplexing and trace stretching sections

In order for the display to be satisfactory at high sweep speeds and not show the multiplex action, the unit is capable of operating in the alternate or ALT mode, which means that, as in a conventional scope trace multiplier, each sweep is made of one input and the source change occurs during flyback. In the chopped or CHOP mode the unit sequentially samples each input as fast as is reasonably possible so that during a single sweep a complete multi-trace picture is built up.

In order that any switching transients may be blocked out a Bright Up output is available to drive the oscilloscope tube Z axis.

CIRCUIT DESCRIPTION

Fig. 1 shows the main circuitry for the input multiplexing and the stretch function.

IC5a to IC5f and IC6a and IC6b are input buffers to isolate the rest of the electronics from the unit under test.

IC1 and IC4 are identical 74151 data selectors/ multiplexers. These pass to the output the signal input which is addressed on pins 9, 10 and 11 in binary.

IC1 selects the signal to be made available for triggering the scope timebase. It is convenient to use an 8-way switch for the selection at the front panel and so the switch position has to be coded to binary by IC2 and IC3, a total of three, 4-input NAND gates in two 7420 packages. The W output of the 74151 is inverting with respect to the input but as each input is preceded by an inverter the output is in the same sense as the input selected by S3.

The W output of IC1 is made available at SK9 on the front panel to trigger the scope timebase, as internal triggering is obviously not feasible in this application.

PULSE STRETCHER

The output of IC6b is fed to IC7a and IC7b. When S1 is open IC7a and IC9a are enabled and the output from IC6b is fed directly to pin 12 of IC4, the multiplex chip.

When S1 is closed, however, IC7a and IC9a are no longer enabled and the signal passes through IC7b. According to whether S2 is open or closed the signal is passed to pins 3 or 5 of IC8, a 74121 monostable. Pin 3 is the "A" input and triggers the monostable when it goes negative; pin 5 is the "B" input which triggers when it goes positive.

To use the B input either pin 3 or pin 4 (the A_2 input) has to be low, and to use the A_1 input pin 4 must be high. This is achieved by coupling pin 4 to switch S2.

By changing S2 the monostable can be made to trigger from positive or negative pulse edges. To ensure that the output of the pulse stretch section is in the correct sense with respect to the pulse edge which triggered the monstable, S2 also switches gates IC9b and IC9d to pass either the Q or $\overline{Q}$ output of the monostable respectively.

D1 is included to ensure that when S1 is open IC9d is not enabled. In the quiescent state the Q output of the monostable is also low so that only IC9a is enabled as is required.

To summarise, closing S1 passes the signal through the pulse stretch electronics. The l.e.d. D1 shows when the pulse stretch is in use.

With S2 open the signal is passed to the A_1 input of the monostable and the Q output is selected. with S2 closed the signal triggers the B input and the $\bar{Q}$ output is selected.

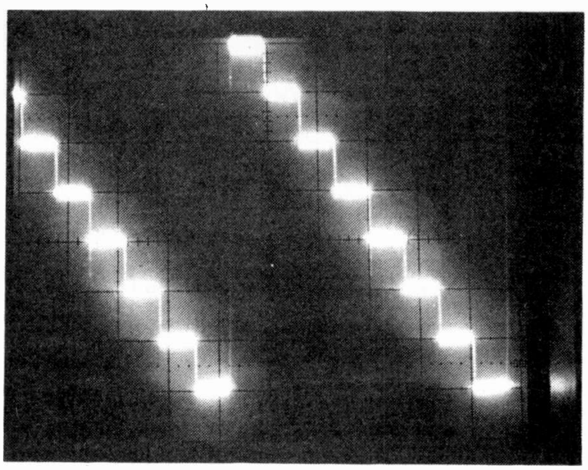
The signal at the output node of IC9a, IC9b and IC9d passes to pin 12 (input selected by address 111) of IC4.

In order to strobe through all the inputs the addresses to IC4 increase sequentially from 000 through 001, etc. up to 111 and then recycle. This is achieved very simply by the two timing counters, IC12b and IC13, both 7476 devices. IC12a serves to produce a true square wave drive for IC12b. The input to IC12b is also the Least Significant Bit (LSB) of the multiplex address and so must be symmetrical, otherwise alternate inputs will be strobed for a longer time—giving unequal trace brightness.

By setting the "Preset" of IC13 to ground the output will go high and so inputs 5, 6, 7 and 8 only will be strobed. Grounding the preset of IC12b (and also of IC13 through diode D3) sends both the Most Significant Bit (MSB) and the MID address bits high, so that only channels 7 and 8 are displayed. Channel 8, with the pulse stretch facility, is displayed in all of the 8-channel, 4-channel and 2-channel display modes.

CLOCK

Fig. 2 shows the clock which drives IC12a input. IC10 is an NE555 timer running at its maximum PRF of about 250kHz. C4 is required to keep supply spikes to a minimum.



The output of the D/A displayed as a staircase without the bright-up connection being made

In the "CHOP" mode S6 is open and so IC11c is enabled, passing the 250kHz clock pulses through to IC11d and so to IC12a.

With S6 closed IC11b is enabled. The input to IC11b is from the emitter follower TR1. The positive gate signal (high during scan, low during flyback) from the CRO is applied to the base via R9 and C7. The input is at a fairly high impedance and so is compatible with most scopes—the only snag is that with a very high input (say, over 100V) the emitter of TR1 could pass spikes in excess of the 5V maximum that would normally occur with TR1 saturated. To remedy this and so avoid damaging IC11 a 4·7V Zener could be connected across R8. However with most transistor scopes this precaution would not be needed.

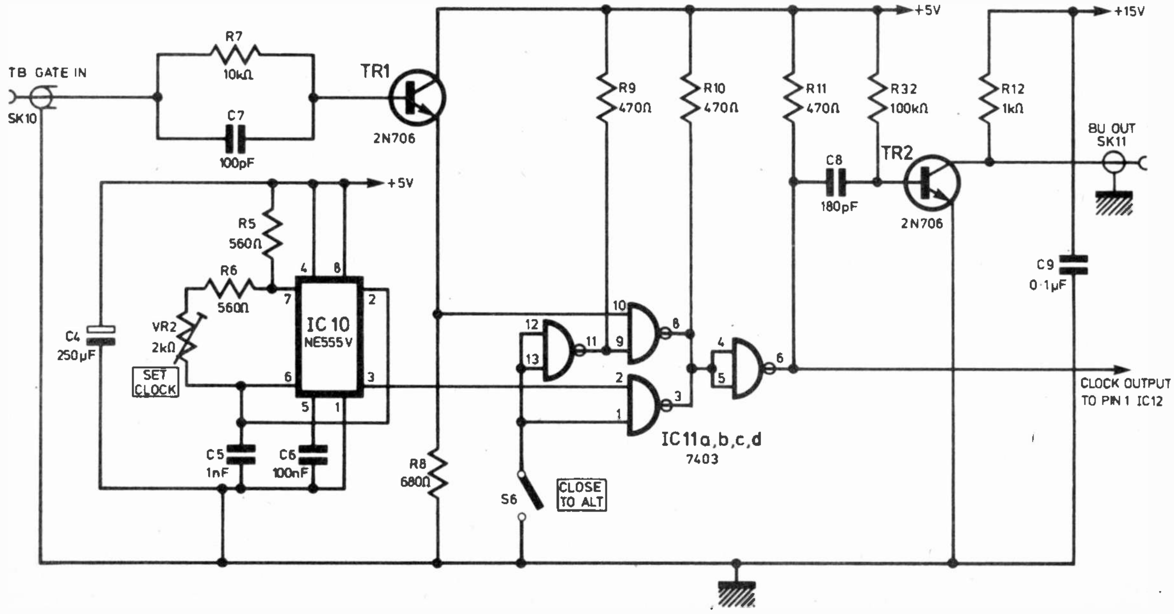


Fig. 2. The clock circuitry with input and output circuitry

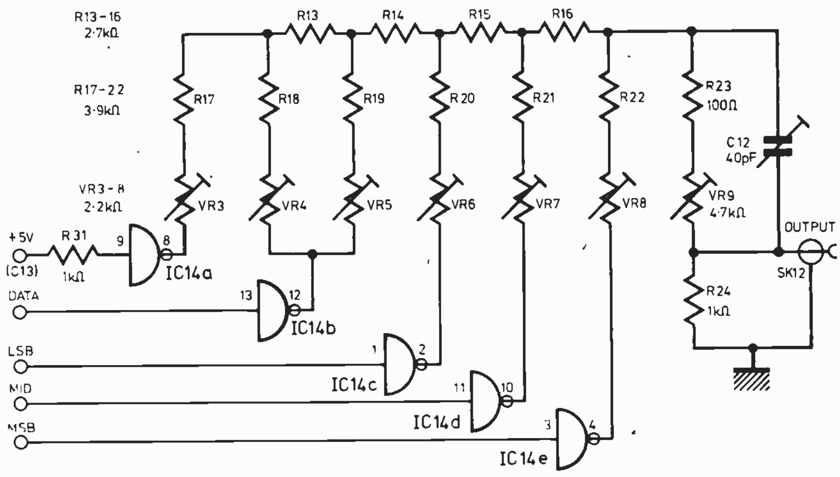


Fig. 3. The D-to-A converter circuitry which uses algebraic addition to achieve the staircase waveform

IC12a output changes in this mode once per sweep (at the end of the sweep) and so the scope sequentially displays one scan of input 1 and then one scan of input 2, etc. This mode can only be used on fairly fast speeds otherwise flicker may prove troublesome.

