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VOLUME 11 No. 5 MAY 1975

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NEWS AND COMMENT

Our June issue will be published on Friday, May 9, 1975

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R T-V C

*COMPLETE STEREO SYSTEM

System 1a. £62.00

40 Watt Amplifier. Viscount III – **R102** now 20 watts per channel (40 watts peak).
All systems include:
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket.
Specification:
20 watts per channel into 8 ohms 40W peak. Total distortion @ 10W @ 1kHz 0.1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV at 1kHz into 47K, equalised within ∓1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) –58dB. Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. 13¾"×9"×3¼".
Garrard SP 25 deck with magnetic cartridge, de luxe plinth and cover.
Two Duo Type IIa matched speakers – Enclosure size approx. 19¼"×9½"×7¾" in simulated teak. Drive unit 13"×8" with 3" tweeter. 15 watts handling.
Complete System with these speakers £62.00 + £5.50 p & p.

System 2. £82.00

Viscount III amplifier (As System 1a)
Garrard SP 25 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 £82.00 + £6.50 p & p.

Scotland P & P Surcharge
System 1a £1.75 System 2 £3.50

PRICES: SYSTEM 1a

Viscount III R102 amplifier	£27.00+£1.60 p & p
2 Duo Type IIa speakers	£26.00+£5.50 p & p
Garrard SP 25 with Mag. cartridge de luxe plinth and cover	£21.00+£2.80 p & p
total: £74.00	

Available complete for only: £62.00 +£5.50 p & p

PRICES: SYSTEM 2

Viscount III R102 amplifier	£27.00+£1.60 p & p
2 Duo Type III speakers	£39.00+£6.40 p & p
Garrard SP 25 with Mag. cartridge de luxe plinth and cover	£21.00+£2.80 p & p
total: £87.00	

Available complete for only: £82.00 +£6.50 p & p

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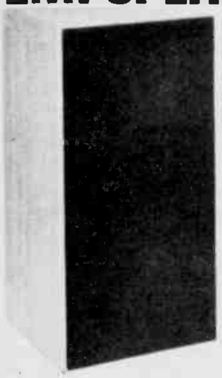
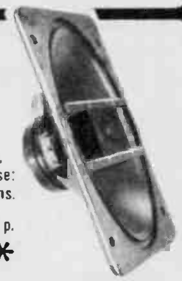


LE-4 SPEAKERS

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

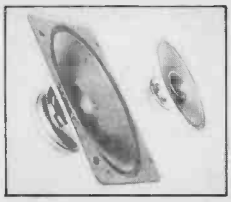
Our Price £29.00
(normally £56.97) +£5 p & p.

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.)
Complete with crossover Components and circuit diagram **£5.50** +£1 p & p.

20 WATT SPEAKER SYSTEM *



System consists of a 13"×8" (approx.) eliptical woofer unit with a 8"×5" (approx.) mid-range unit incorporating parasitic tweeter and crossover components and circuit diagram
Technical Specification: Bass Unit: Flux density – 100 K, speech coil – 1½". Cone. Triple laminated paper with P.V.C. surround. Mid-Range Unit: Flux density – 33 K, speech coil – 1" with parasitic tweeter. Power handling: 20 watts RMS, impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.

Our Price £7.50
Complete +£1.35 p & p.

EASY TO BUILD SPEAKER KITS

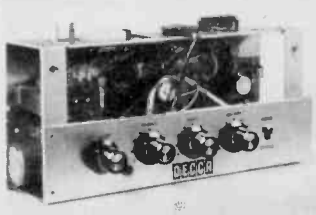
These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13"×8" woofer, 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 20–20,000Hz. Size 20"×11"×9½" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£18.95 pair complete +£4.50 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.

£5.95 +£1 p & p.



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Due to current world shortages, resistor kits may contain some wattage and value substitutions.

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. Mounting: 0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, **3½p**. 0·068µF, 0·1µF, **4½p**. 0·15µF, **4½p**. 0·22µF, **5½p**. 0·33µF, **8p**. 0·47µF, **9p**. 0·68µF, **12p**. 1µF, **15p**. 1·5µF, **23p**. 2·2µF, **26p**.

MULLARD POLYESTER CAPACITORS C296 SERIES
400V, 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 0·0047µF, **2½p**. 0·0068µF, 0·01µF, 0·015µF, 0·022µF, 0·033µF, **3½p**. 0·047µF, 0·068µF, 0·1µF, **4½p**. 0·15µF, **6½p**. 0·22µF, **8½p**. 0·33µF, **12p**. 0·47µF, **14p**.
160V: 0·01µF, 0·15µF, 0·022µF, **3p**. 0·047µF, 0·068µF, **3½p**. 0·1µF, **4½p**. 0·15µF, **5p**. 0·22µF, **5½p**. 0·33µF, **6½p**. 0·47µF, **8½p**. 0·68µF, **12p**. 1µF, **14p**.

MINIATURE CERAMIC PLATE CAPACITORS
50V: (pF) 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1K, 1K5, 2K2, 3K3, 4K7, 6K8, (µF) 0·01, 0·015, 0·022, 0·033, 0·047, **2½p**. each. 0·1, 30V, **5p**.

POLYSTYRENE CAPACITORS 160V 5%
(pF) 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 1000, 1500, 2200, 3300, 4700, 6800, 10,000, **4½p**.

RESISTORS
CF—High Stab Carbon Film, 5% MF—High Stab Metal Film, 5%.

W.	Type	Range	1–99	100–499	500–999	1000+	Size mm
⅛	CF	12–1M	1	0·75	0·60	0·55	2·4x7·5
¼	CF	22–2M2	1	0·75	0·60	0·55	3·9x10·5
½	CF	22–1M	1	0·75	0·60	0·55	5·5x16
⅛	MF	10–2M7	2	1·54	1·32	1·1	3x7
½	MF	10–2M2	2	1·43	1·21	0·99	4·2x10·8
1	MF	10–10M	3	1·98	1·81	1·65	6·6x13
2	MF	10–10M	4·5	3·52	3·08	2·75	8x17·5

For value mixing prices, please refer to our catalogue. (Price in pence each).
VALUES AVAILABLE—E12 Series only. (Net prices above 100.)

PRESET SKELETON POTENTIOMETERS
MINIATURE 0·25W Vertical or horizontal 6p each 1K, 2K2, 4K7, 10K, etc. up to 1M Ω
SUB-MIN 0·05W Vertical, 100 Ω to 220K Ω 5p each.

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Miniature Mullard Electrolytics

1·0µF 63V	6½p	68µF 16V	6½p
1·5µF 63V	6½p	68µF 63V	12p
2·2µF 63V	6½p	100µF 10V	6½p
3·3µF 63V	6½p	100µF 25V	6½p
4·0µF 40V	6½p	100µF 63V	14p
4·7µF 63V	6½p	150µF 16V	6½p
6·8µF 63V	6½p	150µF 63V	15p
8·0µF 40V	6½p	220µF 6·4V	6½p
10µF 16V	6½p	220µF 10V	6½p
10µF 25V	6½p	220µF 16V	8p
10µF 63V	6½p	220µF 63V	21p
15µF 16V	6½p	330µF 16V	12p
15µF 63V	6½p	330µF 63V	25p
16µF 40V	6½p	470µF 6·4	9p
22µF 25V	6½p	470µF 40V	20p
22µF 63V	6½p	680µF 16V	15p
32µF 10V	6½p	680µF 40V	25p
33µF 16V	6½p	1000µF 16V	20p
33µF 40V	6½p	1000µF 25V	25p
32µF 63V	6½p	1500µF 6·4V	15p
47µF 10V	6½p	1500µF 16V	25p
47µF 25V	6½p	2200µF 10V	25p
47µF 63V	8p	3300µF6 4V	26p

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2½ x 5"	36p	36p
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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	16½p	BC212L	12p
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BC107	11p	BC214L	17p
BC108	12p	OC44	18p
BC109	13p	OC71	13p
BC148	12p	OC81	16p
BC149	12p	OC170	23p
BC182L	12p	TIS43	33p
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POTENTIOMETERS
Carbon Track 5K Ω to 2M Ω, log or lin (and 1K lin). Single, 16½p Dual Gang 46p. Log single with switch 26p. Slider Pots. 10K, 100K, 500K, semi log 30mm, 34p. 45mm, 47p. 60mm, 55p.

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IN4001	6½p
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IN4006	14p
IN914	1p
IN916	7p
BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

PLUGS

Din 2 Pin.	12p
3 Pin	13p
5 Pin 180°	16p
Std. Jack	20p
2·5mm jack	13p
Phono	6p

SOCKETS

Din 2 Pin	10p
3 Pin	10p
5 Pin 180°	12p
Std. Jack	15p
2·5mm Jack	13p
Phono	6p

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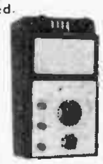
Our New Electronics Centre is now open in Leighton Buzzard and all callers are welcome. As well as our normal stock of over 2,000 products we have a large range of surplus bargains and calculators, etc. Open 6 days. 9-12.30, 1.30-5 p.m.

NEW KIT
5E12 ¼W Metal Film. 5 each value 10 Ω-1M, total of 305 **£3·25**

MULTIMETER U4323
22 Ranges plus AF/IF Oscillator 20,000 Ω/Volt.
Vdc—0·5—1000V in 7 ranges
Vac—2·5—1000V in 6 ranges
Idc—0·05—500mA in 5 ranges
Resistance—5 Ω—1M Ω in 4 ranges.
Accuracy—5% of F.S.D.
OSCILLATOR—1 KHz and 465KHz (A, M.) at approx. 1 Volt.
Size—160 x 97 x 40mm.
Supplied complete with carrying case, test leads and battery.
PRICE £8·30 net P. & P. 25p.


U4323

MULTIMETER U4341
27 Ranges plus Transistor Tester. 16,700 Ω/Volt. Overload protected.
Vdc—0·3—900V in 8 ranges.
Vac—1·5—750V in 6 ranges.
Idc—0·06—600mA in 5 ranges.
Iac—0·3—300mA in 4 ranges.
Resistance—2K Ω—2M Ω in 4 ranges. Accuracy—dc—2½%. ac—4% of F.S.D.
hfe—10—350 in 2 ranges.
Size—115 x 215 x 90mm.
Complete with steel carrying case, test leads, and battery.
PRICE £11·30 net P. & P. 30p.


U4341

NEW CAPACITOR KITS
C280 Kit—PC Mounting polyester 250V. 5 of each value: 0·01 0·022, 0·047, 0·1, 0·22µF. 2 of 0·47, 1µF. **£1·30 net.**
C296 Kit—Tubular polyester, 400V. 5 of each value: 0·01, 0·022, 0·047, 0·1, 0·22µF. 2 of 0·47µF. **£1·30 net.**
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250V Paper kit—Tubular metal case. 3 of each value: 0·05, 0·1, 0·25, 0·5, 1µF. **90p net.**
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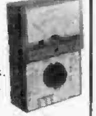
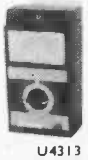
1000V Paper Kit—Tubular metal case. 3 each value: 0·01, 0·025, 0·05, 0·1µF. **£1·10 net.**

MULTIMETER U4324
34 Ranges. High sensitivity. 20,000 Ω/Volt. Overload protected.
Vdc—0·6—1200V in 9 ranges.
Vac—3—900V in 8 ranges.
Idc—0·06—3A in 6 ranges.
Iac—0·3—3A in 5 ranges.
Resistance—25 Ω—5M Ω in 5 ranges.
Accuracy—dc and R—2½% of F.S.D. ac and db—4% of F.S.D.
Size—167 x 98 x 63mm.
Supplied complete with storage case, test leads, spare diode, and battery.
PRICE £9·95 net P. & P. 25p.


U4324

MULTIMETER U4313
33 ranges. Knife edge with mirror scale. 20,000 Ω/Volt. High accuracy. mVdc—75mV.
Vdc—1·5—600V in 9 ranges.
Vac—1·5—600V in 9 ranges.
Idc—60—120 microamps in 2
Idc—0·6—1500mA in 6 ranges.
Iac—0·6—1500mA in 6 ranges.
Resistance—1K Ω—1M Ω in 4 ranges.
db scale—10 to + 12db.
Accuracy—dc—1½%, ac—2½%
Size—115 x 215 x 90mm.
Complete with steel carrying case, test leads, and battery.
PRICE £13·40 net P. & P. 30p.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S-DeC

S-DeC	£2·14
T-DeC	£3·92
µDeC "A"	£4·30
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2 DeC	£4·72

ANTEX

CCN240	£2·43
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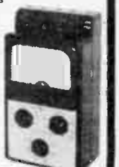
MULTIMETER U435
32 ranges. High sensitivity. 20,000 Ω/Volt.
Vdc—75mV—1000V in 8 ranges
Vdc—2·5—1000V in 7 ranges.
Idc—0·001—2·5A in 6 ranges.
Iac—0·005—2·5A in 5 ranges.
Resistance—3-300K in 3 ranges
Capacitance scales 0-0·5µF.
Accuracy—dc and R—2½% of F.S.D. ac and C—4% of F.S.D.
Size—205 x 110 x 84mm.
Complete with steel carrying case, test leads and battery.
PRICE £9·45 net P. & P. 25p.



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240V—50Mz from your 12V car battery.
25W—£3·90 + 30p p & p
40W—£6·80 + 55p p & p
75W—£9·96 + 75p p & p
150W—£18·30 + 80p p & p
30W (12V)—£28·80 + £1·05 p & p
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

COMPLETE FLUORESCENT LIGHT INVERTOR KIT
8W—12V—Fluorescent light, suitable for tents, caravans, houses, boats and secondary lighting for factories, hotels etc. 12in—8W £2·90 + 25p p & p. 21in—13W £3·30 + 30p p & p.

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up to 2,500°F

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1010 Soft-solder bit for Cub 92p inc.

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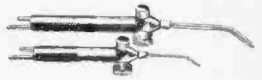
up to 6,000°F



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Sinclair Project 80

For elegant, versatile, stereo hi-fi systems designed and built by <u>you!</u>

Until recently, if you wanted a first-class hi-fi system you had two ways to get it.

You could buy the individual electronic components and build a system from scratch. If you were an electronics genius – fine.

Or you had to buy ready-made units. Expensive – and dull. About the only creative pleasure you'd get would be matching your amp and your speakers, or making your speaker enclosures.

So what's new?

A comprehensive hi-fi system, combining the enjoyment and satisfaction of build-it-yourself (without too much struggle) ... a real value-for-money feeling ... and results of the highest quality.

It's the new Sinclair Project 80.

How does Sinclair Project 80 work?

Project 80 is a comprehensive set of hi-fi modules, or sub-assemblies. Amps ... pre-amps ... FM tuner ... stereo decoder ... control units ... everything you need to assemble hi-fi units. They're all designed to look alike and they're all completely compatible with each other. Simply decide on the specifications of the unit you want to build ... buy the necessary modules ... connect them ... and house them.

No need to buy everything at once for your eventual set-up. All the modules are designed so that you can add to them as your system grows – whether or not it's based on Project 80.

This applies to refinements, like filters ... to up-grading, adding a second set of amps, say, for greater output ... or to real innovation, like quad. (Add a Project 80 quad decoder, a power supply, a pair of amps, and a pair of speakers – and your stereo's gone quad.)

Is it difficult to build?

Not at all. The modules are complete in themselves. All you do is connect them to your turntable ... your speakers ... or to each other. It's absorbing, but if you can solder wires to a 5-pin DIN plug, you can build a complete system with Project 80.

And if you're not so hot with a soldering iron? Use Project 805. Project 805 uses Project 80 modules, but provides special clip-on tagged wire connections – absolutely *no* soldering required.

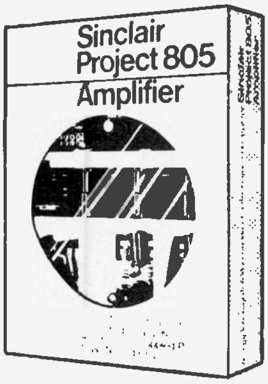
And, of course, both Project 80 and Project 805 come complete with instructions for easy, step-by-step assembly. But if you do run into problems, just call our Consumer Advisory Service who are always happy to help.

OK. Where do I go from here?

Over the page! There you'll see for yourself the exacting specifications to which Sinclair Project 80 modules are made, and you'll see some suggested systems.

As you skim the suggestions, remember all Project 80 modules are backed by the remarkable no-quibble Sinclair guarantee. Should any defect arise from normal use within a year, we'll service the modules free of charge. What could be fairer than that?

Some system suggestions from Sinclair

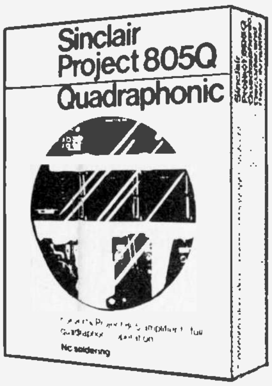


Project 805 amplifier kit

Contains following Project 80 units:

Project 80 control unit
2 x Z40 power amplifier modules
1 x PZ5 power supply unit
Masterlink unit
On/off switch
plus pre-cut wiring loom with clip-on tagged wire connections, nuts and bolts, instruction manual.

Price: £39.95 + VAT



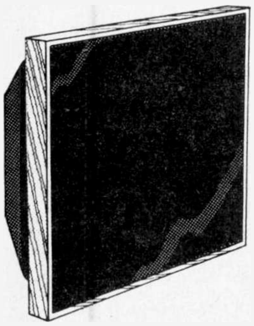
Project 805Q quadraphonic add-on kit

Converts your existing stereo hi-fi system to quad using solderless connections.

Contains following Project 80 units:

Project 80 SQ quad decoder/rear channel pre-amp and control unit
2 x Z40 power amps
PZ5 power supply unit
Masterlink unit
On/off switch
plus pre-cut wiring loom with clip-on tagged wire connections, nuts and bolts, instruction manual.

Price. £44.95 + VAT



Sinclair Q16 speaker

Original and uniquely designed speaker of outstanding quality.

Specification
(10⅜ in square x 4¾ in deep.) Pedestal base. All-over black front. Teak surround. Balanced sealed sound chamber. Special driver assembly. **Frequency response**: 60 Hz to 16 kHz. **Power handling**: up to 14 W RMS. **Impedance**: 8 Ω

Price: £8.95 + VAT

1. Quadraphonic system: 25 W per channel RMS
Pre-amp/control unit + quadraphonic decoder + 4 x Z60 amps + 2 x PZ8 mains power supplies + (2 x mains transformers) + (4 x equivalent speakers) + (turntable). Total Project 80 cost: £79.60 + VAT.

2. Stereo amplifier: 12 W per channel RMS
Pre-amp/control unit + 2 x Z40 amps + PZ6 power supply + 2 x Q16 speakers. Total Project 80 cost: £52.70 + VAT.

3. Stereo tuner/amplifier: 12 W per channel RMS
Pre-amp/control unit + FM tuner + stereo decoder + 2 x Z40 amps + PZ6 power supply + 2 x Q16 speakers. Total Project 80 cost: £75.60 + VAT.

Other applications

4. PA system
(Mic) + pre-amp/control unit + Z40 amp + PZ6 power supply + 2 x Q16 speakers. Total Project 80 cost: £46.75 + VAT.

5. Convert existing mono record-player to stereo
Pre-amp/control unit + Z40 amp + Q16 speaker. Total Project 80 cost: £28.25 + VAT.

What more can we tell you?

The basic facts are covered on these two pages. And you'll find Project 80 at stores like Laskys and Henry's.

But before you look, why not get really detailed information? Clip the FREEPOST coupon for the fully-illustrated Project 80 folder – today!

**Sinclair Radionics Ltd,
London Road, St Ives, Huntingdon, Cambs., PE17 4HJ.
Telephone: St Ives (0480) 64646.**

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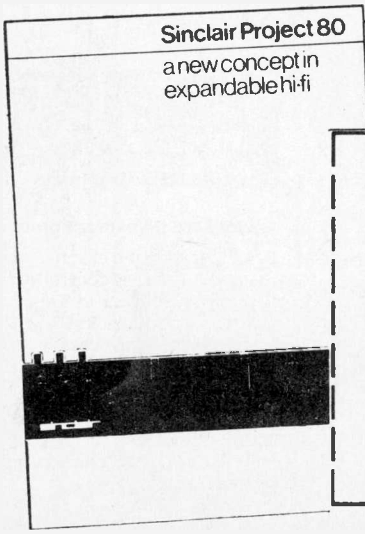

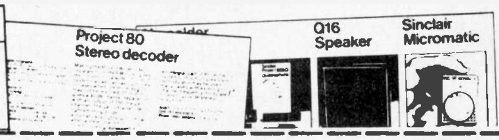

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2N708	0·17	2N3441	0·97	2N5777	0·45	AF200	0·65	BC253	0·25	BF182	0·35
2N709	0·42	2N3442	1·40	2N6027	0·45	AF239	0·65	BC257	0·16	BF183	0·55
2N711	0·50	2N3414	0·20	3N128	0·73	AF240	0·90	BC258	0·16	BF184	0·30
2N718	0·23	2N3415	0·21	3N139	1·42	AF279	0·70	BC259	0·17	BF185	0·30
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2N720	0·57	2N3417	0·24	3N141	0·81	AL102	1·00	BC262	0·25	BF195	0·12
2N914	0·39	2N3638	0·15	3N200	2·49	AL103	1·00	BC263	0·25	BF196	0·13
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2N918	0·32	2N3639	0·27	40362	0·45	BC108	0·14	BC301	0·34	BF198	0·18
2N929	0·37	2N3641	0·17	40363	0·88	BC109	0·14	BC302	0·29	BF200	0·40
2N930	0·22	2N3702	0·12	40389	0·46	BC113	0·15	BC303	0·54	BF225J	0·23
2N1302	0·19	2N3703	0·13	40394	0·56	BC115	0·17	BC307	0·17	BF244	0·21
2N1303	0·19	2N3704	0·15	40395	0·65	BC116	0·17	BC308A	0·15	BF245	0·45
2N1304	0·26	2N3705	0·15	40406	0·44	BC116A	0·18	BC309C	0·20	BF246	0·58
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2N1306	0·31	2N3707	0·18	40408	0·50	BC118	0·14	BC238	3·28	BF254	0·19
2N1307	0·30	2N3708	0·14	40409	0·52	BC119	0·29	BC337	0·20	BF255	0·19
2N1308	0·47	2N3709	0·15	40410	0·52	BC121	0·35	BC338	0·20	BF257	0·47
2N1309	0·47	2N3710	0·15	40411	2·00	BC125	0·16	BCY30	0·80	BF258	0·53
2N1671	1·54	2N3711	0·15	40594	0·74	BC126	0·23	BCY31	0·85	BF259	0·55
2N1671A	1·67	2N3712	1·20	40595	0·84	BC132	0·30	BCY32	1·15	BFR39	0·24
2N1671B	1·85	2N3713	1·20	40601	0·67	BC134	0·13	BCY33	0·85	BFR79	0·24
2N1711	0·45	2N3714	1·38	40602	0·61	BC135	0·13	BCY34	0·79	BFS21A	2·30
2N1907	5·50	2N3715	1·50	40603	0·58	BC136	0·17	BCY38	1·00	BFS28	0·92
2N2102	0·64	2N3716	1·80	40604	0·56	BC137	0·17	BCY39	1·50	BFS61	0·27
2N2147	0·78	2N3771	2·20	40636	1·10	BC138	0·24	BCY40	0·47	BFS98	0·25
2N2148	0·94	2N3772	1·80	40669	1·00	BC140	0·68	BCY42	0·28	BFX29	0·30
2N2160	0·90	2N3773	2·65	40673	0·73	BC141	0·68	BCY58	0·30	BFX30	0·27
2N2218A	0·22	2N3789	2·06	AC126	0·20	BC142	0·23	BCY59	0·32	BFX84	0·24
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2N2646	0·55	2N4037	0·42	AC188K	0·40	BC167B	0·15	BD135	0·43	BSX20	0·21
2N2647	0·98	2N4058	0·18	ACY18	0·24	BC168B	0·15	BD136	0·49	BSX21	0·29
2N2904	0·22	2N4059	0·15	ACY19	0·27	BC168C	0·15	BD137	0·55	BU104	2·00
2N2904A	0·24	2N4060	0·15	ACY20	0·22	BC169B	0·15	BD138	0·63	BU105	2·25
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2N2906	0·19	2N4126	0·21	ACY30	0·58	BC171	0·16	BD529	0·80	CA3020A	1·80
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2N2926		2N4923	1·00	AD162	0·50	BY182L	0·12	BF123	0·35	CA3089E	1·96
Green	0·12	2N5190	0·92	AD161 }	PR	BC183	0·12	BF125	0·35	CA3090Q	4·23
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SN7401AN	0·38	SN7411	0·25	SN7437	0·37	SN7451	0·16	SN7481	1·25	SN7495	0·72	SN74150	1·50	SN74175	0·90
SN7402	0·16	SN7412	0·28	SN7438	0·35	SN7453	0·16	SN7482	0·75	SN7496	0·75	SN74151	0·85	SN74176	1·44
SN7403	0·16	SN7413	0·35	SN7440	0·16	SN7454	0·16	SN7483	0·95	SN74100	1·25	SN74153	0·85	SN74180	1·40
SN7404	0·19	SN7416	0·35	SN7441AN	0·85	SN7460	0·16	SN7484	0·95	SN74107	0·36	SN74154	1·50	SN74181	1·95
SN7405	0·19	SN7417	0·35	SN7442	0·65	SN7470	0·33	SN7485	1·25	SN74118	1·00	SN74155	1·50	SN74190	2·30
SN7406	0·45	SN7420	0·16	SN7445	0·90	SN7472	0·26	SN7486	0·32	SN74119	1·92	SN74157	0·95	SN74191	2·30
SN7407	0·45	SN7423	0·29	SN7446	0·95	SN7473	0·36	SN7490	0·45	SN74121	0·37	SN74160	1·10	SN74192	1·15
SN7408	0·19	SN7425	0·29	SN7447	0·95	SN7474	0·36	SN7491	0·85	SN74122	0·50	SN74161	1·10	SN74193	1·15
		SN7427	0·29			SN7475	0·50	SN7492	0·45	SN74123	0·60	SN74162	1·10	SN74196	1·60
												SN74163	1·10	SN74197	1·58
												SN74164	2·01	SN74198	2·25
												SN74165	2·01	SN74199	2·25

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IN916	0·07	IN1202	0·67	IN5402	0·20	AA119	0·08	BAX16	0·10	OA10	0·45
IN1183	0·84	IN1204	0·97	IN5404	0·22	AA129	0·15	BB103	0·25	OA47	0·06
IN1184	0·92	IN1206	1·37	IN5406	0·25	BA102	0·25	BB104	0·45	OA70	0·07
IN1186	1·18	IN4001	0·06	IN5408	0·30	BA115	0·10	BY100	0·27	OA73	0·10
IN1190	2·52	IN4002	0·65	IN1544	0·06	BA142	0·17	BY126	0·12	OA81	0·18
IN1191	0·59	IN4004	0·07	IN15132	0·25	BA144	0·12	BY127	0·15	OA85	0·18
IN1192	0·80	IN4006	0·09	IN15134	0·25	BA145	0·18	BY182	1·00	OA90	0·06
IN1194	1·06	IN4007	0·10	IN15920	0·07	BA148	0·20	BYZ10	0·60	OA91	0·06
IN1196	1·64	IN4148	0·07	IN15921	0·08	BA154	0·12	BYZ11	0·51	OA95	0·07
IN1198	2·40	IN5054	0·18	IN15922	0·08	BA155	0·12	BYZ12	0·51		

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100	0·36	0·37	0·70	0·75
200	0·30	0·41	0·75	0·80
400	0·36	0·45	0·85	1·10
600	0·40	0·52	0·95	1·25

SCRs	100V	200V	400V	600V
½A TO18	0·43	0·44	—	—
1·2A plastic	0·45	0·50	0·69	0·85
3A plastic	0·55	0·63	0·70	1·05
4A plastic	0·50	0·55	0·65	—

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BA4	5¼"	×	4"	×	1½"	58p
BA5	4"	×	2½"	×	2"	49p
BA6	3"	×	2"	×	1"	42p
BA7	7"	×	5"	×	2½"	85p
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P. & P. 15p on each box

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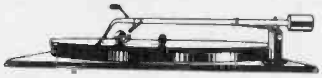
Chrome Finish
Model 60 £1·50



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CCN 240. 15 watt £2·48
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SK2. Soldering Kit £3·25
STANDS: ST3, suitable for all models £1
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1100 For model CCN240 3/32"	42p
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EG 240 £1·07 EX 25 £1·16

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C2	150	Capacitors mixed values approx. count by weight	0·54
C3	50	Precision Resistors mixed values	0·54
C4	75	⅛th W Resistors mixed preferred values	0·54
C5	5	Pieces assorted Ferrite Rods	0·54
C6	2	Tuning Gangs, MW/LW VHF	0·54
C7	1	Pack Wire 50 metres assorted colours	0·54
C8	10	Reed Switches	0·54
C9	3	Micro Switches	0·54
C10	15	Assorted Pots & Pre-Sets	0·54
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·54
C12	30	Paper Condensers preferred types mixed values	0·54
C13	20	Electrolytics Trans. types	0·54
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets, etc.	0·54
C15	5	Mains Slide Switches	0·54
C16	20	Assorted Tag Strips & Panels	0·54
C17	10	Assorted Control Knobs	0·54
C18	4	Rotary Wave Change Switches	0·54
C19	2	Relays 6—24V Operating	0·54
C20	1	Pack Sheets of Copper Laminate approx. 20 sq. ins.	0·54

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PLUGS

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PS	2	D.I.N. 3 Pin	0·12
PS	3	D.I.N. 4 Pin	0·15
PS	4	D.I.N. 5 Pin 180°	0·16
PS	5	D.I.N. 5 Pin 240°	0·16
PS	6	D.I.N. 6 Pin	0·17
PS	7	D.I.N. 7 Pin	0·18
PS	8	Jack 2·5mm Screened	0·18
PS	9	Jack 3·5mm Plastic	0·12
PS	10	Jack 3·5mm Screened	0·18
PS	11	Jack ¼" Plastic	0·15
PS	12	Jack ¼" Screened	0·22
PS	13	Jack Stereo Screened	0·36
PS	14	Phono	0·10
PS	15	Car Aerial	0·22
PS	16	Co-Axial	0·15

INLINE SOCKETS

PS	21	D.I.N. 2 Pin (Speaker)	0·14
PS	22	D.I.N. 3 Pin	0·20
PS	23	D.I.N. 5 Pin 180°	0·20
PS	24	D.I.N. 5 Pin 240°	0·20
PS	25	Jack 2·5mm Plastic	0·16
PS	26	Jack 3·5mm Plastic	0·16
PS	27	Jack ¼" Plastic	0·30
PS	28	Jack ¼" Screened	0·35
PS	29	Jack Stereo Plastic	0·30
PS	30	Jack Stereo Screened	0·38
PS	31	Phono Screened	0·18
PS	32	Car Aerial	0·22
PS	33	Co-Axial	0·22

SOCKETS

PS	35	D.I.N. 2 Pin (Speaker)	0·08
PS	36	D.I.N. 3 Pin	0·11
PS	37	D.I.N. 5 Pin 180°	0·11
PS	38	D.I.N. 5 Pin 240°	0·11
PS	39	Jack 2·5mm Switched	0·12
PS	40	Jack 3·5mm Switched	0·12
PS	41	Jack ¼" Switched	0·20
PS	42	Jack Stereo Switched	0·30
PS	43	Phono Single	0·08
PS	44	Phono Double	0·10
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LEADS
LS 1 Speaker Lead 2 pin D.I.N. plug to open ends approx 3 metres long (coded) 0·20

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CP	1	Single Lapped Screen	0·07
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CP	4	Four Core Common Screen	0·23
PC	5	Four Core Individually Screened	0·30
CP	6	Microphone Fully Braided Cable	0·10
CP	7	Three Core Mains Cable	0·09
CP	8	Twin Oval Mains Cable	0·07
CP	9	Speaker Cable	0·05
CP	10	Low Loss Co-Axial	0·18

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VC	4	1K Lin Less Switch	0·15
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Type	Amps	Price	P. & P.
MT50/1	1	£2·42	48p
MT50/2	2	£3·30	60p

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GP91-18C 200mV at 1·2cm/sec	£1·35
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J-2010C Crystal/Hi Output Compatible	£1·20
J-2006S Stereo/Hi Output	£1·75
J-2105 Ceramic/Med Output	£1·95
J-2203 Magnetic 5mV/5cm/sec, including stylus	£4·95
J-2203S Replacement stylus for above	£3·00
AT-55 Audio-technica magnetic cartridge 4mV/5cm/sec	£3·30

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The E12 Range of Carbon Film Resistors, ⅓ watt available in PAKS of 50 pieces, assorted into the following groups:

R1	50 Mixed 100 ohms–820 ohms	50p
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R3	50 Mixed 10kΩ–82kΩ	50p
R4	50 Mixed 100kΩ–1MΩ	50p

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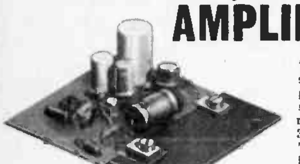
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8–16 Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE −3dB	Po = 2 WATTS	50 Hz–25KHz
SENSITIVITY for RATED O/P	Vs=25V. Rl=8Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" = 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts £2·50
AL 20. 5 watts £2·85
AL 30. 10 watts £3·20

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30) 95p
SPM 80. (Use with AL60) £3·25
FRONT PANELS FP 12 with Knobs £1·00

PRE-AMPLIFIERS

PA 12. (Use with AL10, AL20 and AL30) £4·35
PA 100. (Use with AL60) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·60 P & P 22p
T538 (Use with AL20, AL30) £2·30 P & P 22p
BMT80 (Use with AL60) £2·75 P & P 37p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response— 20Hz–50KHz (−3dD)
Bass control— ± 12dB at 60Hz
Treble control— ± 14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm Sensitivity 300mV
†Input 2. Impedance 30 K ohms Sensitivity 4mV

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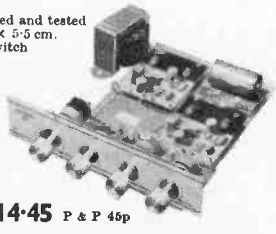
The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plintbs without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.



£14·45 P & P 45p

TC20 TEAK VENEERED CABINET

For Stereo 20 (front board undrilled) Size 10¼" × 8¾" × 3", £3·95 plus 45p postage.

