

PRACTICAL

ELECTRONICS

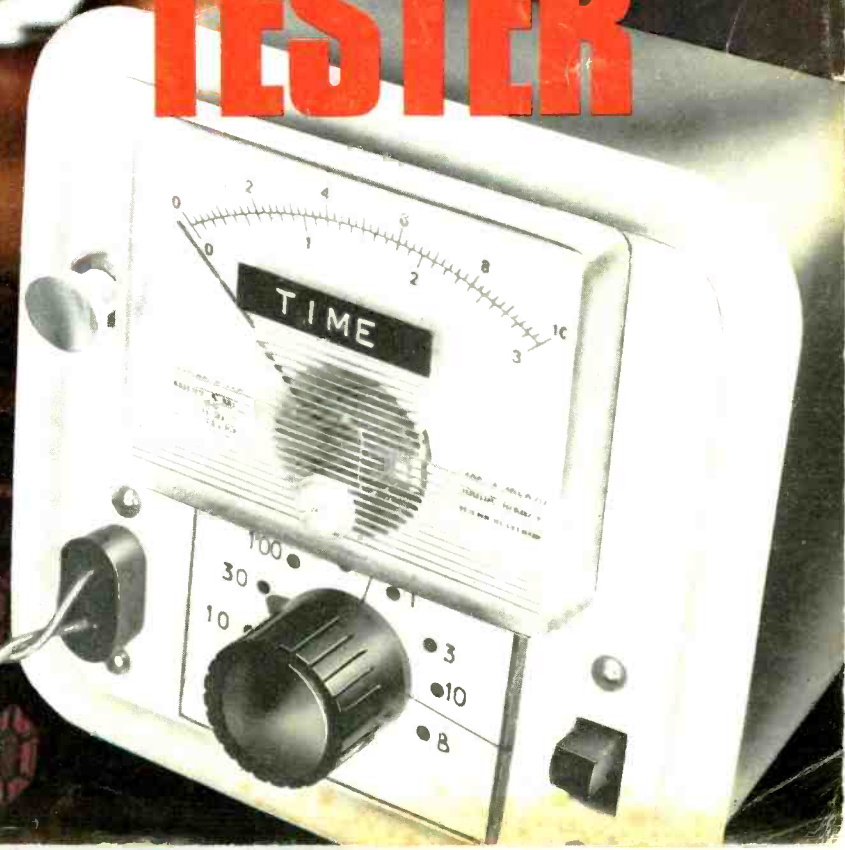
AUGUST 1972

20p

CAMERA SHUTTER TESTER

ALSO INSIDE:

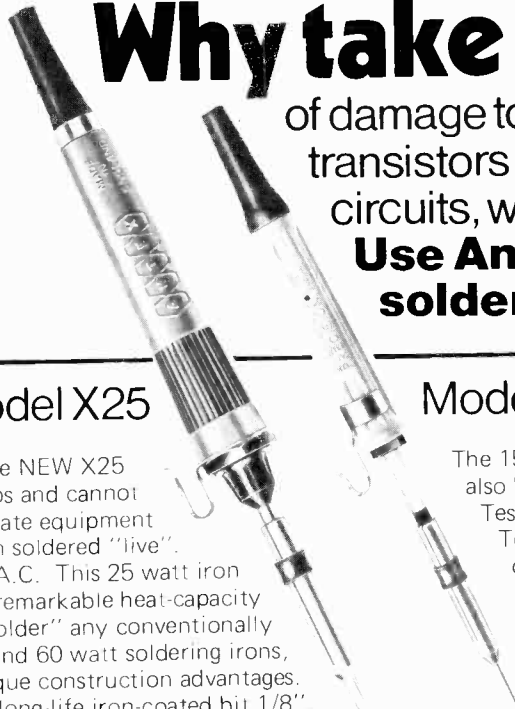
THE P.E. DIGI-CAL
OSCILLOSCOPE
PRE-AMPLIFIER



Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

Use Antex low-leakage soldering irons



220-240 Volts or 100-120 Volts

Model X25

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live".

Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages.

Fitted long-life iron-coated bit 1/8".

2 other bits available 3/32" and 3/16".

Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed

PRICE: £1.75 (rec. retail)

Suitable for production work and as a general purpose iron

Model CCN 220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage.

Test voltage 4000v. A.C.

Totally enclosed element in ceramic shaft. Fitted

long-life iron-coated bit 3/32"

4 other bits available

1/8", 3/16" 1/4" and 1/16"

PRICE: £1.80 (rec. retail)

OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

A SELECTION OF OTHER SOLDERING EQUIPMENT.



MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24

PRICE: £1.70 (rec. retail)

MODEL CN2

Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.

PRICE: £1.70 (rec. retail)



MODEL G

18 Watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.

PRICE: £1.83 (rec. retail)

MODEL SK.1 KIT



contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

PRICE £2.75

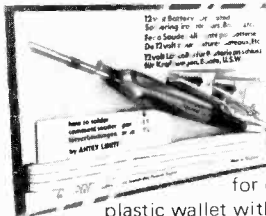
MODEL SK.2 KIT

contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink,

solder and

booklet "How to Solder"

PRICE £2.40



MODEL MES.KIT

Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder."

PRICE £1.95



From radio or electrical dealers, car accessory shops or, in case of difficulty direct from:-

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- Please send the ANTEX colour catalogue.
- Please send the following:
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NEW PRODUCTS

MOTOROLA a famous name for high quality and advanced technology.

Data and Applications information included in the price.

MC 1303L @ £1.75

A dual stereo pre-amplifier. Featuring: large output voltage swing, Open loop voltage gain of 6000 min. 60dB min. Channel separation at 10kHz. Short circuit protection.

MC 1305P @ £2.80

An FM multiplex stereo demodulator. Featuring: wide voltage range 8-14v. Total audio muting capability. Automatic switching from stereo-mono. Monoaural Squelch.

MC 1307P @ £1.65

An FM multiplex stereo demodulator. Featuring: Wide operating voltage range. Built-in stereo indicator lamp driver.

MC 1330P @ £0.80

A low level video detector. Featuring: Very linear characteristics, wide bandwidth design for colour and monochrome television receivers, replacing the third IF, detector, video buffer and the AFC buffer.

MC 1352P @ £2.00

TV Video IF Amplifier with AGC and Keyer circuit. A monolithic IF amplifier with a complete gated

wide range AGC system for use as the 1st and 2nd IF stages and AGC keyer and amplifier in colour or monochrome TV receivers.

MC 4024P @ £2.20

A dual voltage controlled multi-vibrator. Used in phase locked loops for digital frequency control. May also be used in some types of analogue to digital converters.

MC 4044P @ £2.20

A phase frequency detector. This device contains two digital phase detectors and a charge pump circuit which converts, M TTL inputs to a dc voltage level for use in frequency discrimination and phase - locked - loop applications.

MFC 6030 @ £1.63

Voltage regulator. Featuring: Excellent line and load regulation, Current limit feature available.

MFC 8010 @ £1.38

1 watt Audio Amplifier. 1 watt continuous Sine Wave power at +55°C. High gain. Low distortion (-1% @ 1 watt typ.) Short circuit protected. No heat sink required.

MFC 9020 @ £2.12

2 watt Audio Amplifier. 2 watt continuous Sine Wave power. Short circuit protected. High gain. High input impedance.

DIL IC CIRCUIT BOARD

4" x 6" NOM with Circuit layout ready drilled. Accepts up to 25 DIL IC's. £1.10 each.

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½ watt Carbon Film.

Values: E.12 series.

Range: 10 ohms - 1 Meg (5%)
1 Meg - 4.7 Meg (10%)

Price: 1p each.

½ watt Carbon Film.

Values: E12 series.

Range: 10 ohms - 1 Meg (5%)
1 Meg - 8.2 Meg (10%)

Price: 1p each.

E12 series indicates:-

10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms and their decades.

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VALUE	PRICE
100 pf	3p
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220 pf	3p
330 pf	3p
470 pf	3p
560 pf	3p
680 pf	3p
820 pf	3p
1000 pf	3p
1500 pf	3p
2200 pf	3p
3300 pf	3p
4700 pf	3p
5600 pf	3p
6800 pf	3p

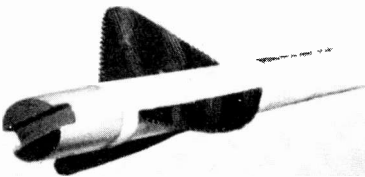
If you have our mauve retail catalogue please read on:

The following lines have been discontinued to make way for new products.

All International Rectifier products from pages 16 and 17 of the mauve catalogue—SL.1142 and TIL.63 from page 15—L14B from page 15 has been replaced by 2N.5777 at a new lower price—The Hardcastle Amplifier Kit from page 13 has been discontinued—Integrated circuit amplifier TH9013P from page 12 has been discontinued and the PA series General Electric I.C. amplifiers from page 12 have also been discontinued.

Varicaps from page 8 have been discontinued due to poor service from the manufacturers concerned. The range of zener diodes by Texas Instruments on page 8 have been replaced by the Mullard BZY88 series.

If you have any comments as to what you would like to see in our September catalogue please drop a line Attention Dick Bowell our Retail Manager. (He won't write back but your remarks will be read and discussed.) Now! 10% Discount on all orders over £4.00.



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point in
September!**

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1000's OF TEST EQUIPMENT BARGAINS!



A PROFESSIONAL DIGITAL MULTIMETER BRAND NEW AT A FRACTION OF THE ORIGINAL PRICE!

3 digit plus polarity indicator. Its 17 positions allow it to measure in the following ranges: d.c. volts 100 μ V to 999V; a.c. volts 100 μ V to 420V; d.c. current 100 μ A; a.c. current 100 μ A. Resistance 0.1 Ω to 999k Ω . Operates from 230V 50Hz. 12V d.c. external. Dry cells or Ni Cad batteries. Original Price £89. **OUR PRICE £55** PLUS 50p P. & P.

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10mV to 199V. 199 measuring points. Input Z=100M Ω . Automatic zeroing. Dimensions 72mm H x 72mm W x 155mm D. Original Price £52. **OUR PRICE £24.50** PLUS 50p P. & P.

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12V heavy duty make. Suitable for spotlights, horns, overdrives, etc. Brand new. Only 37 $\frac{1}{2}$ p. Special price for quantities.

LUCAS POWER DIODES Type DD 716

P.I.V. 400 max. 35A (gold plated) stud mounting. In sets of four. Only £2. P. & P. 10p.

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Morganite high value glass-enclosed resistors. Value 2.5 x 10⁵ Ω \pm 10%. In boxes of four. Per box £1.25. P. & P. 10p.

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Mounted on plug in P.C. Board. Absolutely brand new unused. Size 6 x 5 in. Brand new boards. Only 55p. P. & P. inclusive.

10 MULLARD GET 113 TRANSISTORS + 10 diodes, resistors, etc.

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STC Relcon. 10-turn. Type No. HEL/07-10/1/001/A. Following values supplied ex-stock

Res. 500 Ω \pm 1%
1k Ω
5k Ω
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All above Helicals are brand new stock. Quantities available. Price £1.25 each. P. & P. 5p for one. Beckman Type A Helical pots. 5W. 10 turn. Resistances available. 30k Ω and 50k Ω . Brand new and boxed. Price £1.75 each. Bourne's Helical pots. Miniature type. Resistance 10k Ω . Brand new. Price £1.50.

We have available from stock many other types and values, please telephone for quotation.

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of current manufacture designed especially for mobile equipments, coil voltage 12V, frequency up to 250MHz at 50W. Small size only, 2 in. x 2 in. Offered brand new, boxed. Price £1.50, inc. P. & P.

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15Hz to 50kHz in 3 ranges. Output 0-25V into 600 Ω . In good, serviceable condition. PRICE £18.50. P. & P. 50p.

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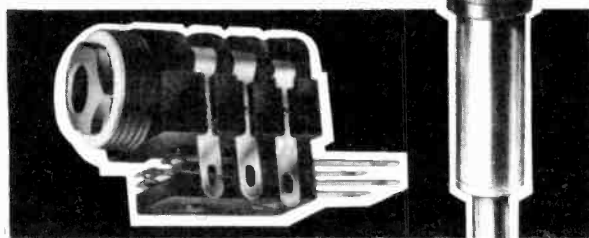
to industry, educational establishments and private enthusiasts. Whatever your requirements: signal generators, audio oscillators, frequency meters, oscilloscopes (by Tektronix and other leading makers), high and low voltage power supply units, relays (simple or special), panel meters, chart recorders, etc.—a telephone call to us could save you pounds!

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Standard, mini and sub-miniature sizes . . . plugs in both screened and unscreened versions . . . socket bodies in high melting point thermoplastic . . . several unique features (some protected by UK and US Patents) . . . Post Office and NATO specifications.

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Suitable for colour and monochrome reception.
PLANAR folded dipoles + MESH reflectors



ILLUSTRATED UHF.50

Aerial Arrays designed for fringe area reception

UHF.50	£3-90
UHF.18	£2-60

Without alochrome process for		
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(Available by mail order only when ordering UHF.50-UHF.18 or FM Aerials)

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Aerial Array single-dipole	B.21	£1-30
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CAR-AERIALS

Wing mounting spring Aerial 3-section extends to 48 $\frac{1}{2}$ "	A.6	£1-60
Motorised electric Aerial complete with details & switch. 12V pos or neg. 5-section extends to 40"	A.7	£6-00

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Suitable for colour and monochrome, freq coverage 40-860 MHz-14dB Gain

Weather proof Pre-Amplifier	T1	£5-25
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Low-Loss co-axial cable sold in multiples of 5 meters at 40p, nylon cable clips per 100 at 30p. Aerial switches at 90p Co-axial plugs at 8p. P & P. UHF & VHF/FM Aerials 50p, Car Aerials-Amps & cable etc., 25p.

When ordering UHF Aerials, please state channel combination or transmitter location. S.A.E. with enquiries please. Terms P.O./Cheque with order. U.K. Mainland only.

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ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic **ASTRAD 17** and **SEE** for yourself that the incredible Russians have done it all **NOW!** It's the radio perfectionist's dream come true! **THIS ONE SUPERSEDES ALL EARLIER MODELS!** It will probably make your present radio seem like a "crystal set!" Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only **£20.75**—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with that of £80 radios! *You can't lose, we'll refund instantly if you are not astounded! Elegant black & chrome finish facia, set in fabulous Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures purer & sweeter tone than ever! Volume controlled from a whisper to a roar that would fill a hall! Much wider band spread, for absolute "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spaceship and satellite communications. **Yes, EVERY WAVEBAND** instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth 24 hours a day including all normal transmissions. VHF, AM, FM, MW, LW, USW, plus local & new stations not yet operational, and messages from all over the world! Expensive **TURRET TUNER** side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! Press-button dial illumination! Take it anywhere—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240v AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39ins approx. It's also a fabulous **CAR RADIO**. Can also be used through extension amplifier, tape recorder or public address system. **SIZE 14ins x 10½ins x 4½ins** overall approx. Magnificently designed, made to give years of perfect service. (U.K. service facilities & spares available for years & years to come, if ever necessary!). With **WRITTEN GUARANTEE** manual with simple operating instructions & circuit diagram. **ONLY £20.75** (with mains/battery eliminator £1.48 extra). **BOX, POST, ETC. 50p.** ***BUT WAIT**, for only 55p extra you get the sensational "**COMPUTERISED**" **WORLD TUNING GUIDE** (it enables you to time, pinpoint & get transmissions the whole world over—even a child can do it in a flash—it even lets you know when to tune into the U.K. when abroad, **NO GUESSING! NO MESSING!**) **PLUS** Standard 'longlife' batteries **PLUS** ultra sensitive earphone for personal listening. (Sorry—We cannot change these new radios for any earlier model purchased.) **HURRY!** Send today or call at either store.

JUST ARRIVED! **THIS YEAR'S NEW *RUSSIAN MIRACLE! COMPUTERISED!**

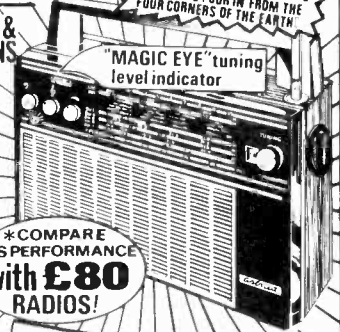
BRAND NEW 'SPACE AGE' model—SO FAR AHEAD OF ITS TIME IT WILL STILL BE MAKING MANY LOOK OUT OF DATE IN 1984!