DIGITAL/ANALOGUE CONVERTER

So far we have only considered how the inputs are scanned and not how the eight traces are separated vertically.

Fig. 3 shows how by weighting the three address lines in proportion to their significance, and performing an algebraic addition we obtain a staircase. This is precisely what is needed for our application to give eight distinctly separated traces.

There are several ways of adding signals, the most common being in an operational amplifier. However, speed limitations exist which reduce the scope of the instrument even with expensive op-amps. The alternative method used in analogue-to-digital (A/D) and D/A converters is the "ladder network" as shown in Fig. 4. Here a 2-bit ladder is shown which gives four output levels according to the binary input. Consideration of Thevenin's theorem will confirm that in all cases the impedance "looking back" into the ladder is always *R* and that the outputs are as shown for the various binary codes applied.

This idea is easily extended to a 3-bit ladder to give an 8-step staircase. By adding two LSB's driven by the output from IC4 we can display eight traces one unit apart with the data having a height of 0·75 units. This leaves 0·25 units of space between adjacent traces. The whole display fits very nicely onto an 8cm × 10cm CRT.

DIGITAL/ANALOGUE CONVERSION

Fig. 3 shows the full circuit of the D/A converter. The ladder elements are easily distinguished. The ladder is driven directly from the outputs of the inverters in IC14. The gates have non-ideal switching characteristics with a high output of about 4V at 75Ω and a low output of 0·2V at 12Ω. In order that this variation of switch "resistance" does not upset the ladder, the ladder impedance is almost 3kΩ, high compared to the 60Ω variation in switch "resistance".

The inverters are used to drive the ladder to provide isolation and to convert the binary code from a count up to a count down, so that trace 1 is displayed at the top of the display (highest D/A output) and trace 8 is displayed at the bottom (lowest D/A output).

The 0V end of the ladder is fed from the output of an inverter, whose input is held high, to avoid linearity difficulties that could arise if this point was taken direct to ground. This means that the actual analogue output is slightly offset from ground, but this is easily compensated by the oscilloscope shift controls.

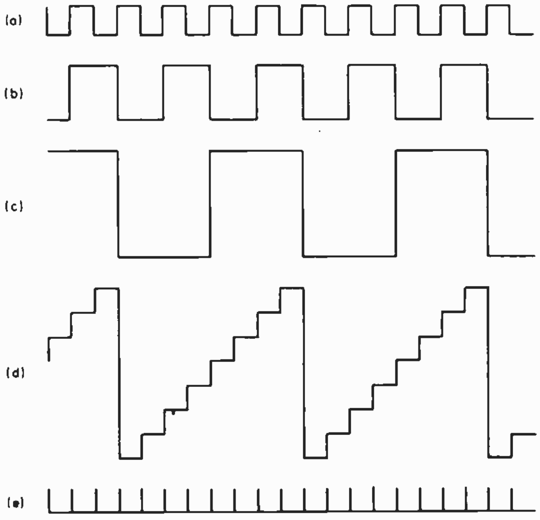
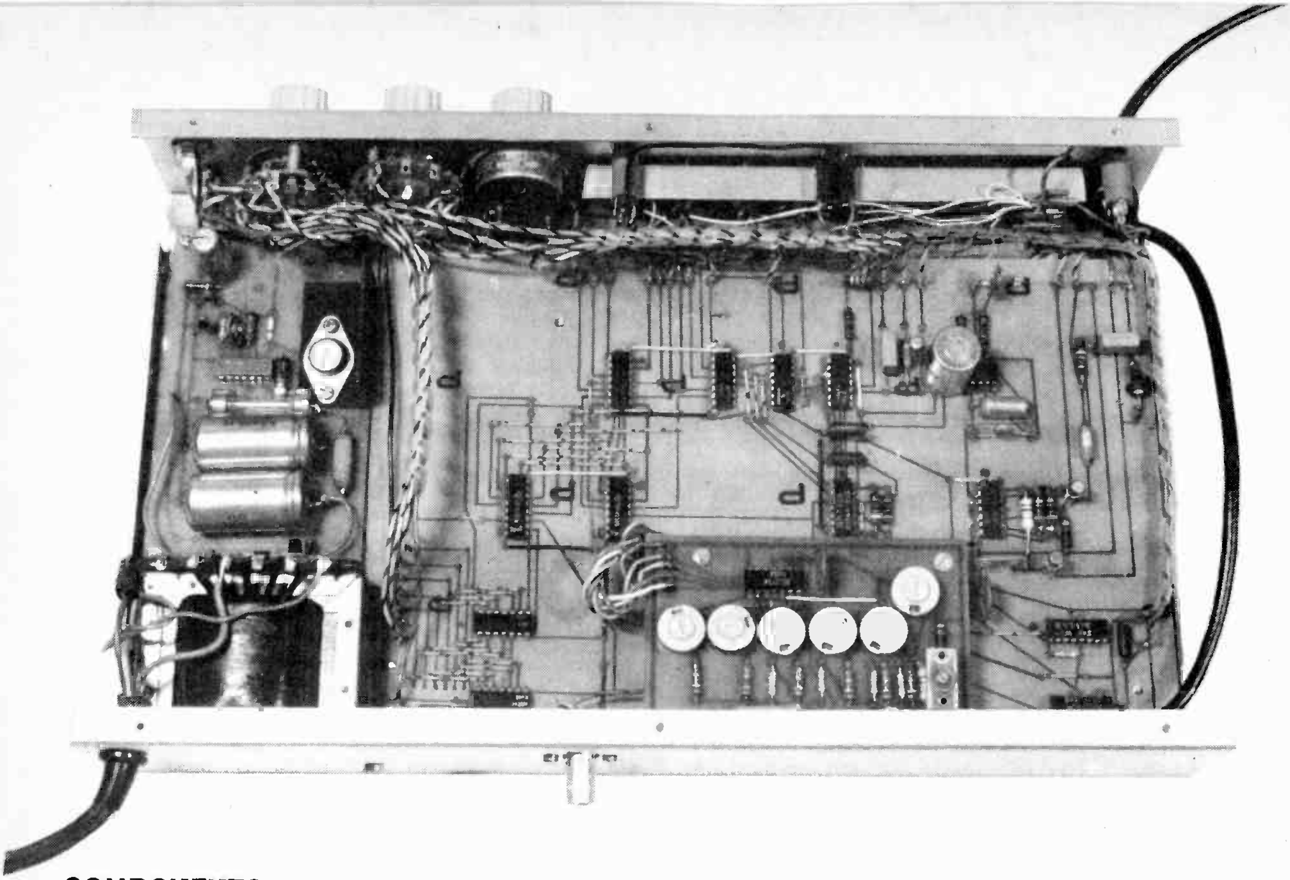


Fig. 4. Waveforms used in the D/A converter. (a) is the LSB, (b) the MID, (c) the MSB, (d) the output staircase which is an analogue output produced by adding the three binary weighted clock rates. (e) is the bright-up output



COMPONENTS . . .