SHP80 STEREO HEADPHONES

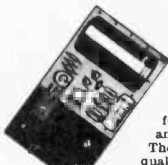
4-16 ohms impedance. Frequency response 20 to 20,000Hz. Stereo/mono switch and volume controls, £4·95

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £4·25

- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- Distortion better than 0·1% at 1KHz
- Supply voltage 15–50 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

STABILISED POWER MODULE SPM80

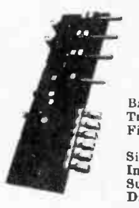


SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·75 p. & p. 40p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	3·25 mV into 50K Ω
2. Radio, Tuner	75 mV into 50K Ω
3. Magnetic P.U.	3 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than −65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £14·25

MK 60 AUDIO KIT

Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. Complete Price: £29·75 plus 45p postage.

TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16¾" × 11¼" × 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc. Kit price: £9·95 plus 45p postage.

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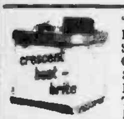

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Type	Volts	Current	Ohms	
27/A	12V	17M/A	700	All
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Heavy duty contacts 2,500 ohm coil. All new and unused D.P.D.T. mains relays 50p, Carr. free. Special quantity £40 per 100 off.

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PRI 240V

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170W r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm).

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Is supplied complete with the mains transformer. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers.

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0·1mA —ME9	0·50V —ME16
0·5mA —ME10	0·300V a.c.—ME17
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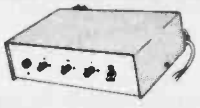

Three Channel: Bass, Middle, Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed.)
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2G381	0·22
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2N404	0·22
2N697	0·16
2N698	0·30
2N706	0·12
2N706A	0·12
2N708	0·15
2N709	0·40
2N1091	0·55
2N1131	0·25
2N1132	0·24
2N1302	0·18
2N1303	0·18
2N1304	0·28
2N1305	0·22
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2N2925	0·15
2N2926	0·12
2N3054	0·48
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2N3702	0·11
2N3705	0·15
2N3706	0·11
2N3707	0·13
2N3709	0·10
2N3710	0·11
2N3711	0·11
2N3819	0·38
2N4289	0·30
2N5027	0·53
2N5088	0·33
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2S304	1·15
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AAZ12	0·75
AAZ13	0·12
AC107	0·51
AC126	0·25
AC127	0·25
AC128	0·15
AC187	0·21
AC188	0·20
ACY17	0·40
ACY18	0·27
ACY19	0·27
ACY20	0·22
ACY21	0·22
ACY22	0·16
ACY27	0·25
ACY28	0·25
ACY39	0·78
ACY40	0·22
ACY41	0·22
ACY44	0·32
AD140	0·50
AD149	0·50
AD161	0·44
AD162	0·44
AF106	0·30
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·24
AF118	0·57
AF119	0·20
AF124	0·30
AF125	0·30
AF126	0·30
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BC113	0·15
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BC116	0·20
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BC118	0·20
BC121	0·20
BC122	0·20
BC125	0·68
BC126	0·65
BC140	0·55
BC147	0·10
BC148	0·08
BC149	0·10
BC157	0·14
BC158	0·12
BC160	0·63
BC169	0·14
BCY31	0·45
BCY32	0·85
BCY33	0·38
BCY34	0·45
BCY38	0·55
BCY39	1·50
BCY40	0·80
BCY42	0·30
BCY70	0·18
BCY71	0·22
BCZ10	0·60
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BDY11	1·45
BF115	0·20
BF167	0·25
BF173	0·28
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BF184	0·22
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BF194	0·10
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BF196	0·15
BF197	0·15
BFS61	0·25
BFS98	0·25
BFX12	0·20
BFX13	0·26
BFX29	0·28
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BFX35	0·98
BFX63	0·50
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BFX85	0·28
BFX86	0·25
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BFX88	0·24
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BFY17	0·40
BFY18	0·45
BFY19	0·55
BFY24	0·45
BFY44	1·00
BFY50	0·21
BFY51	0·20
BFY52	0·20
BFY53	0·17
BFY64	0·36
BFY90	0·81
BSX27	0·50
BSX60	0·93
BSX76	0·18
BSY26	0·17
BSY27	0·20
BSY51	0·50
BSY95A	0·12
BSY95	0·12
BT102/500R	0·75
BTY42	0·92
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BTY79/400R	1·10
BY100	0·27
BY126	0·14
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BY182	0·85

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BYZ10	0·45
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BYZ13	0·42
BYZ15	1·25
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BZY88	0·10
C111	0·55
CRS1/05	0·30
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CS4B	1·90
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DD000	0·15
DD003	0·15
DD006	0·25
DD007	0·40
DD008	0·38
GD3	0·33
GD4	0·10
GD5	0·38
GD8	0·25
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GET102	0·50
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GET882	0·35
GET885	0·40
GEX44	0·08
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GJ3M	0·50
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HG1005	0·50
HS100A	0·20
MAT100	0·20
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MAT120	0·20
MAT121	0·25
MJE520	0·63
MJE2955	1·27
MJE3055	0·77
MJE340	0·47
MPF102	0·40
MPF103	0·36
MPF104	0·35
MPF105	0·36
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OA5	0·72
OA6	0·12
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OA70	0·10
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OA81	0·18
OA85	0·15
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OC44M	0·17
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OC81M	0·20
OC81DM	0·18
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OC82	0·23
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OC83	0·27
OC84	0·30
OC114	0·38
OC122	1·00
OC123	1·10
OC139	0·40
OC140	1·14
OC141	0·80
OC169	0·20
OC170	0·30
OC171	0·30
OC200	0·54
OC201	1·00
OC202	0·90
OC203	0·55
OC204	0·65
OC205	1·00
OC206	1·10
OC207	1·00
OC460	0·20
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74154	2·00
74155	1·00
74156	1·00
74157	0·95
74170	2·52
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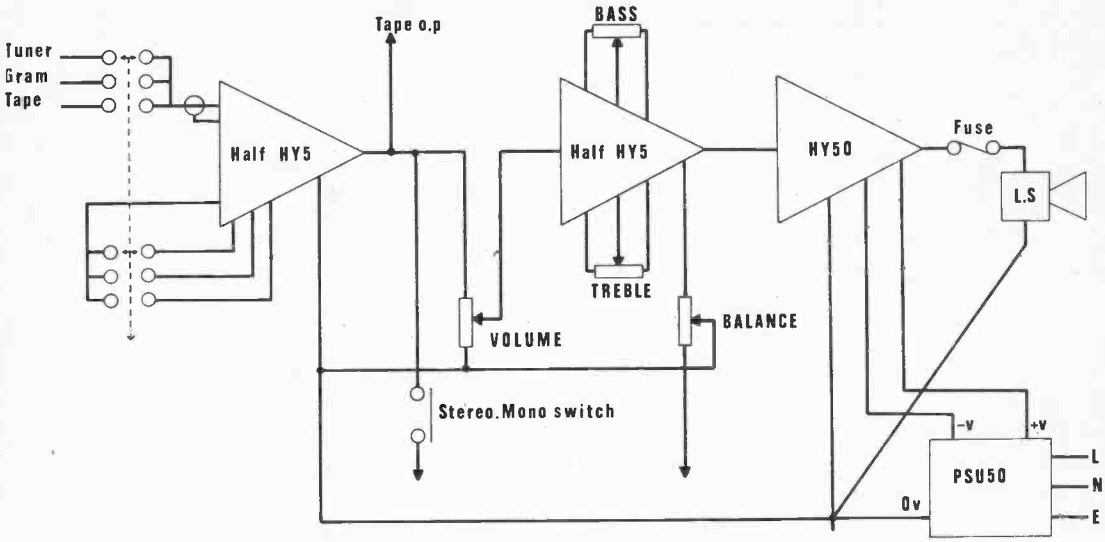
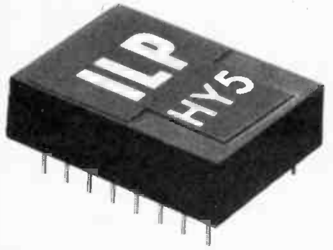
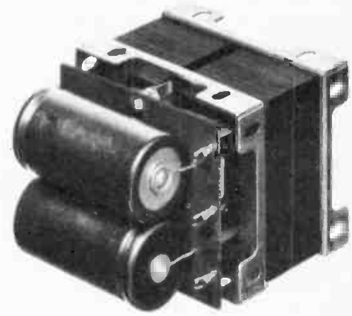


MONO ELECTRICAL CIRCUIT DIAGRAM WITH INTERCONNECTIONS FOR STEREO SHOWN





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 £4·50 + 36p 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 £5·98 + 48p 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.

PRICE £6 + 48p VAT P. & P. FREE

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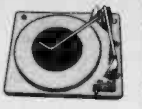


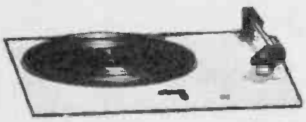
Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250V. Size 13¾ × 11¼in. Above motor board 3¼in. Below motor board 2¼in. with STEREO and MONO XTAL **£7·95** Post 45p.

PORTABLE PLAYER CABINET

Modern design. Rexine covered. Large front grille. Lift-up Lid. Chrome fittings. Approx. size 17in × 15in × 7in. Few only in red and black rexine. Motor board cut for Garrard deck **£4·50** Post 50p

BSR JUNIOR SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono compatible cartridge. **£4.95** Post 25p



R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop. Compatible cartridge. Baseplate. Size 11in × 8½in. Turntable. Size 7in diameter. A/C mains. 200/250V motor has a separate winding 14 volt to power a small amplifier. Three speeds. Plays all records.

£5·50 Post 25p

SOLID MAHOGANY PLINTH Post 45p

With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Size 12¾ × 14¾ × 7½in. **£6·50**

COMPLETE STEREO HI-FI SYSTEM

Two full size loudspeakers 13½ × 10 × 3¾in. Player unit clips to loudspeakers making it extremely compact, overall size only 13½ × 10 × 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. 240V AC Mains.

Attractive Teak finish Weight 13 lb. Bargain Price **£25** 85p Carriage

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0 TO 60 MINUTES

Single pole two-way Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Fully insulated. Makers' last list price £4·50. Brand new and fully guaranteed.

OUR PRICE **£2·20** Post 25p

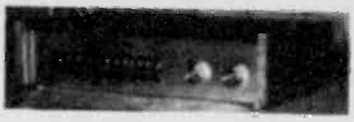
BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1. ALUMINIUM BOXES 3 × 3 × 3in 60p; 4 × 4 × 4in 70p; 6 × 4 × 4in 80p; 9 × 4 × 4in £1; 12 × 4 × 4in £1·30. ALUMINIUM PANELS 18 s.w.g. 6 × 4in 12p; 8 × 6 in 19p; 14 × 3in 20p; 10 × 7in 24p; 12 × 5in 25p; 12 × 8in 34p; 16 × 6in 34p; 14 × 9in 40p; 12 × 12in 47p; 16 × 10in 60p. 1½ inch DIAMETER WAVECHANGE SWITCHES, 45p ea. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way. 1 p.l. 2-way, or 4 p. 2-way, or 4 p. 3-way. TOGGLE SWITCHES, sp. 20p; dp. 25p; dp. dt. 30p.

BRITISH FM/VHF TUNING HEART

88 to 108 Mc/s British made. 2 Transistors ready aligned requires 10·7 Mc/s I.F. Complete with tuning gang. Connections supplied but some technical experience essential. **Our price £3·95** Post 20p

SUITABLE I.F. STRIP £4·95. DECODER £4·95

R.C.S. STEREO FM TUNER BRITISH MADE



This completely cased mains powered Hi-Fi Tuner with brushed aluminium facia is British made using the latest circuitry. **£23** Post 45p.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12V or H.T. line 200-300V d.c. operation. Size: 1¾ × 1¼ × ¾ in. Response 25 c/s to 25 kc/s, 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **£1·25** Post 10p

R.C.S. POWER PACK KIT

12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£2·95** Post 25p
12 VOLT 300mA KIT, £2·75. 9 VOLT 1 AMP KIT, £2·95.

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	50+50/300V	50p
4/350V	14p	500/25V	20p	32+32/350V	35p
8/350V	22p	100+100/275V	65p	32+32/450V	60p
16/350V	30p	150+200/275V	70p	350+50/325V	55p
32/500V	50p	8+8/450V	22p	16+16+16/275V	45p
25/25V	10p	8+16/450V	25p	32+32+32/350V	65p
50/50V	10p	16+16/450V	40p	900/350V	95p
100/25V	10p	32+32/350V	40p	4700/63V	95p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 20p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.
CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 7p; 0·5 18p; 1mF 15p; 2mF 150V 15p.
500V-0·001 to 0·05 4p; 0·1 10p; 0·25 8p; 0·47 25p.
TWIN GANG. "0-0" 208pF+176pF, £1.20p.
Slow motion drive 365pF+365pF with 25pF+25pF, 50p;
Twin 500pF 75p. Twin 410pF 50p. Twin 120pF 50p.
SHORT WAVE SINGLE. 25pF, 45p; 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ¼W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each.
TAPE OSCILLATOR COIL Valve type 35p.
FERRITE ROD 8 × ⅜in 20p; 6 × ⅜in 20p; 3 × ⅜in 10p.

MAINS TRANSFORMERS — ALL POST 25p each

250-0-250 80mA. 6·3V 2 amp .... £2·50
250-0-250 80 mA. 6·3V 3·5A 6·3V 1A or 5V 2A .... £4·00
350-0-350 80 mA 6·3V 3·5A, 6·3V 1A or 5V 2A .... £5·00
300-0-300V 120mA, 6·3V 4A C.T.; 6·3V 2A .... £6·00
MINIATURE 200V 20mA, 6·3V 1A 2½ × 2½ × 2in 75p
MIDGET 220V 45mA, 6·3V 2A 2⅝ × 2⅜ × 2in 90p
HEATER TRANS. 6·3V ½ amp 85p, 3 amp £1.20p
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £4·00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6·00
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
10, 30, 40V 2 amp. £2.20; 20V 3 amp. £2. 5, 8, 13V, 5 amp. £1·50; 6-0-6V 500mA 90p; 9V 1 amp. 95p; 12V 300mA 75p; 12V 500mA 85p; 12V 750mA 95p; 40V 3 amp. £2·50; 22-0-22V 4 amp. £3; 16V ½ amp. 95p; 16V 2 amp. £1·85; 5V, 8V, 10V, 16V ½ amp. £1·60.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £4·00; 500W £7·50; 750W £15; 1000W £18.
CHARGER TRANSFORMERS. 200/250V, 4 amp £4·00.
BATTERY CHARGERS. Ready built with leads and clips, 4 amp £4; 5 amp. £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs. 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER

Primary 0-110-240V. Secondary 0-240V 3 amps 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make (Value £19) OUR PRICE **£12** Carr. 95p
Can be used as 800 watt auto transformers 240-110V.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p.

80 Ohm Coax 5p yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd £2·00; 60 yd £3·00. FRINGE LOW LOSS 10p per yd. Ideal 625 and colour.

Wire Wound controls 1½in diam. 3 Watts. 10 ohms to 100K British Made with long spindles ¼in dia. 85p each.
DUAL CONCENTRIC POT 500K LOG AND 500K LIN D.P. switch. Inner spindle 3¼in; outer spindle 2¼in 75p.

E.M.I. 13½ × 8in. SPEAKER SALE!

With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·95** Post 25p
13 × 8in Bass unit 20 watt rubber cone surround £5·50

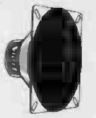
LOUDSPEAKER FRONT GRILLES

Teakwood strips mounted on cloth backing, easily glued on to baffle to modernise cabinets. Size 18½ in × 10¼in. **75p** Or size 10¼in × 7½in. **45p**

E.M.I. 6½in. HI-FI WOOFER

8 ohm. 10W. Large ceramic magnet. Special Rubber cone surround. Frequency response 30-12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**
Suitable Cabinet 12 × 8 × 6 £4 Suitable Tweeter £2

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3¾ × 3¾ × 2in deep. Rating 10W, 3 ohm.
Crossover £1·60 **£1·90** Post 20p.

GOODMANS 8 in. WOOFER

8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi system. **£3·75**

SPECIAL OFFER LOUDSPEAKERS

3 ohm, 2½in; 2¾in; 3½in; 5in.
8 ohm, 2½in; 2¾in; 5in × 3in; 3in; 4in; 5in; 6 × 4in.
15 ohm, 3½in; 5in; 6 × 4in; 5 × 3in; 7 × 4in; 8 × 5in.
25 ohm, 2½in; 5 × 3in; 5in; 6 × 4in.
35 ohm, 3in; 5in.
80 ohm, 2½in; 2¾in. 120 ohm 3in. **£1 EACH**

LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in £1·25; 6½in £1·50; 8 × 5in £1·60; 8in £1·75; 10 × 6in £1·90; 10in £2·50
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in diameter 4W £2·50, 10 in diameter 5W £2·95; Post 25p. 12in diameter, 6W, £3·50; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16Kc/s. 8W 8 ohm or 15 ohm £2·50.
De Luxe Horn Tweeters 2-18Kc/s, 15W, 15 ohm £4·00.
TWO-WAY 3,000 c.p.s. CROSSOVERS 3, 8 or 15 ohm £1·60.

CASSETTE MACHINE MOTOR. 6 Volt. Will replace many types £1·25.

R.C.S. 3 WAY CROSSOVER

Complete with 12 ft. twin lead fitted with din speaker plug. Ready assembled with leads for speakers, bass, mid and tweeter. Crossover frequencies—950 cps and 3,000 cps. **£1·95**

VALVE OUTPUT TRANSFORMER 50p.
MIKE TRANSFORMER MU metal 100-1 £1·25.
PUSH-PULL VALVE OUTPUT TRANSFORMERS.
50 watt .... £12·50 100 watt .... £15·00

ELECTRO MAGNETIC PENDULUM MECHANISM

1·5V d.c. operation over 200 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 20p

R.C.S. RECORD PLAYER AMPLIFIER

2 stage triode pentode valve. 3 watts output. Volume on/off and tone controls. Printed circuit A.C. mains complete and tested. Complete with speaker. **£4·50** Post 35p

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18 OUTLET BOXES, SURFACE MOUNTING 40p.
BALANCED TWIN RIBBON FEEDER 300 ohms, 7p yd.
JACK SOCKET Std. open-circuit 14p. closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 7p. Phono Socket 7p
JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 15p DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p DIN SOCKETS Lead 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p.
VALVE HOLDERS 5p; CERAMIC 10p; CANS 5p.

ALL PRICES INCLUDE VAT ● 20p MINIMUM POST AND PACKING ● CALLERS WELCOME ●

RADIO COMPONENT

Illustrated Brochure, Radio Books & Component Lists 10p Written guarantee.

ALL OUR PRICES INCLUDE V.A.T.

E.M.I. WOOFER AND TWEETER KIT

£5·75 THE PAIR, Post 45p. (Available separately. Woofer £4·25; Tweeter £1·90)

Comprising a fine example of a Woofer 10¾ × 6½in with a massive Ceramic Magnet, 44oz Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard	8 ohms
Maximum power	12 watts
Useful Response	35 to 18,000 cps
Bass Resonance	45 cps

SUITABLE ENCLOSURE 20 × 13 × 9in. MODERN DESIGN. TEAK WOOD FINISH. **£10·50** Post 75p

ANOTHER R.C.S. BARGAIN!

ELAC 9 × 5in. HI-FI SPEAKER TYPE 59RM

This famous unit now available, 10 watts, 8 ohm.

Price **£2·95** Post 25p

8" or 10" x 6" ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts. **£3·75**

10in round £4·50.

TEAK VENEER HI-FI SPEAKER CABINETS Fluted Wood Fronts

MODEL "A". 20 × 13 × 9in For 12 in. dia. or 10in speaker. **£10·50** Post 75p

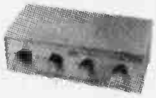
MODEL "B". 16 × 10 × 7in For 13 × 8in. or 8 in. speaker **£6·60** Post 45p

MODEL "4C". 30 × 20 × 12in. Reflex cabinet will accept 1-12in. bass unit, 1-5in. mid range, 1-3in. tweeter. Teak finish. Grooved front **£18·50** Carr. £2

LOUDSPEAKER CABINET WADDING 18in wide, 20p ft.

GOODMANS CONE TWEETER

3½in. diam. 18,000 C.P.S. 25 WATTS 8Ω **£3·30**



BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated. **£4·50**

STEREO VERSION OF ABOVE £5·95.

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. Mains Supply £3. **£3·95**

THE "INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. **£3·75** Post 20p

WAFER THIN HEATING ELEMENTS

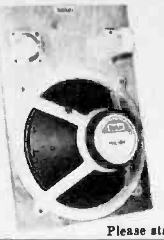
OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse factory (available in manufacturing quantities). Approx size 10¾ × 8¼ × ¹⁄₁₆in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photo-copiers and print drying equipment.

Ideal for home handymen and experimenters. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos, etc., to make efficient clothes dryers, towel rails—ideal for airing cupboards. Ideal for anti-frost device for the garage—preventing frozen radiators or acting as oil sump heater. Use in greenhouse for seed raising and plant protection. Invaluable aid for bird houses, incubators, etc., etc. Can be used in series for lower heat. Or in parallel for higher heat applications.

ONLY **40p** EACH (FOUR FOR £1·50)

ALL POST PAID—Discounts for quantity.

BAKER MAJOR 12" £8·50



30-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s Rated 20 watts. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£10·95**

Please state 3 or 8 or 15 ohms.

BAKER "BIG SOUND" SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful response 30-13,000 cps. Bass Resonance 55 cps.

GROUP "25" 12in 25 watt 3, 8 or 15 ohms. **£7·75**

GROUP "35" 12in 35 watt 3, 8 or 15 ohms. **£8·50**

GROUP "50" 15in. 50 watt 8 or 15 ohms. **£17·80**

50 watt 12in VERSION £12·95

MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm a.c. Mains. Separate treble and bass controls. Guaranteed. Details S.A.E. **£49** Carr. £1·00

NEW MODEL MAJOR 50 WATT

4 inputs, 2 way mixing. £39·95. Carr. £1. Ideal disco amp.

CALLERS ONLY! DE-LUXE 100 WATT AMPLIFIER CHASSIS. 7 Valve version, 4 inputs, 10 wide range controls. For Mikes, Discos, Organs, Guitars, etc. 4, 8 and 15 ohm Loudspeaker matching. **£69**

QUALITY LOUDSPEAKER ENCLOSURE

Teak veneered ½in thick wood cabinet. Size 18½in × 18½in × 8½in. Weight 23lbs. This cabinet features a wide mesh Silver Grill covering a separate compartment for mounting Tweeters or Mid-Range Horn. The fully sealed bass compartment is cut out for 6½in Woofer. £7.50. Carr. 85p. Rosewood Version £8·50. Carr. 85p.

Baffle could be cut for larger speaker.

SPECIAL OFFER 95p. Post 25p. 100 Ohm 20 watt Rheostat 2½in dia. Ceramic Former. Screw Terminals ¼in. dia. spindle.

R.C.S. STEREO DECODER

British made. Ready aligned and tested. Complete with instructions. Size 3in × 2in. **£4·95**

WEYRAD COILS

P50/2CC	40p	RA2W	85p
P50/1AC	60p	OPT1	65p
P50/3CC	40p	LFDT4	65p
PCA1	85p	Twin gang	£1·20

DELUXE 4 POLE MOTOR

1,400 r.p.m. reversible 42 Watt, spindle 1⅛in × 7/32in, size 3¼in × 3in. As illustrated. 240V a.c. mains. **£2·25** Post 25p

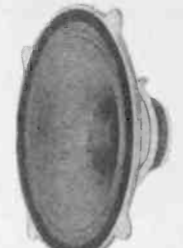
E.M.I. GRAM MOTOR

120V or 240V a.c. 2,400 rpm. 2-pole 70mA. Size 2¾ × 2¼ × 2¼in. **£1·00** Post 25p

BAKER HI-FI SPEAKERS

HIGH QUALITY—BRITISH MADE

REGENT 12in. 15 watts



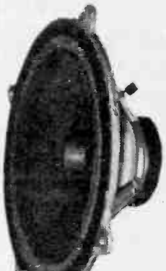
An inexpensive unit for the beginner in high fidelity and for general purposes. May be used to improve any Radio, Amplifier, Hi-Fi or Television receiver.

Bass Resonance	45cps
Flux Density	12,000 gauss
Useful response	45-13,000cps

3 or 8 or 15 ohm models.

£7·75

DE-LUXE Mk II 12in. 15 watts



Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

Bass Resonance	30cps
Flux Density	14,000 gauss
Useful response	25-16,000cps

8 or 15 ohms models.

£9·75

SUPERB 12in. 20 watts

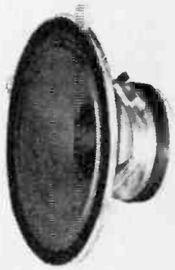
A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance	25cps
Flux Density	16,500 gauss
Useful response	20-17,000cps

8 or 15 ohms models.

£13·80

AUDITORIUM 12in. 25 watts



A full range reproducer for high power. Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.

Bass Resonance	35cps
Flux Density	15,000 gauss
Useful response	25-16,000cps

8 or 15 ohms models.

£12·95

AUDITORIUM 15in 35 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home Hi-Fi.

Bass Resonance	35cps
Flux Density	15,000 gauss
Useful response	20-14,000cps

8 or 15 ohms models.

£17·80

Hi-Fi Enclosure Manual containing plans, designs, crossover data and cubic tables. 63p.

CUSTOMERS FREE CAR PARK • OPEN 9-6 p.m. WEDNESDAYS 9-1 p.m., SATURDAYS 9-5 p.m. (Closed for Lunch 1.15-2.30)

SPECIALISTS 337 WHITEHORSE ROAD • CROYDON

(Export: Remit cash and extra postage.) *Buses 50, 68, 159. Rail Selhurst* Telephone 01-684-1665

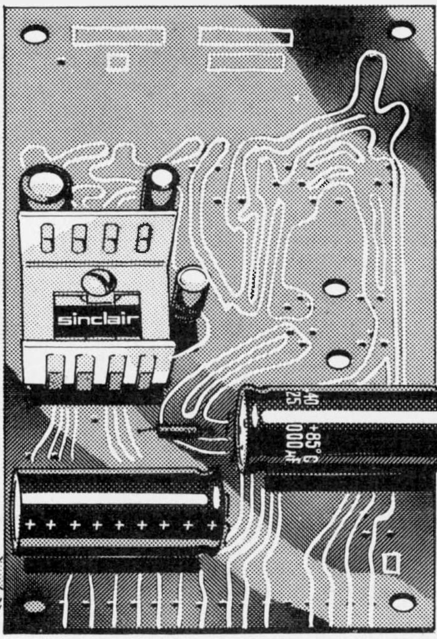
New. Sinclair IC20. 20 watts stereo amplifier kit for only £7.95 (plus VAT)

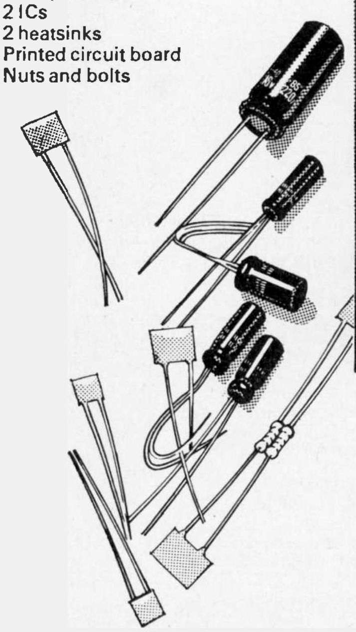
A build-it-yourself stereo power amplifier with latest integrated circuitry... 10 W RMS per channel output... full short-circuit and overheat protection.

Latest from Sinclair – the brand new IC20 power amp. It incorporates state-of-the-art integrated circuits – 2 monolithic silicon chips each containing the equivalent of over 20 transistors! These deliver 10 W per channel into 4 Ω speakers. And the IC20 has integral short-circuit protection and thermal cut-out – it's virtually indestructible!

How should I use the IC20?
Use the IC20 for converting your mono record player to stereo ... for upgrading your existing stereo ... for improving your car radio/tape player. The IC20 runs off a 9-24 V power supply. If you're running the IC20 off the mains, simply add a Sinclair PZ20 power supply (£4.95 plus VAT).

Using the IC20 to improve your car radio/tape player's quality and volume? Run the IC20 off the car battery direct. You don't need a separate power supply, and you're reducing the drain on the player's dry batteries.





A complete kit!
6 resistors
15 capacitors
2 ICs
2 heatsinks
Printed circuit board
Nuts and bolts

Typical performance of the IC20 stereo amplifier
Supply voltage: absolute maximum 24 V, minimum 6 V.
Current consumption: *24 V, no signal* – 20 mA each channel.
18 V, 9 W into 4 Ω – 770 mA each channel.
Power output: *14 V supply, 4 Ω load, 10% distortion* – 5½ W RMS per channel, *20 V supply, 4 Ω load, 10% distortion* – 10 W RMS per channel.
Total harmonic distortion: at *50 mW, 4 Ω load, 20 V supply* – less than 0.1%.
Input sensitivity: *for 9 W into 4 Ω* – 90 mV.
Frequency response: –3 dB at 40 Hz and 16 KHz.
Load impedance: 4 Ω or 8 Ω, but device is safe with any load.

Improve your audio equipment – today

Both the IC20 and the PZ20 are covered by the Sinclair one-year, no-quibble guarantee – if absolutely any defect arises, Sinclair will replace the whole unit – unconditionally.

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PE

DISCORDANT VOICES

All is not harmonious in the musical world, as students of electronics are likely to be well aware. Opinion among musicians is certainly found to be sharply divided when the involvement of electronic techniques is discussed. Is there any real danger that traditional musical styles will suffer, or even be swept away, in the future by the new sounds and tonal expressions electronics alone is capable of producing? Fears of such an impending catastrophe are sometimes expressed by the more conservative minded.

The technology of electronics and the art of music have long been intermeshed one with the other. As a sound reinforcing agency, electronics has an extremely long association with traditional music and instruments. But ever since the infinite capabilities of tone pattern generation became recognised by circuit designers, innovation in sounds has become as important, and even more exciting, a role for electronics in the music field. From then on, it seems, a dilemma emerged. For some at any rate. Which is the right road for music-electronics to pursue: using electronic techniques to imitate or to reinforce without altering the essential character of traditional instrument sounds; or using electronic circuitry freely without limitations to create sounds that are original or, at least, do not have to be considered mere imitations of the voicing of acoustical instruments.

Undeniably there are two distinct paths; but each is clearly signposted. Both obviously have important parts to play in the development of the musical art and its wider appreciation. But the territory between these two well defined paths has become rather mudded and some state of confusion has been created in the minds of certain travellers who have become bogged down in this ill-defined area. So arguments and protests have arisen from upholders of the pure traditional approach to music, with counter arguments from the protagonists of uninhibited exploitation of electronic means and ends in the whole area of music, from composition to performance.

The non-specialist in musical affairs can leave the finer points of the debate to those who are academically or commercially involved in the musical arts. Sufficient to say electronics is a ready and willing servant of unquestionable value always at the disposal of the guardians of the muse, whensover they make the call.

A good concrete example of the first line of approach as mentioned above is the electronic piano, where electronic techniques are employed to imitate a classical type of musical instrument. The great advantage over the conventional piano is less bulk and weight. Factors of considerable importance in the modern home. In regard to performance electronics is here paying the conventional instrument a compliment, since modern circuit techniques are applied to the task of simulating as closely as possible the characteristics of a normal piano. Though extra voicing facilities are incorporated in the case of the PE Joanna as a bonus. A small electronic indulgence which should not offend even the purists among piano players.

F.E.B.

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- **Lightweight, attractive styling with amplifier incorporated in stool**
- **Cost to build £120 approx.**

PE JOANNA

By A.J. BOOTHMAN B.Sc.

CONVENTIONAL

HARPSICHORD

SINCE the first publication of an electronic piano design, which was in PRACTICAL ELECTRONICS over the period September 1972 to January 1973, the instrument has been the subject of a sharp increase in popularity. A number of commercial versions have become available on the market, whilst many organ manufacturers now include a piano stop on a large part of their range. Many of the types on offer are not touch sensitive, which, although being an advantage when used in conjunction with an organ, is a distinct drawback when a full piano substitute is required. Other designs have questionable tone or voicing which can soon become unacceptable. The P.E. Electronic Piano had a very small degree of touch sensitivity and a basic functional tone, and has now grown into the "Joanna" which combines a very wide range of touch with a good piano tone, whilst achieving a further decrease in size. In addition to its ideal adoption as the family instrument this therefore makes it very convenient to sit on top of an organ as an extra manual with or without touch sensitivity.

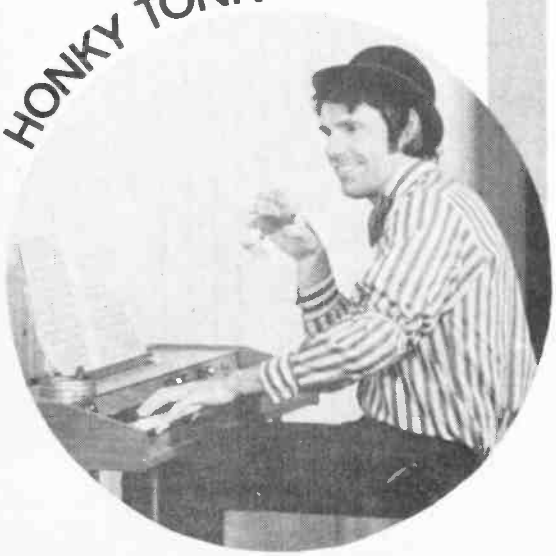
In establishing the new design the standard piano was investigated in more detail and the following facts and comments will be of interest to the reader.

PIANO HISTORY

According to past literature on the subject the first stage in the evolution of the piano was the clavichord, which used the impact of metal blades on horizontally stretched wires. The other notable predecessor was the harpsichord in which a mechanically coupled plectrum was used to pluck the strings. Instruments of the latter type can still be obtained, and in the "Joanna" a harpsichord tabswitch is provided.

The pianoforte, in which the wire is struck by a felt covered wooden hammer which is allowed to quickly fall back, has evolved into two basic types, namely the grand and the upright. The latter, which is of course the most common type, covers a wide range of tonal qualities, many of which have their

HONKY TONK



P.E. PIANO SPECIFICATION

MUSICAL COMPASS

Five Octaves C to C 61 Notes

FREQUENCY COMPASS

Fundamental Frequency Range	60Hz to 2kHz approx
Master Oscillator	500kHz approx

NOMINAL OUTPUT LEVELS

External Amplifier	1V into 1MΩ 400mV into 10kΩ 100mV into 2kΩ
Headphones	50mW into 4Ω

TOUCH CHARACTERISTICS

Dynamic Range	>27dB
Key Action	<1oz

MAINS INPUT

240 Volts 50 Watts

SOUND ENVELOPE (nominal times)

Touch Range	2 to 40mS
Attack Period	<1mS
Early Decay	500mS
Sustain Period	3 to 5S (varies over compass)

TREMOLO FREQUENCY (nominal)

Slow	5Hz
Fast	10Hz

DIMENSIONS AND WEIGHT

Case	38in × 14in × 5in
Height of legs	24in
Weight	20lbs

CONTROLS

Level Control/On-Off Switch
Piano Tab
Honky-Tonk Tab
Harpsichord Tab
Tremolo Slow Tab
Tremolo Fast Tab
Sustain Foot Pedal
Soft Foot Pedal

SOCKETS

Mains Supply Socket
Pedal Socket
External Amplifier Socket
Headphone Socket
Stool Amplifier

POWER

Output Power 15–25 Watts

own individual appeal. Apart from the rich full piano sound obtainable from a high quality instrument, the other most characteristic variation, which is usually associated with age, is the honky-tonk. The "Joanna" provides a honky-tonk tabswitch, and by using all three tabs in combination a wide range of tone is available to the performer.