THE FABULOUS ASTRAD 17

THIS OFFER ONLY 50p!

WORLD WIDE RECEPTION
THOUSANDS OF TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH

PORTABLE RADIO & COMMUNICATIONS RECEIVER



28 TRANSISTORS AND DIODES!
WAVEBANDS:
STANDARD LONG and MEDIUM
Plus 5 SHORT WAVEBANDS
Plus ULTRA SHORT WAVES
(V.H.F. AM, FM, MW, LW, USW.)

WE COULDN'T EVEN MAKE THEM FOR THIS PRICE!

BATTERY MODEL £20.75 BOX POST ETC. 50p
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***COMPARE ITS PERFORMANCE with £80 RADIOS!**

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***NOW AVAILABLE WITH fabulous 'COMPUTERISED' WORLD TUNING GUIDE!**
NO MORE GUESSWORK—INSTANT DATA at your fingertips—enables you to TUNE IN A FLASH to transmissions the world over!

MOTORING SENSATION! **SAVE £24.50!**

8-TRACK CAR STEREO PLAYER
Plus 2 MATCHED SPEAKERS FOR ONLY £1.25 EACH!
LIST PRICE £39.97!
ONLY £12.97
Plus CARR. ETC 33p
Plus ALL CONNECTIONS and FITTINGS!

FANTASTIC "BANK BUSTING" OFFER! ASTRONOMICAL REDUCTION! Frustrated import order must be turned into cash! Brand New, from first-class makers—we must not mention name. Absolutely the ultimate in luxury car equipment. The sort of offer that you only dream about, but **THIS** is true! Yes, for the incredible price of **£12.97** carr. etc. 33p you can have this magnificent complete 8-track Stereo Player. Beautifully made—so compact, overall size 6½in x 6½in x 2½in approx. for easy mounting in any car, boat or truck—or even in the home. (Runs off 12V battery.) Just "slap-in" your favourite recordings (obtainable everywhere) and you get hours of continuous playing and experience rich true-fidelity stereo sound! Autoplay, automatic track-changer, plus manual programme selector. Separate thumbwheel volume and treble/bass tone controls, sliding balance control. Outstanding 80-10,000 c/s frequency response! Circuit—10Tr OTL system! Playback system—8 track, 4 channels! Speaker impedance—4-8 ohms each channel! Output power—5 watts (2.5 watts per channel), plus all leads, connections, fittings, etc. Designed for fast, easy mounting. Complete with simple instructions & **WRITTEN GUARANTEE**. **BUT WAIT!** For another £2.50 extra (£1.25 each) you get the option to buy **TWO SUPERB COMPACT MATCHED SPEAKERS**—each 4½in diam. approx.—to give you a **COMPLETE MAGNIFICENT 8 TRACK CAR STEREO SYSTEM!** Everything for **£15.47** carr. 33p. (SAVING YOU £24.50), but please hurry! We don't want to disappoint a single reader! Refund guarantee. Order by post to **Uxbridge Road address**, or call at either store.

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BATTERY/MAINS AC Combined V.H.F. AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER



WITH REMOTE CONTROL MICROPHONE

OUR PRICE £23.75 **CARR. ETC. 35p**

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★ Press-button Keyboard Control Panel or latest **MASTER SWITCH CONTROL!** ★ "MAGIC EYE" Visual Battery checking/recording level indicator or built-in automatic Leveller! ★ Separate **ON/OFF** and **HI-LO** volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or "monitoring") and extension speaker sockets!
★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Philips Cassette Tapes obtainable everywhere. The amazing built-in full circuit V.H.F. AM/FM Radio gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus B.B.C. National, VHF. Picks up dozens of foreign stations. Fabulous in your car! You could pay **£44** more for a Car Radio or Car Cassette player **ALONE!** **£23.75, CARR. ETC. 35p.** Complete with simple instructions, remote control microphone with on/off switch and microphone stand. **WITH WRITTEN GUARANTEE.** Send today or call at either store. **BONUS OFFER!** Batteries and Cassette Tape 25p extra if required.

Dept. PE/19, 164 UXBIDGE ROAD (facing Shepherd's Bush Green), LONDON W12 8AQ. (Thurs. 1, Fri. 7) Also at 37/39 HIGH HOLBORN (opposite Chancery Lane), LONDON, W.C.1. (Thurs. 7 p.m.) **BOTH STORES OPEN FROM MONDAYS TO SATURDAY 9-6.**

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VISCOUNT III AUDIO — £52 complete

SYSTEM 1	Viscount III R101 amplifier	£22.00 + 90p p&p
	2 x Duo Type II speakers	£14.00 + 12 p&p
	Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23.00 + £1.50 p&p
	Total	£59.00

Available complete for only **£52 + £3.50 p&p**

SYSTEM 2	Viscount III R101 amplifier	£22.00 + 90p p&p
	2 x Duo Type III speakers	£32.00 + £3 p&p
	Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23.00 + £1.50 p&p
	Total	£77.00

Available complete for only **£69 + £4.00 p&p**

14W + 14W per channel 40Hz to 40kHz ±3dB
Total distortion at 10 watts at 1 kHz — 0.1%

This is real value for money! We have designed 2 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect transistors) are incorporated on the input stages, just like the top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For both systems we have chosen the famous Garrard SP25 Mk. III deck which comes complete with simulated teak plinth and dust cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

Check through the technical specification for convincing evidence of the true value and excellence of Viscount III suites.

SPECIFICATION. 14 watts per channel into 3-4 ohms (suitable 3-15 ohms). Total distortion at 10W, at 1 kHz, 0.1%. P.U.1 (for ceramic cartridges): 150mV into 3 Meg. P.U.2 (for magnetic cartridges). 4 mV at 1 kHz into 47 K equalised within ±1 dB R.I.A.A. Radio: 150 mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250 mW per channel. Tone controls and filter characteristics. Bass: +12 dB to -17 dB at 60 Hz. Bass filter: 6 dB per octave cut. Treble control: treble +12 dB to -12 dB at 15 kHz. Treble filter: 12 dB per octave. Signal to noise ratio: (all controls at max) P.U.1 and radio -65 dB. P.U.2: -58 dB. Crosstalk better than -35 dB on all inputs. Overload characteristics better than 26 dB on all inputs. Size: Approx. 13½in × 9in × 3½in.

SPEAKERS Duo Type II. Size: Approx. 17in × 10½in × 6½in. Drive unit: 13in × 8in with parasitic tweeter. Max. power 10 watts, 8 ohms. Simulated teak cabinet. **£14 pair + £2 p&p.**

Duo Type III. Size: Approx. 23½in × 11½in × 9½in. Drive unit: 13½in × 8½in with H.F. speaker. Max. power, 20 watts at 3 ohms. Freq. range: 20 Hz to 20 kHz. Teak veneer cabinet. **£32 pair + £3 p&p.**



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Send S.A.E. for fully illustrated leaflet.

Radio & TV Components (Acton) Ltd., 21D High Street, Acton, London W3 6NG. 323 Edgware Road, London, W.2.

Mail orders to Acton. Terms C.W.O. All enquiries S.A.E.



£25

takes the wraps off UNISOUND a new concept in stereo



See opposite page for addresses

The whole system is complete including superb cabinets in simulated teak—just simply screw together the components and you save pounds! Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13" x 8" EMI twin cone speakers ready for mounting in their elegant cabinets which simply need screwing and gluing together. All glue and screws supplied. Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.

£25 complete plus £2.80 P. & P.

Power output: 4 watts per channel into 8 ohms.

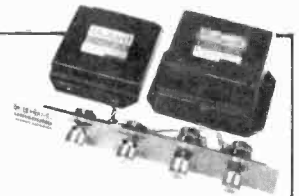
Inputs: 120 mV (for ceramic cartridges)

Diamond stylus £1.25

Stereo headphones with adaptor £4

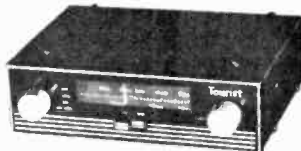
UNISOUND MODULES ONLY £6.95

If you prefer, you can buy the three modules—pre-amplifier, power supply dual power amplifier, and control panel—by themselves for only £6.95. P. & P. 50p extra. No soldering, just simply screw together with screw-driver supplied. Their overall specification is the same as shown for the complete Unisound console using the high efficient I.C. monolithic power chips to ensure very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum.



TOURIST

**MARK 3
CAR RADIO
ALL TRANSISTOR**



Beautifully designed to blend with the interiors of all cars. Permeability tuning and long wave loading coils ensure excellent tracking, sensitivity and selectivity on both wave bands. R.F. sensitivity at 1MHz is better than 8 micro volts. Power output into 3 ohm speaker is 3 watts. Pre-aligned I.F. module and tuner together with comprehensive instructions guarantees success first time. 12 volts negative or positive earth. Size 7in 2in 4 1/2in deep.

Circuit diagram 13p, free with parts Speaker, baffle and fixing kit £1.25 extra plus P. & P. 25p

SET OF PARTS

£6.30 Plus P. & P. 50p

Speaker postage free when ordered with parts



DUETTO MK. II I.C. STEREO AMPLIFIER

Sophisticated styling combined with up-to-date electronics means Hi-Fi. This is what the Duetto Mk. II offers at a realistic price. Mullard built stereo pre-amplifier, tone control module and the highly efficient I.C. monolithic power chips ensure: reliability, very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum, etc.

Inputs: P.U. 150mV @ 2.2 Meg. (for cer. cartridge). Auxiliary 100mV @ 1 Meg. (for radio, tape, etc.).

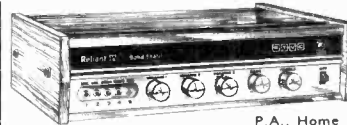
Outputs: 5 watts rms per channel into 8-15Ω speakers. Switched stereo headphone socket with power correction.

Controls: Mono/stereo switch, selector switch, treble, bass, volume, balance and on/off switch. Neon indicator.

Tone Controls: Treble = 14dB @ 15kHz. Bass ± 14dB @ 60 Hz.

Power Bandwidth: ± 2db 20Hz - 25kHz.

£11.50 plus P. & P. 60p



RELIANT MK. IV

The Reliant Mk. IV provides a high standard of sound reproduction, with full mixing facilities. Its versatility makes it suitable for: Discotheque, P.A., Home Entertainment Applications, etc.

- ★ Five Electronically Mixed Inputs
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- ★ Separate bass and treble controls common to all five inputs
- ★ Mixer employing F.E.T. (Field Effect Transistor)
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1. Crystal Mic. or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 and 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.). All 250mV sensitivity.

CONTROLS: 3 Volume controls. Bass control range ±13dB @ 60 Hz. Treble control range ±12dB @ 15kHz. Separate ON/OFF Switch. Neon Indicator.

POWER OUTPUT: 12 Watts R.M.S. into 3 to 4 ohms speaker.

SIGNAL/NOISE: Better than -60dB on inputs 3, 4 and 5 and -50dB on 1 and 2.

SUPPLY: 220 to 250V A.C. Mains.

SIZE: 12 1/2in x 6in x 3 1/2in.

PRICE

£10.50

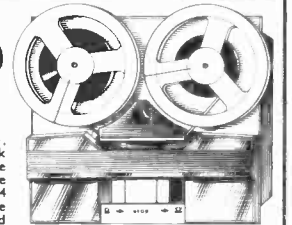
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CONTINENTAL 4-TRACK, 3-SPEED TAPE DECK

with high impedance heads

R.C. 74 tape deck. Three speeds—7 1/2, 3 1/2 and 1 1/2 i.p.s. 4-track record/playback head. Plus 4-track erase head. Positive pressure pad system. Takes any tape spool up to and including 7in. The R.C. 74 is driven by a powerful 200/250V 50-cycle a.c. motor. A heavy, accurately balanced flywheel brings wow and flutter levels down to approx. 0.3% total at 3 1/2 and 7 1/2 i.p.s. Fast rewind in both directions. Controls couldn't be simpler! Just five push buttons that interlock to cut out accidental tape damage. Efficient servo-action type braking. Easy drop-in tape loading.

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See opposite page for addresses

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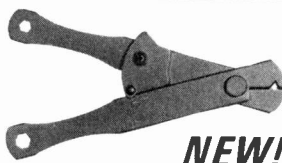


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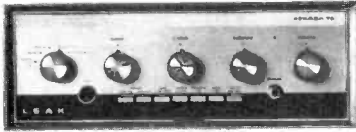
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2-speed 45 and 33½ rpm belt drive turntable complete with plinth, cover and Shure cartridge.

LIST PRICE £69.50

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SINCLAIR PHASE LOCK LOOP STEREO FM TUNER



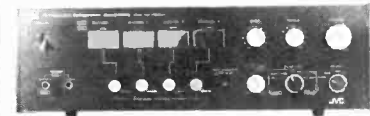
Incorporates varicap diodes, printed circuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to

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USE IT AS A 4-CHANNEL AMP
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USE IT WITH SYNTHESISED
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Stereo car Player

Accepts all standard pre-recorded 8 track stereo cartridges. Features include automatic head cleaner, channel select and channel repeat push buttons, slider type volume and tone controls, channel balance. Output 5 watts per channel, frequency response 50Hz-10kHz. Output imp. 4 ohms, size 4½(W) x 1½(H) x 6½(D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.

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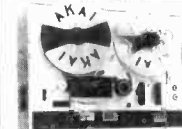
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Matches the C5700, the ideal car stereo system.

LASKY'S PRICE **£18.95** C & P 25p

Add **£3.75** to any BELTEK car player for pair of FANTAVOX KS701 car speakers.



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2 ADM 11/8 mics. Suitable for use on all Akai tape recorders. List Price £11.90. Lasky's Price **£7.50**. C & P 15p.

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PRE-AMP. Input imp. PU 2.2M, tuner 1M. Sensitivity PU 320mV, tuner 140mV. Treble and bass control range -14dB to 14dB Treble at 16KHz, bass at 60Hz. Size 4in x 5in x 1in. **£2.40.**

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FOR QUANTITIES PRICE 25p



BSR TD8S

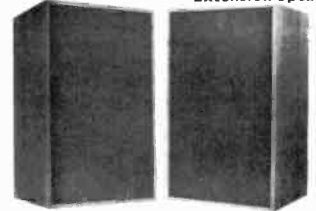
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Bookshelf Extension Speakers



An attractive bookshelf

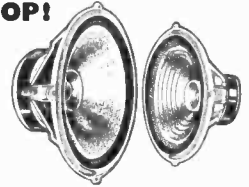
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250	£48.95
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Tuner parts with screening box	Less than	£12
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Please send S.A.E. for lists and order form.

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80 mm square fronts

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300V d.c.	\$2-80
VU Meter	\$3-87

"SEW" CLEAR PLASTIC METERS

Type MR.85F. 4 1/2 in. 4 1/2 in. fronts.



50 μ A	\$3-60
50-0-50 μ A	\$3-10
100 μ A	\$3-10
100-0-100 μ A	\$3-00
200 μ A	\$3-00
500 μ A	\$2-90
500-0-500 μ A	\$2-80
1mA	\$2-80
1-0-1mA	\$2-80
5mA	\$2-80
10mA	\$2-80

Type MR.85P. 2 1/2 in. square fronts.

50 μ A	\$3-10
50-0-50 μ A	\$2-60
100 μ A	\$2-60
100-0-100 μ A	\$2-60
500 μ A	\$2-60
1mA	\$2-60
10mA	\$2-60
50mA	\$2-60
100mA	\$2-60
1A	\$2-60
5A	\$2-60
10V d.c.	\$2-60

Type MR.85P. 3 1/2 in. 3 1/2 in. fronts.

50 μ A	\$3-37
50-0-50 μ A	\$2-75
100 μ A	\$2-75
100-0-100 μ A	\$2-65
200 μ A	\$2-65
500 μ A	\$2-40
500-0-500 μ A	\$2-20
1mA	\$2-20
5mA	\$2-20
10mA	\$2-20
50mA	\$2-20
100mA	\$2-20
1A	\$2-20
5A	\$2-20
10V d.c.	\$2-20

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"SEW" EDUCATIONAL METERS

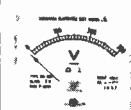


Type ED.107. Size overall 100mm x 90mm x 108mm.

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The easily accessible to working. Available in the following ranges:

50 μ A	\$5-00
100 μ A	\$4-85
1mA	\$4-40
50-0-50 μ A	\$4-65
1-0-1mA	\$4-40
1A d.c.	\$4-40
5A d.c.	\$4-40
10V d.c.	\$4-40

Type MR.38P. 1 21/32 in. square fronts.