Resistors

R1	1·5kΩ	R18	3·9kΩ
R2	47kΩ	R19	3·9kΩ
R3	470Ω	R20	3·9kΩ
R4	470Ω	R21	3·9kΩ
R5	560Ω	R22	3·9kΩ
R6	560Ω	R23	100Ω
R7	10kΩ	R24	1kΩ
R8	680Ω	R25	1Ω
R9	470Ω	R26	4·7Ω 2W
R10	470Ω	R27	100Ω
R11	470Ω	R28	4·7kΩ
R12	1kΩ	R29	2·2kΩ
R13	2·7kΩ	R30	1·0Ω
R14	2·7kΩ	R31	1kΩ
R15	2·7kΩ	R32	100kΩ
R16	2·7kΩ	R33	470Ω
R17	3·9kΩ		

All $\frac{1}{3}$W, 5% unless stated

Potentiometers

VR1	500kΩ log. ganged to S1
VR2	2kΩ skeleton preset
VR3–VR8	2·2kΩ preset, 6 off
VR9, VR10	4·7kΩ skeleton preset, 2 off

Capacitors

C1	2nF	C11	0·1μF
C2	47nF	C12	40pF trimmer
C3	1μF	C13	0·1μF
C4	250μF elect. 6V	C14	100μF
C5	1nF	C15	1,000μF elect. 25V
C6	0·1μF	C16	1,000μF elect. 25V
C7	100pF	C17	100pF
C8	180pF	C18	10μF
C9	0·1μF	C19	220μF elect. 16V
C10	0·1μF	C20	10μF
		C21	100μF, 6V

All 5V working or greater unless stated

Semiconductors

IC1	74151	TR1	2N706
IC2	7420	TR2	2N706
IC3	7420	TR3	2N3054
IC4	74151		
IC5	7404	D1	TIL 209 or any general purpose l.e.d.
IC6	7404		
IC7	7403	D2	OA81
IC8	74121	D3	OA81
IC9	7403	D4	1N4001
IC10	NE555V	D5	1N4001
IC11	7403	D6	5·1V 400mW Zener
IC12	7476		
IC13	7476		
IC14	7404		
IC15	μA723C		

Switches

S1 Single pole ganged with VR1

S2	SPST	S5	1-pole 3-way
S3	1-pole 8-way	S6	SPST
S4	1-pole 3-way	S7	DPST mains on-off

Miscellaneous

T1 Mains transformer. 12V-0-12 @ 0·5A sec.

D7 to D14 These are required if it is desired to indicate the trigger channel selected. Any general purpose l.e.d.s will suffice

SK1 to SK12 BNC 50 chassis mounting sockets. SK12 may be replaced with 1m of cable terminated in a b.n.c. plug to reduce ground line noise pick-up (see text)

FS1 250mA

FS2 500mA fuse ($1\frac{1}{4}$in)

Printed circuit board, TR3 heatsink, cabinet, wire and cable connecting leads, knobs, mains neon indicator, etc.

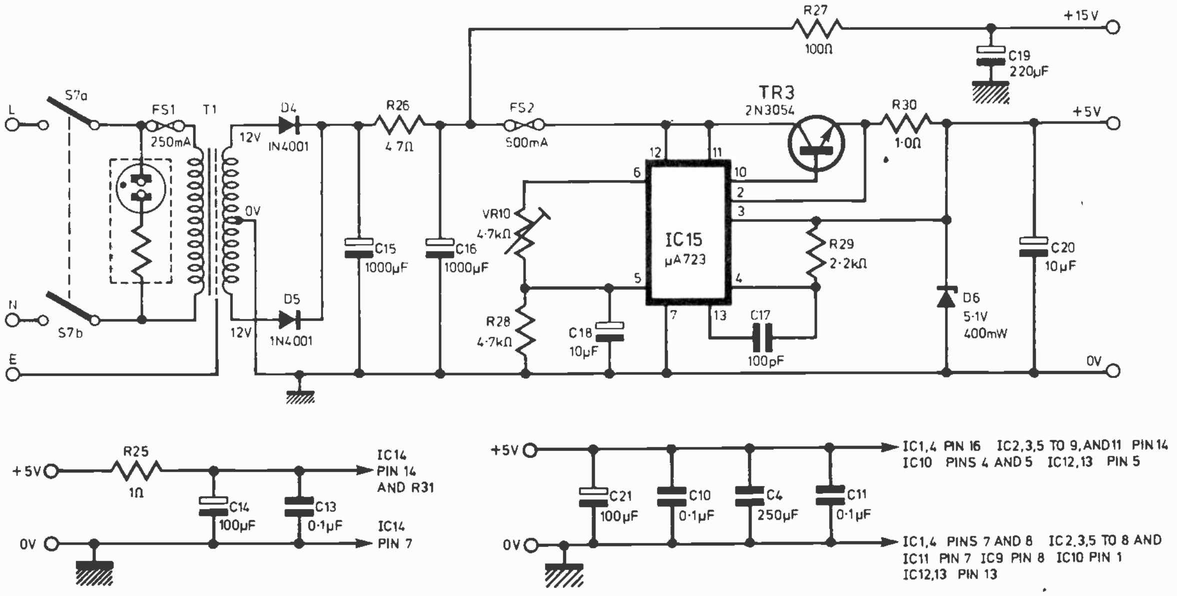


Fig. 5. Complete power supply circuit together with added smoothing for IC 14 and power bus to i.c.s.

The ladder output is at a fairly high impedance and is susceptible to waveform distortion by capacitance loading. To minimise this effect the output cable is fed from the potential divider VR9/R23. C12 provides high frequency compensation to trim up the leading and falling edges of the display.

Various switching transients on the supply lines can appear as a signal on the output of the D/A converter. To eliminate this disturbing effect the supply rail is well decoupled. The output lead braid must be grounded only at the point next to the D/A converter output to avoid picking up spikes on the ground line.

BRIGHT UP

At high speeds the transition times of the D/A converter can be quite significant and lead to an overall blurring of the display. The D/A steps occur on the falling edge of each clock pulse. TR2 is normally near saturation (V_{ce} about 1V) but the falling edge of the clock, applied through C8 (Fig. 2), cuts off the transistor momentarily. Thus the collector of TR2 has a series of +15V spikes, each coincident with a D/A step as shown in Fig. 4.

Applying these pulses to the cathode of the display CRT cuts off the trace for the duration of the transition and the short ringing period following. If a very high gain transistor is used in TR2 position it may saturate and so will not switch very fast. This can be remedied by increasing R23 a little, a quiescent collector voltage of about 1V or 2V should be aimed for. Should R23 need increasing, C8 may be reduced to keep the width of the spike at TR2 to about 10% of the clock period.

POWER SUPPLY

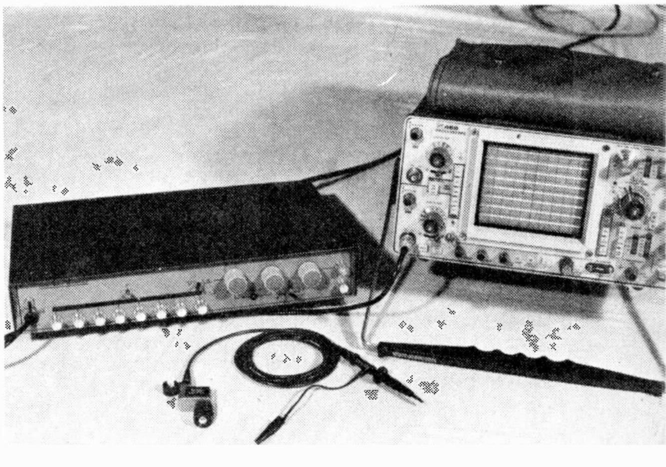
The power requirements for the instrument are a modest 5V at 500mA and 15V at 15mA.

Mains transformer T1 (Fig. 5) output is full wave rectified and smoothed. R26 and C19 provide additional decoupling for the nominal 15V supply.

The regulated 5V output is provided by IC15, a µA 723, which feeds the emitter follower TR3. A portion of the 7V reference on pin 6 of the IC is fed to pin 5, the non inverting input, where it is compared with the output from TR3, which is fed to pin 4 via a 2·2kΩ resistor for thermal stability. C17 provides high frequency compensation to prevent oscillation or ringing with transient load charges.

Overcurrent protection is achieved by monitoring the voltage drop across R30, a 1·0Ω. When the potential across pins 2 and 3 exceeds 0·6V the regulator shuts down. This corresponds to a current of 0·6 ÷ 1·0 = 600mA. Should the output exceed 5V, say, because of failure of TR3, then FS2 will blow as D6 will pass a heavy current.

Next Month: Full constructional details and setting-up.



INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit **YOUR IDEA**?

A VERSATILE FLASHER/ PULSER

A SIMPLE circuit suitable for a lamp flasher, alarm pulser, or time pulse generator, is shown in Fig. 1. Transistors TR1, TR2 and timing network *C* and *R*. form a multivibrator circuit in which both transistors are turned on whilst capacitor *C* charges and turned off when *C* discharges. Resistors R1 and R2 provide just sufficient bias for TR1, to make the circuit self-starting when *C* is fully discharged. The circuit behaves as a free running astable multivibrator, and the on and off time periods may be made almost identical by choosing a suitable value for R1. This circuit differs from the more conventional astable multivibrator circuit by having only one *CR* timing network, the single potentiometer allowing adjustment of both periods simultaneously over a wide range. Frequencies between 10kHz and 0·002Hz may be generated using values of *C* between 1,000pF and 1,000μF.

Reliable operation of this circuit can be obtained with supply voltages from five to fifteen volts.

Transistor TR3 is a medium power driver stage, controlling a lamp, l.e.d., buzzer, bleeper, etc. However, a collector load resistor may be connected to TR3 to produce a low output impedance pulse generator. If mains voltage lamps or equipment are to be controlled using this circuit, then TR3 may be connected to operate a relay or trigger a triac.