COMPASS AND SIZE

A normal piano covers $7\frac{1}{4}$ octaves, with some smaller versions having a limited availability. The stringing of the piano is necessarily complex and takes up a considerable amount of space, fold-over techniques being used to minimise the volume where possible. Limiting the compass to five octaves greatly assists in reducing the size of the electronic instrument to minute proportions when compared with the conventional instrument, and is convenient from the electronic component point of view in simple economic tone generation. The choice of compass is an individual matter, but the author now prefers to use C-C in the general home environment, whereas F-F has been used for group work. In order to give some compensation for the loss of bass notes it has been simple to arrange for a slight enhancement of the level of the bottom two octaves, and the result has been assessed to be a good compromise by a number of pianists with widely differing styles.

TOUCH ACTION

The keyboard dynamic range of a piano is in the range 50–60dB, but this level of touch sensitivity is not often available in the average instrument, and the 30dB or so offered by the "Joanna" should be pleasing to most pianists. The principle of touch action is the subject of much discussion but suffice it to say that the majority opinion is that the final hammer velocity is the only determining factor in the resulting sound. In the conventional piano the velocity defines the level of output and the tonal quality, and the means by which this velocity is achieved, e.g. a gradual build up of key speed, effects neither parameter.

In the "Joanna" the level of output is varied by the average speed of the key over the depression period, and the tone is not altered, other than through the normal effect in the ear of the listener where perceived tone varies with level. The level control is used to limit the maximum volume achievable to suit the environment and is not operated during the execution of a musical score. The final aspect of touch is the key-weight which is considerably less than the normal 2oz. This gives a very fast action, but does of course feel different to a normal piano keyboard, and requires time to become adjusted.

ENVELOPE

Many resonance effects are present in a piano which result in a complex decay portion of the envelope, both in terms of level and harmonic content. A large influencing factor is the use of multiple stringing and the way in which sympathetic resonances can be initiated by the note being struck. Simulation of these effects could be achieved by extensive electronic synthesis, but to produce a polyphonic instrument by such techniques is outside the

Control switches and voicing tabs

economic scope of the large area of interested constructors who are also prepared to accept that a full detailed synthesis of a piano is not of the utmost importance, whilst an improvement on presently available designs is welcome. The "Joanna" offers a decay characteristic which varies in length across the compass, and is in the region of five to three seconds.

VOICING

Two tonal aspects are mentioned above where simulation is not attempted, i.e. variation of the harmonics content with key velocity and over the decay period. The harmonic content of the basic note differs over the range of the board, and the voicing circuits are designed to give a greater level of high harmonics at the lower end of the piano to match the conventional instrument. The voicing circuits allow the constructor some freedom of fine adjustment to suit his own taste, and are split into three groupings across the keyboard.

PEDAL ACTION

The soft pedal of a grand piano operates the hammer action mechanism to move it into a position whereby the number of strings hit on the multi string sections is reduced, whereas the upright system is to reduce the hammer travel and thus its terminal velocity. The "Joanna" by simultaneously reducing the output level from all notes is similar to the upright action. The sustain pedal raises all dampers, and is directly simulated in the electronic version.

ENVIRONMENTAL ACOUSTICS

As with all sound sources, the acoustics of the environment can have a very great effect on the overall result obtained from a piano. The first noticeable effect is the difference in tone experienced at varying distances from the sound source which occurs with both the conventional and electronic piano. The second is the way in which the size of the room influences the bass response of the instrument.

Reverberation can enhance the piano tone considerably as would be experienced by comparing the result on a high quality piano in the average living room, with the same instrument located in a concert hall. The "Joanna" can easily be fed into a spring line reverberation unit, which if used to a very small degree can give a pleasing sound in a small room. Headphones can be plugged into the instrument for silent practice, or to create your own sound stage without any influence from the room environment.

TUNING

The conventional piano requires tuning at least once a year, and is often left considerably longer. The use of the master tone generator in the "Joanna" ensures that the relative tuning of all notes is extremely accurate and not subject to variation. Compared with some two hundred tuning adjustments on the normal piano, the "Joanna" has only one.

COST

As stated earlier it is not beyond the reach of electronics to completely synthesise the action and sound of a piano, but the value of attempting such a project is extremely questionable. We are not going to see a concert pianist changing to an electronic piano for major performances and the project should be judged against the background of the average domestic upright, taking up considerable room space and having a present day cost of at least £400. For an outlay of approximately £120, depending on the amount of effort which the constructor wishes to apply, an attractive practical instrument can be provided for the use of all the family which will give many hours of pleasure.

OVERALL SYSTEM

The block diagram Fig 1.1 shows the way in which the various sub-units are interconnected to make up the "Joanna" and from the diagram the overall principles of operation can be understood.

The keyswitch assembly, linked to the five octave keyboard, consists of 61 single pole changeover switches, operating between ground potential when at rest and a rail voltage of approximately 20 volts when the key is depressed. Touch resistors are mounted on the keyswitch assembly as indicated.

The switch outputs are routed to 12 boards, each containing five envelope circuits, such that all octaves of one semitone go to one board. Three outputs are taken from the Envelope Boards, grouping the bottom two octaves, the middle two octaves, and the top octave, and lead to the Preamplifier Board. This contains separate voice filters for each of the groupings mentioned, feeding to a preamplifier the gain of which is determined by a voltage controlled amplifier in the feedback loop. The latter has both tremolo and soft pedal control inputs. A direct output is taken from the preamplifier for

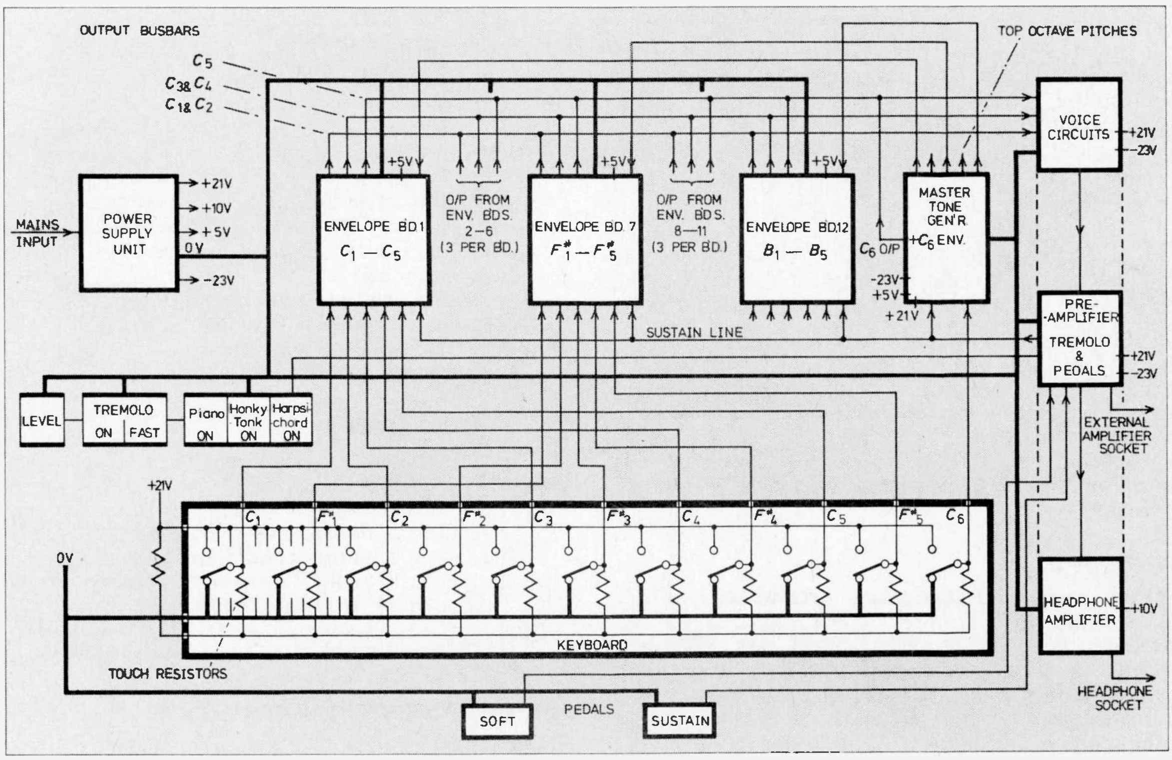


Fig. 1.1. Block diagram of the "Joanna"

Bulk Component List

To take advantage of any concessions offered by retailers for bulk purchases the following quantity list is included.

Individual component lists will appear as usual with circuit diagram as they occur.

Integrated Circuits

ZN7404	2
ZN7472	1
ZN7493	12
μA741 (8-pin d.i.l.)	5
MFC6040	1
MFC4000	1
μA7805	1
AY-1-0212	1

Transistors

ZTX108	77
ZTX501	1

Diodes

Cheap silicon diodes 20 volts 183
(e.g. 1S44, OA200 types)

Capacitors

4·7μF Electrolytic 25Vmin	61
4·7μF Electrolytic 12Vmin	61

Resistors

56Ω	61	120kΩ	122	270kΩ	12
2·2kΩ	12	150kΩ	50	330kΩ	12
33kΩ	61	180kΩ	24		
47kΩ	170	220kΩ	26		

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

The above list includes all semiconductors, 80% of the resistors, and approximately 50% of the capacitors

use with an external power amplifier and a low power output stage is included to drive headphones when required. The Preamplifier Board also contains a sustain pedal circuit, the output of which is linked to the Envelope Boards.

Generation of the 12 semitones in the top octave is carried out by one integrated circuit fed by a 500kHz input frequency. This is mounted on the Master Tone Board which also carries the envelope circuit for the top note of the piano. The dividers for the lower four octaves are included on the Envelope Boards.

The voice switching is performed between the voice circuits and the preamplifier. The use of a single tab gives the pure sound for that instrument, whilst more than one tab can be used simultaneously in order to provide tonal variations to suit the performer. The tremolo switching offers two speeds of tremolo as required.

PIANO ACTION

The fundamental piano action is obtained from the envelope shapers which are shown in block form in Fig 1.2.

The time taken for the keyswitch to travel between the two busbars is converted by the touch sensor into a reducing voltage which is passed onto the sustain storage circuit as a fast leading edge to the envelope. The early decay circuit emphasises the percussive nature of the sound, and the damper operates in the normal piano manner, where it can be overidden by the sustain pedal. The resulting envelope is shown in Fig 1.3.

The final decay is obtained from the loading of the chopper on the sustain storage circuit. The chopper is fed from the divider circuits and feeds an output to the signal busbars.

INTEGRATED CIRCUITS

It can easily be envisaged that an electronic piano is an ideal equipment for total integration, and this will be achieved when a special i.c. is designed for the envelope circuit. At present it would seem that different circuits, in discrete form, are used by each

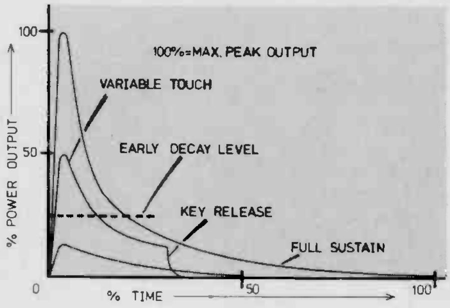


Fig. 1.3. Envelope shapes

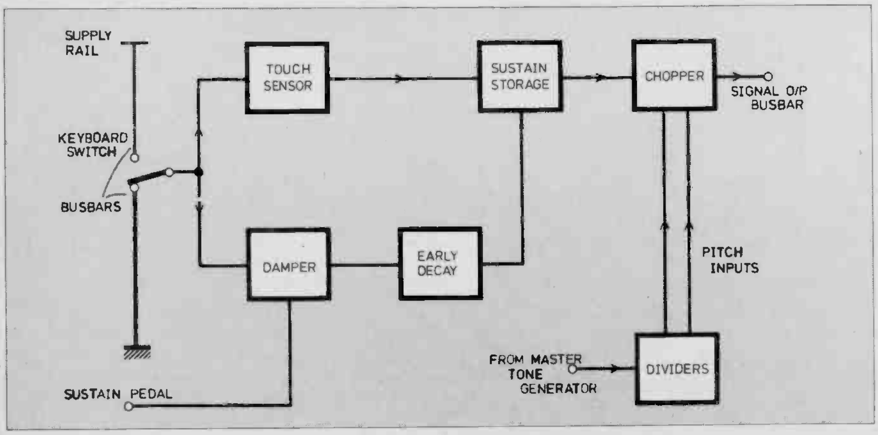
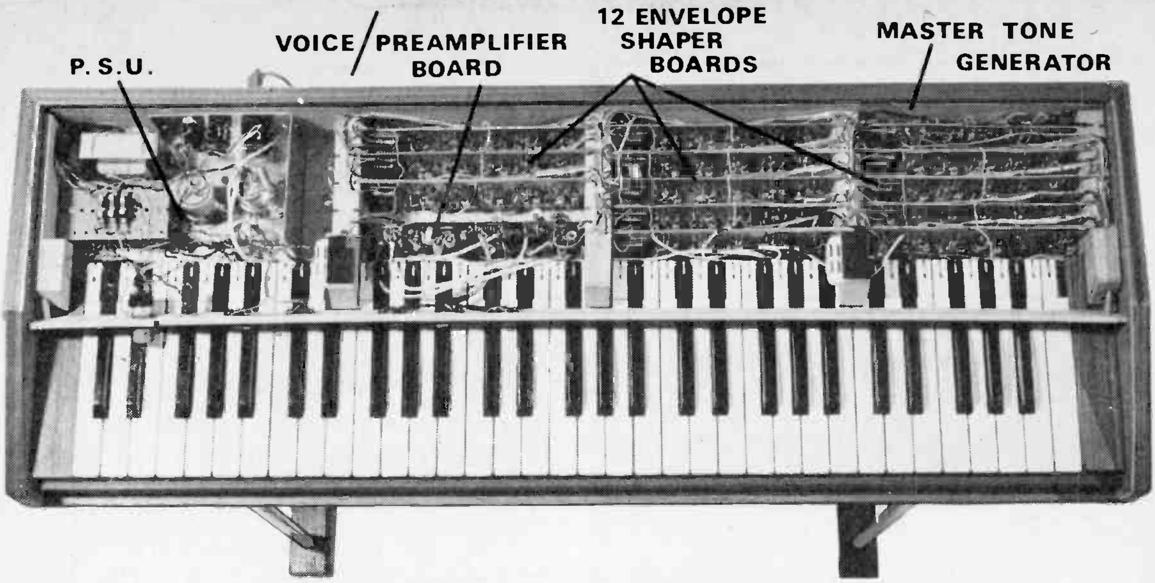


Fig. 1.2. Block diagram of envelope shapers. 61 are required



Interior of piano showing location of sub-assemblies

manufacturer of commercial equipment, but eventually one configuration would be expected to dominate, and the design of a hex or quintuple envelope i.c. will emerge. The "Joanna" uses i.c.s for master tone generation, dividers, voice circuits, preamplifier, headphone amplifier, and power supply.

PHYSICAL CONSTRUCTION

The prototype was housed in a teak veneered cabinet, mounted on chromium plated tubular legs. The pedals are fixed to a similar tube which spans the supporting feet which are made of solid teak. Whilst this combination gives a very attractive finish, a cheaper cabinet could be produced using a mixture of ordinary chipboard and blockboard, covered in a heavy vinyl material, which would also be more suitable if portability is required.

All the controls, except for the pitch adjustment, are mounted on the narrow strip immediately above the keyboard, in an easy playing position. The pitch control is revealed by removal of the music stand and lid.

Referring to the photograph of the interior details, the Power Supply is built on its own separate chassis, whilst the cabinet is designed to provide natural support for all the printed boards. Plug in connectors have not been used, in order to keep the cost to the minimum. The socket panel, sunk into the rear of the instrument, provides external amplifier, and headphone outputs, mains and pedal inputs, and carries the mains fuse. The keyboard is mounted directly to the base of the cabinet. This has the particular advantage, when used as an extra manual in an organ, of reducing the height between the keyboard and the top surface of the organ. The base of the cabinet is designed to give very easy access to the keyswitch assembly, without removal of the keyboard.

The piano stool has been designed to accommodate a power amplifier and 12in heavy duty loudspeaker. A mains socket has also been provided to give a neater appearance to the necessary interconnecting leads between piano, stool, and wall socket.

KEYBOARD AND KEYSWITCH

The "Joanna" cabinet design is based on the use of the five octave Kimber-Allen Swedish keyboard type S.K.A., and the Clef Products keyswitch type CPS 1027, which is specially designed for use with this keyboard. The high quality Kimber-Allen unit has been adopted due to its relatively low weight and high mechanical rigidity which also simplifies cabinet construction.

BUILDING SEQUENCE

The recommended sequence for construction is to commence by building a simple jig as shown in Fig. 1.4. This allows accurate construction of the final cabinet to be carried out in parallel with the electronic work, thus avoiding the delay associated with high standard woodwork and the possibility of damaging the cabinet during the testing of the sub-assemblies.

If finances allow the purchase of the keyboard and keyswitch at the start of the project, they can be mounted in the jig immediately and used later in testing out the envelope boards, but an alternative is to make a set of five single pole two-way switches as shown in Fig. 1.5, and mount them on the front base-panel of the jig. This will allow the testing of one Envelope Board at a time.

The first electronic units to build are the Power Supply and Tone Generator Board, which can be placed in their appropriate positions in the jig. Any power amplifier can be used to test the outputs from the Tone Generator Board, and the Socket panel can be used to give a permanent connection to the amplifier, with a test lead connected to the output socket via a $47k\Omega$ resistor and a $0{\cdot}5\ \mu F$ capacitor. The next step will be to build the Envelope Boards, which after insertion into their allotted places in the jig can be tested using the experimental keys and the test lead described earlier.

The final board to construct will be the Preamplifier, which will then allow testing of the complete system to be carried out. At this point the tested system, including the Keyboard, can be transferred to the completed cabinet.

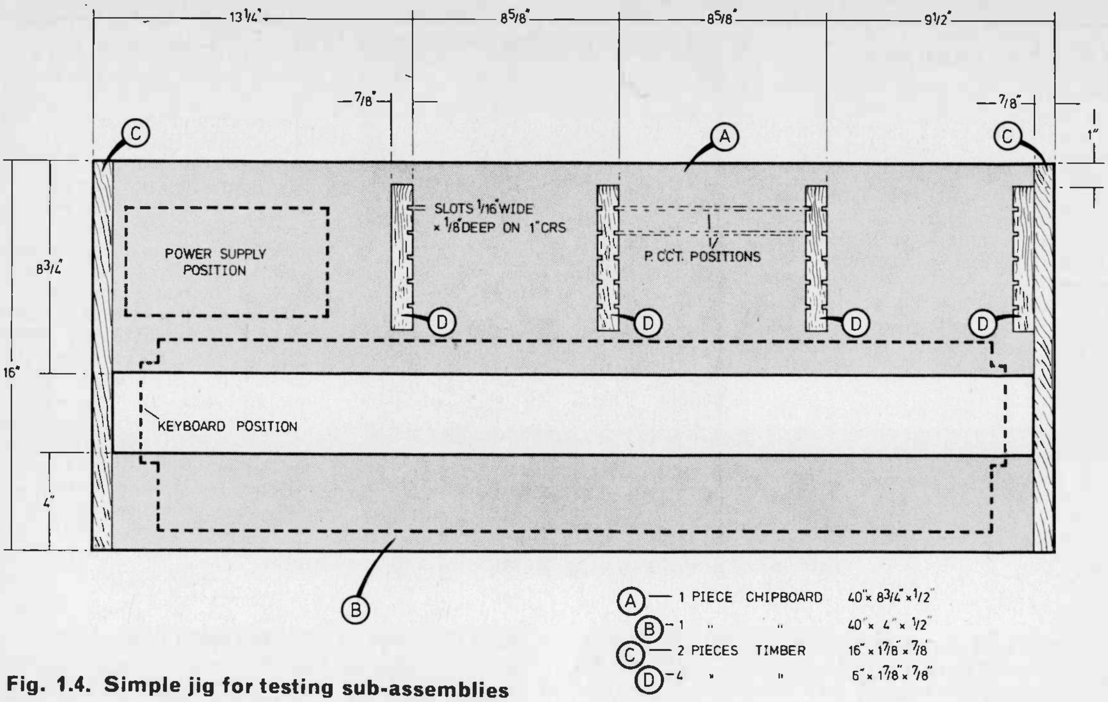


Fig. 1.4. Simple jig for testing sub-assemblies

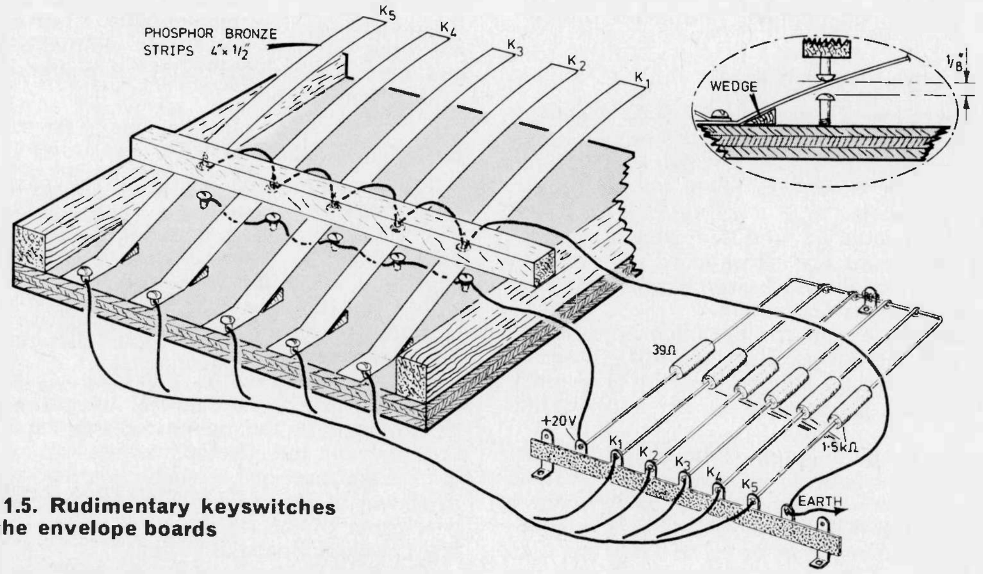


Fig. 1.5. Rudimentary keyswitches for the envelope boards

TEST/CONSTRUCTION JIG DETAILS

The base of the jig is split into two parts, the front part 4in wide, and the rear part 8¾in wide. This leaves a gap of 3¼in which is spanned by the keyboard. The two base panels are held together by timber end cheeks, screwing from underneath. Four p.c.b. supports are mounted on the rear base panel in the positions shown. Two of the supports require slots cutting on both sides.

The Keyboard and Power Supply are fixed in the positions indicated. The p.s.u. chassis carries all plugs and sockets, and will provide the anchor point for the test lead. Four standard legs can be screwed onto the jig which produces a very useful work bench for the period of the project.

EXPERIMENTAL KEYS

If it is decided to leave purchase of the keyboard until later in the programme, the experimental key system shown in Fig. 1.5 can be constructed.

The five spring strips should be biased to press against the top screws, which are linked together and returned to ground potential. The five lower screws are also linked and returned to the supply voltage. In order to test the touch action the touch resistors should be wired as shown in the diagram.

Next month: Power Supply, Tone Generators and Envelope circuitry are described

BY FRANK W. HYDE

1975 SPACE PROGRAMME

One of the most noticeable developments of the space era is that each year there is more and more international co-operation. The benefits of space science and earth applications from space activities. are becoming more widely recognised. This attitude is being reflected in the increasing number of launches.

The number of USA launches planned for 1975 was set at 25. Of these no less than 15 were to be from other countries or from international missions.

All the missions except one are unmanned. The manned mission is the joint USA and USSR *Apollo-Soyus* docking for which the training is almost complete. The Russian final field (space) trial took place in January with two astronauts living for 31 days in space. During this period they practised docking and moving from one vehicle to the other.

The link-up mission between the Russian and American astronauts is scheduled to take place on July 15. The crews will exchange visits and perform some scientific experiments. It is planned that the two spacecraft will be joined up for two days.

Altogether, there have been 25 joint planning meetings which began in 1972. In February the final arrangements were completed leaving only the final training of the crews. The final tests of the control communications between the two centres in Soviet Union and Houston has been successful.

Professor Bushuyev said at the last meeting that the *Soyus* spacecraft was fully prepared. Some special modifications have been made to the spacecraft in order that conditions may be more compatible. They have lowered the air pressure and raised the oxygen content. This brings the *Soyus* craft more in line with the system used by the USA.

Other modifications include the installation of new antennae and communication equipment together with flashing beacons, lights and an approach target which will assist the docking of the *Apollo* craft with *Soyus*.

The joint crews will have trained together and separately for five months before launch date. Some of this will take place in the USA and some in the USSR. The Russian crews, each of two men are, Commander Aleksey Leonov and Valeriy Dubasov the first crew with Anatliy Filipchenko and Nikolay Rukavishnikov of the second crew. The American team are Commander Thomas Stafford, Command Module Pilot Vance Brand, and Module Pilot Donald K. Slayton.

The joint mission of the USSR and the USA represents an important point in space history. The success of this mission will establish that it will be possible to affect rescue from space. Of course, it has always been possible to do this from the *Apollo* facilities but now the first steps in international facilities will be taken.

The ten day mission of *Apollo-Soyus* Test Project (ASTP) will commence with the launch from Baikonor, Kazakhstan on July 15. Some 7½ hours later a three man *Apollo* will be launched from the Kennedy Space Centre. Various activities will take place during which the crews will visit each other's quarters, and remain as one group for about two days. The *Soyus* spacecraft will then undock and return to Earth. The *Apollo* will remain in orbit six more days while the crew carry out some special scientific experiments.

OTHER MISSIONS

Of the remainder of the missions planned two are for the study of the Sun, nine for communications and navigation. Three are devoted to the study of the Earth's atmosphere and the environment and another four will study climate and air pollution. Two more are for astronomy and another for oceanographic research.

Twelve of the spacecraft to be launched by NASA are owned variousy by other nations or other government agencies and private agencies. These pay NASA for the launches. West Germany and France have the *Symphonie 2*. Two satellites are for *Intelsat*, the consortium of 80 nations. The European Space Research Organisation has one satellite for the study of cosmic rays.

RESOURCES SATELLITE

The second Earth Resources Satellite *ERTS 2* will it is hoped repeat the enormous success of *ERTS 1* which surpassed the most ambitious hopes of the planners. During the 29 months of activity prior to the launch of *ERTS 2* in January, the first of the satellites sent back more than 100,000 images covering the whole of the United States and most of the rest of the world.

The satellites are inter-nations in scope and mission. Any nation can obtain data taken over its own territory. The orbital time is 103 minutes with an observation band 115 miles wide. The data covers the observation of agriculture, forestry, marine resources and biology, water resources and air pollution. The data can be processed into images or other forms for computer assessment. These observations over any particular territory are repeated every 18 days.

The sensors on the *ERTS 2* are the same as those on *ERTS 1*. The return beam vidicon sub-system is a complement of three cameras sensitive to different regions of the electromagnetic spectrum. Full colour images can be constructed from the data, when each separate image is superimposed in its respective colour in a single frame. Every item found in nature reflects solar energy in a different way, often invisible to the naked eye, and this situation is overcome by the system used in the satellite. Thus desease of plants can be "seen" as well as many other changes.

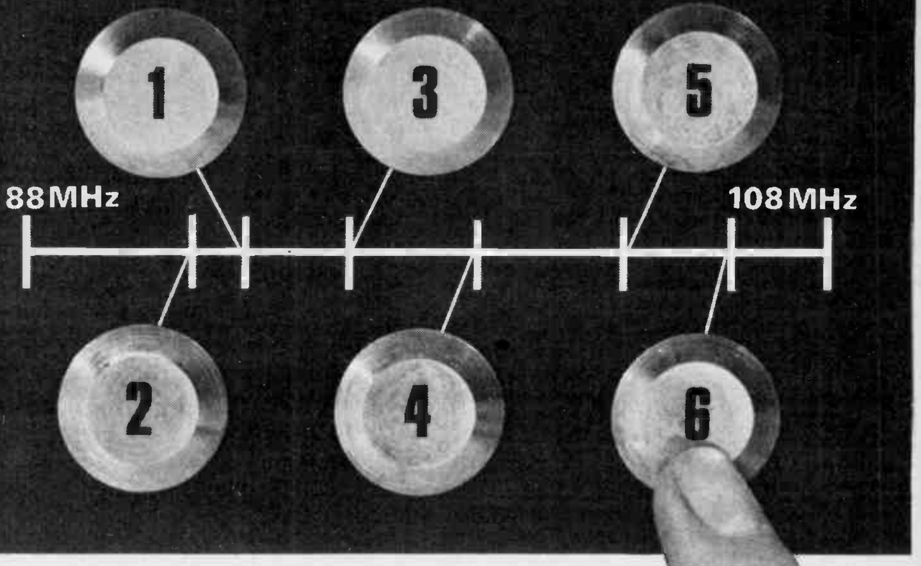
The multispectral scanner collects similar data by scanning the Earth directly below the satellite. Another, the data collector sub-system, collects and relays from some 1,000 ground based platforms located in remote areas. These platforms measure ground temperature, moisture content, winds and pressure and is correlated with the data recorded on the spacecraft.

THROUGH THE COMET'S TAIL

Comet Kahoutek revealed some of its secrets when the *Helios* satellite encountered space debris from the comet. Only a few particles were detected by the micrometeorite detector, but the implications are extensive.

The team responsible for the data suggest that the second *Helios* probe should be held back so that it can intercept Comet Encke which is due to return to our vicinity in 1977. This could have important consequences with regard to the theory of comet construction. Most workers lean toward the theory that conglomerate and icy particles fit the data so far available.

TOUCH TUNING UNIT



By R. J. BONFIELD

A PUSHBUTTON varicap stereo tuner was described in the May 1973 issue of PRACTICAL ELECTRONICS which was designed to overcome the problem of the mechanical tuning capacitors and the associated pulleys and pointers.

The pushbutton arrangement adopted solved these problems to a certain extent, but did not eliminate them altogether since the pushbuttons are mechanical devices. The requirement is a completely electronic method of tuning, namely a system of touch-operated switches, as is to be described.

PRINCIPLE OF OPERATION

When the base of any one of the Darlington pairs (Fig. 1) is touched a minute current will flow which is amplified. This current causes the voltage on the corresponding collector line to drop, and one of the flip-flops in IC1 will switch on. As the i.c. contains six flip-flops, six pre-tuned stations are available.

To ensure that only one station is selected at any one time, diodes D1–D6 reset all the flip-flops when any one is selected.

The voltage at the output of the selected flip-flop will rise to 7V and appear across the preset potentiometer used for tuning. This voltage is not sufficient for most varicap tuners, so it is amplified by the operational amplifier IC2.

L.E.D. DISPLAY

The circuit of the l.e.d. station readout is shown in Fig. 2. The 7-segment l.e.d. displays a station from 1 to 6. When the unit is initially switched on,

Table 1: Allocation of stations

Touch Button	Station Selected
1	BBC local radio (Radio London)
2	BBC Radio Two
3	BBC Radio Three
4	BBC Radio Four
5	Alternative IBA or BBC local radio stations
6	Alternative IBA or BBC local radio stations

COMPONENTS . . .

Resistors

R1–R6	10kΩ (6 off)
R7	470Ω
R8–R9–R10	(see Table 2)
R11	82kΩ
R12	100kΩ
R13–R15	1kΩ (3 off)
R16	(see Table 2)
R17–R24	150Ω (8 off)

All 10%, $\frac{1}{2}$W carbon except where otherwise stated

Capacitors

C1	680μF elect. 16V
C2	10μF elect. 16V
C3	2,200μF elect. 6·3V
C4	0·1μF polyester
C5	1μF elect. 16V
C6	10μF elect. 16V
C7	1μF elect. 16V

Potentiometers

VR1–VR6 10kΩ trimpots or skeleton presets

Diodes

D1–D6	IN914 or OA200 (6 off)
D7	(see Table 2)
D8	BZY88 C6V8 6·8V 400mW Zener
D9–D16	IN914 or OA200 (8 off)
D17	BZY88 C5V1 5·1V 400mW Zener
D18–D26	IN914 or OA200 (6 off)
D27	BZY88 C5V1 5·1V 400mW Zener

Transistors

TR1–TR12 BC109C (12 off)

Integrated Circuits

IC1	SN74118N
IC2	741C
IC3	SN7447A
IC4	DL709 (Bywood Electronics)

Miscellaneous

Pegboard, Veropins, wire, 8 and 16 pin i.c. sockets, six metal buttons

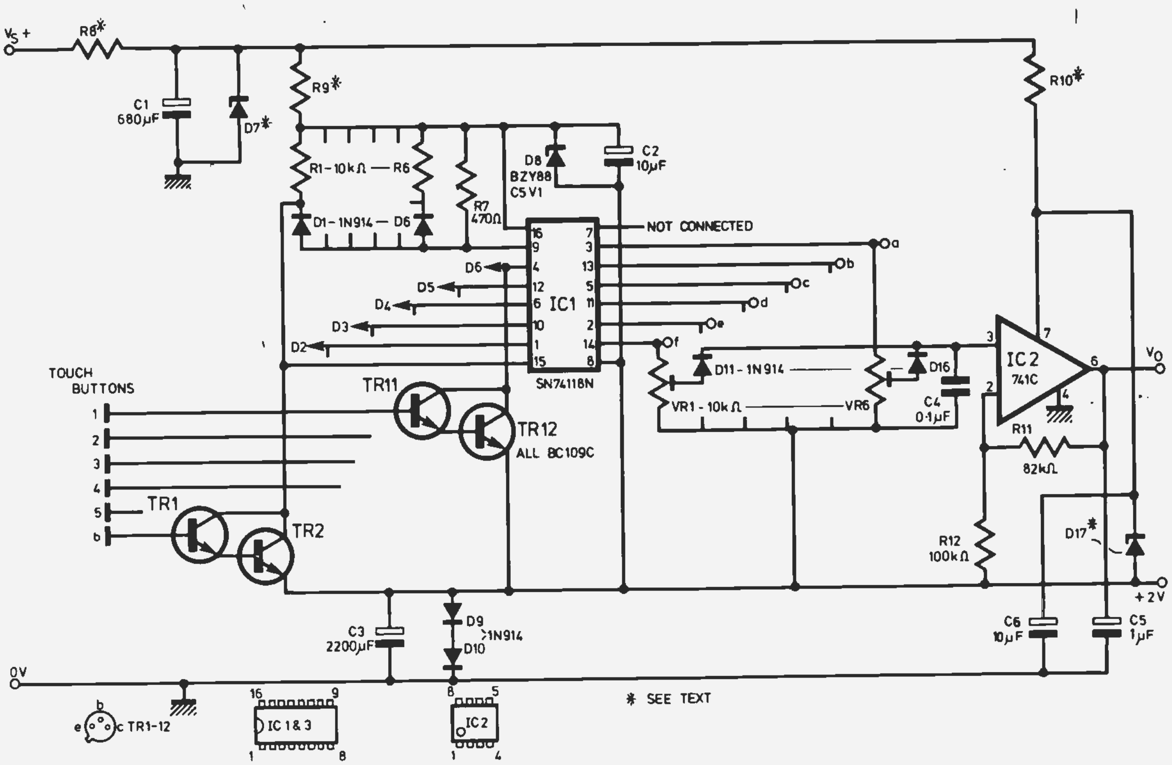


Fig. 1. Circuit diagram of basic Touch Tuner. Note the inclusion of the large electrolytics C1 and C3. These are for ripple suppression if a stabilised mains supply is used

the figure "0" appears until a station is selected. The user must remember which station corresponds to each number.