50 μ A	\$2-10
50-0-50 μ A	\$1-90
100 μ A	\$1-90
100-0-100 μ A	\$1-75
200 μ A	\$1-75
500 μ A	\$1-65
500-0-500 μ A	\$1-60
1mA	\$1-60
1-0-1mA	\$1-60
2mA	\$1-60
5mA	\$1-60
10mA	\$1-60
20mA	\$1-60
50mA	\$1-60
100mA	\$1-60

Type MR.45P. 2 in. square fronts.

50 μ A	\$2-25
50-0-50 μ A	\$2-10
100 μ A	\$2-10
100-0-100 μ A	\$1-87
200 μ A	\$1-87
500 μ A	\$1-75
500-0-500 μ A	\$1-70
1mA	\$1-70
5mA	\$1-70
10mA	\$1-70
50mA	\$1-70
100mA	\$1-70
1A	\$1-70
5A	\$1-70

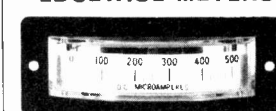
"SEW" BAKELITE PANEL METERS

Type MR.85 3 1/2 in. square fronts.



25 μ A	\$3-50
50 μ A	\$2-87
50-0-50 μ A	\$2-35
100 μ A	\$2-35
100-0-100 μ A	\$2-25
500 μ A	\$2-20
1mA	\$1-95
1-0-1mA	\$1-95
5mA	\$1-95
10mA	\$1-95
50mA	\$1-95
100mA	\$1-95

EDGEWISE METERS



PE.70 3 17/32 in. 1 15/32 in. 2 1/2 in. deep.

50 μ A	\$3-10
50-0-50 μ A	\$3-00
100 μ A	\$3-00
100-0-100 μ A	\$3-90
500 μ A	\$2-80
100mA	\$2-80
500 μ A	\$2-75
1mA	\$2-85
300V a.c.	\$3-45
VU meter	\$3-40

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0/10/50/250/1000 V. D.C.
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0/1/100 M.A. 0/150 K ohms.
\$1-97. P. & P. 15p.

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20,000 O.P.V.
Overhead protection.
5/25/100/500/1000V D.C.
10/50/250/1000V A.C.
30 μ A/250mA. 20K/2 meg
ohm. — 5 to + 62dB.
\$4-97. P. & P. 15p.

TMK MODEL MD.180.
Mirror scale. 20K Ω /volt
d.c. 10k Ω /volt a.c. 30/
60/300/600/3,000V d.c. 6/
120/1,200V a.c.
Current — 0-60 μ A/0-12/0-
300mA. — 0-60k Ω /0-63M Ω .
— 20 to +63dB. \$4-62. P. & P. 15p

MODEL 500. 30,000 O.P.V. with overload protection. mirror scale
0/5/25/5/10/25/100/
250/500/1,000 V d.c. 0/2/5/
10/25/100/250/500/1,000 V a.c. 0/50 μ A/5/50/500 mA. 12 amp. d.c. 0/60K/6 Meg/60 Meg Ω .
\$3-97. Post paid.

MODEL PL436. 20k Ω / Volt d.c. 8k Ω /Volt a.c. Mirror scale. 0-6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600A/1/60/600MA. 10/100K/1Meg/10meg Ω . — 20 to +46dB.
\$3-97. P. & P. 12 1/2p.

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THE LAB TESTER. 120,000 O.P.V. 6 1/2 in. scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.C. volts: 0-5, 2-5, 10, 50, 250, 1,000V. A.C. 2.5, 5, 10, 50, 100, 500MA. D.C. current: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: — 10 to +49dB. Plastic case with carrying handle, size 7 1/2 in x 6 1/2 in x 3 1/2 in. \$18-90. P. & P. 25p.

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A.c. volts: 3, 10, 50, 250, 1,000V. D.C. current: 10, 100 μ A, 10, 100, 500mA. Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: — 10 to +49dB. Plastic case with carrying handle, size 7 1/2 in x 6 1/2 in x 3 1/2 in. \$18-90. P. & P. 25p.

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3/6/12/30/60/120/300/600/1200V D.C. 1/3/6/12/30/60/150/300/600/1200V A.C.
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6/12 AMP DC
2K/200K/2 Meg/20 meg ohm
— 20 to + 63 db
\$13-50 P. & P. 20p

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OUR PRICE \$5-97. P. & P. 25p.

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Battery operated, 11 meg input, 25 ranges. Large 4 1/2 in. mirror scale. Size: 3 1/2 in x 4 1/2 in. x 2 1/2 in. D.C. volts 3-1,200V. A.c. volts 3-300V R.M.S. 80-800V P-P. D.C. current 0-12/2MA. Resistance up to 2,000M ohm. Decibels — 20 to +51dB. Complete with leads/instructions. \$17-50. P. & P. 20p.

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Accurate wide range signal generator covering 120Kcs-500Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration 220/240V. A.C. Brand new with instructions. \$15. Carr. 37 1/2p. Size 140 x 215 x 170 mm.

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2G309	2N3566	2N3803	50p	BC125	20p	BFX44	30p	NKT242	35p
2G371	2N3568	2N3804	75p	BC126	20p	BFX68	25p	NKT271	30p
2G374	2N3569	2N3805	30p	BC134	25p	BFX84	25p	NKT244	30p
2G381	2N3570	2N3806	30p	BC135	25p	BFX85	25p	NKT245	30p
2N388A	2N3572	2N3807	25p	BC136	15p	BFX86	25p	NKT261	20p
2N404	2N3605	2N3808	40p	BC137	15p	BFX87	25p	NKT262	20p
2N406	2N3606	2N3809	30p	BC138	20p	BFX88	20p	NKT263	20p
2N407	2N3607	2N3810	40p	BC139	30p	BFX89	20p	NKT264	20p
2N408	2N3608	2N3811	30p	BC140	30p	BFX90	20p	NKT272	30p
2N409	2N3609	2N3812	30p	BC141	30p	BFX91	20p	NKT273	30p
2N410	2N3610	2N3813	30p	BC142	10p	BFY11	42p	NKT274	30p
2N411	2N3611	2N3814	87p	BC143	10p	BFY12	42p	NKT275	30p
2N412	2N3612	2N3815	87p	BC144	10p	BFY13	42p	NKT276	30p
2N413	2N3613	2N3816	87p	BC145	10p	BFY14	42p	NKT277	30p
2N414	2N3614	2N3817	87p	BC146	10p	BFY15	42p	NKT278	30p
2N415	2N3615	2N3818	87p	BC147	10p	BFY16	42p	NKT279	30p
2N416	2N3616	2N3819	87p	BC148	10p	BFY17	42p	NKT280	30p
2N417	2N3617	2N3820	87p	BC149	10p	BFY18	42p	NKT281	30p
2N418	2N3618	2N3821	87p	BC150	10p	BFY19	42p	NKT282	30p
2N419	2N3619	2N3822	87p	BC151	10p	BFY20	42p	NKT283	30p
2N420	2N3620	2N3823	87p	BC152	10p	BFY21	42p	NKT284	30p
2N421	2N3621	2N3824	87p	BC153	10p	BFY22	42p	NKT285	30p
2N422	2N3622	2N3825	87p	BC154	10p	BFY23	42p	NKT286	30p
2N423	2N3623	2N3826	87p	BC155	10p	BFY24	42p	NKT287	30p
2N424	2N3624	2N3827	87p	BC156	10p	BFY25	42p	NKT288	30p
2N425	2N3625	2N3828	87p	BC157	10p	BFY26	42p	NKT289	30p
2N426	2N3626	2N3829	87p	BC158	10p	BFY27	42p	NKT290	30p
2N427	2N3627	2N3830	87p	BC159	10p	BFY28	42p	NKT291	30p
2N428	2N3628	2N3831	87p	BC160	10p	BFY29	42p	NKT292	30p
2N429	2N3629	2N3832	87p	BC161	11p	BFY30	42p	NKT293	30p
2N430	2N3630	2N3833	87p	BC162	11p	BFY31	42p	NKT294	30p
2N431	2N3631	2N3834	87p	BC163	11p	BFY32	42p	NKT295	30p
2N432	2N3632	2N3835	87p	BC164	11p	BFY33	42p	NKT296	30p
2N433	2N3633	2N3836	87p	BC165	11p	BFY34	42p	NKT297	30p
2N434	2N3634	2N3837	87p	BC166	11p	BFY35	42p	NKT298	30p
2N435	2N3635	2N3838	87p	BC167	11p	BFY36	42p	NKT299	30p
2N436	2N3636	2N3839	87p	BC168	11p	BFY37	42p	NKT300	30p
2N437	2N3637	2N3840	87p	BC169	11p	BFY38	42p	NKT301	30p
2N438	2N3638	2N3841	87p	BC170	11p	BFY39	42p	NKT302	30p
2N439	2N3639	2N3842	87p	BC171	11p	BFY40	42p	NKT303	30p
2N440	2N3640	2N3843	87p	BC172	11p	BFY41	42p	NKT304	30p
2N441	2N3641	2N3844	87p	BC173	11p	BFY42	42p	NKT305	30p
2N442	2N3642	2N3845	87p	BC174	11p	BFY43	42p	NKT306	30p
2N443	2N3643	2N3846	87p	BC175	11p	BFY44	42p	NKT307	30p
2N444	2N3644	2N3847	87p	BC176	11p	BFY45	42p	NKT308	30p
2N445	2N3645	2N3848	87p	BC177	11p	BFY46	42p	NKT309	30p
2N446	2N3646	2N3849	87p	BC178	11p	BFY47	42p	NKT310	30p
2N447	2N3647	2N3850	87p	BC179	11p	BFY48	42p	NKT311	30p
2N448	2N3648	2N3851	87p	BC180	11p	BFY49	42p	NKT312	30p
2N449	2N3649	2N3852	87p	BC181	11p	BFY50	42p	NKT313	30p
2N450	2N3650	2N3853	87p	BC182	11p	BFY51	42p	NKT314	30p
2N451	2N3651	2N3854	87p	BC183	9p	BFY52	42p	NKT315	30p
2N452	2N3652	2N3855	87p	BC184	9p	BFY53	42p	NKT316	30p
2N453	2N3653	2N3856	87p	BC185	9p	BFY54	42p	NKT317	30p
2N454	2N3654	2N3857	87p	BC186	9p	BFY55	42p	NKT318	30p
2N455	2N3655	2N3858	87p	BC187	9p	BFY56	42p	NKT319	30p
2N456	2N3656	2N3859	87p	BC188	9p	BFY57	42p	NKT320	30p
2N457	2N3657	2N3860	87p	BC189	9p	BFY58	42p	NKT321	30p
2N458	2N3658	2N3861	87p	BC190	9p	BFY59	42p	NKT322	30p
2N459	2N3659	2N3862	87p	BC191	9p	BFY60	42p	NKT323	30p
2N460	2N3660	2N3863	87p	BC192	9p	BFY61	42p	NKT324	30p
2N461	2N3661	2N3864	87p	BC193	9p	BFY62	42p	NKT325	30p
2N462	2N3662	2N3865	87p	BC194	9p	BFY63	42p	NKT326	30p
2N463	2N3663	2N3866	87p	BC195	9p	BFY64	42p	NKT327	30p
2N464	2N3664	2N3867	87p	BC196	9p	BFY65	42p	NKT328	30p
2N465	2N3665	2N3868	87p	BC197	9p	BFY66	42p	NKT329	30p
2N466	2N3666	2N3869	87p	BC198	9p	BFY67	42p	NKT330	30p
2N467	2N3667	2N3870	87p	BC199	9p	BFY68	42p	NKT331	30p
2N468	2N3668	2N3871	87p	BC200	9p	BFY69	42p	NKT332	30p
2N469	2N3669	2N3872	87p	BC201	9p	BFY70	42p	NKT333	30p
2N470	2N3670	2N3873	87p	BC202	9p	BFY71	42p	NKT334	30p
2N471	2N3671	2N3874	87p	BC203	9p	BFY72	42p	NKT335	30p
2N472	2N3672	2N3875	87p	BC204	9p	BFY73	42p	NKT336	30p
2N473	2N3673	2N3876	87p	BC205	9p	BFY74	42p	NKT337	30p
2N474	2N3674	2N3877	87p	BC206	9p	BFY75	42p	NKT338	30p
2N475	2N3675	2N3878	87p	BC207	9p	BFY76	42p	NKT339	30p
2N476	2N3676	2N3879	87p	BC208	9p	BFY77	42p	NKT340	30p
2N477	2N3677	2N3880	87p	BC209	9p	BFY78	42p	NKT341	30p
2N478	2N3678	2N3881	87p	BC210	9p	BFY79	42p	NKT342	30p
2N479	2N3679	2N3882	87p	BC211	9p	BFY80	42p	NKT343	30p
2N480	2N3680	2N3883	87p	BC212	9p	BFY81	42p	NKT344	30p
2N481	2N3681	2N3884	87p	BC213	9p	BFY82	42p	NKT345	30p
2N482	2N3682	2N3885	87p	BC214	9p	BFY83	42p	NKT346	30p
2N483	2N3683	2N3886	87p	BC215	9p	BFY84	42p	NKT347	30p
2N484	2N3684	2N3887	87p	BC216	9p	BFY85	42p	NKT348	30p
2N485	2N3685	2N3888	87p	BC217	9p	BFY86	42p	NKT349	30p
2N486	2N3686	2N3889	87p	BC218	9p	BFY87	42p	NKT350	30p
2N487	2N3687	2N3890	87p	BC219	9p	BFY88	42p	NKT351	30p
2N488	2N3688	2N3891	87p	BC220	9p	BFY89	42p	NKT352	30p
2N489	2N3689	2N3892	87p	BC221	9p	BFY90	42p	NKT353	30p
2N490	2N3690	2N3893	87p	BC222	9p	BFY91	42p	NKT354	30p
2N491	2N3691	2N3894	87p	BC223	9p	BFY92	42p	NKT355	30p
2N492	2N3692	2N3895	87p	BC224	9p	BFY93	42p	NKT356	30p
2N493	2N3693	2N3896	87p	BC225	9p	BFY94	42p	NKT357	30p
2N494	2N3694	2N3897	87p	BC226	9p	BFY95	42p	NKT358	30p
2N495	2N3695	2N3898	87p	BC227	9p	BFY96	42p	NKT359	30p
2N496	2N3696	2N3899	87p	BC228	9p	BFY97	42p	NKT360	30p
2N497	2N3697	2N3900	87p	BC229	9p	BFY98	42p	NKT361	30p
2N498	2N3698	2N3901	87p	BC230	9p	BFY99	42p	NKT362	30p
2N499	2N3699	2N3902	87p	BC231	9p	BFY00	42p	NKT363	30p
2N500	2N3700	2N3903	87p	BC232	9p	BFY01	42p	NKT364	30p
2N501	2N3701	2N3904	87p	BC233	9p	BFY02	42p	NKT365	30p
2N502	2N3702	2N3905	87p	BC234	9p	BFY03	42p	NKT366	30p
2N503	2N3703	2N3906	87p	BC235	9p	BFY04	42p	NKT367	30p
2N504	2N3704	2N3907	87p	BC236	9p	BFY05	42p	NKT368	30p
2N505	2N3705	2N3908	87p	BC237	9p	BFY06	42p	NKT369	30p
2N506	2N3706	2N3909	87p	BC238	9p	BFY07	42p	NKT370	30p
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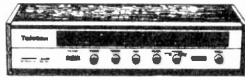
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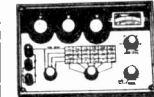
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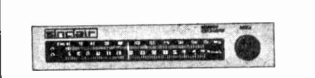
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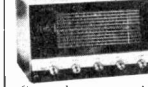
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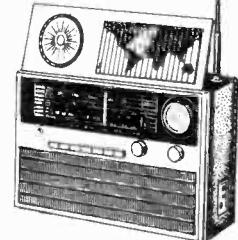
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5	25	3p	500	10												
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8	25	3p	640	10												
10	6	3p	1000	3												
10	15	3p	1000	6												
10	25	3p	1000	12												
10	40	4p	1000	25												
10	50	4p	1000	50												
16	15	3p	2000	12												
16	25	3p	2000	25												
20	25	3p	2500	12												
25	15	3p	2500	25												
25	25	3p														
25	50	4p														
32	25	4p														
32	50	4p														
40	6	3p	2N706	10p												
40	6	3p	2N708	13p												
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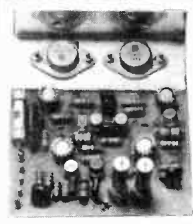
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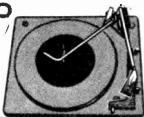
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Home Tweeters 2-16Kc/s, 10W 8 ohm or 15 ohm £1-50. De Luxe Horn Tweeters 2-18 Kc/s, 15W, 15 ohm 2£. TWO-WAY 3,000 c.p.s. CROSSOVERS 8 or 16 ohm 95p. SPECIAL OFFER! 80 ohm. 2 1/2 in. 2 1/2 in. 35 ohm, 2 in. 25 ohm, 2 1/2 in. dia.; 3 in. dia.; 6 1/2 in.; 6 1/2 in. £1 TYPE 15 ohm, 3 1/2 in. dia.; 8 1/2 in.; 7 1/2 in.; 4 in.