R. A. Smith,
Kempston,
Bedford.

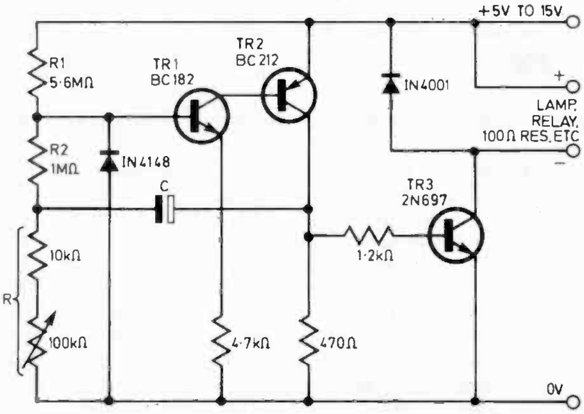


Fig. 1

COIN TOSSER

THE circuit illustrated was built as an electronic "coin toss" binary decision maker. With S1 depressed IC1 functions as an astable multivibrator with an equal mark-space ratio, and the l.e.d. flickers rapidly, the actual rate depending on the value of C2 and VR1.

When S1 is released the circuit stops with the output either on or off depending on its state at the actual instant of release, the connection of the output to the input + through S1 assisting to maintain the stable state.

D1 and D2 are necessary to prevent a small residual glow in the l.e.d. in its "off" state, caused by the inability of the 741's output to swing closer than within a volt of either supply rail. The forward voltage drop of the diodes overcomes this problem.

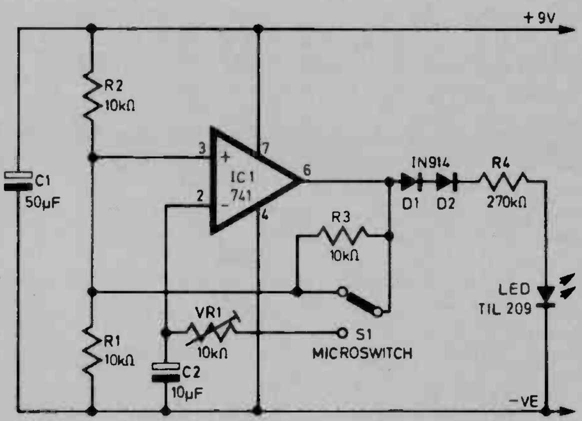


Fig. 1

The circuit may be used as a random decision maker, or ESP enthusiasts can try to influence a series of results.

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Taunton,
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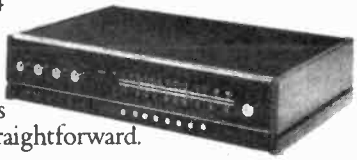

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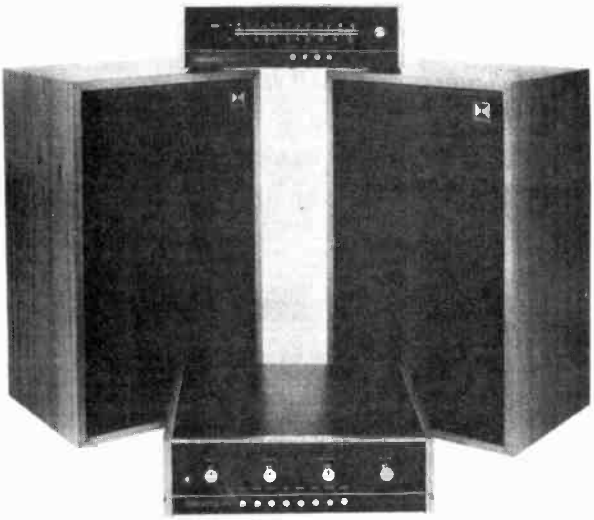

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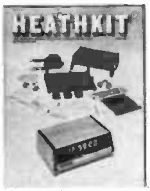

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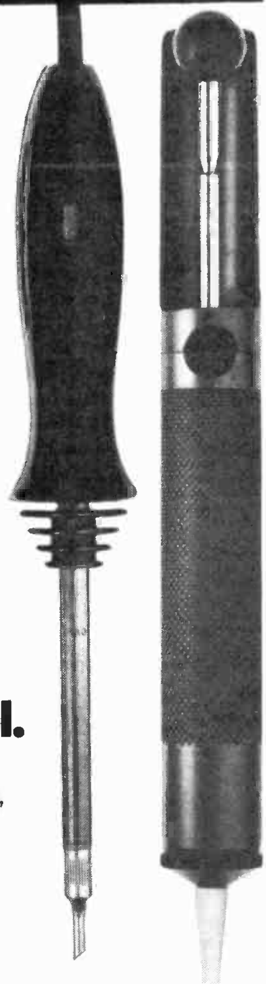

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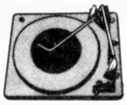

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32/500V	60p	8 + 8/450V	35p	350 + 50/325V	85p
25/25V	15p	8 + 16/450V	35p	100 + 50 + 50/350V	85p
50/50V	15p	16 + 16/450V	60p	32 + 32 + 32/350V	65p
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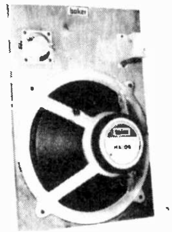

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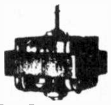

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HEADS OR TAILS

FIG. 1 shows a "heads or tails" circuit which is very low in cost and easy to build.

Gates a and b are connected as an astable multivibrator. Gates c and d are connected as a bistable. The astable output is applied through switch S1 to gate c. If a logic 1 is applied to pin 5, since pin 4 is connected to the positive supply line the output at pin 6 will be a 0 causing D2 to light.

S1 must be a push to make, release to break switch.

D. Manoharan,
Kuala Lumpur

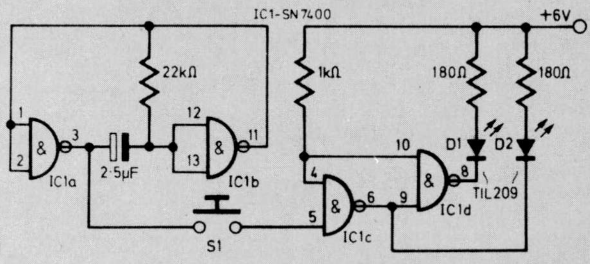

Fig. 1

DISPLAY FOR DIGITAL ALARM CLOCK

THE constructional feature on the Digital Alarm Clock in PE, April/May 1974 was most welcome. However, as not all constructors would want the complexity (quite apart from the high cost) of a liquid crystal display I wish to offer the following suggestions for using the clock chip with the more usual 7-segment l.e.d. display.

It is usual to buffer each of the display outputs with transistors in order to drive the appropriate segment of the l.e.d. indicator.

While the scheme works fine, it lands the constructor with two dozen or so transistors and a host of discrete components! To avoid this, use was made of the SN75492 i.c. in place of transistors. This i.c. is used to interface MOS circuits to l.e.d. displays in calculators, and each contains six Darlington drivers. Four SN75492 i.c.s will provide the 24 buffers required and the wiring is shown in Fig. 1.

Although common-anode l.e.d. indicators are drawn, it is possible to use common-cathode displays in similar fashion. In this case, however, the SN75491 i.c. which contains four Darlington drivers with free emitter connections, has to be used in place of the SN75492. Six SN75491 i.c.s will therefore be required and the circuit is indicated in Fig. 2.

When using the SN75491 or SN75492 as drivers it is necessary to limit the supply voltage to 10V as this is their maximum rating.

Finally it is just as possible to use other types of 7-segment displays, e.g. Minitron indicators, provided the current required does not exceed the capabilities of the driving i.c.s used (250mA for SN75492 and 50mA for SN75491).