A suggested method of station identification is shown in Table 1. A similar table could be printed on the front of the tuner using Letraset, or similar transfers.

VOLTAGE STABILISATION

If the supply voltage is derived from the mains it is essential that stabilisation is included. To adapt to various supply voltages as shown in Table 2, the requisite component changes are given. Total power requirement is about 5W.

Table 2: Changes for various supplies

V_S	R8	R9	R10	R16	D7 BZY88-	D17 BZY88-
35	200Ω (2W)	82Ω	560Ω	220Ω (5W)	C15V	C6V8
24	82Ω (2W)	82Ω	560Ω	120Ω (5W)	C15V	C6V8
15	27Ω (½W)	47Ω	270Ω	33Ω (1W)	C12V	C6V8
12	—	47Ω	270Ω	33Ω (1W)	—	C6V8
9	—	22Ω	—	15Ω (½W)	—	—

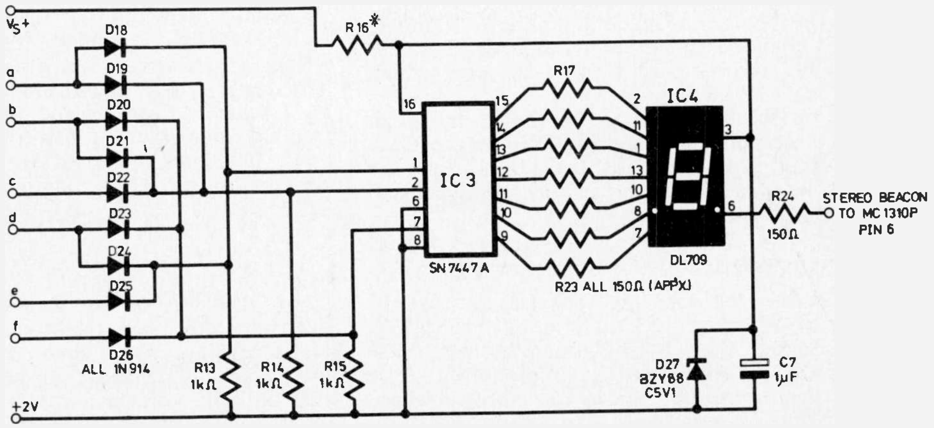
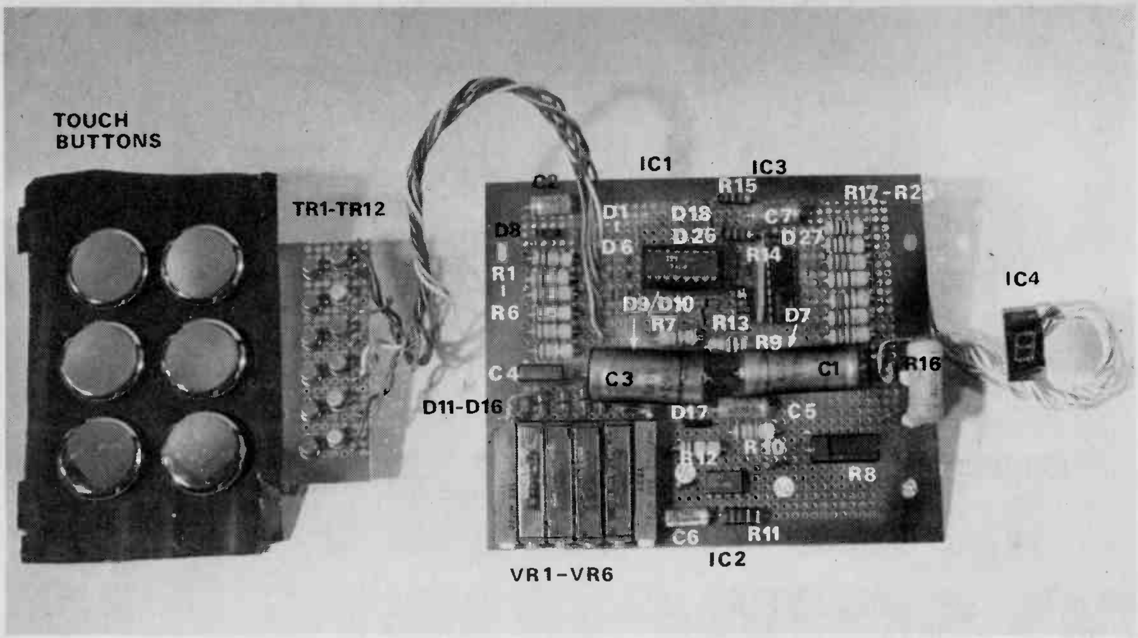


Fig. 2. Circuit for decoder and readout



Component layout for Touch Tuner. Keep lead lengths from transistor board short. Other layouts can be attempted on Veroboard or p.c.b. if so desired

COMPONENTS

Diodes D1 to D6, D11 to D16 and D18 to D26 can be any silicon types. The six preset potentiometers are ideally trimpots for ease of tuning, although carbon skeleton types may be used. In this case it may be desirable to add padding resistors between each preset and IC1, the value of these resistors may be in the range 4·7kΩ to 27kΩ depending on the tuning spread required.

The values of R8, R9, R10 and the voltages of Zeners D7 and D17 should be selected from Table 2. Where they are not required, resistors must be replaced by short-circuits and diodes by open circuits.

Resistor R16 will become hot when a high supply voltage, i.e. 24V or 35V, is used. In these cases it must be a 5W component and must be mounted where it will not damage other components, preferably off the main circuit board.

The decimal point on the 7-segment display can be employed as the stereo beacon, by connection to pin 6 of the MC1310 stereo decoder i.c.

The l.e.d. may be glued to the rear of the tuner's front chassis, behind a rectangular hole. Connections would then be made by wires several inches long from the circuit board to an i.c. socket which is plugged onto the l.e.d.

The pin numbers shown in Fig. 2 for the l.e.d. apply to the Hewlett Packard 5082-7730 or the Data Lit 707. Other types, such as the DL747, can be used, but the pin connections must be checked. IC3 is the 7-segment decoder.

CONSTRUCTION

It is recommended that i.c. sockets are used, in particular for IC1 and IC3. The input transistors must be mounted close to the touch buttons on a separate board, as shown in the photograph. *It is important that the touch buttons are not connected to the transistors by long leads.*

The preset potentiometers should be mounted away from the circuit board, in a position convenient for adjustment. If the maximum output voltage is too low, it can be increased by changing R12 to 120kΩ or 270kΩ.

In the prototype, six metal buttons were Araldited to Bakelite, otherwise any small metal objects are suitable.

TESTING

To test the unit connect V_s and 0V to any one of the recommended power supplies given in Table 2, making sure that the appropriate component amendments are made.

Connect the output, V_0, to pin C of the LP1186 tuner module. It is not necessary to make a connection between the touch circuit and pin E of the LP1186. Check that R17 is connected if it is external to the board and check the connections to the 7-segment l.e.d. if fitted.

Turn each preset to its lowest voltage position and switch on. The l.e.d. should read "0". Touch each panel in turn and the readout should change each time. If this is not so, check the connections to IC1. If incorrect segments are illuminated, check diodes D18 to D26 and the l.e.d. connections.

Locate the preset for the selected station. The voltage across this potentiometer should be 4V to 5V. The output should be 1·5V to 2V. Rotate the potentiometer to its maximum position and the output should be 8V to 10V. Check these voltages with a voltmeter.

As the preset is rotated from its minimum position, the first station to be tuned in should be Radio 2. If it is Radio 3 or Radio 4, and Radio 2 cannot be tuned in, then the voltage across D9 and D10 is too high, so one of these diodes should be removed or replaced. If no stations can be tuned in, and the voltage across D9 and D10 is less than 1·5V, check whether one of the diodes is faulty and if so replace it, otherwise add a third diode in series with the first two. ★

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Radford FN12	£8·95
Richard Allan Twinkit	each £8·95
Richard Allan Triple 8	each £13·75
Richard Allan Triple	each £19·95
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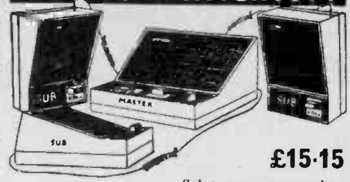

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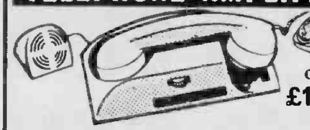

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NEWS BRIEFS

Symbol for Safety

THE British Standards Institution is to adopt a distinctive safety certification mark in addition to its famous Kitemark.

This is necessary because under article 10 of the EEC Low Voltage Directive, Community Members are required to conform to the safety requirements of the Directive in the field of electrical equipment by providing safety marks or certification or declarations of conformity.

Bodies authorised to grant such marks or issue such certificates have to be nominated by member governments. BSI, with other certification bodies, has been nominated by the UK Government for certain categories of electrical products.

To be considered for nomination in terms of the schemes for which currently the Kitemark operates, BSI needed a mark concerned *only* with safety requirements.

This has now been designed and is being registered by BSI. The new mark, based on a triangle incorporating the letters BSI in stylised form, will be a mark of conformity with a British Standard dealing only with safety, or with those parts which relate to safety characteristics in British Standards of wider application.

The stringent Kitemark testing and surveillance methods will be used in the certification of product safety. It is intended that, as with Kitemark procedures, a separate scheme will be devised for each standard, discussed and agreed with manufacturers, and then lodged with the Registrar.

Tubeless Cameras

EMPLOYING an advanced type image sensor, called a charge-coupled device (CCD), that performs the functions of Vidicon tubes in TV cameras, RCA are proposing to market two solid state tubeless black and white TV cameras in Europe in 1976.

The new RCA camera "eye" is claimed to be the first solid state image sensor to be fully compatible with present TV monitors and accessories, eliminating the need for equipment modification. The CCD image sensor produces standard pictures with a resolution comparable to images made from a two-thirds inch silicon Vidicon tube in present use.

The picture resolution of these tubeless cameras indicates that charge-coupled devices are now practical for a wide range of applications extending from surveillance cameras to more highly sophisticated use in industrial and military equipment.

Scramblers Abroad

RECENT events have highlighted the difficulties of protecting business and commercial information, and it is recognised that the complexity of modern telephone networks makes them particularly vulnerable to accidental or deliberate eavesdropping. It is claimed that this security risk can be overcome by using the EMI Privateer, designed to be linked to the telephone system in a manner fully approved by the British Post Office.

To promote overseas sales of the EMI EMISOUND Privateer telephone scrambler equipment, the company has entered into an agreement with Communications Security Limited, security consultants with world wide connections.

Basing their activities on the marketing techniques which have secured a rapid rise of interest in Privateer in the UK, the new agents will initially be concentrating on opening and developing outlets in the Middle East, South America, and certain African states.

The portable Privateer telephone scrambler

New CCD tubeless TV camera

NEW DEVICES ...APPLICATIONS

ULTRASONIC REMOTE CONTROL

WITH the growing availability of ultrasonic transducers suited to various applications this as yet generally unused area of radiation is now coming in for much greater investigation.

Last month an ultrasonic system for the remote control of T.V. sets was announced, based on two purpose-built integrated circuits. The new system, made by ITT Semiconductors, uses multi-frequency coding, one frequency per channel, which has overcome many of the interference problems associated with earlier attempts to use ultrasonic energy in this type of application.

Of course, any system dependent on a frequency for operation must suffer from ageing effects, component drift causing frequency drift and subsequent system failure. However, the circuits developed by ITT overcome this by locking the transmitted and received signals to a crystal. In the primary application this is a colour sub-carrier crystal since one is available in the T.V. receiver and only one more is required for the remote transmitter.

Such crystals exhibit a tight frequency tolerance, a very slow ageing rate, and a small temperature coefficient. In this way no trimming is needed at either end of the system for satisfactory operation.

Two basic systems have been developed, a 15-command system and a 30-command system. Each has transmitter and receiver chip, and the associated circuitry required for both ends is fairly simple.

The 15-command system can be used for switching up to eight T.V. channels and additionally controlling three analogue functions such as volume, colour and brilliance. For each analogue function two channels are used, one to initiate upward and the other downward movement of the function concerned. In addition, in the system developed and displayed by ITT the commands could be given both at the receiver and on the remote control unit by means of touch switches.

The 30-command system carries other function controls such as up to 16 channels, a sound mute button, a "granny" button which centralises all main analogue controls and other commands.

OPERATION

A 15-command system is shown in Figs. 1 and 2, Fig. 1 being the circuit of the SAA1000 transmitter circuit. A diode matrix is required to provide the correct coding input to the pins *a* to *g* and since the input impedance at these pins is in the region of 10^{12} ohms touch operation is possible using suitably selected external pull-up resistors. Such a circuit is shown in Fig. 3.

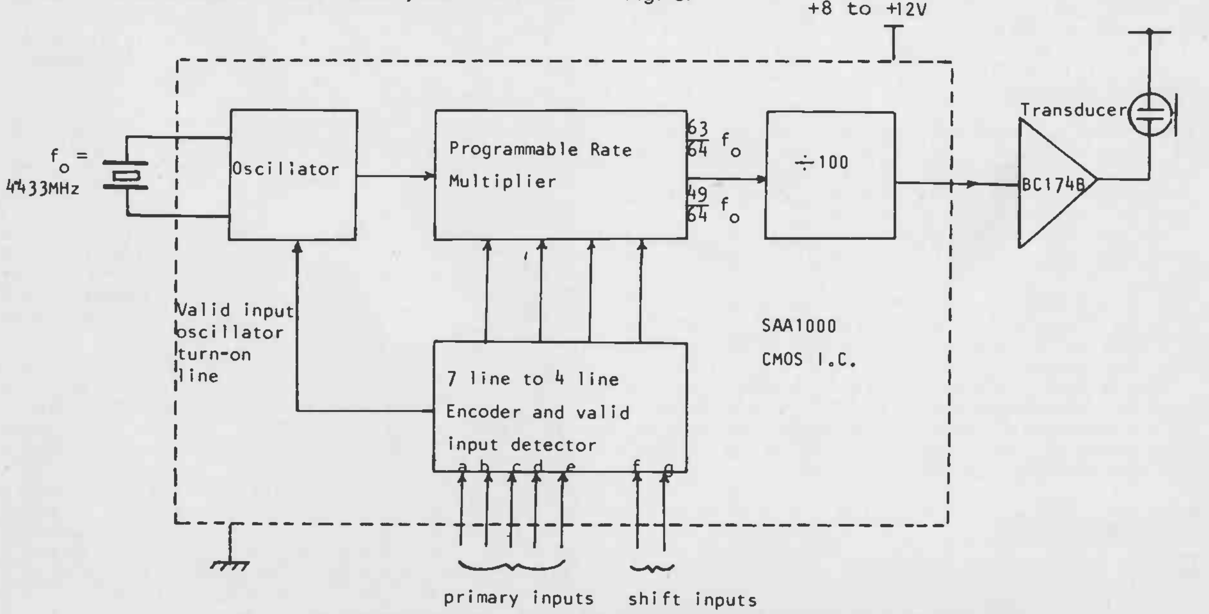


Fig. 1. Block diagram for the SAA1000 transmitter integrated circuit

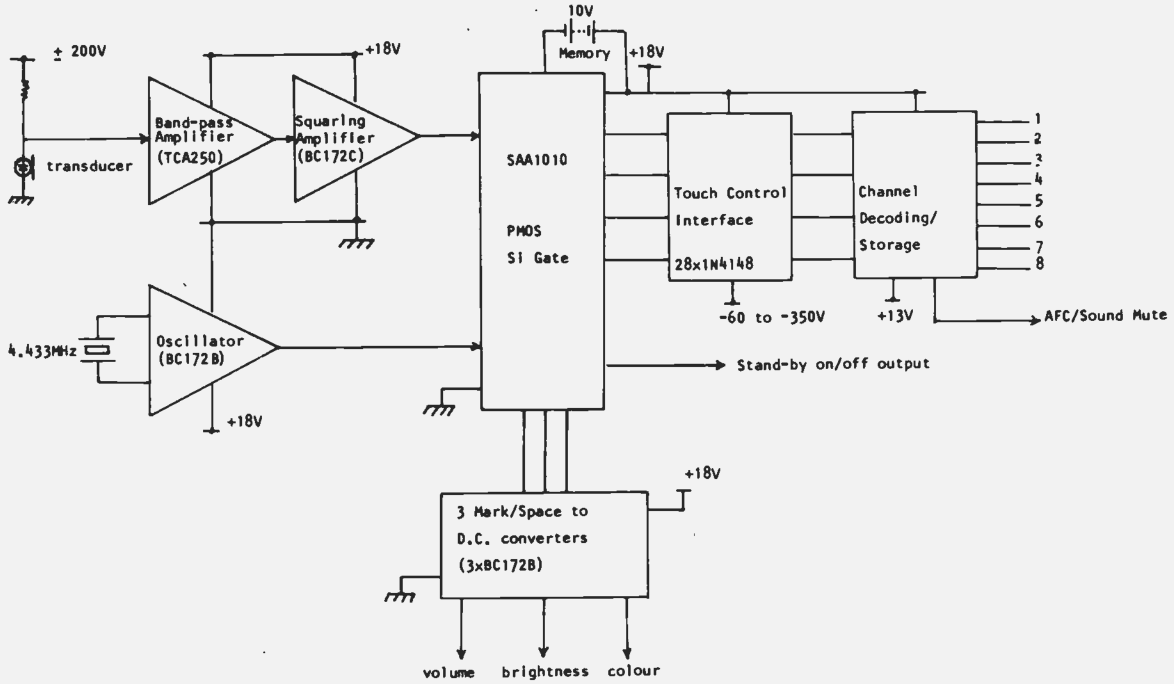


Fig. 2. Circuit diagram for 15-channel receiver

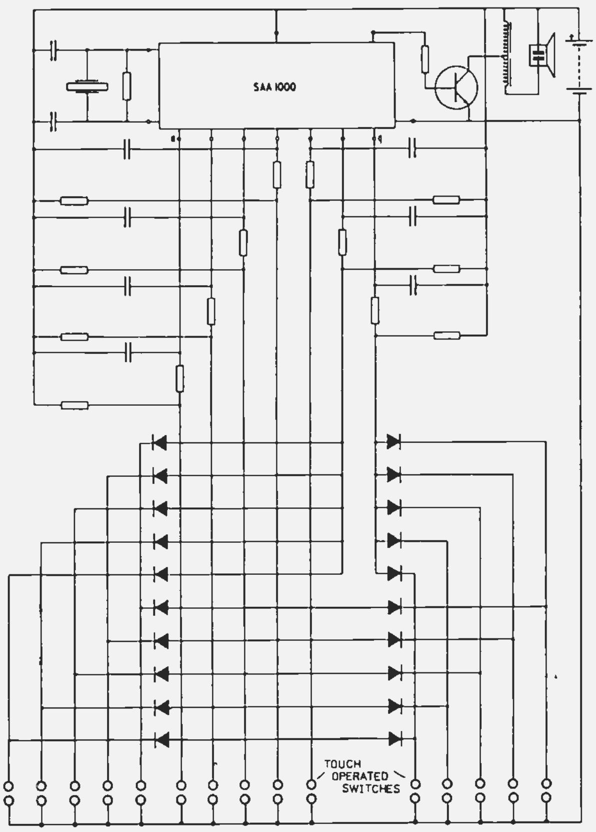


Fig. 3. Proposed circuit for an ultrasonic transmitter

Normally all the inputs *a* to *g* rest at the positive rail voltage, held there by external pull-up resistors and an input is detected whenever one of the lines is pulled down to below half the voltage supply rail. Validity checking is supplied by making any valid input either any one of the lines *a* to e alone or jointly with lines *f* or *g*.

As soon as a valid input is detected the rate multiplier is set and the oscillator becomes operative to give a continuous ultrasonic output from the transmitter i.c. as long as the input is activated. A single transistor amplifier is sufficient to power the capacitive transducer used via a broadband step-up transformer.

The receiver circuit is shown in Fig. 2. This is identified as the SAA1010 chip and it operates by counting the local crystal-derived clock against the incoming ultrasonic signal and then decoding the count into the relevant channel.

Frequencies of less than 27kHz or greater than 54kHz are automatically invalidated internally and in any case an external band-pass amplifier reduces the strength of any unwanted signals.

Apart from these built-in immunity checks the receiver circuit contains a memory capable of storing the last value of each of the analogue conditions it controls. A small battery actuates this memory section during switch-off periods.

The analogue information is put out as a mark-space ratio variable between 1 : 30 and 30 : 1 in 30 steps. At switch-on and without the extra battery for the memory these ratios are preset on the chip to predetermined values. If, however, the battery is used then the ratios are as last set during use.

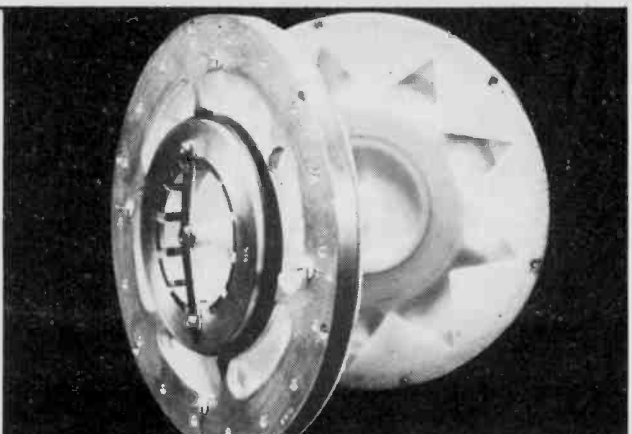
On-chip decoding of the analogue controls into mark-space ratios is provided on the receiver i.c.s but, so as to reduce the number of pins, programme channel information is not stored on the chip but is delivered instead in pulsed b.c.d. form whilst transmission is under way.

Four basic chips are available, the 15-command transmitter SAA1000 and receiver SAA1010, a silicon gate m.o.s. chip, the SAA1024 30-command transmitter and finally the SAA1025 30-command receiver. The first is in a 14-lead package whilst the rest are all 16-lead packaged.

For further details contact ITT Semiconductors, Foots Cray, Sidcup.

LOUDSPEAKER BREAKTHROUGH

A new look at an old concept in loudspeaker design



Composite view of the new loudspeaker showing the rear partially obscuring the front face. The arrangement of the four connectors supplying power to the double voice coil are visible

Almost forty years ago two gentlemen, C. W. Rice and E. W. Kellogg, invented the loudspeaker construction which has ever since been the standard form used by almost every manufacturer.

Called the "mass and compliance" type of diaphragm, their loudspeaker design has changed little in the intervening years. The modern loudspeaker uses a small resistive or damping component to control the movement of the diaphragm and, at this time, the only way to come anywhere near achieving a frequency-independent system is as we all know to our cost, to use a multiplicity of units and associated crossover circuits.

A great deal of technology, effort and discussion has been put into current loudspeaker design, with, in the eyes of many, still questionable results. However, it seems possible that now yet another of the Rice & Kellogg ideas might provide a better solution to the whole problem anyway.

When making their original proposals they suggested that a resistive diaphragm, that is one which damps or absorbs the sound energy, would be the only type in which the electrodynamic forces would be directly proportional to the desired diaphragm velocity. Of course, at the time they were unable to make such a diaphragm through lack of materials and thus they settled, like all sensible inventors, for the working solution.

NEW MATERIALS

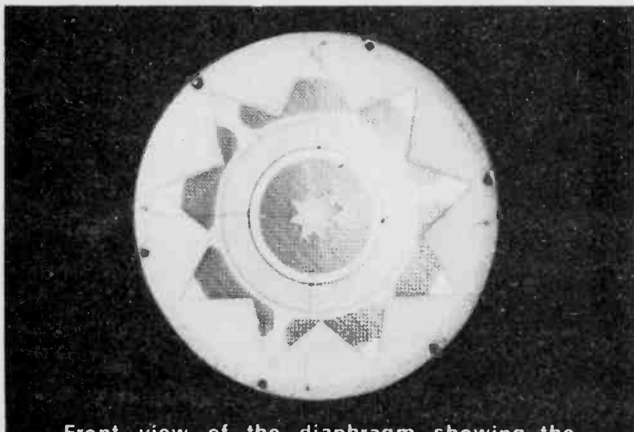
Now, using modern materials and techniques, Josef W. Manger, a radio retailer from Germany, has managed to create a loudspeaker which embodies the basis of the Rice & Kellogg resistive diaphragm concept (reported last month in Practical Electronics).

The new loudspeaker has been demonstrated to both an I.E.E. audience and some members of the technical press, and there is no doubt whatsoever that the Manger device is a serious contender for quality loudspeaker applications. Whilst all such demonstrations are open to attack on the grounds of location, suitable comparison examples and so on, the use of the new loudspeakers in an acoustically "bad" hotel room, but able to produce sounds very comparable with the original noises recorded, can only speak in their defence.

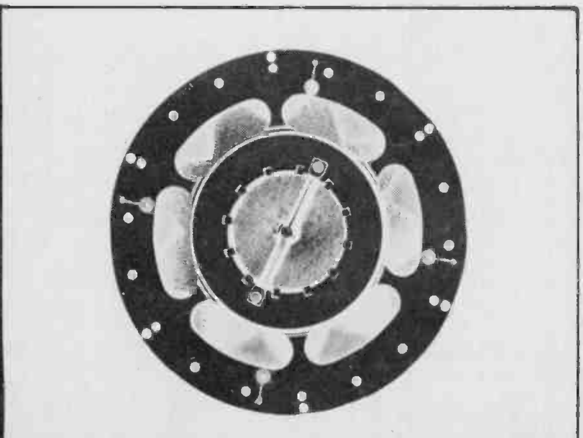
All such tests are, of course, subjective and often very personal but this is the first time the writer has seen any loudspeaker capable of demonstrably producing a square-wave output from a square-wave input over a frequency spectrum from 40Hz to 40kHz.

LOUDSPEAKER CONSTRUCTION

Even if the quality of the demonstration had been poor, and it certainly was not that, the construction of



Front view of the diaphragm showing the centre and edge damping foam plastic and the annular voice coil



Rear view of the loudspeaker showing the light frame structure in silhouette

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BC212	14p
BC214	16p
BC213	15p
BC213L	15p
ZTX300	15p
ZTX500	17p
2N2484	24p
2N2904	30p
2N2905	27p
2N2219	22p
2N3054	100p

FETS

2N3819	46p
2N5459	60p

DIODES

1N5401	21p
1N914	5p
BA148	25p
1SJ50	12p
1GP7	10p

NOISE DIODES

Z1J	60p
Z1M	120p

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REC46	255p
REC70	40p
EA100/10	100p
MDA942A/1	210p

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723	180p

ARRAYS

ML3046P	75p
CA3096AE	120p

OP. AMPS

709/8 Dip	39p
710/TO5	39p
741	37p
748	48p
FETMOPA	450p

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SG3402T	174p
SG1495D	290p
MFC6040	100p
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T.T.L.

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7410PC	24p
7420N	24p
7430PC	23p
7473N	48p
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the new loudspeaker would evoke interest in any exhibition of audio equipment. At first glance, the driver unit looks rather as if it were intended to be a chemical filter as the construction of the framing is light and open.

An outer ring (see the photographs) supports the outer edge of the diaphragm via a foam-plastic section of variable width. An inner ring, supported on thin webs just a little behind the outer ring, carries a large-diameter speech coil magnet and a central support point on which a foam-plastic pillar stands to which the centre of the diaphragm is attached.

DIAPHRAGM

So far, so good. It looks at least somewhat like a loudspeaker, if a rather shallow one. However, an examination of the diaphragm puts paid to the similarity ideas. It is soft, rather like a cross between old-style oilskin and putty, and a spare diaphragm was used to demonstrate just how pliable it really is. Forcing a finger into the material to make a deep "dent" which would normally ruin a cone only resulted in the dent slowly disappearing and the material resuming its original shape.

This ability to totally absorb at least slowly applied mechanical loads is achieved by the use of a knitted fabric coated in a suitably elastic material to provide a sound "piston".

To further assist in avoiding the usual problems of resonance, reflections from the outer cone edge, and cone break-up, the centre and the outer edge are both supported by foam plastic which is provided with a symmetrical but irregular edge. This absorbs most if not all of the energy which would otherwise be thrown back at the cone.

With the centre damping construction, it can be seen that the cone, if one can call it that, is vibrated at a ring spaced between the outer edge and the middle. This gives a larger radiating area whilst avoiding break-up problems. Indeed, the driver coil is itself interesting.

It is formed from two indenendent coils which, whilst driven in-phase in so far as the input signal is concerned, can be biassed with a d.c. signal so as to prevent massive excursions of the cone with any violent transients.

A ceramic ring magnet is used and the field energy is quite low, only of the order of 150mWb which compares with values of twice to three times this value for most modern units.

EFFICIENCY

There is no doubt that the new units are not quite as efficient as normal cone equipments. The relationship is of the order of 80 per cent, or where one uses 3W with a normal cone to obtain 96dB, the new unit requires 5W.

Apart from the nature of the edge and centre supports, the main secret of the new units seems to lie in the material of the diaphragm. In fact it does not act as a piston at all but, because of its viscoelastic nature, it operates in a bending mode. The attenuation factor of the material is very high, almost 1, and in practice the effective diameter of the unit decreases with increasing frequency.

One drawback so far experienced is that the lower resonant frequency of the unit varies with the power applied. At zero power it is d.c. but this rises to about 40Hz at full power with the units shown which were demonstrated handling up to around 25W peak.

Currently the units are being made individually by hand in Germany but soon mass production is to be instituted and it is understood that the manufacturers may well licence a suitable manufacturer here for local operation.

The man responsible for this novel application of an old idea is Josef W. Manger, manager of JWM, D 8725 Arnstein, P.O. Box 4, Karlstadter Strasse 3-5, and anyone interested should contact him direct. ★

BOOK REVIEWS

COLOUR TELEVISION SERVICING (2nd Edition)

By Gordon J. King
Published by Newnes-Butterworths
342 pages, 26cm × 16cm, plus fault procedure chart.
Price £4.40

THIS revised edition of the book first published in 1971 is aimed at a range of readers, from the technician changing from black and white to the enthusiastic amateur endeavouring to obtain the best performance from his set.

The eighteen chapters cover the basics of colour science, cameras and tubes, with details of the receiver from aerial to display. Chapter eleven onwards, test instruments, fault locating, field servicing and tube symptoms are especially helpful as is the new chapter seventeen—Receiver Design Trends, with information about some of the many developments in thyristor power supplies.

As a whole this book is extremely readable with a minimum amount of mathematics and minimal references to N.T.S.C. The illustrations and photographs (four pages in colour) are excellent and the detachable fault procedure chart should give a good start in locating the general area of trouble.

R.J.G.

110 OPERATIONAL AMPLIFIER PROJECTS FOR THE HOME CONSTRUCTOR

By R. M. Marston
Published by Newnes-Butterworths
123 pages, $5\frac{1}{4} \times 8\frac{3}{4}$in. Price £2.80, cased

THE operational amplifier is probably doing more to alter the face of practical electronics, both domestic and industrial, than almost any other single item of technology. Thus any document which helps to expand our knowledge of this particular area of electronics is bound to be helpful.

The present book is filled with useful circuits culled from a broad spectrum of arts including audio, measurement and signal generation to mention but three. Whilst some will be familiar the fact that they are gathered in one volume is in itself an aid to location.

An introduction takes the reader through the basics of operational amplifier techniques and introduces one to the universally acceptable 741 device which is used throughout the book. This is followed by five chapters dealing with subjects such as a.c. and d.c. amplifiers, instrumentation projects, oscillators and multivibrators, sound generators and alarms and finally, relay driving and switching circuits.

All the projects are provided with discussion of the operational methods used and the various forms of circuit selected. Whilst one may find that one's favourite circuit is missing, as is the fate for analogue thermometry, for example, there is certainly sufficient information present to make up a circuit from the elements in the book.

One point is perhaps important. This is not a wiring diagram/p.c.b. layout textbook. The circuits are given with some design information and construction is left to the reader. Nonetheless it is still a very useful book.

R.D.R.

TRANSDUCERS

Distance Heat Light Temperature Speed Force Frequency Pressure Light Temperature Load Sound Frequency Distance Heat Light Speed Force Load Sound Frequency Distance Force Load Sound Frequency Distance Heat

PART 2 Measuring Temperatures & Physical Parameters

By P. R. ALLCOCK*

MANY materials have the property that their resistance changes with temperatures and some of these find application as temperature-sensing devices. For metallic conductors the changes are very small when compared with, say, negative temperature coefficient thermistors, but metals have the advantage that their resistance variation is nearly linear over wide temperature ranges. Thermometers based on this variation are usually called resistance thermometers. Semiconductor thermometers based on germanium, silicon and carbon exhibit negative temperature coefficients of resistance similar to the thermistors already mentioned.

RESISTANCE THERMOMETERS

These devices usually employ a wire element made of platinum, tungsten, nickel or nickel alloy, or special metallic films. The platinum resistance thermometer is the most accurate available and is used as the calibration standard in the International Practical Temperature Scale. Resistance values range from about $0{\cdot}1\,\Omega$ to $10\,k\Omega$ and the useful temperature range is approximately $-260°C$ to $1{,}000°C$. Less expensive and widely used in many industrial applications are the nickel and nickel-alloy resistance thermometers which can be used over a temperature range of about $-100°C$ to $+320°C$.