10HMS SPEAKERS P.M. 3 OHMS. 7 1/2 in. £1-25; 6 1/2 in. £1-50; 8 x 5in. £1-60; 8 x 2 1/2 in. £1-50; 8in. £1 7/8; 10 x 6in. £1-90. RICHARD ALLAN TWIN CONE LOUSPEAKERS 8in. dia. 4 watt; 10in. dia. 5 watt; 12 in. dia. 8 watt. 3 or 8 or 15 ohm models £2 each. Post 15p. VALVE OUTPUT TRANS. 25p. MIKE TRANS. 50:1 25p. 5 WATT MULTI RATIO. 3, 8 and 15 ohms 80p.

BAKER 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

4 inputs speech and music. Mixing facilities. Response 10-30,000 cps. Matches all loudspeakers. A.C. 200/250V. Separate Treble and Bass controls. Guaranteed. Details S.A.E. £39 Post Free



BARGAIN AM TUNER. Medium Wave. £4-50

Transistor Superhet. Ferrite aerial. 9 volt.

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. £3-50

Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. Stereo version of above £4-50.

BARGAIN FM TUNER 98-108 Mc/s Six Transistor. 9 volt. Printed Circuit. Calibrated slide dial tuner. Walnut Cabinet. Size 7 x 5 x 4 inch

BARGAIN FM TUNER as above. £8-85 Chassis only, less cabinet.

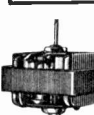
BARGAIN 3 WATT AMPLIFIER. 4 Transistor £3-50

Push-Pull Ready built, with volume control. 9v.

COAXIAL PLUG 6p. PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES. SURFACE OR PLUMB 25p. BATTENTED TWIN FEEDERS 5p. yd. 80 ohms or 300 ohms. JACK SOCKET Std. open-circuit 14p. closed circuit 22p; Chrome Lead Socket 45p. Phone Plugs 6p. Phone Socket 5p. JACK PLUGS Std. Chrome 15p; 5mm Chrome 14p. DIN SOCKETS Chassis 8-pin 10p; 5-pin 10p. DIN SOCKETS Lead 8-pin 18p; 5-pin 15p. DIN PLUGS 8-pin 18p; 5-pin 15p. VALVE HOLDERS, 6p; CERAMIC 8p; CAN 5p.

E.M.I. TAPE MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0.187 x 0.75in. Size 2 1/2 x 2 1/2 in. (Illustrated). Post 15p

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THE PULLMAN PB PUSH BUTTON CAR RADIO KIT



Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulated IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Pullman PB is suitable for 12 volt working with both negative and positive earth. It covers the full medium and long wave bands. Four push-buttons for medium wave, one for long wave. It is permeability tuned and sturdily constructed. Output is a full 2.5 watts into an 8 ohm speaker. But the Pullman PB will operate into any loud-speaker from 8 to 15 ohms. Power consumption is less than 1 amp.

★ Circuit diagram and comprehensive instructions 50p, free with parts.

★ Car aerial £1.25 post paid.

If you can solder on printed circuit board, you can build this push-button car radiokit. It's simple—just follow the step-by-step instructions

**PRICE ONLY
£7.00 + p&p 50p**

THE PULLMAN PB CAN BE MOUNTED IN ANY STANDARD SIZE DASH PANEL AND IT HAS AN ILLUMINATED TUNING SCALE FOR EASY READING AT NIGHT. CHASSIS SIZE IS: 7" WIDE, 2" HIGH AND 4 1/16" DEEP (EXCLUDING FRONT PANEL, ETC.)

Bohm speaker, with baffle and fixing strips. £1.50 post free if bought with the kit

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Semiconductors incl. LDR and Thyristor, £3.00

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PCB (3 1/2in x 10 1/2in) Stereo. Specially designed to also hold rotary or slider pots, and rotary switches, £1.65

R's, C's, Rotary pots and switches to match PCB (Stereo set), £7.90

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GEMINI POWER SUPPLY. PCB (2in x 4in), 60p

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Semiconductors, R's, C's, Pot, £1.80

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Semiconductors, R's, C's, Pots, £3.90

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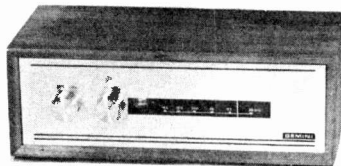
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All components to build this outstanding phase lock easily aligned tuner as described in April/May/June P.E. We are offering an optional chassis and solid wood sleeve in ready to assemble form. S.A.E. for details and itemised prices. Complete kit £33.90.

SCORPIO ELECTRONIC IGNITION

Complete kit with comprehensive construction and fault finding data. £11. Post paid. Data 10p. Itemised prices, S.A.E. please.

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MM6 6V, 500mA + 6V, 500mA
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MM20 20V, 150mA + 20V, 150mA
£1.29 plus 13p p. & p.

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LT1 6.3V, 1.5A—75p plus 18p p. & p.
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LT5 9-0-9V, 0.5A—75p plus 21p p. & p.
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LT7 30-0-30V, 1A—£1.87 plus 30p p. & p.

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MT30/2 0-12-15-20-24-30V, 2A—
£1.95 plus 30p p. & p.
MT60/1 0-5-20-30-40-60V, 1A—
£1.97 plus 30p p. & p.
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£2.90 plus 34p p. & p.

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CT101 1A—£1 plus 26p p. & p.
CT102 2A—£1.25 plus 30p p. & p.
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AT75 30V—£1.18 plus 30p p. & p.
AT75 75V—£1.85 plus 30p p. & p.
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AT300 300V—£4.75 plus 42p p. & p.
AT1000 1000V—£8.90 plus 62p p. & p.

All shrouded with terminal blocks.
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110-200-220-240V.

Speaker isolating transformer
I:1 ratio for 3-15Ω, 2W—86p plus
13p p. & p.

Speaker matching transformer
Tapped 3, 8, 16Ω. Will match
almost any speakers to an amplifier.
15W max.—90p plus 20p p. & p.

ALUMINIUM BOXES
with lids and screws

Type	L	W	D	Price p. & p.
GB7*	5 1/2 in	2 1/2 in	1 1/2 in	38p 15p
GB8*	4 in	4 in	1 1/2 in	38p 15p
GB9*	4 in	2 1/2 in	1 1/2 in	38p 13p
GB10*	5 1/2 in	4 in	1 1/2 in	44p 18p
GB11	4 in	2 1/2 in	2 in	38p 13p
GB12	3 in	2 in	1 in	33p 13p
GB13	6 in	4 in	2 in	52p 18p
GB14	7 in	5 in	2 1/2 in	63p 19p
GB15	8 in	6 in	3 in	81p 26p
GB16	10 in	7 in	3 in	92p 26p

* These sizes fit standard veroboards

EQUIPMENT CASES
with sloping front panel

Type	W	D	Price p. & p.
SF1	2 in	3 1/2 in	45p 12p
SF2	2 in	3 in	60p 16p
SF3	2 in	3 1/2 in	75p 19p

Plain aluminium.
Scove - enamelled silver-grey hammer finished, 20p extra.

CONSOLE CASES
in plain aluminium, ideal for mixers, instruments, etc.

Type	W	A	B	C	D	Price p. & p.
GB20	8 in	9 in	3 1/2 in	3 in	£1.42	30p
GB21	10 in	9 in	3 1/2 in	3 in	£1.58	30p
GB22	12 in	9 in	3 1/2 in	3 in	£1.72	30p

VEROBOARD

Size	0-1 matrix	0-15 matrix
2 1/2 in x 3 1/2 in	22p	16p
2 1/2 in x 5 in	24p	25p
3 1/2 in x 3 1/2 in	24p	25p
3 1/2 in x 5 in	27p	29p
17 in x 2 1/2 in	75p	57p
17 in x 3 1/2 in	£1	75p

Pins—either size; packet of 36, 18p

ELECTROLYTICS

1µF	450V	19p	1,000µF	25V	27p
2µF	500V	20p	1,000µF	50V	39p
4µF	350V	14p	2,000µF	25V	36p
8µF	450V	16p	2,000µF	50V	53p
16µF	450V	17p	2,500µF	25V	45p
25µF	25V	7p	2,500µF	450V	60p
25µF	50V	8p	3,000µF	25V	48p
32µF	450V	24p	5,000µF	25V	55p
50µF	50V	10p	5,000µF	50V	98p
100µF	25V	10p	8-16µF	450V	18p
100µF	50V	10p	8-16µF	450V	20p
250µF	25V	12p	16-32µF	450V	27p
250µF	50V	17p	16-32µF	450V	63p
500µF	25V	18p	32-32µF	450V	49p
500µF	50V	25p	50-50µF	350V	38p

MINIATURE ELECTROLYTICS

1µF	63V	6p	10µF	64V	7p
2µF	63V	6p	16µF	40V	7p
4µF	40V	7p	30µF	15V	7p
4µF	63V	6p	47µF	16V	7p
8µF	15V	7p	47µF	25V	6p
8µF	40V	7p	68µF	10V	6p
10µF	25V	6p	100µF	16V	6p

ENTIRE MULLARD 015/016/017 RANGE ALSO STOCKED

CASSETTE OWNERS!

For Philips and similar cassette recorders.
PU12 Power unit for connection to 12V + or - E car electrical systems, giving 7 1/2 V, stabilised output.
£3.25

PU14 As above but switched for 6V, 7 1/2 V or 9V output. **£5.10**

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All units are complete with cable and plug.

VARIABLE POWER SUPPLY
Input: 240V, a.c.
Output: Switched 3, 4.5, 6, 7.5, 9, 12 volts d.c. at 500mA **£4.20**

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suitable for transistor radios and similar light current equipment
PP6 Input 240V a.c. Output 6V d.c.
PP9 Input 240V a.c. Output 9V d.c.
Price £1.50 plus 12p p. & p.

NEW ILLUSTRATED 1972-73 CATALOGUE
Post Free 15p

CONTROLS, Log. or Lin.
Single, less switch, 15p
Single, D.P. switch, 24p
Tandem, less switch, 40p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

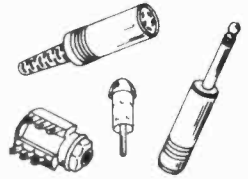
SLIDER CONTROLS, 87mm.
complete with knobs.
Single, 44p; Tandem, 55p. 10kΩ, 25kΩ, 50kΩ, 100kΩ, log. or lin.

RESISTORS
Carbon
All 5%, high-stability, E12 values. 1W, 1p; 1/2W, 1 1/2p; 1W, 4p; 2W, 6p
Wire-wound
5W, 10p; 10W, 12p

LOUDSPEAKERS
7in x 4in, 3Ω—£1.12, 8Ω—£1.12, 15Ω—£1.40.
8in x 5in, 3Ω—£1.85, 8Ω—£1.77, 25Ω—£1.70.
10in x 6in, 3Ω—£2.32, 8Ω—£2.32, 15Ω—£2.32.
8in round, 3Ω—£2.10, 8Ω—£2.50, 15Ω—£2.10.
Astrada "Hi-Ten", 10in, 10W, 8 or 15Ω—£3.40.
Please add 20p p. & p. to all speakers.

PLUGS

Car aerial 14p
Co-axial 9p
D.I.N. 2 pin (speaker) 10p
D.I.N. 3 pin 13p
D.I.N. 4 pin 14p
D.I.N. 5 pin, 180° 13p
D.I.N. 5 pin, 240° 15p
D.I.N. 6 pin 15p
Jack, 2 1/2mm unscreened 9p
Jack, 2 1/2mm screened 10p
Jack, 3 1/2mm unscreened 8p
Jack, 3 1/2mm screened 12p
Jack, 4in unscreened 12p
Jack, 4in screened 20p
Jack, stereo, unscreened 20p
Jack, stereo, screened 35p
Phono, plastic top 5p
Phono, plated metal 12p
Phono, fitted 4 ft lead 8p
Wander, red or black 3p
Banana 4mm, red or black 6p



SOCKETS

Car aerial 8p
Co-axial, surface 8p
Co-axial, flush 9p
D.I.N. 2 pin (speaker) 10p
D.I.N. 3 pin 9p
D.I.N. 5 pin, 180° 9p
D.I.N. 5 pin, 240° 9p
Jack, 2 1/2mm 10p
Jack, 3 1/2mm 10p
Jack, 4in unscreened 15p
Jack, 4in switched 17p
Jack, stereo, switched 24p
Phono, single 35p
Phono, 2 on a strip 7p
Phono, 3 on a strip 16p
Phono, 4 on a strip 19p
Wander, single, red or black 5p
Wander, twin strip 7p
Banana 4mm red, or black 6p

CAPACITORS

2-2pF	500V	S/M	7 1/2p	0.0027µF	500V	S/M	13p
3-3pF	500V	S/M	7 1/2p	0.003µF	500V	Cer.	5p
5pF	500V	S/M	7 1/2p	0.0033µF	125V	P.S.	3p
10pF	125V	P.S.	5p	0.0033µF	500V	Poly.	6p
10pF	500V	S/M	7 1/2p	0.0036µF	500V	MDC	6p
10pF	500V	S/M	7 1/2p	0.0047µF	125V	P.S.	5p
15pF	125V	P.S.	5p	0.0047µF	500V	Poly.	6p
15pF	500V	Cer.	4p	0.0047µF	500V	S/M	20p
18pF	500V	S/M	7 1/2p	0.0047µF	1,000V	MDC	6p
22pF	125V	P.S.	5p	0.005µF	100V	Mylar	3p
22pF	500V	S/M	7 1/2p	0.005µF	500V	Cer.	5p
25pF	500V	S/M	7 1/2p	0.0068µF	125V	P.S.	10 1/2p
27pF	500V	Cer.	4p	0.0068µF	500V	S/M	30p
33pF	125V	P.S.	5p	0.0068µF	500V	Poly.	6p
33pF	500V	S/M	7 1/2p	0.0082µF	125V	P.S.	10 1/2p
39pF	500V	S/M	7 1/2p	0.0082µF	500V	S/M	30p
47pF	125V	P.S.	5p	0.01µF	18V	Disc	4p
47pF	500V	Cer.	4p	0.01µF	125V	P.S.	10 1/2p
50pF	500V	S/M	7 1/2p	0.01µF	160V	Poly.	4p
56pF	500V	S/M	7 1/2p	0.01µF	250V	M.F.	3p
68pF	125V	P.S.	5p	0.01µF	400V	Poly.	3p
68pF	500V	S/M	7 1/2p	0.01µF	500V	Cer.	30p
75pF	500V	S/M	7 1/2p	0.01µF	500V	S/M	35p
82pF	500V	S/M	7 1/2p	0.01µF	600V	Poly.	7p
100pF	125V	P.S.	5p	0.01µF	1,000V	MDC	9p
100pF	500V	S/M	7 1/2p	0.015µF	160V	Poly.	3p
100pF	500V	Cer.	5p	0.015µF	400V	Poly.	3p
120pF	500V	S/M	7 1/2p	0.02µF	100V	Mylar	3p
150pF	125V	P.S.	5p	0.022µF	18V	Disc	3p
150pF	500V	S/M	7 1/2p	0.022µF	250V	M.F.	3p
150pF	500V	Cer.	5p	0.022µF	400V	Poly.	3p
180pF	500V	S/M	7 1/2p	0.022µF	600V	MDC	7 1/2p
200pF	500V	S/M	7 1/2p	0.022µF	1,000V	MDC	9p
220pF	125V	P.S.	5p	0.033µF	250V	M.F.	4p
220pF	500V	Cer.	5p	0.033µF	400V	Poly.	4p
250pF	500V	S/M	8p	0.047µF	12V	Disc	6p
270pF	500V	Cer.	5p	0.047µF	160V	Poly.	3p
300pF	500V	S/M	8p	0.047µF	250V	M.F.	3p
330pF	125V	P.S.	5p	0.047µF	400V	Poly.	4p
330pF	500V	S/M	8p	0.047µF	600V	MDC	8p
390pF	500V	S/M	8p	0.047µF	1,000V	MDC	10p
470pF	125V	P.S.	5p	0.1µF	30V	Disc	6p
470pF	750V	Disc	5p	0.1µF	250V	M.F.	4p
500pF	500V	S/M	8p	0.1µF	400V	Poly.	5p
560pF	500V	S/M	8p	0.1µF	600V	MDC	10p
680pF	125V	P.S.	6p	0.1µF	1,000V	MDC	13p
680pF	500V	S/M	8p	0.15µF	250V	M.F.	5p
820pF	500V	S/M	8p	0.22µF	160V	Poly.	6p
0.001µF	100V	Mylar	3p	0.22µF	250V	M.F.	5p
0.001µF	125V	P.S.	6p	0.22µF	400V	Foil	10p
0.001µF	400V	S/M	10p	0.22µF	1,000V	MDC	15p
0.001µF	500V	S/M	10p	0.33µF	250V	M.F.	5p
0.001µF	500V	Cer.	5p	0.47µF	250V	Foil	8p
0.001µF	1,000V	MDC	6p	0.47µF	400V	Foil	8p
0.0015µF	400V	Poly.	3p	0.47µF	1,000V	MDC	20p
0.0015µF	500V	S/M	10p	1.0µF	250V	M.F.	15p
0.0015µF	500V	Cer.	5p				
0.0018µF	500V	S/M	10p				
0.002µF	100V	Mylar	3p				
0.002µF	500V	Cer.	5p				
0.002µF	125V	P.S.	6p				
0.002µF	500V	S/M	10p				
0.002µF	1,000V	MDC	6p				