C. S. Soh,
Singapore, 9

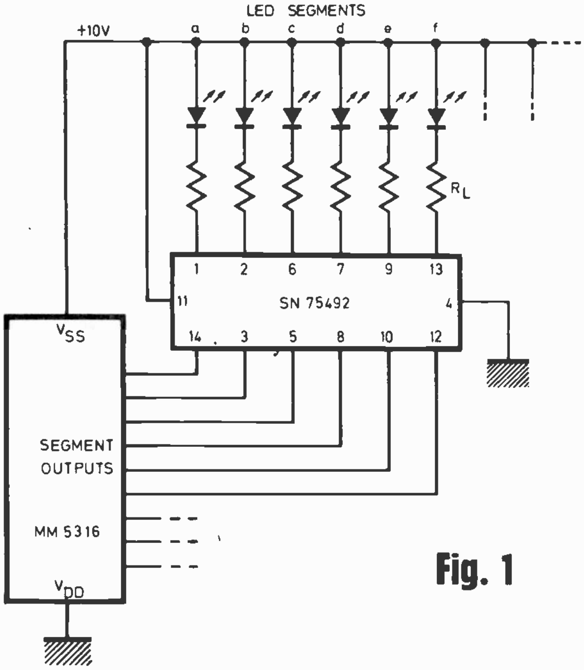

Fig. 1

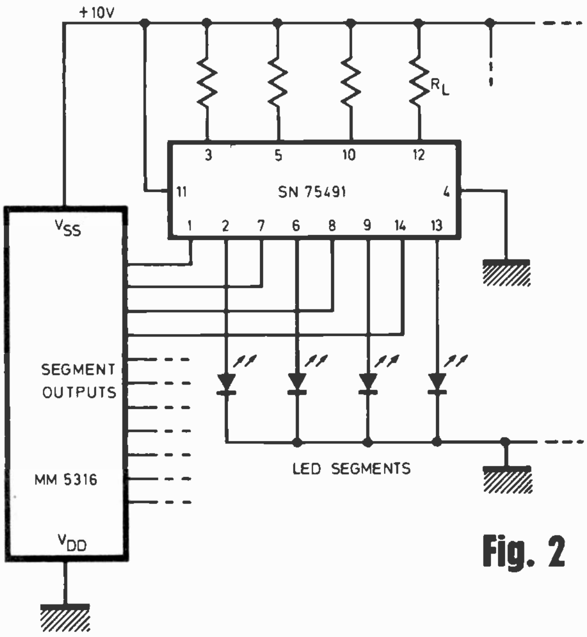

Fig. 2

FUZZ EFFECT

The circuit shown in Fig. 1 produces the well known "Fuzz" effect associated with electric guitars, with a minimum of components and, thus, a very low cost compared with commercial equivalents.

Fuzz is obtained by amplifying the input (20–50mV) so as to produce a swing of over 0·6V on the output. Anything above this voltage causes one of the two silicon diodes to conduct and hold the output at a maximum/minimum of +0·6V/−0·6V. The gain of the amplifier, which determines the degree of clipping or fuzz, is varied by selecting a different amount of negative feedback via the potentiometer. By this means the fuzz can be varied from zero to maximum.

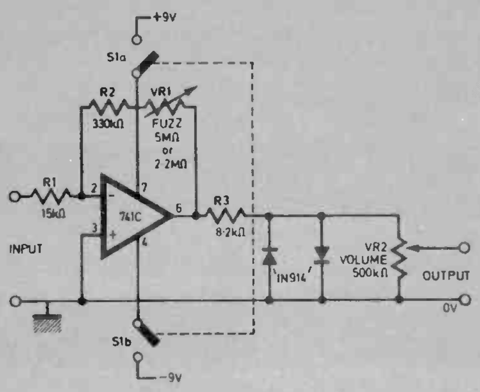

Fig. 1

With some guitars the input might be too high and cause some fuzz on the zero setting. Should this occur R1 should be increased until no distortion is present.

The original was placed under a guitar scratch plate, powered by two rechargeable batteries (4·8V) together with an active tone control. This method has been found to be very reliable and a lot more convenient than a normal foot operated unit.

S. Carter,
Bucks.

NEWS BRIEFS

Oh Buoy!

An ingenious sonobuoy system which, when dropped into the sea by an aircraft, gives information of any submarines in the surrounding area was recently demonstrated by Plessey.

On contact with the water the buoy separates into upper and lower sections interconnected by a compliant cable. The lower section sinks to a predetermined depth at which it rotates in stepped stages through 360°. At each stage it transmits and receives sonar signals and relays the information thus obtained back to the aircraft via the floating buoy section above.

Another device known as a "dunking sonar" when lowered into the sea by a hovering helicopter gives the operator range, bearing and radial velocity target information on a c.r.t. display.

Tifax

The world of Ceefax and Oracle (how to put printed information on your television screen) took a step in the right direction recently with the announcement by Texas Instruments that they have developed a dual Ceefax/Oracle decoder called Tifax.

Such a device will be able to take the BBC Ceefax and the IBA Oracle transmissions and decode them for visual presentation.

As a result, Decca have become involved in making up decoders using discrete LSI/SSI parts in low-power Schottky and including a bipolar Tifax compatible ROM.

Of course, it will be some time before anyone sees the results of this work. Production quantities to set manufacturers from Texas are not expected to be available before next year and initially, at any rate, cost will be high, about £100 per set excluding a suitable control unit.

No doubt, as with all these things, the costs will drop dramatically but no-one seems to be too interested in making guesses at this time as to the possible cost of a system including a hand-held control unit.

Tigerfish

Marconi Space and Defence Systems have received an order from the M.O.D. for the supply of Tigerfish submarine-launched torpedoes to the Royal Navy.

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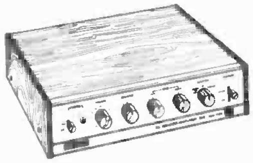

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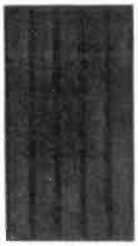

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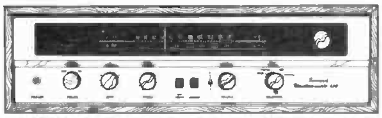

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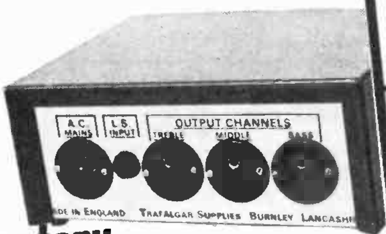

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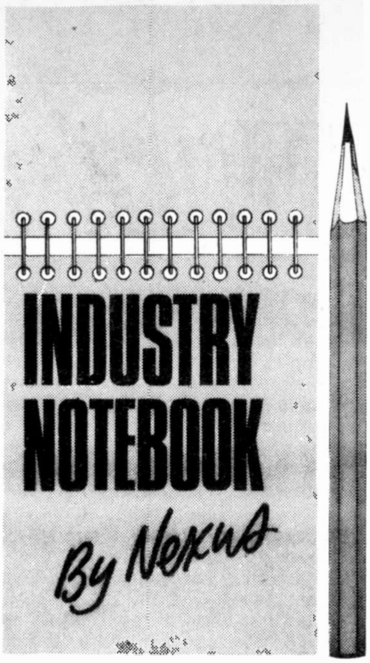

NEW-LOOK CEI?

Professional engineers still enjoy their old status among themselves but not, it seems, with the government or the public. They haven't the industrial muscle power of the trades unions or the leverage on wage claims resulting from real strength in an inflationary situation. To make things worse there are numerous well-intended but often ill-informed ginger groups getting plenty of publicity by blaming a lot of the ills of society on technology and, by inference, on the engineers who generate technology.

So one way and another the poor old engineer is in the dog-house. He often doesn't get the pay he deserves and isn't any longer a popular member of society.

For years the engineers have been fragmented, belonging not to trades unions but to learned societies which under their charters cannot practice in a union-like way. The whole spread of engineering sciences is served by fifteen learned societies of which two have very substantial numbers of electronic engineers in membership, the Institution of Electrical Engineers (IEE) and the Institution of Radio and Electronic Engineers (IERE). The third is The Royal Aeronautical Society to which many electronic engineers engaged in the aerospace industry belong.

Over twenty years ago there was a move towards closer cohesion and an Engineering Institution Joint Council was set up and from this emerged the Council of Engineering Institutions (CEI) in September, 1965. The CEI did good work on raising standards of qualification to membership and in other areas but failed to have much success with putting over what is vaguely termed "image".

The present state of play is that there are proposals that the initials CEI remain the same but the name is changed to the Chartered Engineering Institution and that the major change in constitution will be that individual engineers will be members as well as the fifteen existing institutions. In other words that the new CEI, if it comes into being, can speak directly on behalf of 200,000 chartered engineers at first-hand, instead of at second-hand as at present. But engineers will still, of course, also retain membership of their present institutions.

What are called "professional services" will be a new function for CEI. These include an appointments bureau, advice on education and training, health and insurance schemes, professional advice and similar activities to do with the professional well-being of members.

I give the new movement towards greater professional cohesion my full support. The pattern has already been established in the United States where some of the Institutions jointly run a Washington office to act as an advice centre for the Government on engineering matters and to keep a watching brief on all Congressional bills which have an effect on the professional engineering community.

TRADE BALANCE

The Electronic Engineering Association, representing some fifty British major companies in the electronics capital goods sector gives estimated deliveries for 1974 as worth £924 million compared with £740 million in 1973, which would be a substantial success story but for inflation. As it is, taking into account all the problems experienced in world trade in 1974, it is still a creditable achievement at some 25 per cent increase over the previous year and more than double the 1972 figure.

The balance of trade is precarious, however, with exports at £431 million only just above imports at £423 million. The culprits as usual are computers where Britain imported more than £76 million worth than were exported. But all the other sectors such as broadcast equipment, communications, radar, etc. together had a trade surplus of nearly £85 million over the imports.