The unknown temperature is obtained from measurements of the resistance of the thermometer element in conjunction with published calibration curves, either for the individual thermometer or for the particular class of thermometer. For platinum, the properties are sufficiently well known that mathematical expressions have been devised to permit the user to determine the temperature from the resistance value.

For accurate work an iterative solution is usually necessary because of the complex nature of the expression. For temperatures within the range -180 to $+620°C$ the empirical relationship known as the Callendar-Van-Dusen equation is normally used.

For more sophisticated applications a more accurate power series having 20 terms is available and carefully compiled computer programs are necessary to handle the calculations.

Over the range 0°C to 300°C the resistance variation for a platinum type thermometer is about 2 to 1 compared to a variation of about 1,000 to 1 for the resistance of a thermistor element over the same temperature range.

SEMICONDUCTOR MATERIALS

Silicon-crystal thermometers have been used for the temperature range $-50°C$ to $+250°C$ and offer a reasonably linear relationship but require individual calibration. Germanium crystals with closely controlled impurity levels have also been used in cryogenic (very low) temperature measurements, especially below 25° Kelvin, and also require individual calibration.

NULL METHODS

For constant or slowly changing temperatures the usual method of resistance measurement involves a Wheatstone bridge circuit arrangement whereas for more rapid readings a direct readout method is necessary. The thermometer element is usually remote from the measuring point and connection is therefore made by means of a three- or four-wire cable to provide compensation for the resistance of the connecting leads.

Fig. 2.1 shows one possible circuit arrangement. Terminals A, B, C of the bridge are joined to leads 1, 2, and 3 respectively and a balance is obtained by adjustment of R_V. At balance we find that $R_V + r_1 = R_T + r_3 + R_B$ where r_1 and r_3 represent the resistance of leads 1 and 3 respectively. Rearranging this equation we have $R_T = (R_V - R_B) + (r_1 - r_2)$.

Ideally the term $(r_1 - r_2)$ should be zero as this will then minimise error due to temperature variations along the connecting cable. Resistor R_B can be set to any convenient value compatible with the adjustment range of R_V and the variation of R_T over the temperature interval of interest. The null sensitivity of a bridge is greatest when all four arms have the same resistance value and for this circuit this would imply that $R_V + r_1 = R_B + r_3 + R_T = R$.

This last equation can be used to indicate a suitable nominal value for R_B. Since R_T varies with the temperature being measured the choice of R_B is a compromise.

By switching points A, B, C to leads 4, 3 and 2 respectively as shown dotted, a second reading can be taken and the two results averaged to minimise error due to lead resistance variation.

JUNCTION ERRORS

Thermo-electric voltages at the junctions of any dissimilar metals can cause errors when the bridge is used with a d.c. supply. The use of a low frequency a.c. supply can help in this respect but introduces problems of its own. As with the thermistor bridge, self-heating due to current flow must be minimised as otherwise systematic error could be introduced.

An alternative approach is to pass a constant known current through the thermometer resistance element and to measure the resulting potential difference by, say, a digital voltmeter. This method is used in some semiconductor thermometer systems where the relatively large resistance change partly compensates for the low sensitivity of the method.

* North Staffordshire Polytechnic

THERMAL INERTIA

The most significant problem that the instrumentation engineer must solve is that of ensuring that the temperature sensing element or device is in fact at the same temperature as the subject for measurement. Often it is necessary to either protect the sensing element from the environment in which it operates or to cement or otherwise secure it in place. Materials commonly used for both these purposes have low thermal conductivity and consequently there is a significant temperature difference between the element and its environment.

In some situations the sensing element may absorb significant amounts of heat energy from the environment or the device to which it is attached, thus causing a change in the temperature being measured. Thermal inertia effects may also be a problem when rapid temperature fluctuations are being examined.

REFERENCE VALUES

Temperature reference points relating to specific states of matter are currently used to define the International Practical Scale of Temperature. Some of the states used are shown in Table 2.1.

Table 2.1

Temperature in degrees Kelvin	Physical "State"
20·28	Boiling point of hydrogen at standard pressure
90·188	Boiling point of oxygen at standard pressure
273·16	Triple point of water
373·15	Boiling point of water
692·73	Freezing point of zinc
1,235·08	Freezing point of silver
1,337·58	Freezing point of gold

STRAIN GAUGES

Yet another application of the "change of resistance" principle is in the field of strain measurement. Strain gauges are transducers in which the resistance of a wire or foil element is varied by physical means. The most universal type is the bonded foil gauge but bonded semiconductor gauges are also available and find increasing applications.

The basic construction of two types is shown in Fig. 2.2. The gauge is usually cemented to the surface of some part or member in which a strain will be produced by an applied stress. In the usual arrangement two or more gauges, are employed and arranged in such a way that the stress-induced resistance changes combine to cause an output whilst allowing cancellation of resistance change due to, say, temperature effects.

The foil gauge for example has a metallic pattern which gives a larger resistance change when stressed along the preferred axis. This usually occurs when the stress increases the foil path length and decreases the cross sectional area, both of which cause an increase in gauge resistance. The semiconductor gauge experiences a change in crystalline structure which leads to a change in resistance due to the piezo-resistive effect. The effect is much greater than that obtained with wire or foil gauges but the variation is less uniform.

WIRE GAUGE

A further type is the unbonded wire gauge such as the biradial gauge shown in Fig. 2.3. In this type the resistance elements consist of fine wire wound round the small posts and connected in a bridge circuit. Pressure applied to the centre of the diaphragm causes a tilting of the four posts in such a way that the elements on one side of the diaphragm increase resistance whilst those on the other side decrease. The resistance changes are additive in that they both act to cause the bridge to become unbalanced in the same sense. Temperature induced resistance changes affect all four arms of the bridge equally and consequently errors due to temperature are minimised.

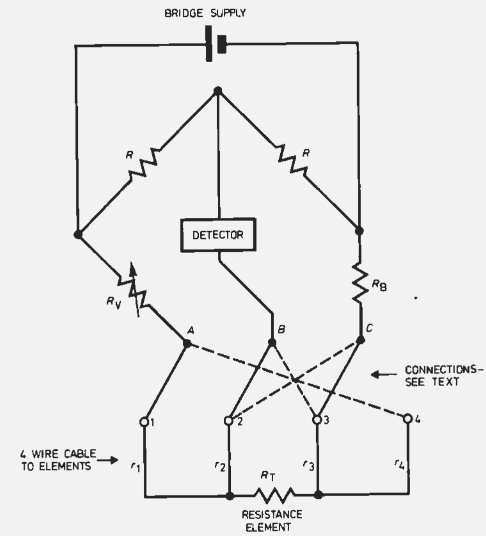

Fig. 2.1. One form of null bridge for temperature measurement

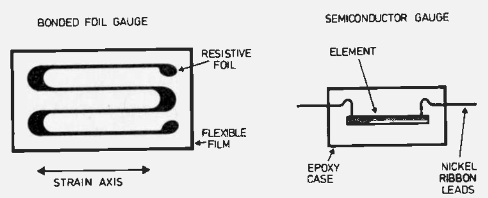

Fig. 2.2. The basic physical form of the foil and the semiconductor strain gauge

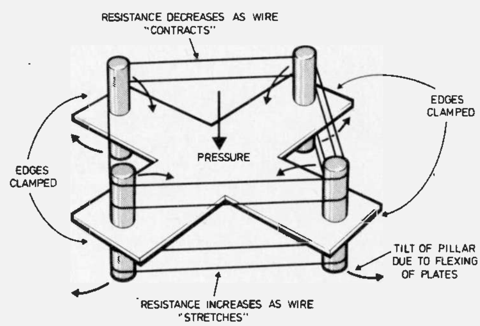

Fig. 2.3. The biradial wire strain gauge where resistance changes are additive because of the physical arrangement

OTHER RESISTIVE CHANGES

Strain is not the only measurand that can be used to cause a change in resistance. For example electrolytes, in general, exhibit a resistance which varies with the degree of concentration, within certain limits. Elastomers and special paints have also been developed in which the applied pressure gives rise directly to a change in resistance of the material.

Strain gauges are sometimes used as the electrical transduction stage of more complex devices in which an electrical output is desired. Unbonded gauges find application in pressure measurement, accelerometers and similar devices. The dimensional deformation or strain of an "elastic" material is related to the force or stress by Hooke's Law and the proportionality is constant over a restricted range. However, excessive inputs can damage or alter the characteristics of many types of gauge.

FOIL GAUGES

The bonded foil gauge is widely used as it is cheap and readily cemented to the workpiece. The gauge must be aligned so that the strain coincides with the axis of the gauge. The resistance change occurs for two distinct reasons. Resistance can be defined by $R = \rho \frac{L}{A}$ where ρ is the material resistivity, L is the material length and A is the cross-sectional area of the material.

When the wire or foil is in tension, L increases and A is reduced, both effects giving rise to an increase in resistance.

The second reason is due to the change of resistivity when the material is under stress. Strain gauges can

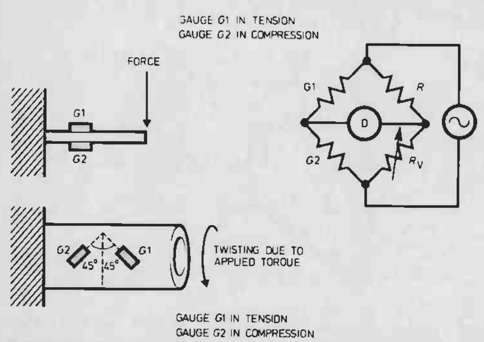

Fig. 2.4. Two commonly used arrangements of foil strain gauge where linear force and torque are under investigation

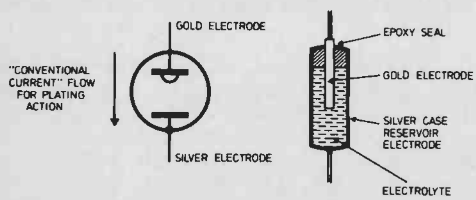

Fig. 2.5. The symbol for and basic structure of the electrochemical cell, useful in timing applications

Table 2.2

Nominal gauge factors for some common materials

Material	Nominal gauge factor
Nickel (pure)	−12·1
Nichrome	+2·1 to +2·3
Constantan	+2·0 to +2·1
Chromel	+2·5
Soft Iron	+4·2
Platinum	+4·8
Carbon	+20·0 (typical)
Solid state (doped crystal)	100 to 5,000

be used in both compression and tension and two of the commonly used arrangements are shown in Fig. 2.4.

The output of strain sensitive devices is usually specified in terms of a so-called gauge factor. This is the relationship between the change in resistance, the basic resistance, the change in length and the basic length.

This can be expressed as $\frac{\Delta R/R}{\Delta L/L}$ where ΔR and ΔL represent the changes of resistance and length respectively and R and L represent the unstrained values of resistance and length.

The gauge factor is really a measure of the sensitivity of the transducer and a typical gauge might have a resistance of 100Ω to 150Ω and a gauge factor of approximately 2·0. Nominal gauge factors for some common materials are given in Table 2.2.

The main problems met with strain gauges are the requirement for care in mounting, the fragility and the need for temperature compensation.

Mounting requirements are usually specified by the manufacturer and the instructions should always be followed if reliable results are to be obtained. It is the quality of the cement bond that determines the coupling between the resistance element and the workpiece. A dummy gauge, positioned to experience the same temperature as the working gauge is a useful technique for temperature compensation although multiple gauge systems achieve the same result and give a greater output due to the "additive" resistance changes.

Thermal-potential effects can be avoided by using a.c. for the bridge supply and amplification of a.c. signals is easier than d.c. Self heating effects must be kept small and pulse excitation has been used in some applications to give a greater peak output voltage whilst keeping the average heating effect to a minimum.

ELECTROCHEMICAL CELLS

Special electro-chemical cells are now available that can be utilised for the measurement of total charge flow or time. The cells rely on the movement of ions between a silver case and an inner gold electrode, Fig. 2.5.

The direction of ion movement depends on the direction of current flow and when the gold inner electrode is free of ions the resistance of the cell and hence its voltage drop rises.

During the "plating" process the cell behaves essentially like a low value resistor of around 30Ω and for normal current levels this implies a voltage drop across the cell of a few millivolts. This state continues during the clearing or de-plating period until the gold electrode is completely free of silver ions. The cell voltage-drop then increases rapidly to about 1·2V. An approximate equivalent circuit is shown in Fig. 2.6.

The switch *S* opens when the gold electrode is unplated and the cleared cell then behaves as a low voltage Zener in shunt with a large capacitor of about 200μF. Whilst not strictly a transducer the device behaves as a variable voltage cell and can be used in event counting, timing and related applications.

THERMOCOUPLES

Thermocouples are heat-input/electrical-output self generating transducers and depend for their operation on the fact that if two different metal conductors are joined at their extremities to form a loop, a current will flow round the circuit dependent on the temperature difference between the two junctions.

This phenomenon of thermo-electricity was discovered by Seebeck in 1821 and named after him. The corresponding reverse action, whereby current flow through a junction of dissimilar metals gives rise to the liberation or absorption of heat, was not discovered until 1834 by Peltier. From the proportionality of the Peltier effect one might assume that the Seebeck e.m.f. would also be proportional to the temperature difference between the respective junctions, but this is not so.

A third effect, known as the Thomson effect, which is that of heat being liberated or absorbed when a current flows along a conductor in which there is a temperature gradient, accounts for the discrepancy and is similar to the Peltier effect but occurs in homogenous conductors rather than at a junction. These effects are in addition to the normal I^2R heating that occurs when a current I flows in a resistance R.

THERMOCOUPLE BEHAVIOUR

To understand the behaviour of thermocouples it is necessary to understand that the nett e.m.f. in a circuit of homogeneous conductors depends only on the nature of the metals and temperatures of the metal junctions. From this, if the junctions are at the same temperature, the circuit has zero nett e.m.f. In a circuit containing several dissimilar conductors and junctions the e.m.f. generated by any one junction is uniquely related to the temperature of that junction if all other junctions are kept at some constant reference temperature.

These situations are illustrated in Figs. 2.7 and 2.8. Assume that the temperature of the lower junction in Fig. 2.7 is T_2 and that T_2 is greater than T_1 the temperature of the upper junction, the nett Seebeck voltage will cause a current I to flow. The current will depend on the circuit resistance and the nett voltage. For the copper-constantan combination with $T_2 = 100°C$ and $T_1 = 0°C$ the nett voltage is approximately 4·2mV.

The nett voltage versus temperature difference relationship is not perfectly linear and at $T_2 = 300°C$ the voltage would be approximately 14·6mV. Fig. 2.8 illustrates the case where a measuring device has been incorporated and it can be seen that two additional junctions have been introduced at A and B. If A and B are maintained at the reference temperature T_1 no error is introduced by the meter even though the circuit between A and B may not be entirely made of copper. (If other junctions of dissimilar metals exist within M these should also be at the temperature T_1.)

Present day thermocouples cover a very wide range of temperatures from about −250°C to +1,600°C with

Table 2.3
THERMOCOUPLE CHARACTERISTICS

Temperature	Iron—Constantan	Chromel—Alumel	Copper—Constantan	Platinum—Platinum Rhodium
°C	mV	mV	mV	mV
−100	−4·63(41)	— (—)	−3·35(28)	— (—)
0	0 (50)	0 (40)	0 (38)	0 (5·6)
+25	+1·28(52)	+1·00(40)	+0·99(41)	+0·14(6·0)
+50	2·58(53)	+2·02(41)	+2·04(43)	+0·30(6·5)
+100	5·27(54)	4·10(42)	4·28(47)	+0·64(7·3)
+200	10·78(56)	8·13(40)	9·29(53)	+1·44(8·5)
+400	21·85(55)	16·40(42)	— (—)	+3·25(9·5)
+1,000	— (—)	41·13(39)	— (—)	+9·57(11·5)

Figures in brackets represent the rate of change of voltage with temperature in μV/deg C
Reference junction is 0°C for all types

Approximate Useful Temperature Range

Iron—Constantan	−200°C to +900°C
Chromel—Alumel	−180°C to +1,100°C
Copper—Constantan	−250°C to +400°C
Platinum—Platinum Rhodium	0°C to +1,500°C

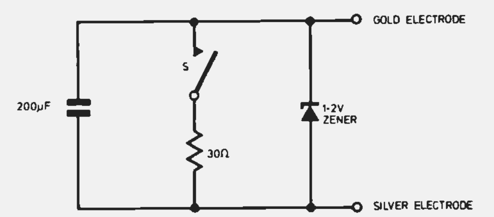

Fig. 2.6. The equivalent circuit for the electrochemical cell

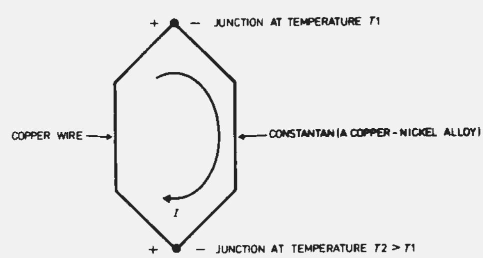

Fig. 2.7. Thermocouple current with dissimilar conductors and a temperature difference between the two junctions

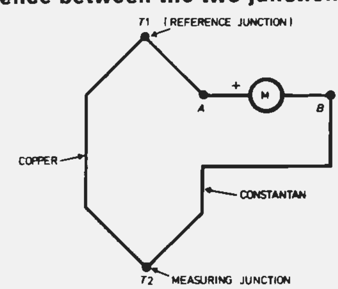

Fig. 2.8. Effect of introducing a measuring device and associated extra junctions

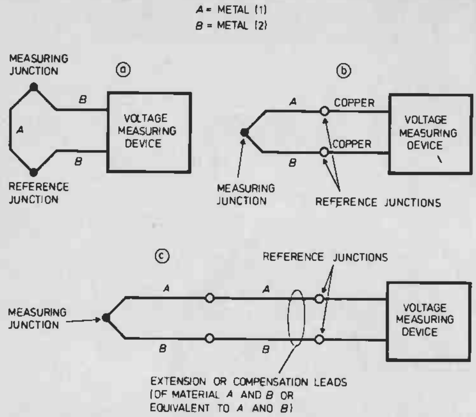

Fig. 2.9. How the thermocouple and measuring device can be interconnected

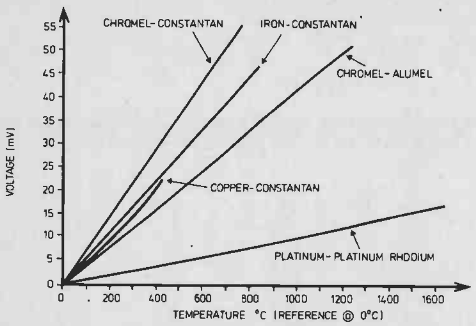

Fig. 2.10. Output/temperature curves for various thermocouple materials

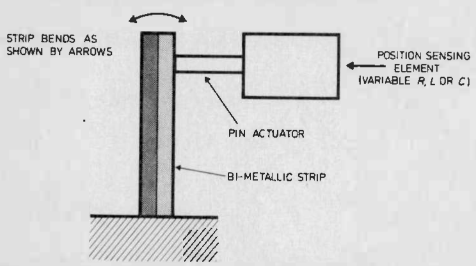

Fig. 2.11. Basic bimetallic device where dissimilar metals produce mechanical action when subject to temperature change

thermoelectric potentials of 10 to 70μV/deg C. Long term stability is not as good as that obtainable with the best resistance thermometers and at high temperatures many thermocouple materials suffer gradual embrittlement due to oxidation or reduction.

Thermocouples can be made up from base metals, rare metals or non-metals such as semiconductor materials. The most commonly used thermocouples are listed in Table 2.3 and the variation of output voltages with temperature is illustrated in Fig. 2.10. As with resistance thermometers, a wide range of protection sheaths are available for thermocouples. These are often of steel or ceramic depending on whether imperviousness to hot gases or chemicals, protection from oxidising or reducing agents and mechanical strength are required. Sheaths tend to slow the response due to increased thermal inertia.

REFERENCE JUNCTIONS

The reference junction in a laboratory can be provided by using melting ice in a thermally insulated flask but for industrial environments a specially made temperature-compensated junction is often used. The thermocouple is often well-removed from the point at which the information is required and special compensating leads are available for this purpose. These may be simply finer gauge wires of the same materials as the thermocouple wires, or special alloys which match the thermocouple characteristics over restricted temperature ranges.

In the latter case the compensated leads must be correctly connected to the thermocouple leads as each wire only "matches" one of the thermocouple materials.

Three possible arrangements for connecting a thermocouple to the measuring device are shown in Fig. 2.9a, b and c, and the position of the "cold" reference junction is clearly indicated for each case. Method (a) is suitable when the indicator is close to the point at which the measurand exists.

Method (b) avoids the need for long lengths of expensive thermocouple material but requires the two reference junctions to be at the same temperature and fairly close to the environment being investigated.

The third method, (c), uses extension leads having thermoelectric properties that are vitually identical with the actual thermocouple leads to which they are connected. The two reference junctions can now be well removed from the environment being measured but must still be held at the same temperature.

For accurate measurements the voltage measuring device should impose negligible loading on the thermocouple circuit. High input-resistance digital voltmeters are taking the place of the earlier potentiometer voltage measurement systems and in automated systems analog-digital convertors change the low-level thermoelectric voltages to a form more suited to the computer or other data-processor.

THERMOPILE

A thermopile is simply a series arrangement of several thermocouples to give a higher output. In some applications the multiple structure is used to sense the average temperature over a particular region of interest. Some types have blackened hot junctions to provide better absorption of radiant energy and are sealed into a container with transparent windows and lens to form a radiation pyrometer. Other types of pyrometers use mirrors to avoid the wavelength restrictions that occur with the lens type.

BIMETALLIC DEVICES

If strips of two metals having different coefficients of expansion are bonded together to form a composite leaf or spring, any subsequent change in temperature will tend to deform the original shape. The effect is increased by selecting metals with widely different coefficients of expansion and the resulting deformation is monitored by means of a displacement sensor, as shown in Fig. 2.11.

The arrangement is widely used in thermostats and similar temperature sensing devices. Careful control of the material properties is essential for reproducible results. In some types, electrical heating elements are also utilised to minimise mechanical hysteresis effects in the switching action.

Next Month: Inductance Transducers

NEXT MONTH....

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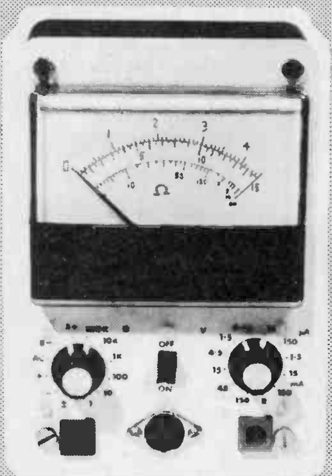

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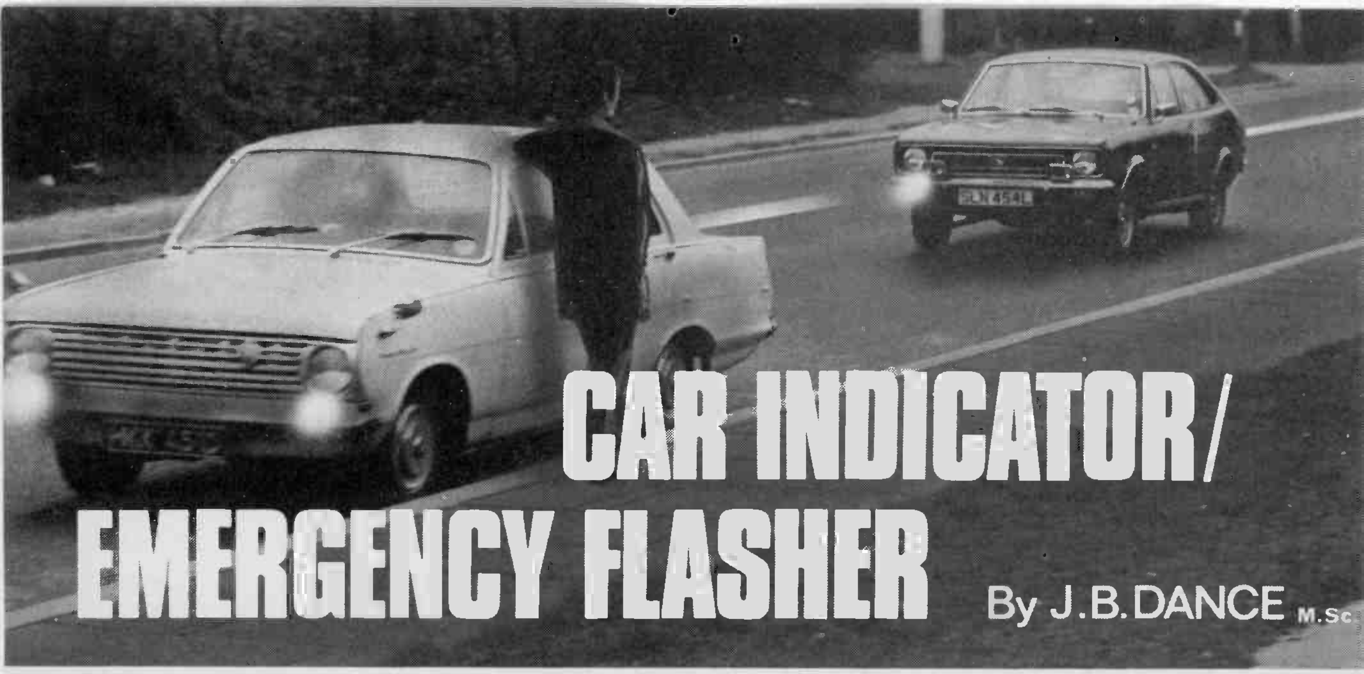


CAR INDICATOR/ EMERGENCY FLASHER

By J.B. DANCE M.Sc.

For negative earth vehicles only

ALMOST all vehicles in current production employ a hot wire thermal switch for controlling the yellow direction indicator flashing lights. The failure of a flasher bulb produces an increased flashing rate which warns the driver that the signal is not being given by one of the lamps.

This article describes how the conventional thermal flasher unit can be replaced by a simple electronic circuit. The only semiconductor device required is an ITT integrated circuit which has been especially designed for automobile applications.

ADVANTAGES

The electronic circuit to be described has some advantages over conventional thermal flasher circuits, namely:

(a) When the direction indicator of the electronic unit is operated, the first flash occurs immediately. In systems using thermal flasher units, the operation of the direction indicator switch produces an initial "lamps off" state which precedes the first flash.

An electronic flashing circuit can therefore assist road safety by eliminating the short waiting period before the driver's intentions are made clear to other road users.

(b) If the relay is placed under the dash board, the clicking noise produced by the operation of its contacts provides a good audible indication that the flasher is operating. The normal warning lamp is also included in the circuit.

(c) A further advantage of the electronic system is the inclusion of an emergency flashing facility in which all four flasher lamps at the corners of the vehicle operate simultaneously. This facility is found on very few cars at present, although breakdown and other vehicles likely to attend accidents have it available.

(d) The conventional thermal switching system is quite reliable, but the use of a carefully constructed electronic system should improve reliability and, therefore, road safety.

The electronic circuit to be described provides all of the facilities offered by a conventional thermal flasher, including a much increased flashing rate when an indicator bulb filament has broken or has a broken connection in its wiring. The rapid clicking of the relay also provides an audible warning in these circumstances.

INTEGRATED CIRCUIT

The integrated circuit required is a TAA 775G power oscillator. This is a dual-in-line device, but three of the pins on each side of a conventional 14 pin dual-in-line device have been replaced by a small metal tab. One or both of these tabs must be connected to the negative (0V) power supply line.

The circuit used is shown in Fig. 1. The connections to the i.c. shown are those when the device is viewed from the top with the pins and tabs pointing downwards. The use of this device enables much simpler circuits to be employed than if discrete transistors were to be used.

CIRCUIT OPERATION

In the circuit, the capacitor C1 charges through R1 from pin 6. When the voltage across C1 has risen to a predetermined level, an internal voltage comparator (the input of which is connected to pin 5) will switch the states of the internal circuits of the device.

The voltage at pin 6 is now switched to a value which is little higher than that of the negative line (actually about +0·2V). C1 therefore discharges through R1 until the potential across this capacitor reaches a value which is low enough for the device to be switched back to its former state.

The voltage at pin 6 now rises rapidly to its former value of about +4·6V and C1 therefore commences to charge again through R1. Hence the oscillatory cycles are repeated.

When the potential at pin 6 is in its higher voltage state of about +4·6V, it is stabilised by an internal voltage stabiliser circuit. This ensures that the frequency of operation is almost unaffected by reasonable variations in the power supply voltage.

The capacitor C2 prevents any transient voltage changes in the car electrical system from affecting the circuit by causing spurious switching.

OUTPUT CIRCUIT

The output transistor in the i.c. is connected to pin 10 of the device. When the potential at pin 6 is high (that is, about +4·6V), the output transistor is non-conducting. The current passing through the relay coil to pin 10 is then less than 1μA.

When the circuit is switched, however, so that the potential of pin 6 is about +0·2V, the output transistor conducts. A current then flows through the relay to pin 10. The maximum permissible value of this current is 150mA, so the resistance of the relay coil should not be much less than about 100 ohms, since the battery voltage can reach about 14V on charge and one must allow for normal tolerances.

The circuit has been designed to operate satisfactorily from supply voltages in the range 9V to 15V.

In most circuits a protective diode would be required across the relay to prevent damage to the integrated circuit when voltage spikes are formed across the relay coil. These spikes occur when the current ceases to flow through the coil. However, the i.c. contains its own internal protective diode and no further diode is needed across the relay when this device is employed.

CONTROL VOLTAGE

The i.c. operates in one of three states, according to the control voltage applied to pin 7. The control voltage affects the circuit only when the output transistor is non-conducting. The three states are:

(a) When the potential at pin 7 is equal to (or slightly less than) the positive supply potential applied to pin 1, the oscillation is blocked. As the potential of pin 5 rises, no switching occurs and the relay is never energised.

(b) When pin 7 is earthed or when its potential does not exceed about +0·35V, the circuit oscillates at a frequency given by the equation:

$$f = \frac{800}{R1(k\Omega)C1(\mu F)}\ \text{Hz}$$

(c) When the pin 7 potential is between about +0·45V and +5V, the circuit switches earlier as the potential across C1 rises. The frequency is thus increased by a factor of about 2·2 above its previous value when pin 7 was earthed. The duty cycle (time on/time off) is also increased from about 0·8 to 1·1.

COMPONENTS . . .

Resistors
R1 5·6kΩ ¼W
R2 82Ω 2W
All 10% carbon

Capacitors
C1 100μF 6V elect.
C2 0·5μF 6V polyester

Integrated Circuit
IC1 TAA 775G
(Phoenix Electronics Ltd., 139 Havant Road, Portsmouth, Hants)

Relay
RLA 12V relay, 10A contacts, coil resistance 110Ω (8 pin relay Doram)

Miscellaneous
S2 T.p.s.t. 4A toggle switch
International octal valve socket. LP6–12V 1·2W emergency flasher monitor lamp

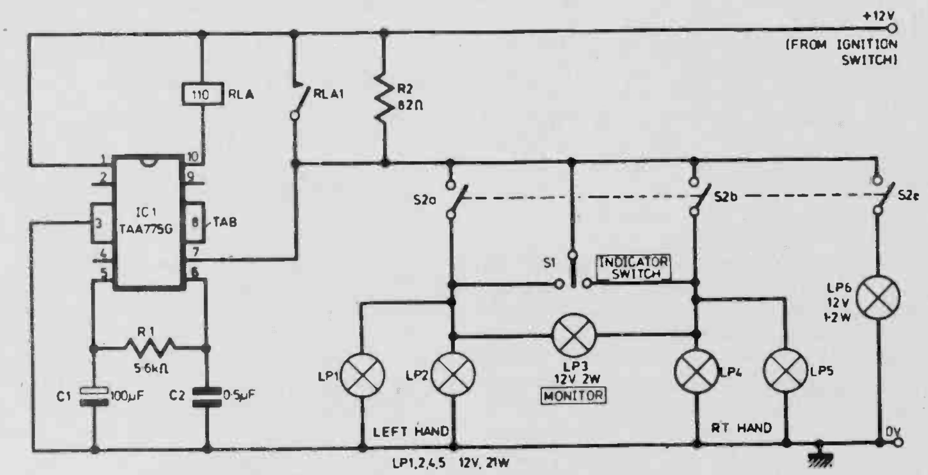
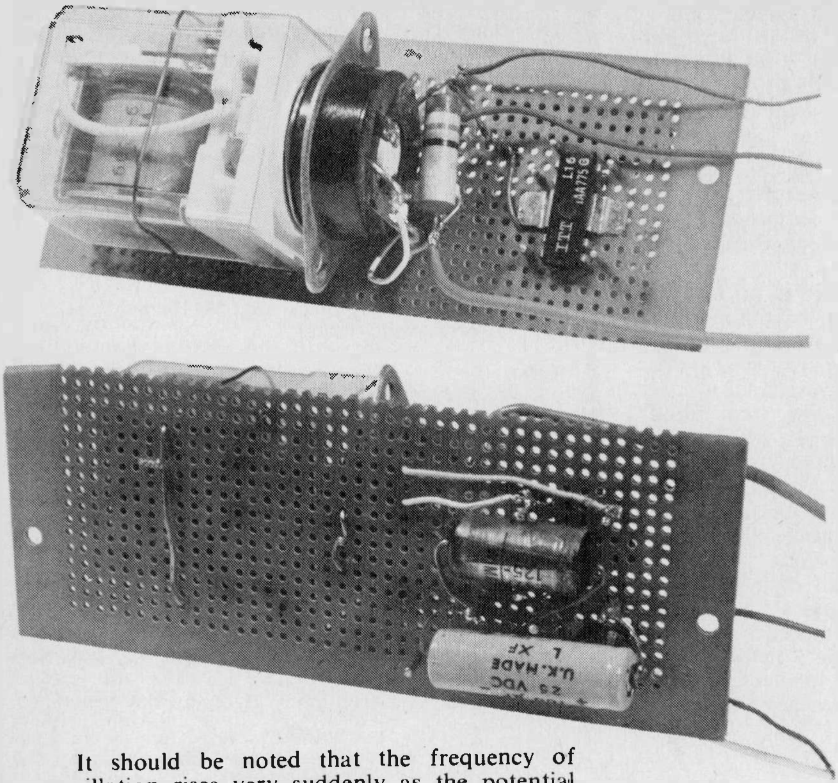


Fig. 1. The circuit of the direction indicator and emergency flasher unit. The connections of the TAA 775G are shown as viewed from above



Prototype assembly of the Car Indicator / Emergency Flasher. Since the wiring layout is not critical and so few components are involved, no interwiring details are given. The unit should be installed under the dashboard and all connections to existing circuitry should only be made after examining the car's wiring diagram

It should be noted that the frequency of oscillation rises very suddenly as the potential of pin 7 rises from +0·35 to +0·45V. There are only the two frequencies of oscillation for any given values of R1 and C1.