Note: S/M = silver mica 1% tol.
P.S. = polystyrene 2 1/2% tol.
MDC = a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus 20p p. & p. charge shown. (Overseas extra.) Telephone 01-692 4412

The largest selection

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A	3A	7A	10A	16A	30A
	TO-5	TO-66	TO-66	TO-48	TO-48	TO-48
50	0.23	0.25	0.47	0.50	0.53	1.15
100	0.25	0.33	0.53	0.58	0.63	1.40
200	0.35	0.37	0.57	0.61	0.75	1.60
400	0.43	0.47	0.67	0.75	0.93	1.75
600	0.53	0.57	0.77	0.97	1.25	
800	0.63	0.70	0.90	1.20	1.50	4.00

SIL. RECTS. TESTED

PIV	300mA	750mA	1A	1.5A	3A	10A	30A
	\$p	\$p	\$p	\$p	\$p	\$p	\$p
50	0.04	0.05	0.05	0.07	0.14	0.21	0.47
100	0.04	0.06	0.05	0.13	0.18	0.23	0.75
200	0.05	0.09	0.08	0.14	0.20	0.24	1.00
400	0.06	0.13	0.07	0.20	0.27	0.37	1.25
600	0.07	0.13	0.10	0.23	0.34	0.45	1.55
800	0.10	0.17	0.13	0.25	0.37	0.55	2.00
1000	0.11	0.25	0.15	0.30	0.46	0.63	2.50
1200		0.33		0.33	0.57	0.75	

TRIACS

VBOOM 2A	6A	10A	
	TO-1	TO-60	TO-88
100	30	60	75
200	50	80	90
400	70	75	1-10

DIACS

FOR USE WITH TRIACS
BR100 D32... 37p each

UNIUNION

UT46, Eqvt. 2N2946, Eqvt. TI843, BEN3000
27p each, 25-99 25p
100 UP 20p.

NPN SILICON PLANAR
BC107/108, 10p each;
50-99, 8p; 100 up,
7p each. Fully tested
and coded TO-18 case.

FREE

One 50p Pak of your
own choice free or with
orders valued \$4 or over.

SPECIAL OFFER

2N2928 (Y) (O), 10 for
60p, 25 for \$1, 20,000
TO CLEAR.

CADMIUM CELLS

ORP12 43p
ORP60, ORP61 40p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS.

TO-18 SIM TO 2N706/8, BSY27/28/95A. Available devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BGY70. When ordering please state preference NPN or PNP.

20	For	0.50
50	For	1.00
100	For	1.75
500	For	7.50
1000	For	13.00

PHOTO TRANS.

OCPT1 Type 43p.

SIL. G.P. DIODES 5p
300mV 30... 0.50
400IV (Min.) 100... 1.50
Sub-Min. 500... 5.00
Full Tested 1,000 9.00
Ideal for Organ Builders.

D13D1 Silicon Unilateral switch

50p each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

FULL RANGE OF ZENER DIODES
Voltage Range 2-33V, 400mV (D0-7 Case) 13p ea. 14W (Top-Hat) 18p ea. 10W (S-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10amp POTTED BRIDGE RECTIFIERS on heat sink, 100 PIV. 90p each.

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Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & T.

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Plus your satisfaction or money back guarantee.

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Coded and Guaranteed
Pak No. EQVT
T1 8 2G371B OC71
T2 8 D1374 OC75
T3 8 D1216 OC81D
T4 8 2G381T OC81
T5 8 2G382T OC82
T6 8 2G344B OC44
T7 8 2G384B OC45
T8 8 2G373 OC78
T9 8 2G389A 2N1302
T10 8 2G417 AF117
All 50p each pak

2N2906 NPN SIL. DUAL TRANS. CODE D1839 TEXAS. Our price 25p each.

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Sim. B8X21 & C407, 2N1893 FULLY TESTED AND CODED NED20. 1-24 17p each. TO-5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

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Each	50V RMS	32p
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	400V RMS	46p
	Size	10mm x 6mm

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Pak No.	Description	\$p
U1	120 Glass sub-min. general purpose germanium diodes	0.50
U2	60 Mixed germanium transistors AF/RF	0.50
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U4	40 Germanium transistors like OC81, AC128	0.50
U5	60 200mA sub-min. Sil. diodes	0.50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0.50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0.50
U8	50 Sil. planar diodes 250mA, OA/200/202.	0.50
U9	20 Mixed volts 1 watt Zener diodes	0.50
U11	25 PNP silicon planar transistors TO-5 sim. 2N1132	0.50
U13	30 PNP-NPN sil. transistors OC200 & 28104	0.50
U14	150 Mixed silicon and germanium diodes	0.50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0.50
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0.50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0.50
U18	8 6-Amp silicon rectifiers BY213 type up to 600 PIV	0.50
U19	25 Silicon NPN transistors like BC108	0.50
U20	12 1.5-Amp silicon rectifiers Top-Hat up to 1,000 PIV	0.50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0.50
U23	30 Matt's like MAT series PNP transistors	0.50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0.50
U25	25 300Mc/s NPN silicon transistors 2N708, HSY27	0.50
U26	30 Fast switching silicon diodes like IN914 micro-min	0.50
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CR81/25-600	1.00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0.50
U32	25 Zener diodes 400mW D07 case mixed volts, 3-18	0.50
U33	15 Plastic case 1 amp silicon rectifiers IN4000 series	0.50
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 28302/4	0.50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0.50
U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0.50
U37	30 Sil. alloy trans. SO-2 PNP. OC200 28322	0.50
U38	20 Fast switching sil. trans. NPN. 400Mc/s 2N3011	0.50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0.50
U40	10 Dual trans. 6 lead TO-5 2N2060	0.50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0.50
U42	10 VHF germ. PNP trans. TO-1 NKT667 AF117.	0.50
U43	25 Sil. trans. plastic TO-18 A.F. BC113/114	0.50
U44	20 Sil. trans. plastic TO-5 BC115/116	0.50
U45	7 3A SCR's TO-66 up to 600 Piv.	1.00

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

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GENERAL PURPOSE GERM. PNP
Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE: OC25-28-29-30-35-36. NKT 401-403-404 405-406-430-431-432-433. T13027-3028... 2N504A, 2N436A-437A-438A, 2N511 A & B, 2C290-322, ETC.
V_{CEO} 80V V_{CEO} 50V I_C 10A PT. 30 WATTS Hie 30-170.
PRICE 1-24 25-99 100 up
43p each 40p each 36p each

SILICON High Voltage 250V NPN		2N3055	
TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400	V _{CEO} 250V/V _{CEO} 100/IC 6A/30 Watts. HFE type 20/FT 5MHz.	115 WATT SIL POWER NPN	50p EACH
OUR PRICE EACH:	1-24 25-99 100 up		
	50p 45p 40p		
EX-STOCK TYPE EACH AS PRICED			
OC20 50p	OC28 40p	AD149 43p	BD131 70p
BD139 75p	BD140 85p		
OC23 33p	OC35 33p	AL108 85p	BD135 70p
BD155 75p			
OC24 45p	OC36 40p	BD121 60p	DB136 80p
BU105 23			
OC25 25p	AD14040p	BD123 75p	BD137 70p
2N3054 45p			
OC26 25p	AD14240p	BD124 70p	BD138 80p

RTL MICROLOGIC CIRCUITS

Price each		
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uL914 Dual 21/p gate	35p	33p 27p
uL923 J-K flip-flop	50p	47p 45p
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TS016	35p	32p	30p
Low Cost No.	1-24	25-99	100 up
BP814	15p	13p	11p
BP816	16p	14p	12p

NEW QUALITY TESTED PAKS

Pak Description	Price \$p
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Q3 4 OC77 type trans.	0.50
Q4 6 Matched trans. OC44/45/81/81D	0.50
Q5 4 OC75 transistors	0.50
Q6 4 OC72 transistors	0.50
Q7 4 AC128 trans. PNP high gain	0.50
Q8 4 AC126 trans. PNP	0.50
Q9 7 OC81 type trans.	0.50
Q10 7 OC71 type trans.	0.50
Q11 2 AC127/128 comp. pairs PNP/NPN	0.50
Q12 3 AF116 type trans.	0.50
Q13 3 AF117 type trans.	0.50
Q14 3 OC171 H.F. type trans.	0.50
Q15 5 2N2928 sil. epoxy trans.	0.50
Q16 2 GET880 low noise germ. trans.	0.50
Q17 3 NPN 1 ST141 & 2 ST140	0.50
Q18 4 Matt's 2 MAT 100 & 2 MAT 120	0.50
Q19 3 Matt's 2 MAT 101 & 1 MAT 121	0.50
Q20 4 OC44 germ. trans. A.F.	0.50
Q21 3 AC127 NPN germ. trans.	0.50
Q22 20 NKT trans. A.F. R.F. cooled	0.50
Q23 10 OA292 sil. diodes germ.-min.	0.50
Q24 8 OA81 diodes	0.50
Q25 6 IN914 sil. diodes 75PIV 75mA	0.50
Q26 8 OA95 germ. diodes sub-min. IN69	0.50
Q27 2 OA 600PIV sil. rects. 1845R	0.50
Q28 2 Sil. power rects. BY213	0.50
Q29 4 Sil. trans. 2 x 2N596. 1 x 2N697. 1 x 2N698	0.50
Q30 7 Sil. switch trans. 2N706 NPN	0.50
Q31 6 Sil. switch trans. 2N708 NPN	0.50
Q32 3 PNP sil. trans. 2 x 2N1131. 1 x 2N1132	0.50
Q33 3 Sil. NPN trans. 2N1711	0.50
Q34 7 Sil. NPN trans. 2N2389, 500MHz	0.50
Q35 3 Sil. PNP TO-5 2 x 2N2904 & 1 x 2N2905	0.50
Q36 7 2N3646 TO-18 plastic 300MHz NPN	0.50
Q37 3 2N3055 NPN sil. trans.	0.50
Q38 7 PNP trans. 4 x 2N3702, 3 x 2N3702	0.50
Q39 7 NPN trans. 4 x 2N3704, 3 x 2N3705	0.50
Q40 7 NPN amp. 4 x 2N3707, 3 x 2N3708	0.50
Q41 3 Plastic NPN TO-18 2N3904.	0.50
Q42 6 NPN trans. 2N5172.	0.50
Q43 7 BC107 NPN trans.	0.50
Q44 7 NPN trans. 4 x BC108, 3 x BC109	0.50
Q45 3 BC119 NPN TO-18 trans.	0.50
Q46 3 BC115 NPN TO-5 trans.	0.50
Q47 6 NPN high gain 3 x BC167, 3 x BC168	0.50
Q48 4 BCY70 NPN trans. TO-18	0.50
Q49 4 NPN trans. 2 x BFY51, 2 x BFY52	0.50
Q50 7 BSY28 NPN switch TO-18	0.50
Q51 7 BSY54 NPN trans. 300MHz.	0.50
Q52 8 BY100 type sil. rect.	1.00
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2N3820	50p	2N5459	40p
2N3821	35p	BFW10	40p
2N3823	30p	MPF105	40p

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BP00=8N7400	£p	£p	£p	BP86=8N7486	0.32	0.30	0.28
BP01=8N7401	0.15	0.14	0.12	BP90=8N7490	0.87	0.84	0.58
BP02=8N7402	0.15	0.14	0.12	BP91=8N7491AN	0.87	0.84	0.78
BP03=8N7403	0.15	0.14	0.12	BP92=8N7492	0.87	0.84	0.58
BP04=8N7404	0.15	0.14	0.12	BP93=8N7493	0.87	0.84	0.58
BP05=8N7405	0.15	0.14	0.12	BP94=8N7494	0.77	0.74	0.68
BP07=8N7407	0.18	0.17	0.16	BP95=8N7495	0.77	0.74	0.68
BP08=8N7408	0.18	0.17	0.16	BP96=8N7496	0.77	0.74	0.68
BP09=8N7409	0.18	0.17	0.16	BP100=8N74100	1.75	1.65	1.55
BP10=8N7410	0.15	0.14	0.12	BP104=8N74104	0.97	0.94	0.88
BP13=8N7413	0.29	0.28	0.24	BP105=8N74105	0.97	0.94	0.88
BP16=8N7416	0.43	0.40	0.38	BP107=8N74107	0.40	0.38	0.38
BP17=8N7417	0.43	0.40	0.38	BP110=8N74110	0.55	0.53	0.50
BP20=8N7420	0.15	0.14	0.12	BP111=8N74111	1.25	1.15	1.00
BP30=8N7430	0.15	0.14	0.12	BP118=8N74118	1.00	0.95	0.90
BP40=8N7440	0.18	0.17	0.16	BP119=8N74119	1.35	1.25	1.10
BP41=8N7441	0.87	0.84	0.58	BP121=8N74121	0.87	0.84	0.58
BP42=8N7442	0.87	0.84	0.58	BP141=8N74141	0.87	0.84	0.58
BP43=8N7443	1.95	1.85	1.75	BP145=8N74145	1.50	1.40	1.30
BP44=8N7444	1.95	1.85	1.75	BP150=8N74150	1.80	1.70	1.80
BP45=8N7445	1.95	1.85	1.75	BP151=8N74151	1.00	0.95	0.90
BP46=8N7446	0.87	0.84	0.88	BP155=8N74155	1.20	1.10	0.85
BP47=8N7447	0.87	0.84	0.88	BP174=8N74174	1.80	1.70	1.80
BP48=8N7448	0.97	0.94	0.88	BP155=8N74155	1.40	1.30	1.20
BP50=8N7450	0.15	0.14	0.12	BP156=8N74156	1.40	1.30	1.20
BP51=8N7451	0.15	0.14	0.12	BP160=8N74160	1.80	1.70	1.80
BP53=8N7453	0.15	0.14	0.12	BP161=8N74161	1.80	1.70	1.80
BP54=8N7454	0.15	0.14	0.12	BP164=8N74164	2.00	1.90	1.80
BP60=8N7460	0.15	0.14	0.12	BP165=8N74165	2.00	1.90	1.80
BP70=8N7470	0.29	0.28	0.24	BP181=8N74181	2.75	2.60	2.40
BP72=8N7472	0.29	0.28	0.24	BP182=8N74182	0.97	0.94	0.88
BP73=8N7473	0.37	0.35	0.32	BP190=8N74190	3.50	3.25	3.00
BP74=8N7474	0.37	0.35	0.32	BP191=8N74191	3.50	3.25	3.00
BP75=8N7475	0.47	0.45	0.42	BP192=8N74192	2.10	1.95	1.75
BP76=8N7476	0.43	0.40	0.38	BP193=8N74193	2.10	1.95	1.75
BP80=8N7480	0.67	0.64	0.58	BP125=8N74125	1.10	1.05	0.85
BP81=8N7481	0.97	0.94	0.88	BP198=8N74198	1.80	1.70	1.80
BP82=8N7482	0.97	0.94	0.88	BP197=8N74197	1.80	1.70	1.80
BP83=8N7483	1.10	1.05	0.95	BP198=8N74198	5.50	5.00	4.00
				BP199=8N74199	5.50	5.00	4.00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442.