One sees the pattern changing since the Middle East became the richest area in the world. Deliveries, especially to the OPEC countries, are shooting up. The Common Market countries, too, are taking much more British-built equipment and in 1974 accounted for 45·5 per cent of all capital goods exports while Commonwealth countries, once our biggest market, now takes less than 10 per cent.

Employment, at 128,000 people was higher and so were wages, over 20 per cent up by the end of 1974, and material input prices were up by 32 per cent. So profitability is suffering and so is investment. But the outlook remains surprisingly cheerful. Member companies of the EEA have substantial order books and even the defence cuts may not prove too harmful because smaller forces need more powerful communications and weapon systems so a greater proportion of money spent on defence will flow to the electronics industry.

ILECS

The International London Electronic Components Show at Olympia couldn't have opened its doors at a more politically stormy time. Pre-referendum squabbles were at their height and the business world was very apprehensive on the effect in both the short and long terms of Mr Benn's Industry Bill, although there were some signs of relief that the Prime Minister, by personal participation, would exert a moderating influence.

The 400 or so exhibitors and thousands of visitors couldn't be said to be exactly in carnival mood but everyone was surprisingly cheerful. A sort of re-run of the experience I had in New York a month earlier at the IEEE Intercon show. I remember in another time of difficulty being at the Paris Salon, still Europe's biggest components bonanza, when people just talked themselves into depression.

And another occasion when I was in Beirut and asked a local businessman how on earth he carried on trading with constant wars, skirmishes, and political upheaval in the countries with which he was trading. His answer was that it was always like that and you learned to live with it. So maybe we Europeans are acquiring the same philosophy.

On the other hand, when you look at the big order books in electronics and aerospace there is a lot to be thankful for. These two great industries, so closely related, continue to do well. In the first quarter of this year the aerospace lads exported £180 million of equipment, more than the figure for a whole year a decade ago. And when you see companies like Mullard, Plessey, Pye and dozens of others with not one or two, but whole new ranges of products coming to the market things can't be all that bad.

Purchasing power has shifted to new areas in the past two years but, as one exporter told me recently, provided you maintain your share of the market on a world scale, this is not important. The big slump only comes when all the money goes to one area and then the new-rich refuse to spend it.

PATENTS REVIEW...

TOUCH SWITCH

In BP 1 383 132, Magic Dot Inc., of Minnesota, U.S.A., claims an improvement over existing touch-actuated switches. The switch relies on the capacitance of an operator providing a reference between electronic circuitry isolated from earth and earth itself. It is suggested that some existing switches are liable to trigger prematurely or fail to trigger reliably.

The basic circuit is shown in Fig. 1. A metal touch switch plate is connected to the input of a d.c. to power frequency amplifier. The output of the amplifier is connected to the input of a second d.c. to power amplifier.

The power supply includes transformer T1, of which the primary receives mains frequency power and is connected to true earth. The transformer secondary is connected to the chassis earth but is isolated from the primary and thus from true earth. It is also connected to amplifier supply inputs.

The a.c. mains on the transformer primary causes the entire switching circuit to oscillate with respect to true earth at mains frequency. The capacitance of a finger on the touch plate provides a reference between chassis earth and true earth. This appears to the earth-isolated switching circuit as an alternating frequency power input of an amplitude equal to the amplitude at which the switch circuit is oscillating with respect to earth. Thus, the switch circuit is modulated by its own oscillation with respect to earth.

The inventors suggest that it is normally considered detrimental to such circuitry to have the input transformer and chassis oscillating with respect to earth. But they take advantage of this customary disadvantage. The oscillation current appearing at the input of the amplifier may be in the order of only 20 nano-amperes. But the amplifier, with a gain of at least 10, is used to charge capacitor C1 connected to chassis between the two amplifiers. When C1 is charged it approximates a current source for the high gain amplifier. As a result, the application or removal of an operator's finger at the touch plate causes the resistance between output terminal of the high gain amplifier and chassis to approximate an electrical short circuit in a first state and an electrical open circuit in a second state. An added advantage of the circuit is that it requires no standby power.

DIGITAL RECORDING BP 1 383 323

The Japanese company, Nippon Columbia, already has several conventional analogue records on the market which were recorded using digital (PCM) techniques. The BBC uses digital transmission to convey f.m. radio signals between national transmitters, and it has been an open secret for some time now that work is in progress at the BBC on the digital recording of television signals.

In BP 1 383 323, the BBC describes its successful techniques. Although these are intended primarily to solve problems encountered with TV recording, the invention concept has wider applications.

To record a full band width colour television signal requires information transfer rates in the region of 10^8 bits/second for the recording and replay systems. Holographic methods of attaining this have been proposed, but these are difficult to apply on a real time basis.

A continuous-wave laser is used to produce a coherent light beam which passes through an intensity modulator and is directed by a plane mirror to a circular scanner. The scanner includes a concave mirror on the end of a quartz fibre which is caused to nutate at line frequency (15kHz) by a tubular piezo-electric transducer at the other end of the fibre. As a result, the focused laser beam scans in a circular manner and the spot is arranged to pass over the ends of a circular array of glass fibre light guides.

The other ends of these fibres are arranged flat so that there is conversion from circular to linear scan. The light emerging from the ends of the fibres passes through an optical polariser and mask with ten apertures. Nine apertures are used to transmit the digital information and the tenth, centre, aperture passes a reference beam.

An electro-optic crystal (e.g. a Pockels cell) is located in front of each aperture. The lens images the fibre ends of the scan converter onto a length of 35mm movie film as it passes the lens. During scanning the digital information is applied word by word to the crystal and a micro-hologram of the "open" apertures of the mask is formed on the film.

It is interesting to note that the developed negative need not be printed up as a positive.

The recovery equipment consists of a laser, mirror, scanner and scan converter all similar to the record equipment. Due to diffraction at each micro-hologram, sets of discrete images are produced and one of the first-order set of images will have a similar geometrical disposition to that of the original binary mask used in recording.

The recovery mask excludes all but the wanted set of images, and the light emerging from the apertures of the mask is directed onto a set of photo detectors. The outputs of the detectors are used to generate a parallel stream of logic bit streams.

It is claimed that conventional, high contrast photographic film can be used in this way to record TV signals. Particularly interesting is the suggestion that if photo-conductive thermoplastic recording tape with sufficient sensitivity becomes available in the future, this can be used instead of photographic film, and of course without development delay.

BP 1 383 132

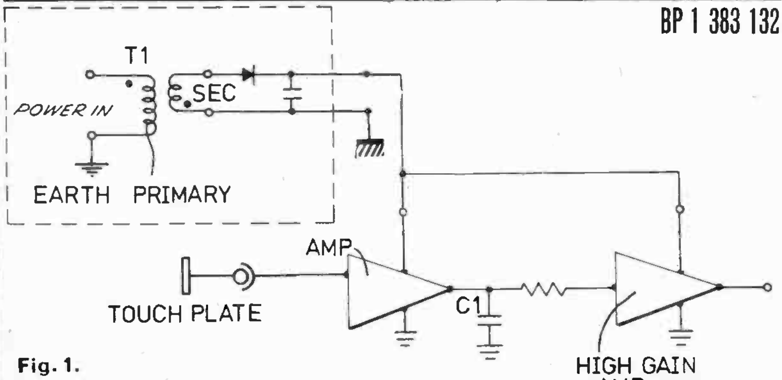

Fig. 1.

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74154	£1.75	£1.48	86p
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74181	£3.20	£2.50	£1.90
74192	£1.35	£1.14	90p
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NE556 £1.29 ●
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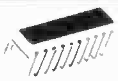

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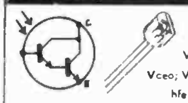

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Green	27p	24p	22p ●	33p	30p	27p ●	30p	27p	25p ●
Orange	27p	24p	22p ●	33p	30p	27p ●	30p	27p	25p ●
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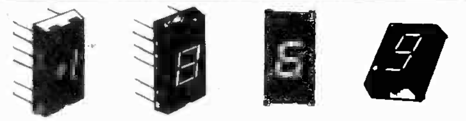

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	YELLOW	MAN81	MAN82	MAN83	MAN84	£1.82 ●
	ORANGE	MAN3610	MAN3620	MAN3630	MAN3640	£1.82 ●
	GREEN	XAN51	XAN52	-	XAN54	£1.49 ●
	RED	XAN71	XAN72	-	XAN74	£1.49 ●
	YELLOW	XAN81	XAN82	-	XAN84	£1.49 ●
0.4"	GREEN	MAN4510	MAN4520	MAN4530	MAN4540	£2.32 ●
	RED	MAN4710	MAN4720	MAN4730	MAN4740	£2.32 ●
	YELLOW	MAN4810	MAN4820	MAN4830	MAN4840	£2.32 ●
	ORANGE	MAN4610	MAN4620	MAN4630	MAN4640	£2.32 ●
		C.A. L/H Dec. Pt.	C.A. ± 1	C.C. L/H Dec. Pt.	C.C. ± 1	
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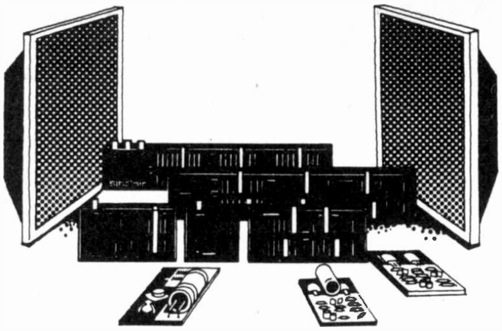