The values of R1 and C1 shown will result in a flashing rate of about 85 per minute when the pin 7 potential is less than +0·35V. Tolerances in component values (especially in that of C1) will produce some variation in frequency between similar circuits with the same nominal component values, but the flashing rate obtained should always be well within the legally permitted limits.

FUNCTIONING

The car power supply voltage is always applied to the integrated circuit whenever the ignition is switched on. The quiescent current consumption is only about 8mA.

When S1 and S2 are both open, pin 7 has a potential of about +12V, since it is returned to the positive supply line via R2. This potential at pin 7 prevents oscillation from occurring.

When S1 is switched to the "left" position, the resistor R2 forms a voltage divider with the parallel connected lamps LP1 and LP2. The lamps have a very low resistance and therefore the potential at pin 7 falls to less than +0·35V. The relay closes immediately and the lamps LP1 and LP2 are illuminated, but are extinguished when the relay opens. Flashing continues as C1 repeatedly charges and discharges.

Similarly, if S1 is switched to the "right" position, LP4 and LP5 will flash. With S1 in either the 'left' or 'right' position, the monitor lamp LP3 inside the vehicle will flash with the other lamps to indicate to the driver that the flashers are working.

If S1 is in the "left" position and either LP1 or LP2 has a broken filament, the potential divider consisting of R2 and the remaining good lamp will apply a voltage exceeding +0·45V to pin 7. The monitor lamp LP3 and the good flasher will therefore flash at a much increased frequency (about 180 flashes per minute). Similarly, if S1 is switched to the 'right' position and LP4 or LP5 has a broken filament, the same high flashing rate will occur.

EMERGENCY FLASHING

If the emergency flashing switch S2 is closed, the lamps LP1, LP2, LP4 and LP5 will all flash simultaneously at the normal rate of about 85 flashes per minute. This is an excellent way of warning other road users that a road hazard (such as an accident) is present near the vehicle.

The lamp LP6 is a warning lamp inside the vehicle which flashes with the emergency lamps. It should be noted that if one or two of the flasher lamps have broken filaments, there will be no change of flashing frequency in the emergency position. However, any broken filaments should have been previously detected when the flashers are used as direction indicators, since their use as emergency flashers is likely to be a very rare occurrence.

The direction indicator monitoring lamp, LP3, does not flash when the switch S2 is closed for emergency warning flashing.

The emergency flashing system of Fig. 1 will operate only when the ignition is switched on.

POTENTIAL DIVIDER TOLERANCE

The value of R2 is by no means critical, but a widely incorrect value can result in an incorrect flashing rate. In the prototype it was found that if the value of this resistor exceeded about 110 ohms, the normal flashing rate occurred even if a bulb had a broken filament. On the other hand, if the value of R1 was less than about 50 ohms, the high flashing rate occurred even when all of the flasher bulbs were good ones.

CONSTRUCTION

The TAA 775G is best mounted on a printed circuit board specially designed for the purpose with slits for the tabs of the device. However, most readers will not have the facilities for making such a board. It is therefore normally convenient to carefully bend the tabs of the device upwards so that the pins of the device can be inserted into a "Lektrokit" board whilst the tabs remain above the board. One can solder the connections directly to the pins and this will hold the device in position on the board.

The relay is fitted into a standard "international octal" type of valve socket. Pins 2 and 7 are connected to the relay coil, whilst pins 1 and 3 are the pair of normally open contacts used in the circuit being described. The other contacts are not connected in the circuit of Fig. 1.

The relay contacts have to switch a current of some 3·7A (or about 7·1A when the emergency flashers are used), so a relay with an adequate contact rating is essential for high reliability and hence road safety. The surge current at switch-on is even higher than the above values owing to the low resistance of the bulbs used when their filaments are cold. The use of a miniature relay should not therefore be contemplated.

FITTING

The switch S1 is already fitted in the car and can be used together with the existing lamps LP1 to LP5 inclusive and their wiring. The emergency switch S2 should be installed well away from other switches so that it is not likely to be operated accidentally. LP6 can be fitted at any convenient place where its flashing light is not likely to remain unnoticed by the driver.

The circuit board is conveniently fitted under the dash board where the driver can hear the clicking of the relay contacts clearly. It may be convenient to place the whole circuit in a thick polythene bag before placing it under the dash board. ★

MILD & BITTER

THE POCKET CALCULATOR BORE By A.P.S.

IT is unfortunate that new ideas always generate over enthusiastic responses, leading eventually to the emergence of a unique class of bore. The poor, innocent pocket calculator has unwittingly become the host of two particularly virulent strains which have gained a foothold in the home counties and appear to be spreading as far north as Merseyside.

These have been identified as "Borus-calculatii-simplex" (found in patients who have purchased the so-called "Four-function" calculators) and a related, but more lethal variety called "Borus-calculatii-sciencus" (found in the owners of the "Scientific" calculators.)

To be forewarned is to be forearmed, so it is well to have some knowledge of their habits and modus operandi.

They could be found almost anywhere but tend to favour workers' canteens, fashionable London clubs, pubs and public transport vehicles.

A slight rectangular shaped swelling in the region of the breast pocket is normally considered to be a positive diagnosis.

If any luckless member of the public wanders too close, the procedure which follows is fairly well established.

The calculator is withdrawn with a casual air and the fiery red digits will begin to blink and splutter in a hypnotic way, almost certainly attracting a glance of interest. The damage is done!

The ordeal begins with some torturous descriptive details of the particular model.

"Of course this has fully floating decimal point, a double re-entry constant button, facilities for extended multiplication and many other unique features which I won't bore you with old boy."

Then follows a demonstration of the number-crunching powers, during which the far reaching discovery could be made that 356 divided by 2·3 squared is "approximately" 67·29678639.

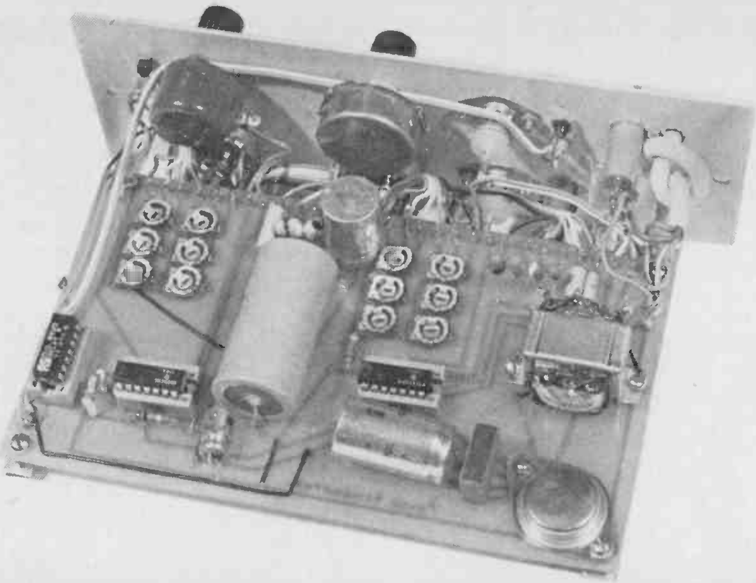
The fingers flash gracefully over the keys (with the dexterity of a Liberace) serving as a prelude to the next lecture which is concerned with some remarkable properties of the solid dodecahedron. Apparently all that is required is five sides, three angles and some cunning use of the aforementioned CONSTANT button. Some properties of pi and epsilon may then be discussed and of course rigidly demonstrated with worked examples.

Blessed relief finally comes when the batteries expire.

There is little doubt that the disease is on the increase and is particularly prevalent on the London Underground, more so on the Metro Line.

During the rush hour, little knots of people may be seen, one hand hanging on to the strap, the other holding the calculator. They use their noses to operate the buttons in a jerky sparrow-like manner, much to the consternation of the other travellers.

The answer to the steadily growing menace has yet to be found. In the meantime, the only advice is attack! Buy one yourself and strap it prominently around the chest but do make sure it has a CONSTANT button, facilities for . . . etc., etc., etc.



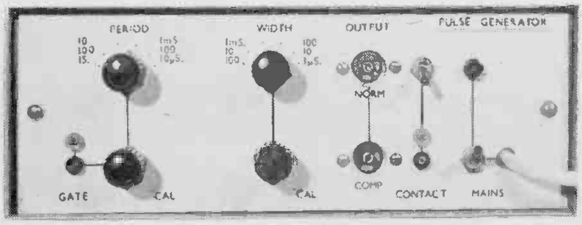
I.C. PULSE GENERATOR

By A.C. AINSLIE

ALL WORK carried out with digital integrated circuits involves the generation or processing of pulses or pulse trains. Complex pulse generators are now available for industrial or development laboratories where a wide range of complex pulse systems are needed, but for the home constructor there is rarely any need for anything other than a simple repetitive pulse train.

SPECIFICATION . . .

Pulse Rate	**0·1Hz to 100kHz (in six decade ranges)**
Period	**1s to 1μs (in six decade ranges)**
Output	**Two TTL compatible outputs available; "NORMAL" and "INVERT". The "NORMAL" output is high during the mark period. High is 4V and low is 0·5V. FAN OUT of 10 for each output. The "CONTACT" output closes during the mark period. Maximum ratings: 100V @ 200mA d.c. Maximum usable PRF approximately 200Hz.**
Gate Input	**TTL compatible—high or floating to enable the pulse train. Sink current to stop the pulse train is less than 2mA.**



The generator to be described was developed for TTL investigations and only a TTL-compatible output is provided. In order to increase the range of applications to cover other output requirements the pulse generator output can drive a small reed relay, the contacts being brought to the front panel to enable external voltages to be controlled up to a rate of a few hundred cycles. Alternatively some form of emitter-follower circuit can be used.

The generator is capable of a wide range of operating frequencies but with readily available switches the limit is six decade ranges. Although capable of operation in excess of 1MHz, pulse width of 100ns with a rise time of better than 20ns, the faster ranges were abandoned in favour of a slow range of 1Hz to 0·1Hz. This is handy for industrial process control and also enables digital counters to be seen counting at this low rate.

ELECTRONIC CIRCUIT

The complete circuit of the generator is shown in Fig. 1. Although it looks fairly complex it can be broken down into four sections, the period generator, timing pulse shaper, monostable pulse width and output circuit, and power supply. The first three are shown in Fig. 2 in block form.

Before describing the circuitry in detail we should perhaps see how these parts fit together to form a generator of variable period and width. Fig. 3 shows how the period generator, timing pulse generator and width monostable waveforms are interrelated to form the complete generator.

The waveform at A is the output from the period generator which can be a free-running multivibrator or astable. Variation of the duration of one cycle of the waveform varies the output period, P. In the present instance the period generator is made up from three of the four gates in an SN7400 (IC1).

If at an instant the inputs to G3 (Fig. 1) are at logic 1 then the output of gate G3 is at logic 0, and so the output of G1 is at logic 1. The output of G2 must therefore be at logic 0 and so the capacitor C1 to C6 selected by S1A will charge through VR7 and the preset VR1 to VR6 introduced by S1B. Thus the input to G3 will be high as the charging current is high but as the capacitor becomes charged, G3 inputs will fall to logic 0, sending G1 output to logic 0 and G2 output to logic 1 discharging the capacitor until the input to G3 once again goes to logic 1, repeating the cycle.

The duration of the cycle is dependent on the value of the charging capacitor and VR7 plus the preset selected by S1B. This preset is to enable each range to be calibrated in decade steps when VR7 is at zero resistance—i.e. shortest period for each range. The capacitors are arranged to give decade ranges of 1s to 10μs. The slowest range could be deleted and a faster range (1μs) added with a 4·7nF capacitor.

The open circuit input of G1 naturally acquires logic 1 when left floating and so the circuit operation is normal with no connection to the GATE. When GATE is taken to logic 0 or ground however the period generator stops operating, enabling fully gated operation.

G4 (the last gate in IC1), C7 and R1 form the timing pulse. C7 and R1 ensure that when the output of G3 goes to logic 1 the input to G4 only goes to logic 1 for about 70ns. G4 output therefore goes to logic 0 for 70ns during each period. This logic 0 pulse applied to IC2 inputs, A1 and A2, starts the monostable cycle.

Fig. 2. Block diagram of the first three sections of the pulse generator

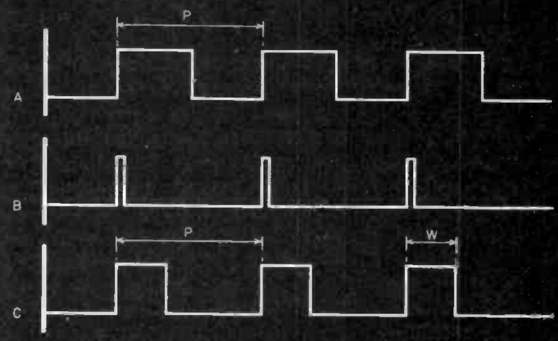


Fig. 3. Time relationships of the waveforms from the sections of Fig. 2 showing how the complete waveform is created

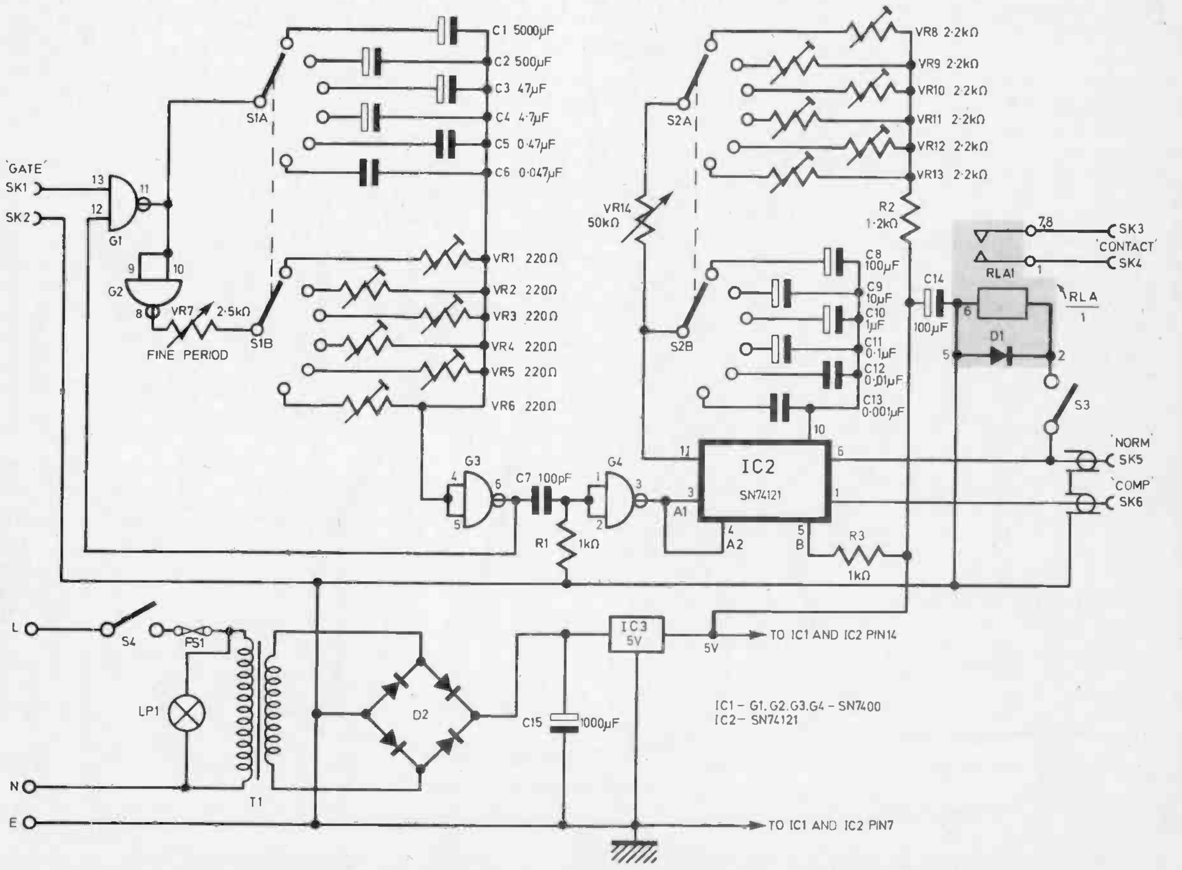


Fig. 1. Complete circuit diagram of the pulse generator. Period is controlled by switch S1, variable resistance VR7 and the presets VR1 to VR6. Width is controlled by S2, VR14 and presets VR8 to VR13

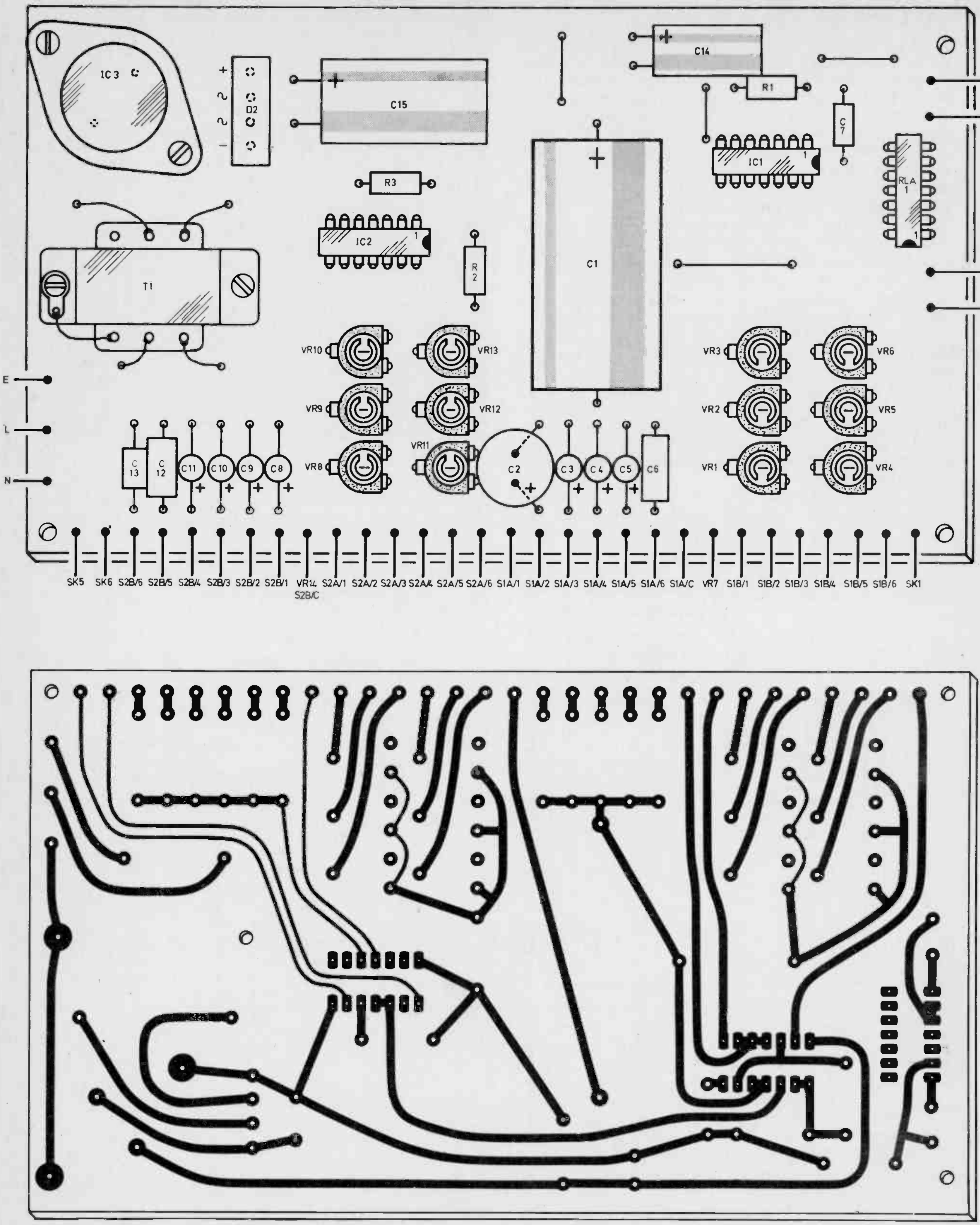


Fig. 4. Suggested p.c.b. pattern (full size) and component layout for the pulse generator, including the reed relay but excluding current sinking resistors

PULSE WIDTH

S2A and S2B select the time-determining components as previously. VR8 to VR13 are presets to enable the widths to be calibrated when VR14 is at minimum resistance. R2 is to limit the timing resistor values as required in the device specification.

The monostable chip, IC2, produces a pair of complementary outputs that are taken directly to the front panel sockets. R3 serves to ensure that input B of IC2 is maintained at logic 1.

At one point during the period generator waveform, the timing pulse generator produces a brief pulse as at B in Fig. 3. This point is usually the leading edge of the period waveform as shown. Thus the timing pulses are spaced by the period set by the period generator. The timing pulses are usually arranged to be far shorter than the minimum output width required, in the present case about 70ns.

The timing pulses initiate the width monostable which gives a pulse on receipt of a timing pulse of length determined by the monostable's time constants. This gives an output pulse of duration, W, the pulse width. Thus the output train consists of a series of pulses of width, W, separated by period P.

The only power required by the circuit is +5V at pin 14 of each of the two i.c.'s. This is provided by an integrated voltage regulator fed from a conventional power supply. RLA1 is a miniature reed relay that can be switched to the output by S3. The contacts of RLA1 are taken to the front panel at SK3 and SK4 and can be used to control any external circuitry as required.

COMPONENTS....

Resistors
R1 1kΩ
R2 1·2kΩ
R3 1kΩ
All 10%, ¼W

Potentiometers
VR1–VR6 220Ω preset pot. miniature
VR7 2·5kΩ potentiometer
VR8–VR14 2·2kΩ preset pot. miniature

Capacitors
C1 5,000μF
C2 500μF
C3 47μF, Tantalum
C4 4·7μF Tantalum
C5 0·47μF Tantalum
C6 0·047μF
C7 100pF
C8 100μF, Tantalum
C9 10μF Tantalum
C10 1μF Tantalum
C11 0·1μF Tantalum
C12 0·01μF
C13 0·001μF
C14 100μF, 15VW
C15 1,000μF, 16VW
All 5VW except where stated

Semiconductors
IC1 SN7400 (G1, 2, 3 and 4)
IC2 SN74121
IC3 MVR5V (R.S. Components) or 305-377 (Doram). 5V regulator i.c.
D2 20V, 1A bridge rectifier

Switches
S1 2-pole, 6-way
S2 2-pole, 6-way
S3 1-pole, on/off
S4 1-pole, on/off

Miscellaneous
RLA1 D.i.l. reed relay incorporating D1 (Doram)
T1 6V, 100mA output mains transformer
LP1 Neon indicator
FS1 1A mains fuse
Sockets, case, wire, solder, p.c.b. etc. to suit

FAN-OUT

The basic unit supplies TTL-compatible pulses to a fan-out of ten per output. However if the outputs are required to source current then a resistor of 330Ω should be connected between each output line and the +5V bus. This reduces the fan-out but precludes the possibility of damage from shorting the outputs.

Of course the reed relay requires sourcing so it is advisable to connect a 330Ω resistor between the relay side of S3 and the +5V bus. This maintains TTL compatibility with S3 open.

CONSTRUCTION

Several methods will suggest themselves for the construction of this project but the author can only recommend a printed circuit board. A board of 88·9 × 152·4mm (3½in. × 6in.) will accommodate all the main components without too much crowding. Fig. 4 shows a suitable print layout—drawn full size.

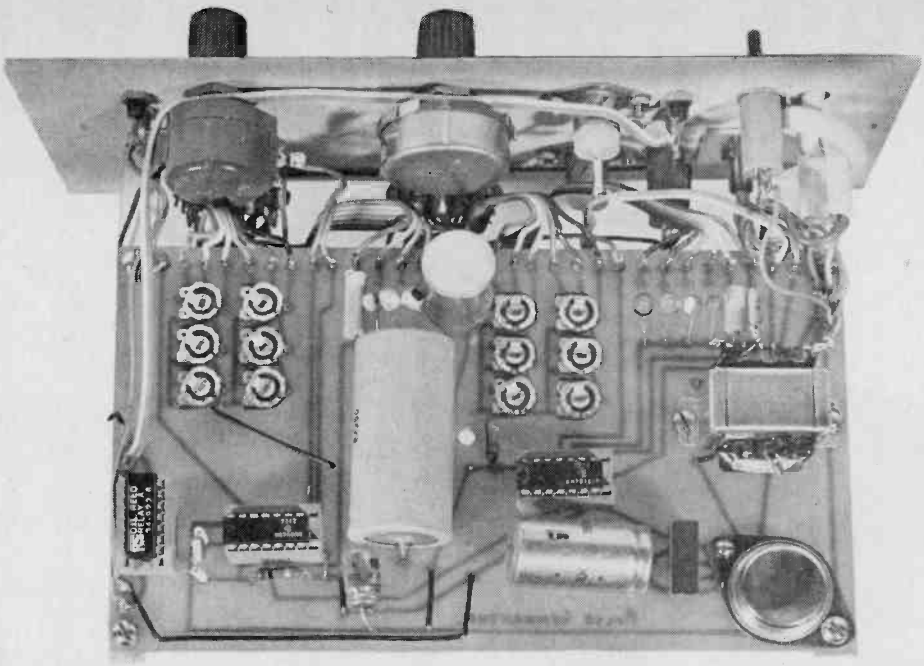
It is recommended that fibreglass board is used both for stability of performance and, because of the greater strength of fibreglass board, the mains transformer can be built onto the board.

The board can easily be made by constructors using the following recommendations. First of all the copper side of the board must be clean and free from scratches and grease. The design can now be copied onto the board using one of the marker pens now available. Etching is carried out in a saturated solution of ferric chloride.

The author has found that difficulty can be experienced when etching large boards due to uneven etching. The best way to overcome this is to float the board copper side down on the surface of the etchant. In this way all of the sludge falls from the board instead of staying on the surface. When completely etched, the board is washed and the resist removed with a solvent.

Most of the holes in the board can be drilled with a number 60 drill but $\frac{1}{32}$in. holes look neater for small components.

The i.c.s can be mounted on small sockets for ease of replacement. The relay can be purchased as a d.i.l. type and should be mounted on a socket



as, being a semi-mechanical device, it is prone to failure. The diode D1 is included in the d.i.l. package if the recommended component is used.

There are no special points to watch during the construction of the board, except perhaps that the i.c.s are the right way round.

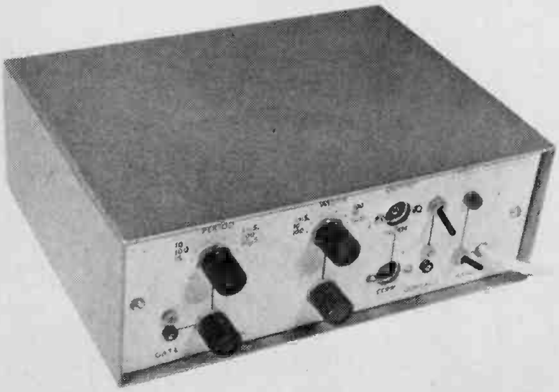
The front panel and case layout are shown in the accompanying photographs but they depend on the components used. The use of ten-way ribbon cable considerably eases the connection of the switches. In general all wiring should be short and direct otherwise "ringing" may occur on transients, spoiling the normally very clean output.

TESTING

When the construction has been completed and all the wiring checked, the generator can be tested.

When switched on, the voltage on pin 14 of both i.c.s should be 5V, within about 0·1V or so. An oscilloscope connected to the generator will verify correct operation.

If no output appears the scope probe should be connected to G3 output to verify that the period stage is working. The output of G4 should be a series of 70ns pulses.



These pulses can be difficult to see on some "ordinary" oscilloscopes which have low e.h.t. and not too wide a bandwidth. However, with Y amplifier set to 1V/cm and the trig set to "−ve, fast a.c." the stability control can be adjusted so that the scope just does not scan with no input. Applying the 70ns signal should now start up the timebase.

CALIBRATION

In order to calibrate the generator, the period and width controls, VR7 and VR14, are turned to minimum resistance. Then with S1 and S2 set to the fastest ranges, the period is set up on a calibrated scope using VR6. The width is then set with VR13.

S1 and S2 are then turned onto the next range and the process repeated with VR5 and VR12. This is continued until all of the ranges have been covered.

The value of VR7 at maximum resistance can be too high to enable G3 input to drop to logic 0. This is shown by the period oscillator stopping on the longer pulse widths on each range. If this occurs, VR7 should be shunted with a small resistor of value in the region of 3·9kΩ so that the oscillator functions correctly over the whole range of VR7.

In use the generator should present no problems as the operation is self-explanatory. However, a little care is needed as regards the output connections to avoid cable reflections and ringing. Generally, if 75Ω co-ax connectors are used together with 75Ω cable, no reflections will be experienced unless a cable of several yards' length is used. Experience will dictate the best loading for each situation—usually co-ax can be fed directly to a TTL gate input without any trouble at all. ★

Hi-Z HIGH INPUT IMPEDANCE TECHNIQUES

By R.A.PENFOLD

IT IS common practice to design any piece of test equipment which is to draw current from the apparatus under test, to have an input impedance as high as possible. Thus the minimum current is drawn from the apparatus, and the test rig will have virtually no adverse effect on it. An accurate result is therefore obtained.

Recently a few items of commercial test gear have been put on the market, offering input impedances as high as 1,000 megohms.

F.E.T. CIRCUIT

A circuit diagram of a preamplifier using a field effect transistor in the source follower mode is shown in Fig. 1. This uses an inexpensive junction f.e.t. type 2N3819, and has a calculated input impedance of over 100 megohms. Resistors R1, R2, and R3 bias the transistor, and R4 is the source load. C1 is the input coupling capacitor, and C2 is the bootstrapping capacitor.

It is the use of bootstrapping, plus of course the very high input impedance of the f.e.t., which gives the circuit such a high input impedance, as, if C2 is removed, the input impedance will be only approximately 6·9 megohms. The source follower is the f.e.t. equivalent of the emitter follower in bipolar transistor circuitry.

Like an emitter follower, a circuit such as this has 100 per cent negative feedback and has unity (slightly less in practice) voltage gain.

The input and output are in phase. Therefore, if an input voltage is appled to TR1 gate, the voltage at TR1 source will alter by an almost identical amount. C2 couples this change to the junction of R1–R2–R3.

As the input signal causes a change in the potential at one end of R3, the signal via C2 will cause a similar change at the other end. Theoretically there will be no change in the current passing through R3, and to the input signal this will appear to possess an infinite resistance.

TRANSISTOR GAIN

In practice this is not so, as the gain between TR1 gate and the junction of R1–R2–R3 is less than unity. The gain of TR1 is only about 0·95, and there is also a small loss through C2, although this is only small compared to the 5 per cent loss through TR1.

The effective resistance of R3 will be increased to approximately 20 times its actual value, or 136 megohms. When one takes into account the input impedance of the f.e.t. itself, the input impedance of the amplifier is still in excess of 100 megohms.

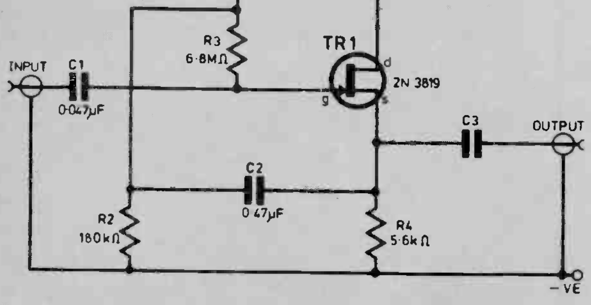


Fig. 1. An amplifier having an input impedance of over 100 megohms

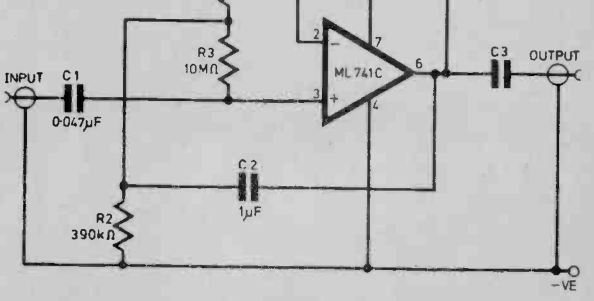


Fig. 2. This circuit using an operational amplifier i.c. has a typical input impedance of 400 megohms

When dealing with input impedances as high as this, the input capacitance of the circuit must be borne in mind, as even at audio frequencies this will noticeably reduce the input impedance.

The input capacitance of the circuit shown in Fig. 1 is about 8 to 12pF, and the exact figure will depend upon the individual f.e.t. used, and the component layout used.

OPERATIONAL AMPLIFIER CIRCUIT

Operational amplifier i.c.s can be used very effectively to obtain ultra high input impedances. Fig. 2 shows a circuit which uses a 741C or similar device, and a typical input impedance of 400MΩ shunted by 1pF.

As the output is coupled to the inverting input the circuit has unity voltage gain. The i.c. is intended to operate from two equal supplies, one being positive, and the other negative, with respect to earth. A biasing resistor is normally connected between the non-inverting input, and earth. As this circuit operates at a.c. only, this normal arrangement can be modified slightly. R1, and R2 form the centre tap on the supply, and R3 is the biasing resistor.

In order to prevent the biasing resistor from shunting the input, bootstrapping is applied via C2. The gain of the circuit is so close to unity that the bootstrapping is very effective, and the shunting effect of R3 is, to all practical purposes, non-existent.

D.C. CIRCUIT

A d.c. version of the circuit of Fig. 2 is shown in Fig. 3. Here equal positive and negative supplies are used. The biasing resistor is split into two parts (R1 and R2), and the output is coupled to the junction of the two halves. Bootstrapping is thus applied to R2, and the biasing resistors have very little shunting effect upon the input impedance.

The circuit uses the two offset null connections to the i.c. The offset null is adjusted by VR1, which is set with the slider half way along the track at first, and is then adjusted to give zero volts across the output terminals.