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Type No.	Price	1-24	25-99	100 up	Type No.	Price	1-24	25-99	100 up
BP 201C -8L201C	83p	53p	45p		BP930	12p	11p	10p	
BP 701C -8L701C	83p	50p	45p		BP932	13p	12p	11p	
BP 702C -8L702C	83p	50p	45p		BP933	13p	12p	11p	
BP 702	72702	53p	45p	40p	BP935	13p	12p	11p	
BP 709	72709	53p	45p	40p	BP936	13p	12p	11p	
BP 709P	μA709C	53p	45p	40p	BP944	13p	12p	11p	
BP 710	72710	53p	45p	40p	BP945	25p	24p	22p	
BP 711	μA711	53p	45p	40p	BP946	12p	11p	10p	
BP 741	72741	75p	60p	50p	BP948	25p	24p	22p	
μA 703C μA703C	43p	35p	27p		BP951	8p	6p	5p	
TAA 263	70p	80p	55p		BP962	12p	11p	10p	
TAA 293	70p	75p	70p		BP9093	40p	38p	35p	
TAA 350	170p	158p	150p		BP9094	40p	38p	35p	

NUMERICAL INDICATOR TUBES



MODEL	CU66	GR116	3015P
Anode voltage (Vdc)	170 min	175 min	5 min
Cathode current (mA)	2.3	14	8
Numerical height (mm)	16	13	9
Tube height (mm)	47	32	22
Tube diameter (mm)	19	13	12 wide
I.C. driver rec.	BP41 or 141	BP41 or 141	BP47
Price each	£1.70	£1.55	£1.90

All indicators 0-9 + Decimal point: All side viewing: Full data for all types available on request.

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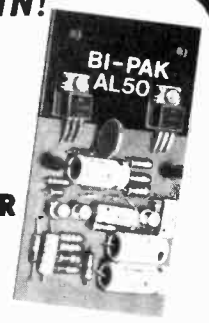
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ONLY
£3.25p each
★ Supply voltage 10-35 volts.
★ Overall size 63mm x 103mm x 13mm

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs. **FULLY BUILT—TESTED—GUARANTEED.**

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DTL AND TTL INTEGRATED CIRCUITS

Manufacturers' "Full out"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C.'s and experimental work.

Pak No.	Price	Pak No.	Price
UC1930 = 12 x μA 930	50p	UC1948 = 8 x μA 948	50p
UC1932 = 12 x μA 932	50p	UC1951 = 5 x μA 951	50p
UC1933 = 12 x μA 933	50p	UC1961 = 12 x μA 961	50p
UC1935 = 8 x μA 935	50p	UC19093 = 5 x μA 9093	50p
UC1936 = 12 x μA 936	50p	UC19094 = 5 x μA 9094	50p
UC1944 = 12 x μA 944	50p	UC19097 = 5 x μA 9097	50p
UC1945 = 8 x μA 945	50p	UC19099 = 5 x μA 9099	50p
UC1946 = 12 x μA 946	50p	UC19X 25 Ass'd 930 Series	£1.50

Paks cannot be split but 25 Assorted Pieces (out mix) is available as PAK UC19X. Data Booklet available for the BP930 Series. PRICE 13p.

UC100 = 12 x 7400N	50p	UC148 = 5 x 7446N	50p	UC181 = 5 x 7481N	50p
UC101 = 12 x 7401N	50p	UC147 = 5 x 7447N	50p	UC182 = 5 x 7482N	50p
UC102 = 12 x 7402N	50p	UC148 = 5 x 7448N	50p	UC183 = 5 x 7483N	50p
UC103 = 12 x 7303N	50p	UC150 = 12 x 7450N	50p	UC186 = 5 x 7486N	50p
UC104 = 12 x 7404N	50p	UC151 = 12 x 7451N	50p	UC190 = 5 x 7490N	50p
UC105 = 12 x 7405N	50p	UC153 = 12 x 7453N	50p	UC191 = 5 x 7491N	50p
UC110 = 12 x 7410N	50p	UC154 = 12 x 7454N	50p	UC192 = 5 x 7492N	50p
UC113 = 8 x 7413N	50p	UC160 = 12 x 7460N	50p	UC193 = 5 x 7493N	50p
UC120 = 12 x 7420N	50p	UC170 = 8 x 7470N	50p	UC194 = 5 x 7494N	50p
UC140 = 12 x 7440N	50p	UC172 = 8 x 7472N	50p	UC195 = 5 x 7495N	50p
UC141 = 5 x 7441N	50p	UC173 = 8 x 7473N	50p	UC196 = 5 x 7496N	50p
UC142 = 5 x 7442N	50p	UC174 = 8 x 7474N	50p	UC197 = 5 x 7497N	50p
UC143 = 5 x 7443N	50p	UC175 = 8 x 7475N	50p	UC198 = 5 x 7498N	50p
UC144 = 5 x 7444N	50p	UC176 = 8 x 7476N	50p	UC199 = 5 x 7499N	50p
UC145 = 5 x 7445N	50p	UC180 = 5 x 7480N	50p	UC19X1 = 25 x Ass'd 74's	£1.50

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100V	0.22µF	6p	16V	47µF	7p
100V	0.33µF	9p	25V	10µF	7p
100V	0.47µF	10p	25V	100µF	9p
100V	0.68µF	15p	25V	220µF	11p
250V	0.01µF	5p	25V	470µF	14p
250V	0.015µF	5p	25V	1,000µF	22p
250V	0.022µF	5p	35V	2,200µF	42p
250V	0.033µF	6p	35V	4.7µF	7p
250V	0.047µF	6p	35V	220µF	14p
250V	0.068µF	6p	100V	10µF	9p
250V	0.1µF	6p	100V	22µF	9p
			100V	47µF	14p

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AD162	27p	25p	NKT212	24p	19p	IN4005	10p	9p
AF139	28p	26p	NKT213	24p	19p	IN4006	12p	11p
BC107	9p	8p	NKT214	19p	17p	IN4007	18p	16p
BC108	8p	7p	NKT218	24p	19p	IN4148	4p	3p
BC109	9p	8p	NKT219	24p	19p	2N1302	16p	15p
BC147	8p	7p	NKT223	26p	20p	2N1304	21p	20p
BC148	8p	7p	NKT224	21p	19p	2N1613	14p	13p
BC149	8p	7p	NKT242	14p	12p	2N1711	15p	14p
BCY70	14p	13p	NKT243	51p	44p	2N2904	29p	28p
BCY71	20p	19p	NKT401	70p	56p	2N2905	24p	22p
BCY72	14p	12p	NKT402	75p	59p	2N2906	19p	18p
BDY20	91p	73p	NKT403	64p	50p	2N2907	22p	21p
BFX29	24p	23p	NKT453	41p	33p	2N3053	17p	16p
BFX30	24p	23p	OA7	6p	5p	2N3054	49p	47p
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Ref. No.	VA (Watts)	Weight lb oz	Size cm.	P & P £ p
07	20	1 11	7.0 x 6.0 x 6.5	1-61 30
100	60	3 8	8.9 x 8.0 x 7.7	2-39 36
61	100	5 12	10.2 x 8.9 x 8.3	2-62 52
30	200	9 8	12.0 x 10.3 x 10.0	4-39 52
62	250	12 4	9.5 x 12.7 x 11.4	5-80 67
55	350	15 0	14.0 x 10.8 x 12.4	7-77 82
63	500	27 0	17.1 x 11.4 x 15.9	11-20 82
92	1000	40 0	17.8 x 17.1 x 21.6	20-63 82
128	2000	63 0	24.1 x 21.6 x 15.2	34-10 82

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	Auto Taps	P & P £ p
113	20	1 11	7.3 x 4.3 x 4.4	0-115-210-240	0-85 22
64	75	1 14	7.0 x 6.4 x 6.0	0-115-210-240	1-66 30
4	150	3 0	8.9 x 6.4 x 7.6	0-115-200-220-240	2-00 36
66	300	6 0	10.2 x 10.2 x 9.5	"	3-89 52
67	500	12 8	14.0 x 10.2 x 11.4	"	5-78 67
84	1000	16 0	11.4 x 14.0 x 14.0	"	10-49 82
93	1500	28 9	13.5 x 14.9 x 16.5	"	15-20 82
95	2000	40 0	17.8 x 16.5 x 21.6	"	19-84 82
73	3000	45 8	17.4 x 18.1 x 21.3	"	26-99 82

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Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Windings	P & P £ p
111	0.5	2 5	7.6 x 5.7 x 4.4	0-12V at 0.25A x 2	0-85 22
213	1.0	5 1	8.3 x 5.1 x 5.1	0-12V at 0.5A x 2	1-01 22
71	2	1 1	7.0 x 6.4 x 6.0	0-12V at 1A x 2	1-33 22
18	4	2 2	8.3 x 7.0 x 7.0	0-12V at 2A x 2	1-86 36
70	6	3 3	10.2 x 7.6 x 8.6	0-12V at 3A x 2	2-24 42
108	8	4 5	10.8 x 8.3 x 8.2	0-12V at 4A x 2	2-48 52
72	10	5 6	12.1 x 9.5 x 10.2	0-12V at 5A x 2	2-94 52
17	16	8 7	12.1 x 9.5 x 10.2	0-12V at 8A x 2	4-44 52
115	20	10 11	12.1 x 11.4 x 10.2	0-12V at 10A x 2	5-78 67
187	30	15 16	13.3 x 12.1 x 12.1	0-12V at 15A x 2	10-67 82
226	60	30 34	17.0 x 14.5 x 12.5	0-12V at 30A x 2	19-61 82

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
112	0.5	1 4	8.3 x 3.7 x 4.9	0-12-15-20-24-30V	1-01 22
79	1.0	2 0	7.0 x 6.4 x 6.0	"	1-35 36
3	2.0	3 2	8.9 x 6.0 x 7.6	"	1-71 36
20	3.0	4 6	10.2 x 8.9 x 8.6	"	2-48 42
21	4.0	6 0	10.2 x 10.0 x 8.6	"	2-94 52
51	5.0	6 8	12.1 x 10.0 x 8.6	"	3-66 52
117	6.0	7 8	12.1 x 10.0 x 10.2	"	4-36 52
88	8.0	10 0	14.0 x 11.7 x 10.0	"	5-64 67
89	10.0	12 2	14.0 x 10.2 x 11.4	"	7-14 67

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
102	0.5	1 11	7.0 x 7.0 x 5.7	0-19-25-33-40-50V	1-33 30
103	1.0	2 10	8.3 x 7.3 x 7.0	"	1-94 36
104	2.0	5 0	10.2 x 8.9 x 8.6	"	2-69 42
105	3.0	6 0	10.2 x 10.2 x 8.3	"	3-65 52
106	4.0	9 4	12.1 x 11.4 x 10.2	"	4-83 52
107	6.0	12 4	12.1 x 11.1 x 13.3	"	7-14 67
118	8.0	18 9	13.3 x 13.3 x 12.1	"	9-31 67
119	10.0	19 12	16.5 x 11.4 x 15.9	"	11-68 97

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
124	0.5	2 4	8.3 x 9.5 x 6.7	0-24-30-40-48-60V	1-35 36
126	1.0	3 0	8.9 x 7.6 x 7.6	"	1-88 36
127	2.0	5 6	10.2 x 8.9 x 8.6	"	2-94 42
125	3.0	8 8	11.9 x 9.5 x 10.0	"	4-48 52
123	4.0	10 6	11.4 x 9.5 x 11.4	"	5-78 67
120	6.0	16 12	13.3 x 12.1 x 12.1	"	8-37 82
122	10.0	23 2	16.5 x 12.7 x 16.5	"	13-85 82

Ref. No.	Amps.	Weight lb oz	Size cm.	P & P £ p
45	1.5	1 9	7.0 x 6.0 x 6.0	1-34 30
5	4.0	3 11	10.2 x 7.0 x 8.3	2-03 42
86	6.0	5 12	10.2 x 8.9 x 8.3	3-07 52
146	8.0	6 4	8.9 x 10.2 x 10.2	3-49 52
50	12.5	11 14	13.3 x 10.8 x 12.1	5-20 67

All ratings are continuous. Standard construction: open with solder tags and wax impregnation. Enclosed styles to order.

Ref. No.	Amps.	Weight lb oz	Size cm.	P & P £ p
BC107/108/109	9.0p	each	2N 3055 68p	each
	25+	7p	+ mica and bushes	AD 161/162 60p
	100+	6.5p	25+ 55p	+ mica and bushes
	500+	6p	100+ 45p	25+ 55p
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10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS AND AIRCRAFT BAND.

Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated telescopic aerial, for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. Switched earpiece socket complete with earpiece. 10 transistors plus 3 diodes. 8" x 2 1/2" speaker. Air spaced ganged tuning condenser with VHF section. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in x 7in x 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts).

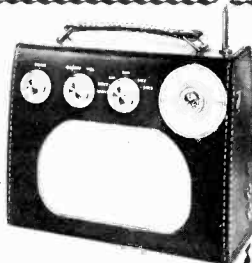
TOTAL BUILDING COSTS

£8-50

P.P. & INS. 50p
(OVERSEAS P. & P. £1)



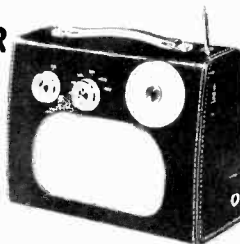
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7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. Switched earpiece socket complete with earpiece. 8 transistors plus 3 diodes. 8" x 2 1/2" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£6-98** P.P. & INS. 41p
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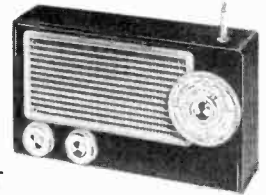
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7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. 8" x 2 1/2" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening. 30p extra.

TOTAL BUILDING COSTS **£5-98** P.P. & INS. 41p
(OVERSEAS P. & P. £1)

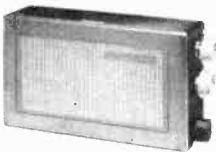
ROAMER SIX



6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages - 6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£3-98** P.P. & INS. 26p
(OVERSEAS P. & P. £1)

POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages - 5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5 1/2in x 1 1/2in x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£2-23** P.P. & INS. 21p
(OVERSEAS P. & P. 63p)

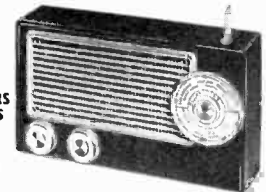
TRANSONA FIVE



5 TRANSISTORS AND 2 DIODES
3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage - 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6 1/2in x 4 1/2in x 1 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£2-50** P.P. & INS. 22p
(OVERSEAS P. & P. 63p)

TRANS EIGHT



8 TRANSISTORS AND 3 DIODES
6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£4-48** P.P. & INS. 31p
(OVERSEAS P. & P. £1)



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BUILD RADIOS, AMPLIFIERS, ETC., FROM EASY STAGE DIAGRAMS. FIVE UNITS INCLUDING MASTER UNIT TO CONSTRUCT. Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: 4" 2 1/2" Speaker: Terminal Strip: Ferrite Rod Aerial: 3 Plugs and Sockets: Battery Clips: 4 Tag Boards Balanced Armature Unit: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three 1/2in Knobs

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Parts price list and plans for

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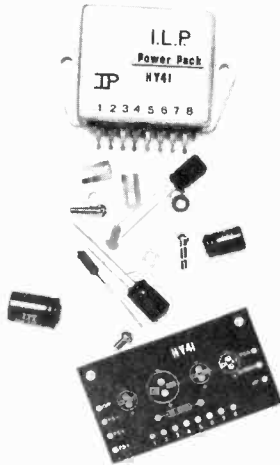
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THE HY41



The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts

R.M.S. continuous.

LOAD IMPEDANCE: 4-16 ohms.

INPUT IMPEDANCE: 30K ohms at 1KHz.

VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%) at 1KHz.

FREQUENCY RESPONSE: 5Hz-50KHz \pm 1db.

SUPPLY VOLTAGE: + 22.5volts D.C.

SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P.:-
MONO: £4.90 **STEREO: £9.80**

UNIQUE HYBRID PRE-AMPLIFIER

The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16-50 Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely integrated system.

INPUTS

Magnetic Pick-up (within \pm 1db RIAA curve)
2mV. 47K Ω

Tape Replay (external components to suit head). 4mV. 47K Ω

Microphone (flat) 10mV. 47K Ω

Ceramic Pick-up (equalized and compensatable) 20-2000mV. variable.

Tuner (flat) 250mV. 100K Ω

Auxiliary 1 250mV. 47K Ω

Auxiliary 2 2-20mV. 100K Ω

OUTPUTS

Main Pre-amp output 500mV.

Direct tape output 120mV.

ACTIVE TONE CONTROLS (Baxendall)

Treble + 12db.

Bass + 12db.

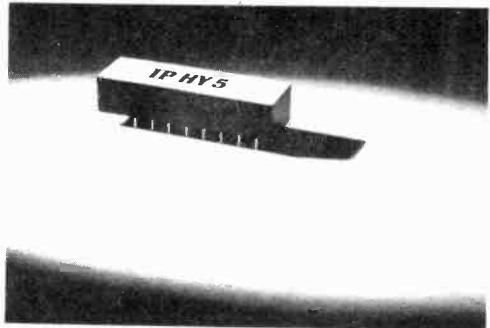
INTERNAL STABILIZATION

Enables the HY5 to share an unregulated supply with the Power Amplifier.

SUPPLY VOLTAGE

16-50 volts

PRICE: MONO: £3.60 STEREO: £7.20



SUPPLY CURRENT

6mA approx.

OVERLOAD CAPABILITY

better than 26db on most sensitive input infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE: 0.5mV.

POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

Specification

Input: 200-240 Volts.

Output: \pm 22.5 Volts at 2 amps.

Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: £4.50 inc. P. & P.



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CONNOISSEURS AND CONSUMERS

DESPITE current technical progress, the past compels attention today, possibly more than ever before. It is significant that industrial archeology has developed into a popular study for young and old alike; while antique collecting extends beyond the fine art of painter and potter and embraces the more prosaic and practical works of engineer and craftsman as well.

Such nostalgia has not bypassed electronics. We know there are people who still cherish some early model radio, or gramophone. The characteristic materials of the '20s and '30s, predominantly mahogany, ebonite, and brass, infused a sense of sturdy dignity and dependability into these early electronic products. Their obsolescence came about not because of any physical failure, but because technical progress passed them by.

Mass production, in all branches of engineering, has spread benefits far and wide. But in the process, quality and substance has all too often been sacrificed. In a fast changing industry such as electronics, these effects are frequently all too apparent, especially in consumer products.

Designers of domestic entertainment equipments are without doubt fully conscious of the ephemeral nature of today's electronic circuits. This realisation coupled with strong commercial instincts makes certain that few radio and audio equipments of this decade will be around in 2000 to be proudly displayed as mementoes of the "late transistor—early i.c." period of electronic entertainment history. (Aluminium plus all the trimmings combined with teak wafers can give a cheaply splendid appearance, but not the durability of solid mahogany and brass. All this contrasts strangely with the inherent long life and reliability of most modern circuit components.)

Yet it is an inevitable result of rapid technological change that modern products should tend to have but a brief life. We are already being conditioned to accept that servicing is an uneconomical proposition for many of the cheaper "consumer products".

Small wonder therefore that in our more reflective moments we look back upon some of yesterday's technological achievements with an appreciative and even envious eye. Particularly where they well demonstrate the skills and meticulous care of some individual craftsman or engineer.

Fortunately, the craft tradition has survived mass production, and today is perpetuated in the electronics field by a host of individuals who design and build their own equipments. Who knows, posterity may well have cause to be grateful to such amateurs, and for tangible evidence of their enterprise, skill, and single minded devotion to a given task!
F.E.B.

THIS MONTH

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*Our September issue will be published on
Friday, August 11*

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CAMERA SHUTTER TESTER



By D. BOLLEN

WHEN an occasional shot taken with a camera turns out to be under or over exposed, this could be due to equipment error. Brand new professional cameras costing hundreds of pounds sometimes show exposure variations of as much as 30 per cent, and this figure tends to get much worse with age.

In most cases, the shutter is responsible for exposure errors. By comparison, the mechanism for setting the aperture is simpler and less prone to abuse.

MEASURING SHUTTER SPEED

Camera shutters are normally calibrated in fractions of a second, with the one omitted, thus 1/25 second is shown as 25 and is equivalent to a decimal time of 40 milliseconds (1,000/25). Camera shutter testers are calibrated in milliseconds, mainly because this can easily be shown on a linear meter scale, and the operator quickly learns to convert the reading into fractions, or refers to a simple conversion chart. The range of shutter speeds covered by most medium price cameras is 1 second to 1/1,000 second.

To measure shutter speed, a light beam is shone through the camera lens on to a photocell positioned

close to the film plane, and at slow shutter speeds the output is a rectangular shaped pulse, Fig. 1a, which has a width identical to effective shutter speed.

At fast speeds, however, the time taken by the shutter to open and close becomes significant, giving the pulse a taper, as shown in Fig. 1b. As long as this fast pulse has a linear rise and fall, and is symmetrical, the mid-point pulse width will be a true measure of effective shutter speed, but shutters are far from linear, and sometimes take longer to open than to close, or vice versa.

PULSE SHAPE DISTORTION

A factor often overlooked is pulse shape distortion caused by the slow response and non-linearity of ordinary photodevices. A representative modern silicon phototransistor has a logarithmic type response to light intensity and a rise time of as much as 250 microseconds, which alters the true pulse shape to something like that shown in Fig. 1c.

On the other hand, if the phototransistor is operated so that it becomes saturated with light before the shutter is fully open, this could make pulse rise and fall times much steeper than they should be, as in Fig. 1d.

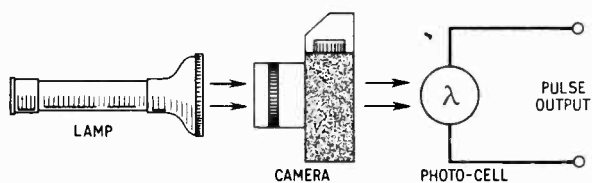
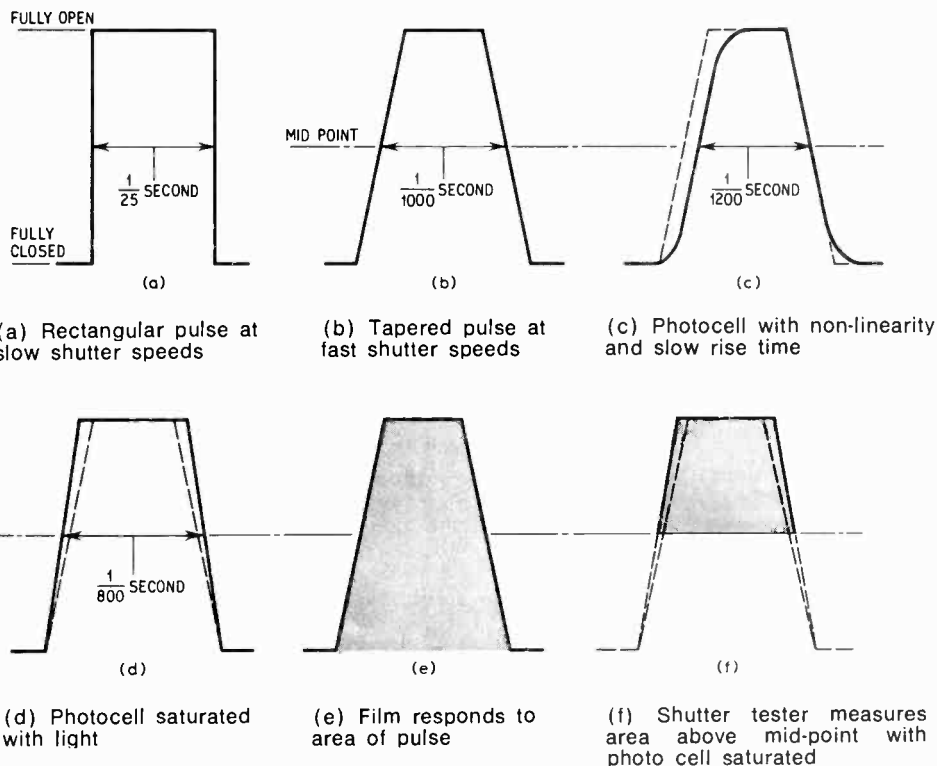


Fig. 1. The principles of the camera shutter tester



At fast shutter speeds, therefore, considerable distortion of the shutter pulse shape can occur, and the accuracy of the shutter tester will then depend mainly on the characteristics and operating mode of the photodevice than on the timing circuit which follows it.

Of course, a film responds not to the width of the shutter pulse but to its area, and integrates the light on an intensity time basis, see Fig. 1e. A result quite close to true shutter speed can be obtained by just saturating a phototransistor so that rise and fall times are slightly steeper than they should be, and then measuring the area of the pulse above mid-point with an electronic integrator, Fig. 1f. This is the system used here, and it caters for slow as well as fast shutter pulses.

FOCAL PLANE SHUTTER MEASUREMENT

Yet another problem can occur in the measurement of focal plane shutter speeds, where a slit in a roller blind travels across the surface of the film. At fast speeds this slit may be more than one or two millimetres wide, and the time required to be checked is how long light shines on a microscopically small spot on the film, rather than how long it

remains on the larger sensitive area of a phototransistor.

If the width of the photosensitive area is the same as the width of the focal plane slit, the shutter tester will record a time of 50 per cent greater than the actual speed. The answer here is to place a slit of about 0.5mm between the shutter and the phototransistor, exactly parallel to the slit in the blind, but this will, of course, reduce sensitivity.

Although some professional camera testing stations claim a measurement error of one or two per cent, with the aid of digital time meters, this is seldom realised in practice, certainly at fast shutter speeds, because of the problems outlined above. It was felt therefore that an error of ± 5 per cent for the timing circuit would be more than adequate.

BASIC CIRCUIT

The shutter tester uses an i.c. operational amplifier integrator to cover shutter speeds from 10 seconds to less than 1/1000 second, and can be calibrated with nothing more than a stopwatch or clock with a sweep second hand.

Readout is with a moving coil meter calibrated 0.3 and 0.10, with full scale coverage of 10 seconds

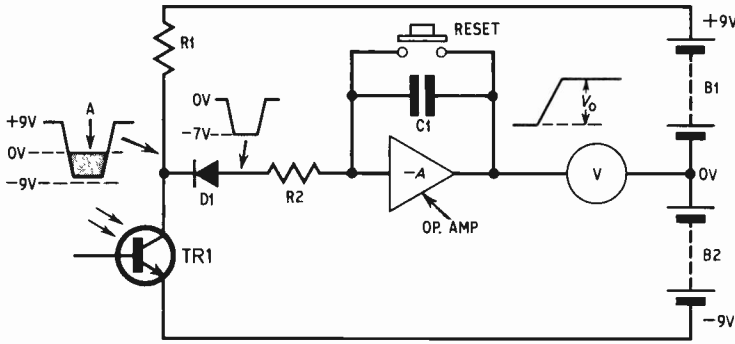


Fig. 2. Basic circuit principles of the tester

to 3 milliseconds in eight steps, with an additional switch position for aligning a lamp with the phototransistor.

Fig. 2 shows the basic circuit of the shutter tester. Phototransistor TR1 develops a negative going pulse at its collector when the shutter is operated, and this is fed via diode D1 and input resistor R2 to the inverting input of the operational amplifier. Capacitor C1 charges linearly when TR1 collector drops below 0V; the circuit therefore measures the area of that part of the pulse between 0V and the combined saturation voltage of TR1 and D1 (about -7V).

Diode D1 isolates the integrator input after an input pulse, leaving a charge on C1 which is proportional to shutter time. If C1 is made greater than, say, 10 μ F the charge will be retained for many minutes, long enough for the voltmeter to "hold" its reading after the shutter has been operated.

The circuit in Fig. 2 can accommodate a wide range of shutter speeds by means of switched values of input resistor R2.

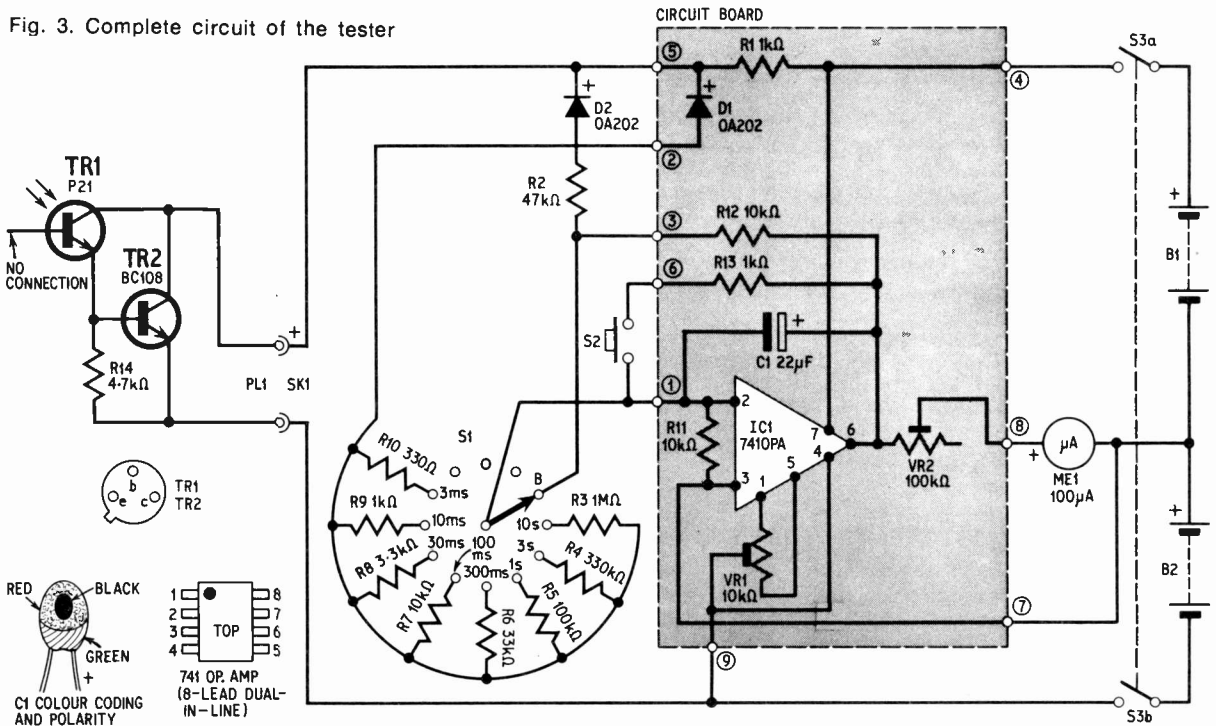
TIMING CIRCUIT

The complete timing circuit of the shutter tester is shown in Fig. 3. The light probe is connected via SK1, with R1 acting as the "collector" load resistor. Resistors R3 to R10 provide the integrator time ranges; switch position "B" places a feedback resistor R12 across integrating capacitor C1, to convert the integrator to a linear amplifier with a gain of less than unity.

Resistor R2 is selected to give approximately half scale deflection of meter ME1 when the phototransistor is saturated with light. The diode D2 prevents a reverse voltage being developed across the meter in the absence of illumination. Thus, with S1 in the "B" position, and the camera shutter held open, a lamp in front of the camera can be aligned so as just to saturate the phototransistor by observing the meter reading.