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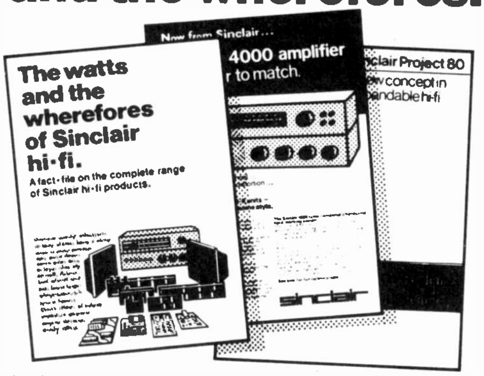

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The well-acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits, and having a wider range of functions than the P.E. Minisonic, though the two may be used in conjunction with each other to great advantage. Published in P.E. Feb. 1973 to Feb. 1974.

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HI-FI TAPE-LINK (P.E. Mar./Apr. 73)
Designed for use with reasonable quality tape-decks, this high performance pre-amp includes record, play-back and metering circuits.

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An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements. While stocks last.

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PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

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The new Electronic Piano published in P.E., series commencing May 1975. Send S.A.E. for our details and discounts.

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A manually controlled unit for producing the above-named sounds.

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Electronic Piano:	
Pre-amp PCB (P.E. Oct. 72)	95p
Pitch PCB (P.E. Nov./Dec. 72)	£1·50
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Gemini Stereo Tuner (P.E. June 72)	£1·50
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Power Supply PCB	55p
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For colour and B & W, an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

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BC109	13p	MJE2955	110p	2N4060	12p
BC147	12p	MJE3055	75p	2N4871	36p
BC148	12p	NKT0033	112p	2N5245	51p
BC149	12p	OC28	60p	2N5777	45p
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BC159	13p	OC84	25p		
BC182L	12p	ORP12	60p		
BC184	12p	ZTX107	12p		
BC204	14p	ZTX503	15p		
BC209C	14p	ZTX531	23p		
BC212L	15p	2N706	13p		
BC213	15p	2N914	22p		
BC476	29p	2N1304	22p		
BCY71	22p	2N2219	27p		
BF178	40p	2N2905	27p		
		2N2907	22p		
		2N3054	66p		
		2N3702	12p		

Diodes

1N914	4p
1N4001	6p
1N4002	7p
1N4004	8p
1N4005	8p
1N4007	10p
OA91	7p
OA200	8p
OA202	8p
1GP7	12p
1SJ50	11p
ZIL (ZIJ)	75p

Integrated Circuits

709 8-pin DIL	40p
709 TO5	40p
723 TO5	95p
741 8-pin DIL	35p
747 14-pin DIL	115p
748 TO5	63p
748 8-pin DIL	63p
748 14-pin DIL	63p
7400	20p
7402	20p
7410	20p
7420	20p
7447	175p
7473	44p
7489	425p
µA7815 TO220	250p
CA3046	80p
MFC8040	83p
SG3402N	180p

Zeners

3·3V 400mW	12p
3·9V 400mW	15p
4·7V 1W	25p
5·1V 400mW	15p
5·6V 400mW	15p
5·6V 1·3W	20p
8·2V 400mW	15p
9·1V 400mW	15p
11V 1W	25p
12V 400mW	15p
12V 1·3W	30p
18V 400mW	15p
18V 1W	20p
20V 400mW	15p
20V 1·3W	23p
27V 400mW	15p

Thyristors

1A 400V	75p

Electrolytic Capacitors (µF/V)

0·47/63V	8p	47/63	7p	470/40	20p
1·0/63V	6p	100/4	6p	500/64	46p
1·5/63V	8p	100/10	6p	680/6·3	10p
2·2/63V	6p	100/25	6p	680/25	20p
4·7/63	6p	100/40	7p	680/40	25p
6·8/40	6p	100/63	13p	1000/10	14p
10/25	6p	150/16	8p	1000/16	25p
10/63	6p	150/63	13p	1000/25	30p
15/40	6p	220/10	8p	1000/40	54p
22/10	6p	220/16	7p	2200/25	45p
22/25	6p	220/25	11p	2200/40	71p
33/6·3	6p	220/40	14p	2800/100	300p
33/16	6p	220/63	21p	3300/63	133p
33/40	8p	330/10	8p	3300/100	300p
33/50	6p	470/6·3	5p	4700/16	80p
47/10	6p	470/10	12p	4700/25	75p
47/25	6p	470/25	18p	4700/40	93p
47/40	6p				

Polyester (µF)

0·01	3p
0·015	3p
0·022	3p
0·033	3½p
0·047	3½p
0·068	3½p
0·1	4p
0·15	5p
0·22	5½p
0·33	7p
0·47	9p
0·68	11p
1·0	14p
2·2	24p

Tantalum (µF/V)

0·1/35	12p
0·22/35	12p
0·47/35	12p
1·0/35	12p
1·5/35	16p
2·2/35	12p
4·7/35	12p
10/16	14p
10/25	16p
15/6·3	16p
22/16	16p
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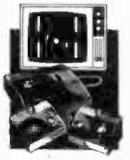

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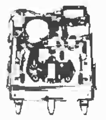

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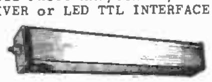

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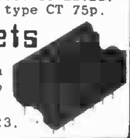

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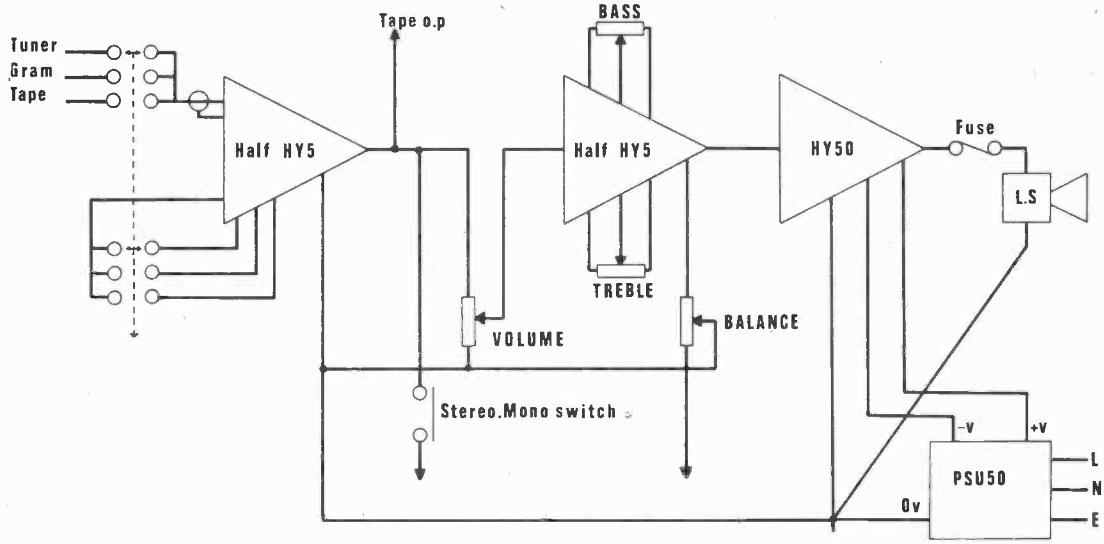
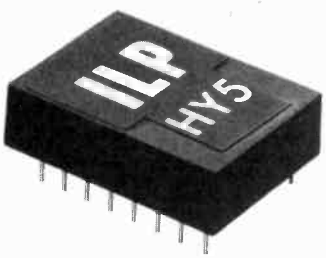


MONO ELECTRICAL CIRCUIT DIAGRAM WITH INTERCONNECTIONS FOR STEREO SHOWN



The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

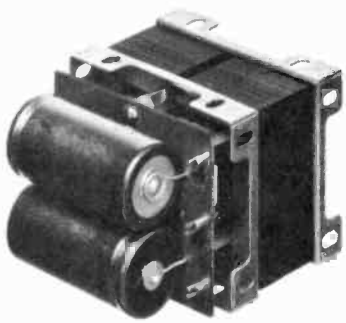
TECHNICAL SPECIFICATION
Inputs: Magnetic Pick-up 3mV RIAA; Ceramic Pick-up 30mV; Microphone 10mV; Tuner 100mV; Auxiliary 3–100mV; Input/impedance 47kΩ at 1kHz. **Outputs:** Tape 100mV; Main output 0db (0 775V RMS). **Active Tone Controls:** Treble ± 12db at 10kHz; Bass ± 12db at 100Hz. **Distortion:** 0·5% at 1kHz. **Signal/Noise Ratio:** 68db. **Overload Capability:** 40db on most sensitive input. **Supply Voltage:** ± 16–25V.