Both the circuit of Fig. 2. and that of Fig. 3 have good linearity and a low output impedance. The output has short circuit protection controlled by the i.c. itself. ★

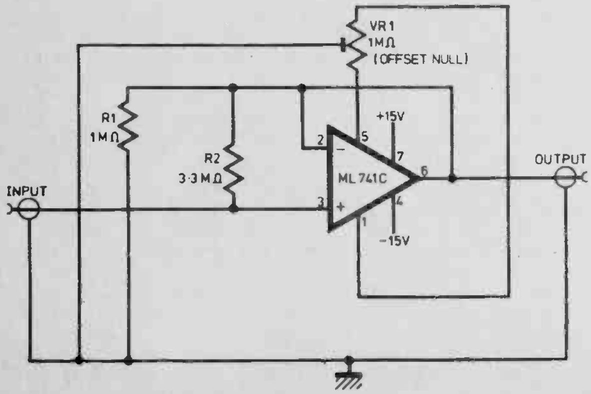


Fig. 3. A d.c. version of the circuit of Fig. 2

NEWS BRIEFS

New Plessey Radio System

A NEW experimental radio communication system, which provides two-way speech contact between underground workers and the surface, was successfully used in rescue operations at the Moorgate Tube disaster. The system, known as "Fire Ground" radio, is being developed by Plessey Avionics and Communications, under a contract from the Home Office Directorate of Telecommunications, for use by fire fighting services.

With this equipment, communication can be fully maintained from within steel-framed buildings, cellars, tunnels, caves, mines and similar locations. Each rescue worker is permanently in two-way contact with the base station and a talk-through facility is available which permits person-to-person contact. The degreee of penetration is quite outstanding.

The equipment consists of a number of special waistcoats, containing portable transmitter-receivers and a mobile base station, all of which may be rushed to the scene of a fire or other disaster.

It's A Hot Wind

FREE power from the wind is one of the "in" subjects nowadays so it is no surprising that a company has been formed specifically to make use of current technology to develop ways of utilising this free energy source.

The new company, called Wesco Ltd., is a joint venture of Control Technology of Peacehaven and Servotec of Redhill and technology for the generation of heat energy from the wind is said to be already in existence.

Wesco will manufacture wind systems embodying the latest in solar dynamics and design, and a new form of compact heat energy storage. Applications are legion and include greenhouse heating (a requirement which, it is claimed, in the UK alone uses three quarters as much energy as British Rail), agricultural heating and drying, and heating on large estates.

It is interesting to note that use has been made of helicopter expertise gained by Servotec and it is understood that the basic units to be made will be modular in concept.

PRACTICAL ELECTRONICS

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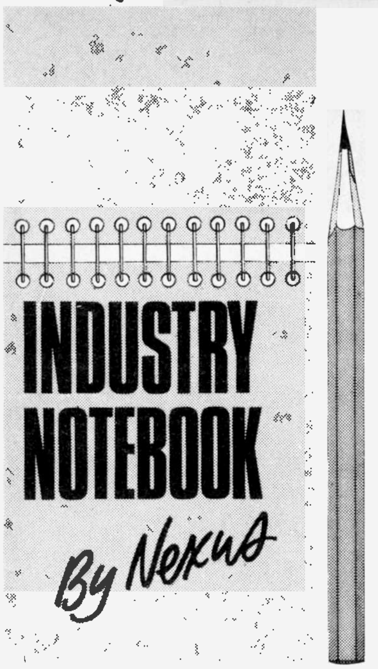

SAFETY AT SEA

Like other companies with a big stake in consumer electronics, Decca is feeling the chill wind of the economic recession. But the company is holding up well in capital goods with turnover up 23 per cent at £32 million and profits up from £3 million to £3·6 million. Almost half the business is in professional navigation equipment in which Decca is still a world leader both in technology and volume of production.

Increasing pressure on shipping to observe the new mandatory traffic lanes in the English Channel has brought Decca a £350,000 order for improved surveillance radar which will extend the present 15 miles radius of the "policing" system to 50 miles. Some 35 ships a day are still breaking the traffic rules that are supposed to keep east-bound ships to the French side of the Dover Straits and west-bound ships to the British side. Ships straying from the traffic lanes are reported and in some cases are fined. The new installation is to follow the success of a pilot installation which has been monitoring channel traffic for the past three years. The "police" are H.M. Coastguards.

It isn't only the safety of ships and crews that is causing concern. It's pollution as well, especially from oil, and a major accident could do untold damage. The Government has recently set up a new Standing Committee on Pollution Clearance at Sea to keep constantly under review the arrangements for pollution clearance following a disaster. But prevention is better than cure and, here again, Decca Radar has taken a lead by producing a portable aid for bringing supertankers more safely into harbour. The equipment is currently being tested at a major oil port and an official announcement is expected soon together with some technical details.

Also doing well with their Situation Display radar which employs television techniques to give a bright radar display is Kelvin Hughes. The 45,000 ton P&O cruise ship "Canberra" has just been fitted with one in preparation for a busy cruise season.

When "Canberra" was launched in 1961 she had the then revolutionary system developed by Kelvin Hughes in which the radar picture was projected on to the plotting table and which was the forerunner of the KH "Photoplot" system. The new installation has the main display forward on the bridge and a slave monitor just aft in the navigation console. A video recorder may be used to take a complete record of the exact sequence of events as the ship is leaving and entering harbour.

The marine electronics business remains buoyant both in civil and defence applications and in defence, of course, there is new business in the protection of the oil rigs in the North Sea.

MICROWAVE LANDING SYSTEM

A first-class row has developed over the U.S. Federal Aviation Administration's decision to recommend a scanning beam microwave landing system in preference to the doppler system which is claimed to be technically superior. Plessey, who has been working hard on the doppler system in conjunction with RAE and with British government support, has gone into the attack with a strongly worded protest. The Hazeltine Corporation, also a proponent of the doppler technique, has gone further and has won a court order restricting the FAA proposal and charging the FAA with illegally excluding Hazeltine from further work in the competition for the final system.

Few of the companies involved in the competition for the best system (which will replace present ILS systems and bring millions of dollars of business in the next 20 years) is happy with the FAA recommendation except Texas Instruments and Bendix who appear to be on a winning streak. Hazeltine, ITT/Gilfilan and Plessey are clearly enraged. The present squabble has all the aspects of international bad feeling generated over the respective merits of the Decca Navigator and VOR systems of some 15 years ago.—Watch out for the next thrilling instalment.

PACKET SWITCHING

The Post Office Experimental Packet Switched Service (EPSS) is now virtually full up. F. W. Woolworth has now joined the scheme and major users will be nearly all the computer hardware manufacturers, BICC, Joseph Lucas and, possibly, Cambridge University who will investigate the value of EPSS to its growing network requirements.

Altogether, some 38 firms are taking part in the experiment, including Ferranti whose Argus 700E computers are used in the packet switching exchanges and for network monitoring.

ECONOMIC SEESAW

All business eyes are turned east these days. The fabled treasures of the east are now a reality with Iran, for example, trebling real income per head in the five years 1973 to 1978, while we in the west are hard put to it to maintain zero growth. Saudi Arabia is planning similar growth. So, it seems, is everyone else in the area.

It is an odd reflection of the times that while the BBC is making savage cuts in expenditure the tiny Sultanate of Oman has just ordered another £2 million of broadcast equipment from Pye TVT on top of the recent £7·7 million contract for a complete TV system and over a million for odds and ends, bringing Pye TVT orders from this one source to over 210 million in under nine months.

The population of Oman is 700,000, that of Glasgow is 900,000.—It makes you think!

DYNAMO

Ray Brown, the human dynamo who built up Racal in its early days (he was the RA part of the invented name) is top news again. Now Sir Raymond Brown, he is the new President of the Electronic Engineering Association, succeeding G. A. Smith of Plessey whose sudden death is regretted by all.

Sir Raymond relinquished his interest in Racal when he became the first Head of Defence Sales, Ministry of Defence, in 1966. He is now chairman and managing director of Muirhead, the facsimile transmission experts whose 3,000 installations world-wide include a number for Interpol and useage by over a dozen national police forces, as well as in more mundane applications. Sir Raymond got his start in electronics in 1934 as an engineering apprentice with Redifon.

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SN7410	0·14	0·13	0·12	SN7483	0·89	0·80	0·74
SN7412	0·16	0·15	0·14	SN7486	0·30	0·26	0·25
SN7413	0·32	0·31	0·30	SN7489	3·50	3·20	2·90
SN7417	0·30	0·29	0·28	SN7490	0·48	0·44	0·41
SN7420	0·14	0·13	0·12	SN7491	0·83	0·77	0·69
SN7427	0·27	0·25	0·22	SN7492	0·51	0·46	0·42
SN7430	0·14	0·13	0·12	SN7493	0·48	0·44	0·41
SN7432	0·27	0·25	0·22	SN7495	0·68	0·61	0·57
SN7437	0·29	0·26	0·24	SN7496	0·77	0·69	0·65
SN7440	0·14	0·13	0·12	SN74107	0·34	0·31	0·29
SN7442	0·69	0·63	0·58	SN74121	0·34	0·31	0·29
SN7445	0·89	0·82	0·76	SN74123	0·68	0·61	0·57
SN7447	0·89	0·79	0·76	SN74141	0·79	0·72	0·67
SN7450	0·14	0·13	0·12	SN74145	0·86	0·78	0·70
SN7451	0·14	0·13	0·12	SN74157	0·87	0·79	0·72
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TELEPHONE BELL SYNTHESISER

DEVELOPED for use as a novelty in toy telephones or intercoms, the circuit of Fig. 1 gives a reasonable imitation of the normal telephone bell ring although the pulse periods to non-signal periods are even.

The Post Office system uses two rings of roughly 0·5s separated by a silence period of three times that amount. For simplicity the present circuit uses a count of four timing rather than a count of five which the Post Office system would need.

The basic multivibrator TR1, TR2 forms the clock for the unit. After the waveform has been given the current rising form so as to suitably trigger the 7474 i.c. by the Schmitt trigger TR3, TR4, it assumes the shape as at Fig. 2a.

This waveform is fed to a divide-by-four counter, IC1, which is positive-going edge triggered. This provides the waveform 2b, Fig. 2.

IC2 provides a warbling note, rather than a bell ring, and gates G1 and G2, capacitors C3 and C4, and resistors R10 and R11, form a multivibrator running at a few Hz.

The multivibrator switches a similar but much higher-pitched multivibrator formed by G3 and G4 to produce the warbled tone shown in Fig 2c. This is pulsed as shown by utilising the spare gate input to G4 and it is also switched slowly on an off by applying the Fig. 2b waveform to one of the inputs of gate G1.

The final output waveform is as at Fig. 2d and this is fed directly to a crystal microphone insert, adequate for most purposes but amplifiable if required.

If the unit is used in equipment containing a 4·5 to 6V supply the battery B1 can be omitted, together with R9 and D1.

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?

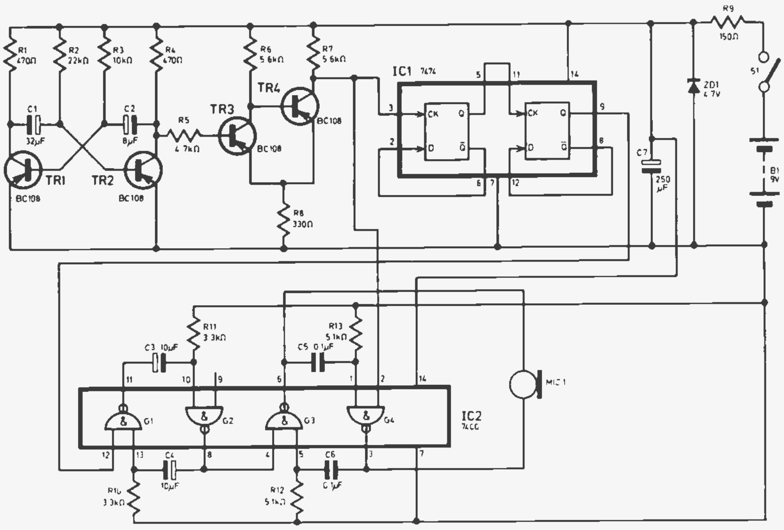

Fig. 1

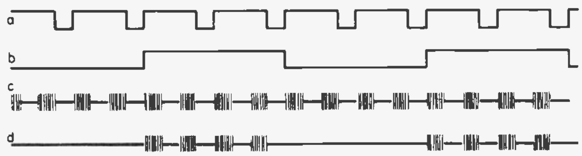

Fig. 2

TWO-WIRE SIGNALLING SYSTEM

THE five devices used in the circuit of Fig. 1 make up a very simple signalling system which can give four indication states using only two wires.

The circuit is battery-powered and operation is as follows. With point L at −6V w.r.t. point E bulb 1 is driven through the forward-biased Zener diode. Bulb 2 does not light. With point L at 0V neither bulb lights.

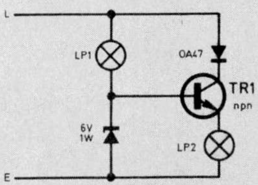

Fig. 1

With L at +6V, bulb 2 lights, the base of TR1 being driven by the very small current through bulb 1.

Finally, with L at +12V, bulb 1 is driven by the 6V supplied by the reverse-biased Zener and bulb 2 is connected to TR1 as an emitter-follower so as to receive the 6V across the Zener.

Both bulbs should be small 6V types and whilst other component types are not critical the Zener must obviously be of the correct voltage and capable of carrying the necessary current. The circuit can be reversed to accommodate a *pnp* transistor.

THE advent of cheap l.s.i. circuits such as clock and calculator i.c.s has opened up the possibility of using these devices in more complicated circuitry; for instance the calculator i.c. could form the basis of a small computer.

The one drawback to using these i.c.s in logic systems is that their output is usually designed to drive seven-segment displays. This output is, of course, no use for feeding into other logic circuitry so the following circuit was designed to convert seven-segment outputs into standard binary coded decimal (BCD) form.

The decoder is shown in Fig. 1. This circuit is designed on the assumption that the l.s.i. chip to be used gives a 0 to 0·8V level for a segment off and an open circuit or 1·2 to 5V level for a segment on. This is of course a rather vain hope and some kind of interface circuitry will probably be required.

P. Northover,
Breaston, Derby

SEVEN-SEGMENT TO BCD DECODER

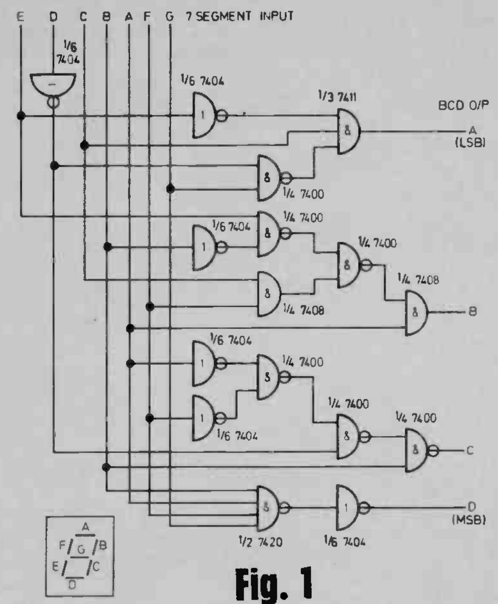

Fig. 1

SOUND SWITCH/TRIGGER

THE circuit of Fig. 1 consists of three basic units, an amplifier, a monostable and a bistable. The amplifier produces a signal large enough to trigger the monostable when it receives a small voltage from the loudspeaker and transformer which form the input. TR1 is biased by the voltage divider in the emitter lead of TR2. As the amplifier is also reasonably sensitive to mains hum, the unit can be used as a touch-sensitive switch provided the transformer is first removed. Sensitivity is controlled by VR1.

The monostable prevents unwanted triggering within its own time limits which are set by varying VR2. Finally the bistable acts as a memory, remembering and maintaining TR7 in an on or off condition. D3 and C5 ensure triggering of the bistable by creating a negative pulse. The output is used as shown here to operate a mains controlling triac and lamp load.

The circuit can be made into a sound trigger by reducing the time constant of the monostable to a minimum 250ms and omitting the bistable. If beat music is now played into the loudspeaker the lamp in series with the output will be modulated in time with the beat.

N. E. Smith,
Newcastle upon Tyne.

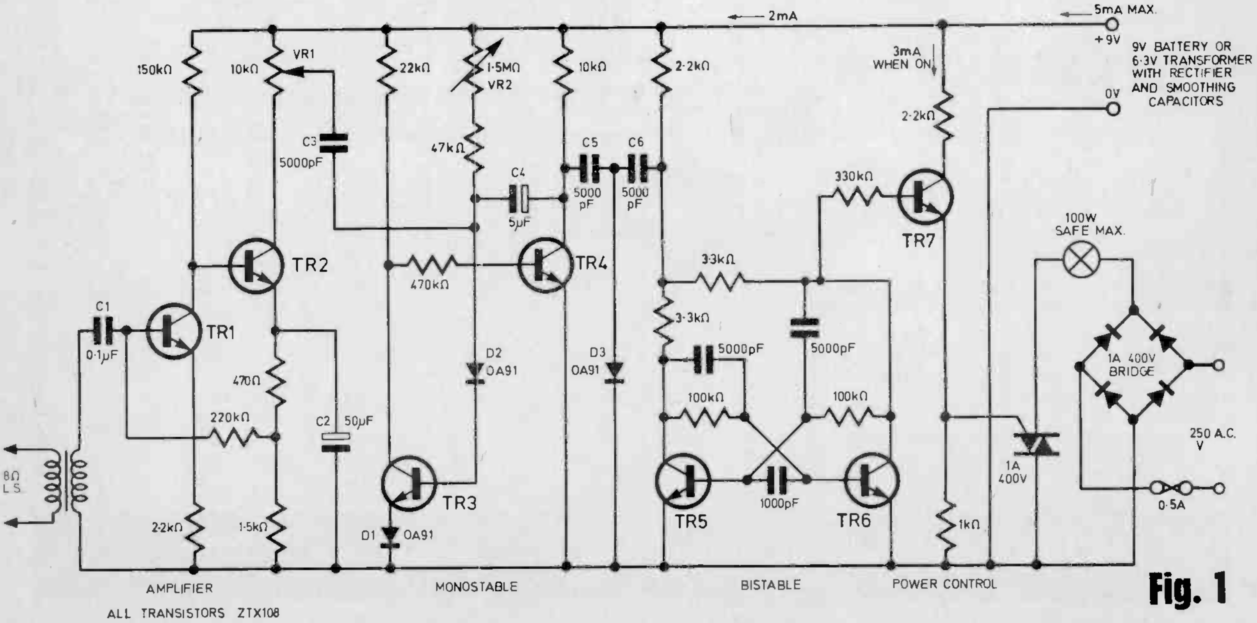

Fig. 1

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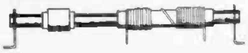

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5	10. 5 Mhz	to	31.5 Mhz
6	30 Mhz	to	50 Mhz *
7	45 Mhz	to	78 Mhz *

* 50 pf tuning, all others based on 300 pf.

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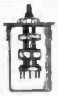

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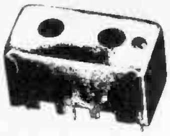

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TUNING CONDENSERS

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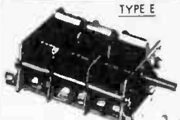

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5pf	80p
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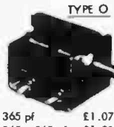
25pf	80p
50pf	83p
60pf	94p
75pf	94p
100pf	99p

TYPE O



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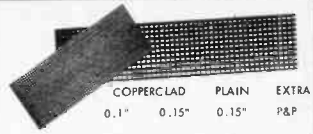

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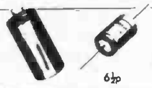
Electrolytics



μF	4V	6.3V	10V	16V	25V	40V	63V	100V	160V	450V
1							6½p		8½p	15p
1.5							6½p			
2.2							6½p		8½p	
3.3							6½p			
4.7							6½p		8½p	17p(4uF)
6.8						6½p	6½p	8½p		
8										21p
10					6½p		6½p	8½p		
15				6½p		6½p	6½p			24p(16uF)
22			6½p		6½p		6½p	11p		
33		6½p		6½p		6½p				33p(32uF)
47	6½p		6½p	6½p	6½p	6½p	8p			25p(50uF)
68		6½p		6½p			11p			350V
100	6½p		6½p		6½p	8p	14p	25p		
150		6½p		6½p	8p	11p	14p			
220	6½p		6½p	8p	11p	14p	19p	31p		
330	6½p		8p	11p			25p	44p		
470		8p	11p		14p	20p	26p	47p		
680		10p		14p	20p	25p		59p		
1000	13p		14p	19p	22p	25p	44p	79p		
1500		18p	19p	25p						
2200		18p	24p		39p	44p	79p	149p		
3300		26p								
4700	25p			44p	68p	79p	149p	252p		
6800				75p						

DIODES

AA119	10p	BY103	22p	OA91	8p
AA120	10p	BY105	16½p	OA200	11p
AA129	10p	BY126	16p	OA202	12p
BA100	10p	BY127	16½p	ZS120	8p
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BA145	22p	BY250	25½p	ZS270	11p
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BA154	20p	Series		ZS278	36½p
BA155	15½p	BZY88	11p	IN914	8p
BA156	16½p	Series		IN916	10p
BAX16	10p	OA47	11p	IN4009	7p
BB104	45½p	OA79	10p	IN4148	5½p
BB105B	41½p	OA81	8p	IN4448	9p
BY100	16½p	OA85	10p	IZS Series	18p
		OA90	8p		

TRANSISTORS

AC107	16p	BC213L	13p	D13V	52½p	ZTX301	13p	2N3707	12p
AC126	13p	BC214L	13p	D40N3	59p	ZTX302	17p	2N3708	10p
AC127	13p	BC268	15p	MJ480	93½p	ZTX303	14p	2N3709	10p
AC128	13p	BC407	16p	MJ481	£1.18	ZTX304	21p	2N3710	11p
AC176	15p	BCY70	17p	MJ490	£1.01½	ZTX311	10p	2N3711	11p
AC187	22p	BCY71	22p	MJ491	£1.42½	ZTX312	10p	2N3772	£2.00
AC187K	20p	BCY72	17p	MJ900	£1.42½	ZTX341	22p	2N3791	£2.55
AC188	22p	BD115	73p	MJ1000	£1.22	ZTX384	18p	2N3819	27½p
AC188K	25p	BD123	89½p	MJ2955	£1.88½	ZTX500	12p	2N3821	81p
ACY17	39p	BD124	80½p	MJ3055	£1.21	ZTX501	13p	2N3823	99p
ACY17	38½p	BD131	44p	MJ4000	£1.46½	ZTX502	17p	2N3903	15½p
ACY20	22p	BD132	52p	MJ4010	£1.95½	ZTX503	14p	2N3904	19p
AD140	48½p	BD131/2PR	£1.17	MJE340	45p	ZTX504	42½p	2N3905	23p
AD149	48½p	BD135	41½p	MJE350	97½p	ZTX531	22p	2N3906	25p
AD161	37½p	BD136	43½p	MJE2955	£1.20	ZTX550	17p	2N4056	13½p
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AD161/62MP	74p	BD202	£1.46½	MPF102	27p	2N706	13p	2N4062	16p
AF114	17p	BF109	74p	MPF103	40½p	2N708	16½p	2N4289	19p
AF115	17p	BF115	25p	MPF104	44½p	2N914	24½p	2N4441	85½p
AF116	17p	BF160	25½p	MPF105	44½p	2N930	22p	2N4442	£1.04½
AF117	17p	BF167	24p	MPF106	49p	2N1302	20p	2N4443	£1.42½
AF118	54p	BF173	24p	MPF111	22p	2N1303	24p	2N4444	£2.06½
AF124	32½p	BF178	28½p	MPSU06	63p	2N1304	24p	2N4871	59p
AF139	34½p	BF179	32½p	MPSU56	77p	2N1305	24p	2N4901	£1.41½
AF172	25p	BF180	32½p	OC28	49½p	2N1306	24p	2N5067	£1.07½
AF239	40½p	BF181	32½p	OC35	49½p	2N1307	27p	2N5129	16½p
ASY26	32½p	BF184	27½p	OC36	49½p	2N1308	34½p	2N5172	11p
BC107	11p	BF185	27½p	OC44	14p	2N1309	34½p	2N5191	77p
BC108	11p	BF194	15p	OC45	14p	2N1711	26p	2N5194	91p
BC109	12p	BF195	17p	OC71	14p	2N1718	£4.37	2N5295	52½p
BC117	22p	BF196	16p	OC72	14p	2N1893	52p	2N5447	16p
BC147	10p	BF197	16p	OC75	15p	2N2218	22p	2N5449	16p
BC148	10p	BF200	31½p	OC76	27p	2N2219	38½p	2N5457	46½p
BC149	10p	BF244B	27p	OC81	14p	2N2646	54p	2N5458	43½p
BC157	13p	BF262	25p	OC83	25p	2N2894	97½p	2N5459	43½p
BC158	12p	BF263	25p	OC170	27½p	2N2904	32½p	2N5485	52½p
BC159	14p	BF272	£1.19	OC171	32½p	2N2905	30½p	2N5777	48½p
BC167	17p			OCP71	£1.54½	2N2924	16p	2N6068	44½p
BC168B	11p	BFS97	23p	ORP12	65p	2N2925	18p	2N6069	51½p
BC169	12p	BFS98	20p	TIP29	53½p	2N2926G	10p	2N6070	57p
BC171	20p	BFW10	65p	TIP31	67p	2N3053	19p	2N6071	62p
BC172	17½p	BFX29	41½p	TIP31A	67p	2N3054	50½p	2N6073	67p
BC177	22p	BFX88	26p	TIP32A	79½p	2N3055	51½p	2N6075	£1.46½
BC178	22p	BFY50	22p	TIP41A	79½p	2N3375	£3.56½	2N6076	16½p
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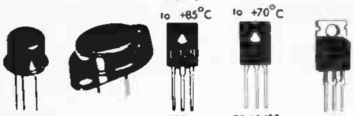
BC183L	12p	BR100	42½p	TIS88A	36½p	2N3638	20p	3N140	99½p
BC184L	12p	BRY39	43½p	TIS91	32½p	2N3702	13p	3N141	87½p
BC187	27p	BSX20	18p	ZTX107	10p	2N3703	12p	3N153	87½p
BC204	14p	BSX21	22p	ZTX108	10p	2N3704	13p	40321	54p
BC209	14p	BSY95A	14p	ZTX109	15p	2N3705	12½p	40430	£1.39
BC212L	12½p	BU105/02	£1.95½	ZTX300	12p	2N3706	14p	40673	55p

REGULATORS



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*600mA; 500mA and 450mA respectively.

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60v	MCR103	44p				
100v	MCR104	49p	106A	48p		
200v	MCR120	51p	106B	53p	2N4442	£1.06
400v			106D	67p	2N4443	£1.45
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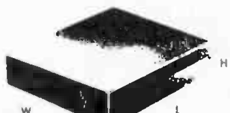

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AB10	4"	$5\frac{1}{4}$"	$1\frac{1}{2}$"	51p	15p
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A "DIVIDE BY ANYTHING" COUNTER SYSTEM

This counter system was originally devised for frequency synthesis for an amateur radio transmitter but it can be modified simply to produce any "divide-by" ratio and should accept any input frequency up to the limit (about 18MHz) set by the counting flip-flops (SN7493's).

The circuit Fig. 1 is based on a simple binary counter system which is reset after reaching a predetermined count. By way of example, Fig. 1 shows a count of eleven, this being achieved by connecting the 8, 2 and 1 outputs of the binary counter to the reset gate.

The circuit operates as follows. The binary counter operates in normal fashion until a count of eleven (binary 8+2+1) is reached. At this instant (point X on the timing diagram, Fig. 2) the reset gate is satisfied and the reset signal sets the J-K flip-flop, FF. The FF 'Q' output resets the counter to zero so that the counter contains the value eleven only for a few nanoseconds whilst the FF is triggering.

The $\overline{Q}$ output of FF sets the flip-latch (FL) which allows gate A to reset the FF when the input next goes high (point Y on the timing diagram). Finally, when the input next goes low (point Z on the timing diagram) the FL is reset and the counter recommences counting from zero. Thus, one output pulse from the FL is obtained for eleven input pulses, i.e. a divide-by-eleven arrangement.

To change the "divide-by" ratio, it is only necessary to connect the appropriate counter outputs to the reset gate, and if a multiway switch is used this ratio can be changed at will.

Suppose we wish to divide the 50Hz mains frequency by 3000 to obtain 1 pulse per minute, for timing purposes. Twelve counter stages are needed with outputs 2048, 512, 256, 128, 32, 16 and 8 connected to the reset gate. The cost of such a system 3 × 7493, 1 × 7430, 1 × 7400, ½ × 7473 is roughly equivalent to a fixed divide system using a 7492 (÷ 1000).

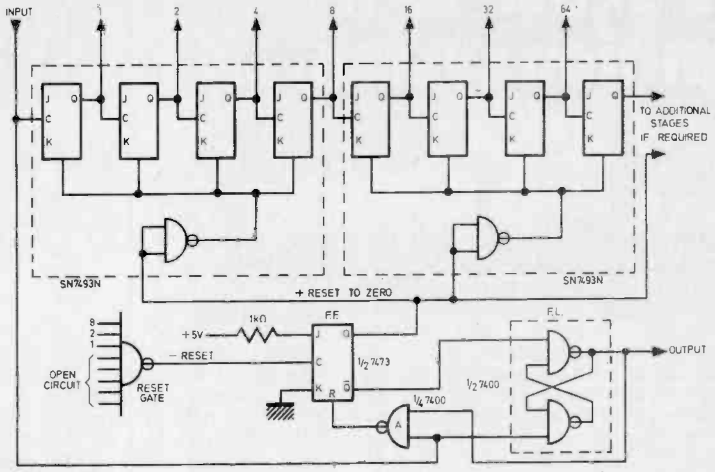

Fig. 1

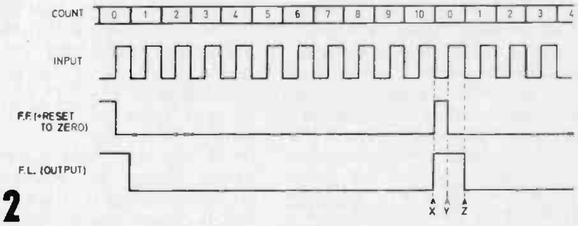

Fig. 2

For a low-cost system the keen experimenter could try reject 7493's, available at 55p for five. A sample test of 25 yielded a 50 per cent usage.

C. J. Brewitt,
Plymouth,
Devon.

TTL OSCILLATOR

As can be seen from the circuit diagram of Fig. 1 this TTL oscillator uses but one gate, albeit a 7413 Schmitt trigger, instead of the more common three gates in a self oscillating ring.

The basic circuit operation is as follows: At switch on C1 is discharged and will begin to charge positively as a result of the gate input current and the current flowing through R1 and VR2 from the gate output high voltage. The voltage against time curve for C1 will be a close approximation to an exponential and when it reaches the positive going input threshold voltage the gate output will switch low.

C1 will then begin to discharge towards a nominal 0·3V through R1, VR2 and the gate output transistor. When the voltage on C1 reaches the negative-going input threshold the gate output will switch high allowing C1 to charge positively again, and so the cycle repeats in sustained oscillation.

The voltage appearing at the positive side of C1 will have the general form as shown in Fig. 2, the output waveform being as shown below.

The unused half of the 7413 may of course be used as a 4 i/p NAND gate elsewhere in the system if required.

T. C. Rogers,
Ontario, Canada.

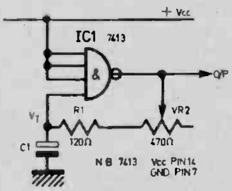

Fig. 1

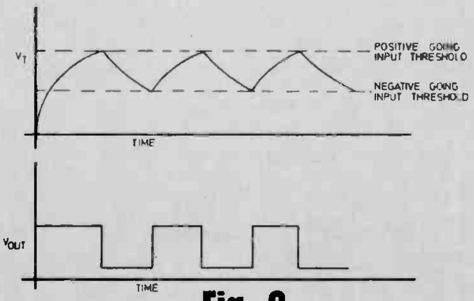

Fig. 2

PATENTS REVIEW...

COMMON PATENT?

With a referendum on our entry into the Common Market now due in the not too distant future, manufacturers in the electronics field may like to consider how EEC industrial property law affects their rights under British law.

It is only now becoming widely understood that the Treaty of Rome, which governs the EEC, can often override established national laws. Traditionally, the layman seeks legal advice from an expert, who gives that advice on the basis of his past experience with precedents or judgments handed down by courts over recent decades. Unfortunately, because the Luxembourg European Court has had occasion so far to hand down only relatively few judgments, legal experts can seldom give laymen the crisp and straightforward advice that they seek. The situation is further confused by the fact that the Treaty of Rome contradicts itself over the value of *national* industrial property laws in the Common Market.

To reduce the problem to words of one syllable, Articles 30, 85 and 86 of the Treaty of Rome make it clear that there shall be no restrictions or barriers to distort free trade between separate countries in the EEC. The whole point of industrial property rights (patents, trade marks and design registrations) is, however, to create barriers to distort free trade! So the Treaty (in Articles 36 and 222) specifically exempts industrial property rights of this type from its other Articles. Which articles of the Treaty, therefore, is a manufacturer to rely on?

It may help readers to have a brief résumé of the few hard facts that have now been established and how they *may* apply to everyday marketing in electronics.

One reported case has shown that under certain special circumstances the European Court will allow the same trade mark to be used on the same goods in the same EEC state, although those goods originate from different companies. What this coud mean is that under certain circumstances a range of components, such as transistors, made under a brand name by one company could be sold alongside an exactly similar range of components, under the same brand name, but originating from an entirely different manufacturer.

PRICE CONTROL

Whatever the Treaty may require in terms of harmonised price control between member states of the Community, the same goods sell at widely differing prices throughout Europe. Spirits such as brandy and whisky are taxed by different amounts in different countries and goods such as domestic electronic equipment are usually cheaper in the UK than anywhere else. For instance, although most Philips' audio gear is imported both into the UK and France, it costs about 50 per cent more in France than here. Likewise, Trio gear, also imported into both countries, costs about twice as much in France. BASF (German) tapes are around 50 per cent more expensive in the French shops than ours.

The crunch is that where a price differential exists between two EEC states, a manufacturer holding national patents will be powerless to stop a third party opportunist bulk buying a patented product in the country where it is cheap and selling it at a slightly higher price to make a profit in the country where it is much more expensive. If a manufacturer has patents in France and England and charges more for his amplifier in France than in England, there is probably nothing that he can do to prevent an entrepreneur buying up those amplifiers in bulk in England and selling them at a half-way price to make a killing in France. Of course, ordinary national laws, if they were not affected by the Treaty of Rome, would usually enable the manufacturer to use his patents to block such sales.

Some inventors with really important new ideas are now being advised that they should file patent applications in all nine EEC countries to be sure of solid protection in any of them. This advice is, however, probably incorrect, because the Commission itself, in a written answer (Official Journal of the Communities, Vol. 17, C90. July 29, 1974, p. 10) has said otherwise. Although the words of the Commission answer are rather tortuous, they add up to a confirmation that an inventor holding a patent in only one, or only a few, of the EEC states should be able to use his patent to prevent the importation of infringing articles made elsewhere in the EEC without his permission.

What this means in practice is that existing laws hold good and although a manufacturer with a patent on a component or piece of equipment in only this country will not, of course, be able to prevent a competitor making the article in another EEC country (which the competitor can do legally if there is no patent there), he *will* be able to stop him importing it into this country for sale. This reassurance from the Commission will be welcomed by manufacturers and inventors with a budget far too low to cover the cost of filing patents in all the EEC countries.

However, it is far from certain what will happen if a British electronics manufacturer, through choice or lack of hard cash, patents a new development in this country only but manufactures it elsewhere in the EEC. He is of course free to do this, but if his wares are cheaper on the Continent (which is possible if he is in a very competitive specialised market there), can he prevent an opportunist buying up those cheap wares and importing them into this country for open sale at under the normal British price? No one is yet sure of the answer to this question.

INFORMATION OFFICE

British researchers and manufacturers with questions like these should not forget that there is in this country a European Communities Commission Information Office. The address to write to is 20 Kensington Palace Gardens, London W8 4QQ.

One function of the Office is to help us understand the Treaty of Rome and what it means to us, also businessmen with an industrial property problem should try putting it to the Commission. There is no guarantee that they will know the answer; but if they do not, then who in the EEC does?

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each

Readout — A SELECTION FROM OUR POSTBAG

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

Excellent platform

Sir—I apologise sincerely if my letter (*Readout*, Dec. '74) caused any upset. In replying, Mr Shaw (February issue) was of course right; 1974 was marked by hundreds of others like me acquiring a synthesiser. This is what I intended to imply and it serves me right for being facetious that the meaning did not come across.

To Mr Shaw's credit is that he gave us more than mere synthesiser circuits; the clarity of his explanations gave the "P.E. Synthesiser" series a terrific educational inuendo. Credit to P.E. also; being the first to publish synthesiser circuits in such a comprehensive way, the series must have been an all-time giant in amateur constructors' projects.

Mr Shaw, however, also highlights what will be the real breakthrough so far as synthesisers are concerned; the recognition of a work of musical power. In agreement with Mr Watson (February), I see this as a work of the ilk of "Silver Apples . . ." or "Touch" (Substnick rather than Kubrik's ninth symphony (original version clockwork, new version electronic) by Walter Carlos.

To Mr Pointon (also February). If I were carried away by "quite a few red herrings" in his article, they had to be there to carry me away. I still contend that too much is being made out of the synthesiser. One need look no further than such electronic classics as "Kontakte" and "Telemusik" (Stockhausen) to see that electronic music was doing nicely, thank you very much, before Robert Moog set up production.

But I certainly must praise Mr Pointon's efforts in presenting so broad a view of musical history so well in such a small space, particularly when it comes to the complexities of twentieth century music. Anyone who has attempted any research in depth will appreciate the difficulties involved. Periodicals such as "Die Reike" (covering German-influenced work in the fifties and sixties) are not the easiest to read.

I am sure many readers who have carried out such research would agree that Mr Pointon's articles provide an excellent platform from which to launch for the lesser initiated. Given choice, I would read them in preference to many others. So, Mr Pointon, we look forward to more . . . and by the way, can I borrow your 24-, or is it 32-track recorder sometime? Thanks!

Ivor Stuart-Colwill,
London, S.W.16.

Time and motion

Sir—I have been for many years a regular reader of PRACTICAL ELECTRONICS, and was particularly interested in the February issue's article on transistorising battery driven electric clocks, because I have gone into this in some detail for a number of years, and built several successful units, for both balance clocks such as the Jaeger car clock, the one I think Mr Cooper had in mind, and for pendulum clocks such as the Bulle.

I was disturbed to find that the method and circuit suggested by Mr Cooper (if I have understood the article correctly) seems to destroy one of the most important design features of such clocks—their inherent automatic compensation for varying supply voltages, vital for car clocks where the battery voltage varies between 12 and 15 volts, and for certain wear-and-tear defects in the movement. The author's very last sentence seems to me to be the most revealing.

The reason for modifying these clocks is to avoid arcing at the contacts and the pitting and wear that follows, so that the clock behaves as if it had perpetually clean and new contacts. This arcing cannot be avoided otherwise, owing to the relatively high self-inductance of the coil; it is extremely minute and generally quite invisible, but its presence can easily be detected by a radio brought close to the clock, when the r.f. signal radiated is heard as a regular "click".

The compensating action is best understood by noting that the balance has to swing through a minimum arc so that each tooth of the escapement may be cleanly released and the next tooth impulsed. An extra amount of swing is allowed for, to take care of random variations in supply and possible slight irregularities in the machining of the escapement. A maximum swing of about 360° is normal.

Suppose now that the arc of swing tends to decrease owing to fall in supply voltage, inadequate contact, or increasing friction; the "contacts closed" time will increase, and therefore the magnetic field. Consequently the balance will receive more drive and the arc will increase. If on the other hand the arc tends to increase, as with a rise in supply voltage, the reverse takes place. Thus the balance will maintain a broadly constant arc irrespective of variation in the conditions.

The problems about the circuit proposed is that it appears to abolish the vital dependence on contact time; once any sort of contact is made, full current flows for a fixed time dependent on a given CR combination and Mr Cooper actually says that the period for which the contacts are closed is not important. If this current is sufficient to maintain a proper arc on a low voltage, it will be too great on a higher voltage; the swing will increase to an unacceptable degree and "overbanking" will take place.

The balance will swing so far in either direction that at the end of one or both swings the escapement will strike a mechanical obstruction such as a guard pin, or in the case of the Jaeger car clock, the end of the helical escapement channel on the balance staff. Apart from anything else, the balance will be bounced back on its next swing sooner than it should be, and the clock will gain. This is just what the author says could be expected.

A far more serious consequence will be rapid wear of escapement and pivots. "Overbanking" can be heard, if at the end of one swing only as "tick-a-tick-a-tick". This cannot be cured as suggested by altering the normal regulator acting on the hairspring effective length (the mean time of the overbanked swing can be reduced so that the clock will cease to gain, but at the cost of ruined timekeeping) because if for any reason overbanking stops for a while, the clock will loose heavily. If the current supply to the clock is as it should be, the timekeeping cannot possibly be affected.

What these clocks need is a transistor as an instantaneous inertia-less relay, whereby the clock contacts only break the minute base current in a non-inductive circuit, while the power to the clock is supplied by the collector circuit. In this way the compensation function is preserved unimpaired. This can be done very simply with far fewer components (one transistor, one resistor, and a protective diode across the clock coil) see Fig. 1. It may be thought wise to protect the transistor against any accident by adding two more resistors, but I have not found this necessary.

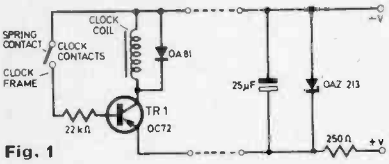

Fig. 1

The clock should be run out of its case on the bench for a day or so and the balance swing watched, in the horizontal orientation it will have when installed, from a power supply of 8 dry cells giving a voltage of about 12·8 volts. The movement will run itself in again and its efficiency may well increase, particularly if advantage has been taken of the dismantling to clean it and to oil the moving parts with watchmaker's oil. It may therefore be necessary, if the swing increases to over 360°, to increase the value of the base resistor somewhat.

A great improvement is to be had by stabilising the power supply. The circuit suggested in the article is rather inadequate, since while it supplies a power reservoir to tide the clock over momentary large falls in voltage such as when the starter is operated, it offers no protection against surges of high voltage. An improvement is the use of a normal Zener diode stabiliser, which will maintain a constant supply voltage, whatever happens to the battery circuit.

Since these clocks will run perfectly well on 11 volts, or even less, the diode should be selected for this voltage, and should be of adequate wattage, since it will be passing some current most of the time and must not overheat—at least 1 watt.

The value of the series resistor should be found by temporarily substituting a 5,000 ohm wire-wound potentiometer, then connecting up the clock, and reducing the resistance from maximum till the clock continues to run; place a voltmeter across the smoothing capacitor, and the reading will be found to fluctuate in time with the clock pulses. Reduce the resistance till the voltage reading remains constant, showing that supply just balances demand. Then measure the resistance of the potentiometer at this setting and substitute a 1 watt fixed resistor of that value.

It is not advisable to mount any components inside the clock case, with the possible exception of the protective diode across the coil, as space is generally very limited and damage might unwittingly be done when screwing the movement back into the case. It is better to mount all the components on to a strip of Veroboard which can be suspended in the supply wires and protected by a wrapping of polythene film.

S. A. R. Guest.
Cornwall.

We hope to publish the author's reply next month

Millivoltmeter

Sir—Constructors of the A.C./D.C. Millivoltmeter (P.E. February 1975) may be interested in a couple of points concerning a.c. operation of the instrument.

The circuit shown with the article can accurately measure symmetrical square wave alternating voltages, but certain qualifications must be borne in mind in measuring sinusoidal voltages. For pure sine wave voltages or currents, two main types of measurement may be distinguished, the average (E_{av}, I_{av}) and the root mean square (E_{rms} etc) which is often abbreviated to a.c. The former is analogous to the effect of d.c. on a moving coil meter and the latter to resistor power dissipation.

If it is wished to measure r.m.s values with the circuit indicated, the following correction should be applied:

$$E_{rms} = \text{scale reading} \times 1{\cdot}11$$

A second point arises in the extent of scale deflection for sinusoidal measurements. For full scale deflection to occur 11V r.ms must be applied to the bridge rectifier; this implies a peak to peak swing of

$$11 \times 2\sqrt{3} = 31 \text{ volts}$$

With the power supply voltages used for the amplifier, a linear input/output response may not be expected above

$$\frac{2 \times 12}{31} = 0{\cdot}77 \text{ of full scale.}$$

Dr J. H. Wood.
Bingley.
W. Yorks.

Dr Boole vindicated

Sir—May I thank Messrs. Thompson, Tozer, Dickson and Everett for their amusing and extremely helpful remarks in *Readout*, March 1975. The two salient points which emerge are, firstly, that Boolean Algebra deals solely with the presence or absence of things, and secondly that the sign = should be read as "if . . . then".

Dr Boole would have read his equation A + A.B = A as, "If A is present, or both A and B are present, then A is present." This, put into breakfast-time English, says that if there is an egg on a plate, whether there is bacon with it or not, there is still an egg on the plate.

This, no one can dispute, but if I am served breakfast again by the same waitress, who may not have read this correspondence, I shall play safe and order cornflakes.

R. Parfitt.
Croydon

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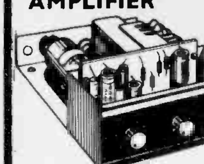

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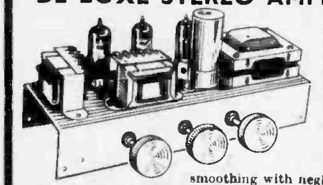

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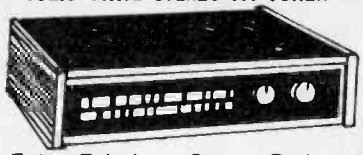

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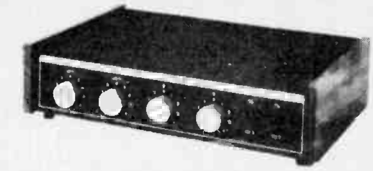
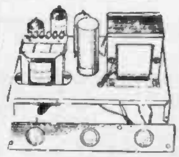
HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass, boost approx. to ±12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × $2\frac{1}{2}$"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

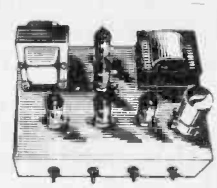
AMPLIFIER KIT	£12·96	P. & P. 50p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·32	P. & P. 55p
CABINET	£4·32	P. & P. 55p

(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £28·08. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size $7\frac{1}{2}$"w. × 4"d. × $4\frac{1}{2}$"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output $4\frac{1}{2}$ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £6·50. P. & P. 70p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £5·50. P. & P. 70p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £10·25. P. & P. £1·00. Also available ready built and tested £14·00. P. & P. £1·00.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. Easily converted for Mono. PRICE £3·50. P. & P. 25p.

PRICES INCLUDE VAT

Open 9.30-5.30 Monday to Friday. 9.30-5 Saturday Closed Wednesday.
Prices and specifications correct at time of press. Subject to alteration without notice

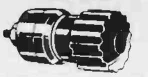
HARVERSON SURPLUS CO. LTD.

(Dept. P.E.) 170 HIGH ST., MERTON, LONDON, S.W.19 Tel.: 01-540 3985
A few minutes from South Wimbledon Tube Station
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

INSULATED TERMINALS



Available in Black, Red, White, Yellow, Blue, and Green. Brand New 13p each Post Paid.

METERS NEW! 2¼in. Flush round. Available in D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20. Voltmeter 0–300V A.C. All types £2·50. Post 20p.

600 WATT DIMMER SWITCH
Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. £2·75. Post 25p.

RELAYS SIEMENS, PLESSEY, Etc, MINIATURE RELAYS

	1	2	3	4
Col. (1) Coil ohms	52	4–8	2 c/o	70p*
	58	5–9	6 c/o	80p
Col. (2) Working	185	8–12	6M	60p*
d.c. volts	230	9–18	2 c/o	70p*
Col. 3	430	15–24	4 c/o	80p*
Contacts	700	12–24	2 c/o	60p*
Col. (4)	700	16–24	4M 2B	60p*
Price	700	16–24	4 c/o	80p*
	1,250	18–36	2 c/o	60p*
HD =	2,500	31–43	2 c/o HD	60p*
Heavy duty	2,500	36–45	6M	60p
	9,000	40–70	2 c/o	60p*
	15k	85–110	6M	60p*

*Incl. Base. All prices incl. P. & P.

OPEN TYPE RELAYS
6 VOLT D.C. 1 make contacts 35p. Post 15p.
9 VOLT D.C. RELAY
3 c/o 5 amp contacts. 70 ohm coil. 75p. Post 15p.
12 VOLT D.C. RELAY
3 c/o 5 amp contacts. 120 ohm coil. 75p. Post 15p.
24 VOLT D.C. 3 c/o 75p. Post 15p.
2 HD c/o 700 ohm coil. 75p. Post 15p.
4 c/o 300 ohm coil. 85p. Post 15p.
ENCLOSED TYPE RELAYS
24 VOLT A.C. Mfg. by ITT.3 h.d. c/o contacts. 55p. Post 10p. Base 15p.
55 VOLT A.C. RELAY
3 h.d. c/o contacts. Price 55p. Post 10p. Base 15p.
100 VOLT A.C. 2 c/o sealed type. 75p. Post 10p. Base 15p.
240 VOLT RELAY
3 h.d. c/o contacts. Price 75p. Post 15p. Octal plug in base 15p extra.
230/240 VOLT A.C. RELAY. Mfg. by Arrow 2 h.d. 15 amp c/o contacts. Amp connectors. Price £1. Post 15p.
220/240 VOLT A.C. RELAY
3 c/o 5 amp contacts. Sealed. Mfg. ISKRA. £1·25. Post 15p. Base 15p extra.
CLARE-ELLIOTT TYPE RP7641 G8
Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. 70p post paid.
110V. 2 c/o. 20 amp contacts. £1·25. Post 10p.
Many others from stock—phone for details.

VERY SPECIAL OFFER

MICRO SWITCH. 5 amp. c/o contacts. NEW. 20 for £2. Post 15p. (Min. order 20). Ditto press to break, 20 for £1·50. Post 15p.

SUB-MINIATURE REED RELAY 3-9 volt d.c.

1 make, size 1¼ × ⅜ × ⅜in.
Outstanding Value only
£1 for six, £1·50 for ten. Post 15p. (Min. order six.)

TRIAC

Raytheon Tag symmetrical Triac. Type TAG. 250/500V, 10 amp, 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long term reliability £1·00. Post 10p. (Inclusive of Data and application sheet.) Suitable Diac 18p.

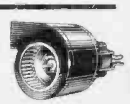
230/250 VOLT A.C. SOLENOID

Approximately 1½lb pull. Size of feet 1⅞" × 1 1/16". Price £1·00. Post 15p.

24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ½ inch travel. 6 × approx. 4oz. pull ½ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price £2·50. Post 75p. **ABSOLUTE BARGAIN.**

CENTRIFUGAL BLOWER



Mfg. Airflow Developments Ltd. Precision continuously rated, smooth running, 230/240V a.c. motor 80 c.f.m. As illustration but with round aperture. £6·50. Post 50p.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types
SHROUDED TYPE

200 watt (1 amp) £10·00
0·5 KVA (2½ amp) (MAX) £11·50
1 KVA (5 amp) (MAX) £16·50
2 KVA (10 amp) (MAX) £30·00
3 KVA (15 amp) (MAX) £33·00
4 KVA (20 amp) (MAX) £72·50
37·5 amp (MAX) £102·50
CARRIAGE AND PACKING EXTRA
OPEN TYPE 1 amp (panel mount) £10·00

L.T. TRANSFORMERS

0, 6, 12 Volt at 10 amp.	£5·60.	Post 70p.
0, 10, 17, 18 Volt at 10 amp.	£7·90.	Post 70p.
0, 4, 6, 24, 32 Volt at 12 amp.	£9·90.	Post 70p.
0, 6, 12 Volt at 20 amp.	£9.	Post 70p.
0, 12, 24 Volt at 10 amp.	£9·20.	Post 70p.
0, 6, 12, 17, 18, 20 Volt at 20 amp.	£10·40.	Post 70p.

Other types to order at short notice—Phone your enquiries.

AUTO TRANSFORMERS

Step up step down
0–115/200/220/240 Volts. 75 watt £2·64. Post 40p. 150 watt £3·50. Post 50p. 300 watt £6·20. Post 60p. 500 watt £9·20. Post 75p. 1000 watt £12·00. Post 90p.

300 VA ISOLATING TRANSFORMER

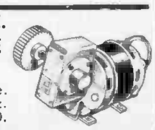
115/230–230/230 volts. Screened. Primary two separate 0–115V for 115 or 230 volt. Secondary two 115V at 150 VA each for 115 or 230 volt output. Can be used in series or parallel connections. Fully tropicalised. Length 13·5 cm. Width 11 cm. Height 13·5 cm. Weight 15 lb.
SPECIAL OFFER PRICE £5. Carr. 80p.

230/240 VOLT A.C. MINIATURE MOTOR. 20 R.P.M. Price £1. Post 15p.

BODINE TYPE N.C.I. GEARED MOTOR

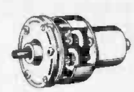
(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 0·38 amp. **(Type 2)** 28 r.p.m. torque 20 lb. in **Reversible** 1/80th h.p. 50 cycle 0·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type £6·25. Post 65p or less transformer £3·75. Post 50p.

'FRACMO' 240 VOLT A.C. 50 cycle SINGLE PHASE GEARED MOTOR



33 r.p.m. 30 lb. ins. Reversible. Fitted with mounting feet. Brand New. £14. Post £1·00. (Total price incl. VAT £15·77).

9-12 VOLT D.C. GOVERNED REVERSIBLE MOTOR



Machine cut gear train, giving final speed of 2 r.p.m. with cam driving 3 sub-miniature micro-switches (removable). Spindle 12mm long 6mm dia. Built to PO spec., in heavy metal hinged case. £3·75. Post 40p.

POWER RHEOSTATS ! ! !

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k/2·5k ohm. £1·70. Post 15p.
50 WATT 1/5/10/25/50/100/250/500/1k ohm £2·10. Post 20p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm £3·30. Post 25p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

INSULATION TESTERS *NEW!*

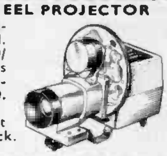
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. 500V, 500 megohms, £30. Post 80p.

All prices are subject to 8% VAT. (8p in the £)
To all orders add 8% VAT to total value of goods including carriage/packaging.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation. **RANGE OF FOUR STROBE KITS FROM STOCK. PRICES FROM £6·30 to £22.** S.A.E. for details.

COLOUR WHEEL PROJECTOR



Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. £20·50. Post 80p.
Extra colour effect wheels from stock. S.A.E. for details.

BIG BLACK LIGHT
400 Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. P.F. ballast is essential. Price of matched ballast and bulb £18. Post £1. Spare bulb £8. Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES
2ft 20 watt, £4·25. Post 40p. (For use in standard bi-pin. **MINI. 12in 8 watt, £1·60.** Post 25p. **9in 6 watt, £1·30.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, £1·70. Post 25p. (9in and 12in measures approx.)

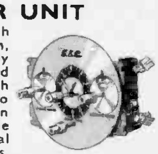
U.D.I. SINGLE CHANNEL 750 WATT MANUAL/AUTO DIMMER
750W Solid State Fader, with three functions. Manual fade; Auto fade-up; Auto fade-down. Automatic cycling up and down. Functions selected with 'three-position' rocker switch. Two ranges of cycling for 'Flashing' or 'Slow blending'. Ready built module 6" × 3" glass fibre board incorporating 10 amp TRIAC. Two or more modules for top quality colour blending and flashing effects. PRICE £15. Post 45p.

50 in 1 ELECTRONIC PROJECTOR KIT
50 easy to build projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price £7·75. P. & P. 50p.

PROGRAMME TIMERS

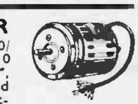
230/240V a.c. 15 r.p.m. Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays, etc. Ex equipment tested.
2 cam model. £2·00 post 35p.
4 cam model. £2·50 post 35p.
8 cam model. £4·75 post 40p.
8 cam model, each cam fully adjustable. 6 r.p.m. M.f.g. by Magnetic Devices. £7·50. Post 35p.

A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135mm × 130mm × 60mm. Price £2. Post 40p. (Total incl. VAT and Post £2·38).

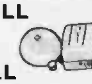
REVERSIBLE MOTOR



A.E.I. 1/15 h.p. reversible motor 100/120 volt A.C. 50/60 cycle 1400/1680 r.p.m. Flange fixing. Dia. 4", length 6½", shaft 1" × 5/16". Brand New. Price £2·50. Post 50p. Suitable 110/240v. 150 watt Auto Transformer £3·50. Post 50p. (Post for both items together 75p.)

COIN MECHANISM (Ex London Transport)
Unit containing, selector mechanism for 1p, 2p and 5p coins. Micro switches, relays, solenoid operated hopper. 24 volt D.C. Precision built to high standard. Incredible VALUE at only £2·50. Post 70p.

'STC' 6" RED ALARM BELL



24/48 volt DC. **Brand New.**
Price £4. Post 50p.

'GENTS' 6" ALARM BELL

200/250V AC/DC. **Brand New.** Price £5. Post 60p.

All Mail Orders—Callers—Ample Parking
Dept. PES, 57 BRIDGMAN ROAD CHISWICK, LONDON W4 5BB
Phone 01-995 1560
Showroom open Mon.-Fri.

SERVICE TRADING CO.

Personal callers only. Open Sat.
9 LITTLE NEWPORT STREET LONDON WC2H 7JJ
Phone 01-437 0576

PHONOSONICS

SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

SOUND-TO-LIGHT (P.E. Apr./Aug. 71)

The ever-popular AURORA—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A *must* for any Disco, and a fascinating visual display for the home.

4 channel component set (excl. thyristors)	£11·49
8 channel component set (excl. thyristors)	£20·32
Power supply component set	£4·78
PCB for 4 frequency channels	£2·50
PCB for power supply and 8 lamp drivers	£1·25

P.E. SYNTHESISER
Details in List

VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during "talk-over"—particularly useful for Disco work, or for home-movie shows.

Component set, incl. PCB	£2·95

P.E. GEMINI 30W STEREO AMPLIFIER

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

Main Amplifier:	
Set of resistors, capacitors and presets	£5·96
Stereo printed circuit board	£1·28
Pre-Amplifier:	
Sets of resistors, capacitors, potentiometers and switches—	
Standard Tolerance Set	£10·57
Superior Tolerance Set	£16·04
Stereo PCB (as Published)	£2·20
Regulated Power Supply:	
Set of resistors, capacitors and preset	£4·58
Printed circuit board	72p

HI-FI TAPE LINK (P.E. Mar./Apr. 73)

Designed for use with reasonable quality tape decks, this high performance pre-amp includes record, playback and metering circuits.

Stereo component set (excl. panel meter)	£22·05
Mono component set (excl. panel meter)	£13·31
Power supply component set	£3·72
Stereo main PCB	£2·50
Stereo sub-assembly PCB	86p

TAPE-NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB)	£2·30
Regulated power supply (including PCB)	£3·71

PROJECT Q4 (P.W. Oct. 73/Jan. 74)

Multi-system Quadraphonic Decoder.
While stocks last

Decoder component set	£13·74
Power supply components	£3·22
Printed circuit board	£2·60

SEMICONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home constructor.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB	£6·56

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£2·20

PHASING CONTROL UNIT (P.E. Oct. 74)

(for use with above Phasing Unit)

Component set (including PCB)	£3·50

P.E. SOUND SYNTHESISER

The well-acclaimed and highly versatile Synthesiser published in P.E. Feb. 1973 to Feb. 1974.

Component sets and printed circuit boards. List shows full details including discounts.

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)

Component set	£3·41
Printed circuit board	£1·10

RHYTHM GENERATOR (P.E. Mar./Apr. 74)

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and cymbal), and with variable time signatures. See list for discount.

P.E. JOANNA
Send S.A.E. for our details

ULTRASONIC TRANSMITTER-RECEIVER

A highly sensitive and long range "invisible beam" detection circuit with numerous applications.

Component set with PCBs, but excluding transducers	£4·40

P.E. RONDO

PCB details in List

POWER SLAVES

PCB details in List.

P.E. ELECTRONIC PIANO

Details in List.

HOME INTERCOM

Details in List.
(While Stocks Last)

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice operated fader, automatic fader and frequency doubler.

Component set	£5·86
Printed circuit board	£1·44

REVERBERATION UNIT (P.W. Nov./Dec. 72)

A high-quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component set (excl. spring unit)	£8·82
Printed circuit board	£1·46

P.E. MINISONIC
Details in list
(inc. discounts)

8W AMPLIFIER (P.W. Nov. 72)

A moderately powered amplifier of more than average performance. (While stocks last.)

Main Amplifier	
Mono component set	£4·18
Stereo component set	£8·36
Pre-Amplifier	
Mono component set	£2·50
Stereo component set	£6·46

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

Pre-Amplifier Module	
Component set and PCB	£3·48
Basic Output Circuits	
Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp driver circuits	£4·96
Audio Amplifier Module	
Type PC7	£5·50

PHOTOPRINT PROCESS CONTROL (P.E. Jan./Feb. 72)

For colour and B. & W. an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

Component set (excl. meter)	£8·85
Printed circuit board	£1·60

ENLARGER EXPOSURE METER AND THERMOMETER (P.E. Sept. 73)

Dual-purpose dark-room unit with good accuracy.

Component set with PCB, but excluding meter	£4·00

WIND AND RAIN UNIT (P.E. Oct 73)

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

Component set incl. PCB	£2·40

PCB LAYOUT AND CIRCUIT DIAGRAMS SUPPLIED WITH ALL PCBs DESIGNED BY PHONOSONICS

LIST
Send S.A.E. for free list giving fuller details of kits, PCBs, and other components.

P. & P.
Add 22p to all orders

VAT
Add 8% (or current rate if different) to total order cost including P. & P.

OVERSEAS
P. & P. will be charged extra. VAT does not currently apply. List gives fuller details including kit weights. Charge for list: Europe 10p, other countries 20p.

COLOUR CODE IDENTIFICATION SUPPLIED WITH MOST KITS AND AS PART OF LIST

Semiconductors

AC128	20p	BFY50	22p	2N3702	12p
AC176	20p	BFY51	22p	2N3703	12p
BC107	13p	BFY52	24p	2N3704	12p
BC108	13p	BSY95A	22p	2N3819	35p
BC109	13p	MJE2955	110p	2N3823E	39p
BC147	12p	MJE3055	75p	2N4060	12p
BC148	12p	NKT0033	112p	2N4871	36p
BC149	12p	OC28	60p	2N5245	51p
BC157	13p	OC71	14p	2N5777	45p
BC158	13p	OC72	14p		
BC159	13p	OC84	25p		
BC182L	12p	ORP12	60p		
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12V 1·3W	20p
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0·15	5p
0·22	5½p
0·33	7p
0·47	9p
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2·2	24p

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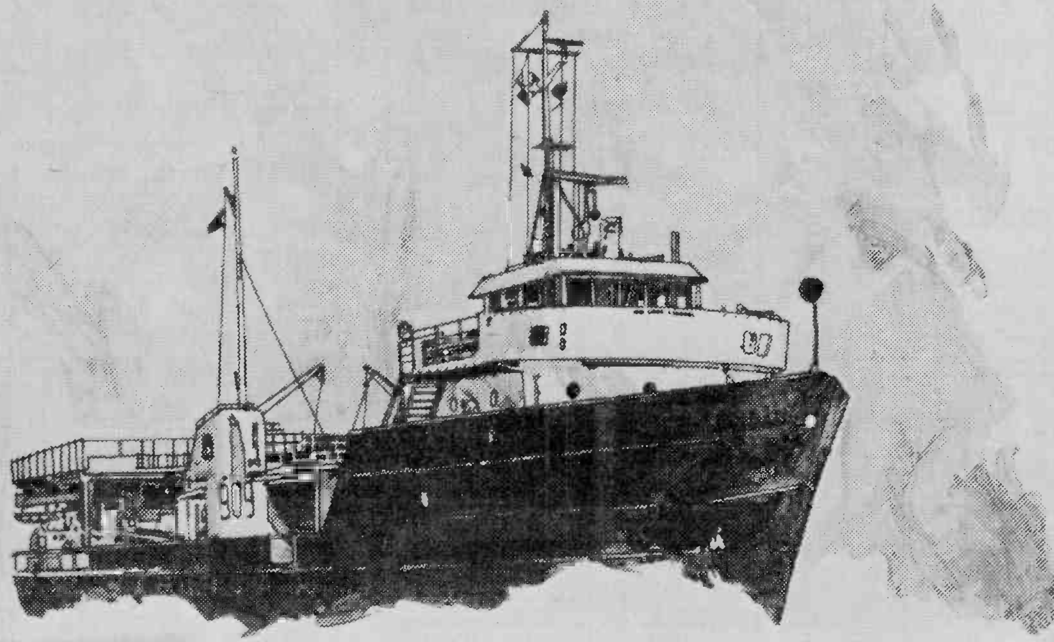

MISCELLANEOUS CONT'D

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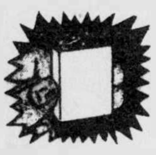
MINI ACCUMULATORS



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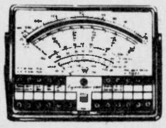

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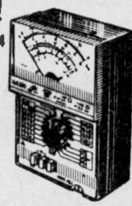

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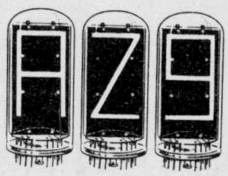

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100mF	4V	7p	470mF	25V	15p
330mF	4V	7p	1250mf†	25V	24p
33mF	6·3V	7p	5000mF†	25V	65p
68mF	6·3V	7p	1000 +		
470mF	6 3V	9p	1000mF†	30V	32p
1000mF*	6V	11p	2500mF†	30V	40p
22mF	10V	7p	6·8mF	40V	7p
25mF	10V	7p	15mF	40V	7p
47mF	10V	7p	100mF	40V	9p
100mF	10V	7p	1000mF†	50V	35p
220mF	10V	7p	1mF	63V	7p
330mF	10V	9p	2·2mF	63V	7p
15mF	16V	7p	4·7mF	63V	7p
33mF	16V	7p	10mF	63V	7p
68mF	16V	7p	15mF	63V	7p
220mF*	16V	9p	22mF	63V	7p
330mF	16V	12p	32mF	63V	9p
1000mF	16V	20p	800mF†	63V	32p
10mF	25V	7p	2500mF†	63V	85p
22mF	25V	7p	4700mF†	63V	145p
47mF	25V	7p			
100mF	25V	7p	* Single end p c fitting		
150mF	25V	9p	† Single end can		

Oddments to clear:

50mF at 50V tubes	6p
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MISCELLANEOUS

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0 1	3p
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1 0	12p
2 2	20p

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7413	32p	7460	18p	7493	40p
7414	72p	7470	30p	74107	37p
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Data sheets on above I.C.s 10p each.

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250mA	18p	—	—	—
1 Amp	22p	24p	27p	29p
2 Amp	30p	35p	45p	48p
4 Amp	—	—	—	—
6 Amp	55p	60p	78p	—

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1 Amp	40p	45p	55p	72p
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1 Amp	Plastic	
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7815	15V	140p
7818	18V	140p
7824	24V	140p

AC126/7	11p	BC212	11p	OC35	48p	2N1308/9	28p	2N4060	13p
AC128	11p	BC213	10p	OC36	52p	2N1613	20p	40361	40p
AC176	11p	BC214	13p	OC41/2	15p	2N1711	20p	40362	43p
AC187	12p	BD115	55p	OC44/5	11p	2N2219	20p	**UJTS**	
AC188	11p	BD124	75p	OC70/1/2	11p	2N2221/2	20p	TIS43	25p
AD149	43p	BD131	42p	OC73	60p	2N2369	14p	2N2160	70p
AD161	36p	BD132	45p	OC81/2	12p	2N2484	30p	2N2646	35p
AD162	36p	BF115	22p	OC83/4	28p	2N2904	20p	2N4871	31p
AF114/5	13p	BF167	23p	TIP2955	70p	2N2905	18p		
AF116/7	13p	BF173	25p	TIP41A	85p	2N2926RB	8p	**FETS**	
AF139	41p	BF184	22p	TIP42A	70p	2N29260	8p	BF244	36p
AF239	44p	BF194	10p	ZTX300	12p	2N2926YG	9p	MPF102/3	30p
BC107/8	9p	BF195	10p	ZTX304	24p	2N3053	18p	MPF104/5	30p
BC109	10p	BF196	12p	ZTX500	15p	2N3054	40p	2N3819	20p
BC147/8	7p	BFR39/40	28p	ZTX504	50p	2N3055	49p	2N3820	57p
BC149	9p	BFR41	28p	2N696	15p	2N3442	140p	2N3823	50p
BC157	13p	BFX29/30	30p	2N697	13p	2N3702/3	11p	2N5457	30p
BC158	12p	BFY50/1/2	15p	2N698	30p	2N3704/5	11p	2N5458	30p
BC159	14p	BRY39	34p	2N706	12p	2N3706/7	11p	2N5459	30p
BC169C	12p	MJE340	45p	2N708	18p	2N3708/9	9p	**MOSFETS**	
BC177	18p	MJE2955	99p	2N930	18p	2N3772	161p	40603	58p
BC178	17p	MJE3055	65p	2N1131/2	18p	2N3773	220p	40673	56p
BC179	18p	MPSU06	58p	2N1302/3	17p	2N3903/4	15p	3N128	75p
BC182/3	10p	OC26	47p	2N1304/5	21p	2N3905/6	15p	3N140	85p
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