PRICE £4·75 + £1·19 VAT P. & P. free

The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided, input, output, power lines and earth.

TECHNICAL SPECIFICATION
Output Power: 25W RMS into 8Ω. **Load Impedance:** 4–16Ω. **Input Sensitivity:** 0db (0–775V RMS). **Input Impedance:** 47kΩ. **Distortion:** Less than 0·1% at 25W typically 0·05%. **Signal/Noise Ratio:** Better than 75db. **Frequency Response:** 10Hz–50kHz ± 3db. **Supply Voltage:** ± 25V. **Size:** 105 × 50 × 25mm.

PRICE £6·20 + £1·55 VAT P. & P. free



The **PSU50** incorporates a specially designed transformer and can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS
Output voltage: ± 25V. **Input voltage:** 210–240V. **Size:** L.70, D.90, H.60mm.

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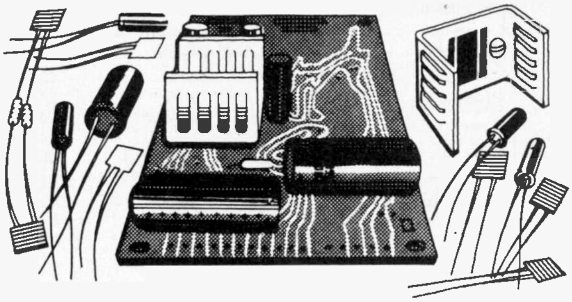

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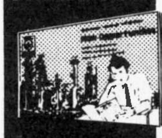

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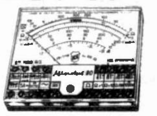

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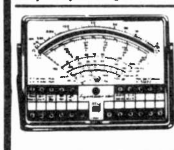

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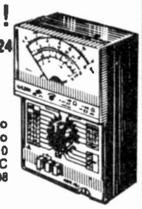

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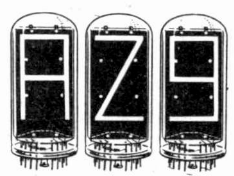

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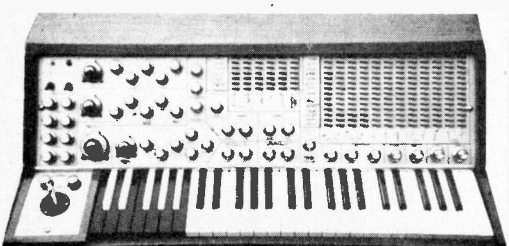

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1 Amp.	+Ve		−Ve	
5V	7805	140p	7905	250p
12V	7812	140p	7912	250p
15V	7815	140p	7915	250p
18V	7818	140p	7918	250p
24V	7824	140p	7924	250p

SCR-THYRISTORS

	50V	100V	400V	600V
1A	40p	42p	50p	70p
3A	43p	49p	75p	100p
7A	—	80p	84p	—
12A	140p	160p	175p	250p
16A	—	170p	190p	270p

Other
BT106 140p. C106D 45p. MCR101 25p.

Other	
2N3525	91p
2N4441	145p
2N4444	185p
2N5060	37p
2N5062	40p
2N5064	45p

TRIACS	100V	400V	500V
3A	85p	95p	120p
6A	88p	120p	150p
10A	109p	154p	185p
15A	145p	180p	200p

Other
40430 99p, 40486 95p, 40669 99p.

BR100 DIAC 21p

Transistors

AC126/7	11p	BC213	10p	OC36	52p	2N2221/2	20p
AC128	11p	BC214	13p	OC41/2	15p	2N2369	14p
AC176	11p	BD124	75p	OC44/5	11p	2N2484	30p
AC187	12p	BD131	42p	OC70/1/2	11p	2N2904	20p
AC188	11p	BD132	45p	OC73	60p	2N2905	18p
AD149	43p	BF115	22p	OC81/2	12p	2N2926RB	8p
AD161	38p	BF167	23p	OC83/4	28p	2N29260	8p
AD162	38p	BF173	25p	TIP2955	70p	2N2928YG	9p
AF114/5	13p	BF184	22p	TIP41A	65p	2N3053	18p
AF116/7	13p	BF194	9p	TIP42A	70p	2N3054	45p
AF139	30p	BF195	9p	ZTX300	12p	2N3055	50p
AF239	44p	BF196	11p	ZTX500	15p	2N3442	140p
BC107/8	9p	BF197	12p	ZTX108	8p	2N3702/3	11p
BC109/C	10p	BFR39	28p	2N697	13p	2N3704/5	11p
BC147/8	7p	BFR79	28p	2N698	30p	2N3706/7	11p
BC149	9p	BFX29/30	30p	2N706	12p	2N3708/9	9p
BC157	10p	BFX84/5/6	25p	2N708	18p	2N3772	181p
BC158	9p	BFX87/8	24p	2N930	18p	2N3773	220p
BC159	10p	BFY50/1/2	18p	2N1131/2	18p	2N3903/4	15p
BC169C	12p	BRY39	34p	2N1302/3	17p	2N3905/6	15p
BC177	18p	MJE340	45p	2N1304/5	21p	2N4058	15p
BC178	17p	MJE2955	99p	2N1306/7	28p	2N4060	13p
BC179	18p	MJE3055	65p	2N1308/9	28p	2N4289	18p
BC182/3	10p	MPSU06	58p	2N1613	20p	40361	43p
BC184	11p	OC26	47p	2N1711	20p	40362	45p
BC212	11p	OC28	55p	2N1893	27p	40594	75p
		OC35	48p	2N2219	20p	40595	85p

UJTS

TIS43	27p
2N2160	70p
2N2646	36p
2N4871	30p
2N6027	48p

FETS

BF244	36p
MPF102/3	30p
MPF104/5	30p
2N3819	22p
2N3820	57p
2N3823	50p
2N5457	30p
2N5458	30p
2N5459	30p

MOSFETS

40603	58p
40673	58p
3N128	75p
3N140	85p
3N141	75p

Diodes

BY100	15p	OA202	7p
BY126	12p	IN914	4p
BY127	10p	IN4001	5p
OA47	7p	IN4004	6p
OA70	8p	IN4007	7p
OA79	7p	IN4148	3p
OA81	7p	OTHER	
OA85	9p	BA145	15p
OA90	6p	BA148	13p
OA91	6p		
OA95	7p	LED	
OA200	6p	TIL209	16p

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4A	—	55p	—	—
6A	58p	63p	—	—

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CD4002AE	19p
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CD4011AE	21p
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CD4022AE	169p
CD4023AE	19p
CD4024AE	120p
CD4027AE	91p
CD4028AE	140p
CD4029AE	175p
CD4046AE	202p
CD4047AE	154p
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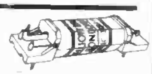

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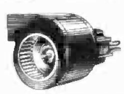

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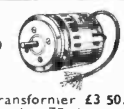

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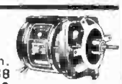

(Type J) 71 **r.p.m.** torque 10 lb. in. **Reversible** 1/70th h.p. cycle 0·38 amp. **(Type 2)** 28 **r.p.m.** torque 20 lb. in **Reversible** 1/80th h.p. 50 cycle 0·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
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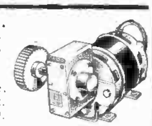

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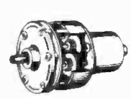

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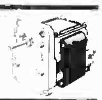

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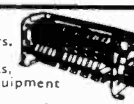

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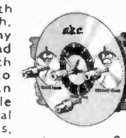

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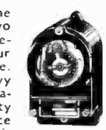

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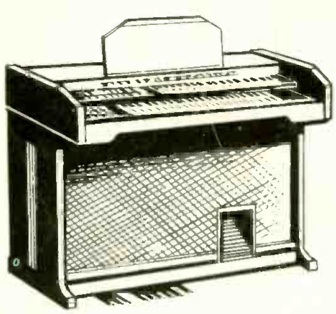

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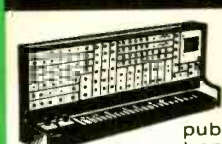

A reprint of the complete article giving full construction details published by "Electronics Today International" between January–September '74 of the International Voltage Controlled Synthesiser, developed as a "state of the art", will be available shortly, price **£1·50**. S.A.E. please for detailed price list.

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