The integrated circuit IC1 is a type 741 operational amplifier with internal frequency compensa-

Fig. 3. Complete circuit of the tester



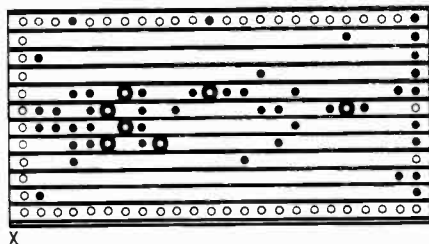
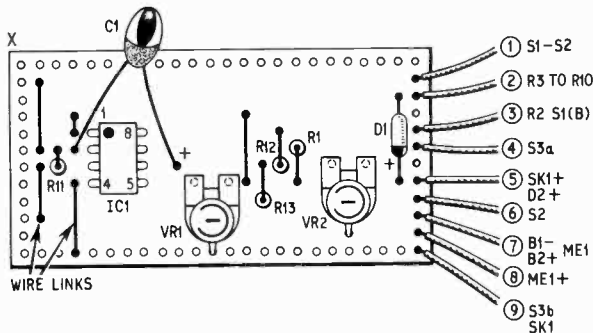


Fig. 4. The components assembled on 0.1in matrix board with the copper strip side shown below

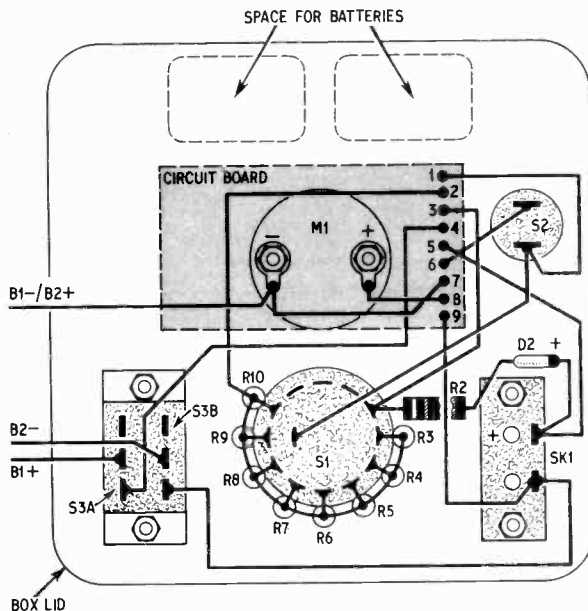
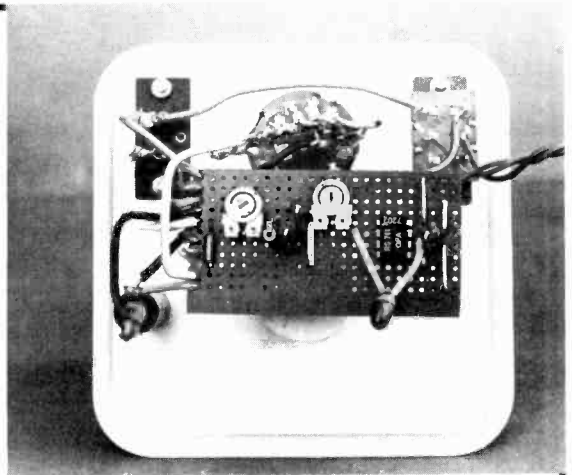


Fig. 5. The component assembly board (dotted) mounted in the box with the other controls and components



Rear view of front panel with circuit board mounted

COMPONENTS . . .

Resistors

*R1 1k Ω	R8 3.3k Ω
*R2 47k Ω	R9 1k Ω
R3 1M Ω	R10 330 Ω
R4 330k Ω	*R11 10k Ω
R5 100k Ω	*R12 10k Ω
R6 33k Ω	*R13 1k Ω
R7 10k Ω	*R14 4.7k Ω

All metal oxide types $\pm 2\%$, $\frac{1}{4}W$ except where asterisk shown for carbon $\pm 10\%$, $\frac{1}{4}W$

Potentiometers

VR1 10k Ω min skeleton preset
VR2 100k Ω min skeleton preset

Capacitor

C1 22 μF tantalum 16V

Integrated circuit

IC1 741 OPA or equivalent 741 type

Transistors

TR1 P21 silicon phototransistor (Bi-Pak)
TR2 BC108

Diodes

D1, D2 OA202

Meter

ME1 100 μA moving coil

Switches

S1 Single-pole 12 way wafer
S2 Single-pole on-off miniature push button
S3 Double-pole changeover slide switch

Socket and plug

SK1, PL1 Non-reversible, two way

Batteries

B1, B2, PP3

Miscellaneous

Veroboard 2.5in \times 1.2in, 0.1in matrix
Screw top container with extra tops
Metal or plastics box 4in \times 4in \times 3in
Single core insulated wire
Knob with pointer

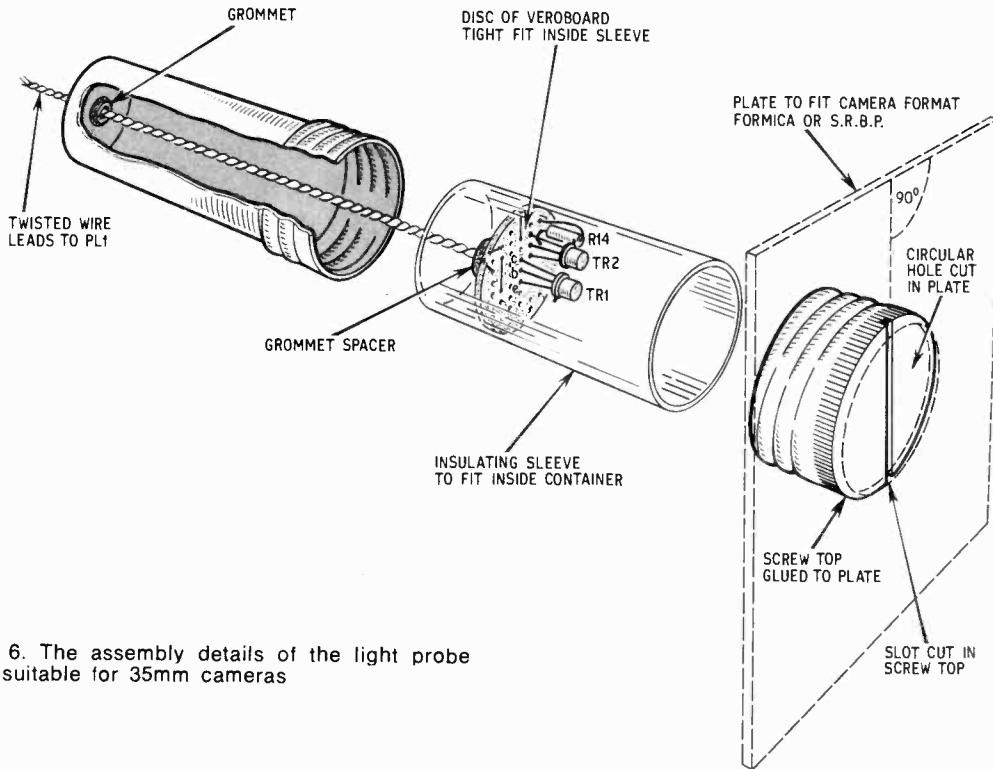


Fig. 6. The assembly details of the light probe are suitable for 35mm cameras

tion and output short circuit protection. Offset compensation, to reduce drift when the circuit is "holding" a reading, is provided by VR1. The output potentiometer VR2 serves to calibrate the instrument by adjusting the sensitivity of ME1. The circuit is reset to zero when S2 is closed so discharging C1 via R13.

LIGHT PROBE

The light probe circuit in Fig. 3 employs a silicon phototransistor in conjunction with an *npn* transistor to form a sensor of high sensitivity with rise time improved by the presence of R14. Photo-Darlington sensors of similar circuit configuration, but with both devices contained in a single package, unfortunately do not allow the use of a resistor between the base and emitter of TR2, and hence suffer from a slow rise time.

CONSTRUCTION

The shutter tester timing circuit can be housed in a small plastics box or instrument case measuring approximately 4in × 4in × 3in deep. Components inside the dotted line in circuit Fig. 2 are mounted on a 2.5in × 1.2in piece of 0.1in matrix Veroboard. The layout in Fig. 4 shows that the board is small enough to be held in position and supported by its non-flexible wire leads.

Fig. 5 gives the layout and wiring of controls and meter, but this may differ depending on the shape

of the box and type and size of meter used. Batteries B1 and B2 can be held in position with metal clips or wide sticky tape.

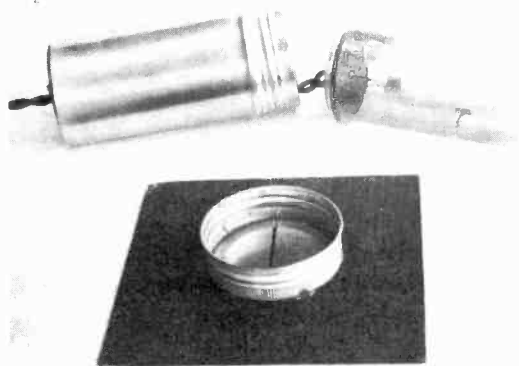
The light probe has to be a snug and accurate fit, as close to the film plane as possible, on the back of cameras of widely differing formats; this was achieved with the prototype by housing light probe components in a cylindrical container such as a 35mm film can provided with several screw tops, see Fig. 6. Each screw top has a slit cut with a fine sawblade, and is glued to an individual plate of laminated plastics or s.r.b.p.

The plate has a circular hole cut in its centre, slightly smaller than the screw top diameter, and is tailored to fit the film guide channels of a particular format. If it is desired to measure the shutter speeds of very small cameras, below 35mm, then TR2 and R14 can be positioned beneath TR1 inside, say, a cigar or pill container.

When gluing a screw top to a plate, care should be taken to align the slit at right angles to the film guides, to match the slit in the focal plane shutter. Orientation of the slit is unimportant with leaf shutters.

CALIBRATING THE SHUTTER TESTER

Connect the light probe to the timing circuit, set S1 to "B" and switch on. Remove the light probe screw top and shine a torch on TR1 lens, then adjust VR2 for approximately half scale deflection.



Light probe showing slit for use with focal plane shutters

Now place a camera on a table top, where it cannot slide about, and with the light probe attached to the back with rubber bands. Set the camera shutter to "B" and hold the shutter open with a cable release. The iris should be at full aperture.

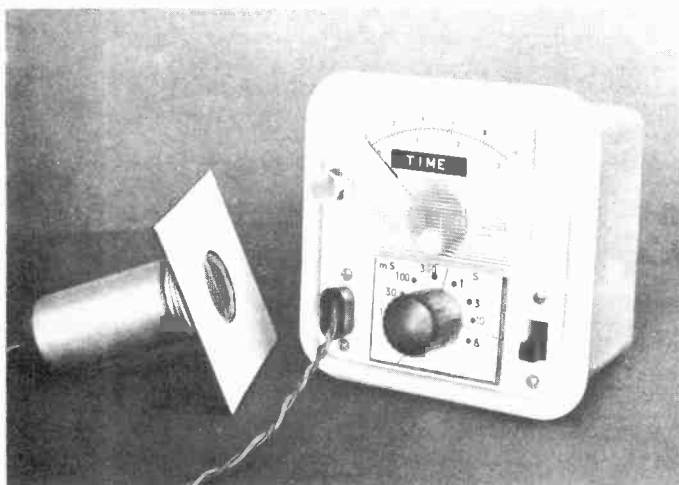
With S1 at "B," switch on the shutter tester and place a lighted torch on the table at about the same height as the camera lens. Move the torch around until the tester meter reads.

The correct torch position is where the meter just attains its maximum reading. This can be checked by closing down the camera aperture one or two stops, whereupon the meter reading should fall. Return the iris to full aperture.

With the torch still in position, the shutter tester can now be calibrated with the aid of a stop watch or clock with a large sweep second hand. Release the camera shutter and wind on, taking care not to move the camera, and set S1 to 10 seconds. Press S2 and adjust VR1 for zero drift over one or two minutes.

Now open the shutter for exactly 10 seconds, and then adjust VR2 for a reading of 10. If an oscilloscope is available, with single shot facility, this can be connected across SK1 to verify timing at fast speeds, but the above procedure should serve for calibration if carried out with care.

To measure camera shutter speed, align the torch as above, set S1 to the appropriate timing range, press S2, and operate the shutter. The meter will register shutter speed in milliseconds or seconds. ★



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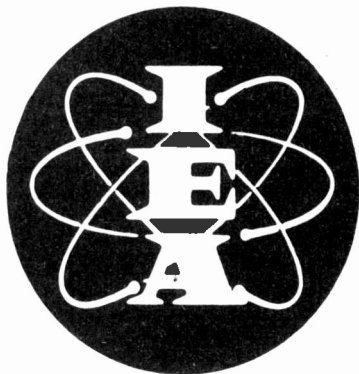
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Instruments Electronics Automation

IN last month's *Industry Notebook*, our contributor Nexus highlighted a trend towards smaller specialist exhibitions. Regular tourists of large scale exhibitions like the I.E.A. and the Components Show will welcome the trend, if only to reduce the route march of three halls to the convivial gathering of smaller select shows.

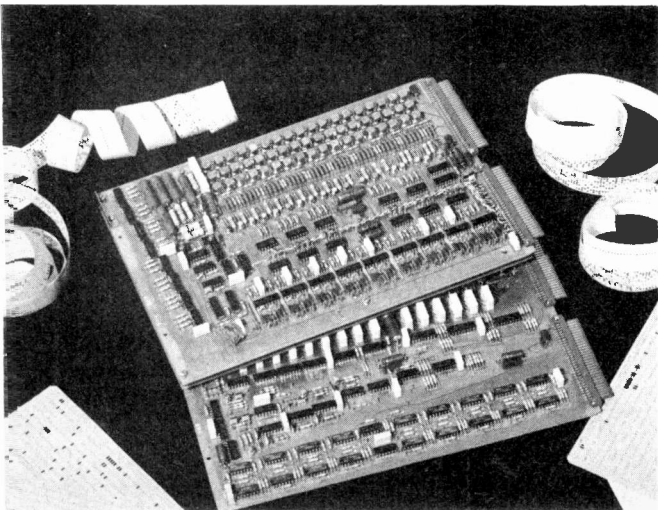
Another increasing trend is towards private shows mounted by individual companies in hotel suites simultaneous with a large exhibition elsewhere. One can look upon this as a snub to big exhibition organisers such as Industrial Exhibition Ltd. (the organisers of I.E.A. among many others), but the hard facts are that people tire of aching feet, buying poor quality refreshment, and often steaming in the glasshouse of Olympia.

The lower attendance forecasted may have been the result of absentee companies or the aforementioned observations. Whatever the reason, it is sad that the expanding publicity business is unable to lift the electronics industry out of an Olympian rut, although Evan Steadman and Co. did try in the right direction.

DEMISE OF THE TRANSISTOR IF . . .

Of the exhibits at I.E.A., we were promised great things; results of dormant research held up by economic climates; new innovations and techniques. There were several new items, or should we say variations of the old. One cannot expect miracles overnight but there were signs that electronics generally is entering a new phase forecasted about five years ago but it is painfully slow.

Mullard fast memory type F1-75 which has a cycle time of 750ns and an access time of less than 300ns



Under the current vogue umbrella title of "technology" we may see the demise of the transistor as a discrete component, but only if industry rationalises extensively its integrated circuit equipment design and manufacturing process.

Secondly, the foundation of modern electronics manufacturing, whether in i.c.s or discrete components, is the etched printed circuit assembly. This is the most significant product, which has been quietly growing up, to strike the electronics industry as a whole since the transistor was invented.

STANDARD PRINTED CIRCUIT SYSTEMS

The manufacturing of one-off or small batch p.c.b.s for development applications can be expensive because of the high cost of capital equipment, precision work, and the setting up of automated equipment for multi-hole drilling.

The bug-bear of the p.c.b. manufacturer is the constant retooling procedures for different designs. Standard hole arrangements on a regular matrix go a long way towards avoiding such problems and DIL i.c. type packages have proved to be ideal for this arrangement.

Some work has been done to standardise p.c.b.s for integrated circuits, but when looking at a cabinet of finished electronic equipment, the individual circuit cards are often tailored to the separate circuit designs. Although discrete components are still often necessary with the i.c.s the standardised i.c. printed circuit card so far available has been inadequate.

DIL PACKAGING

Considering now the dual-in-line packaging technique, the function of all semiconductors, resistors and capacitors can all be incorporated in identical small packages. Added to these we can now include the light-emitting diode display devices now in production, some already housed in DIL packages.

Almost all electronic circuits can be packaged in dual-in-line i.c. form (now even relays) mounted on a standardised d.i.p. printed circuit board with sufficient facility for, say, decoupling components, coils; and transformers, and an occasional preset potentiometer. We have such techniques now but there are limitations, seemingly because of the reluctance of many equipment manufacturers to depart from established methods.

Look at the photograph of the new Mullard fast memory type F1-75. This memory has a capacity of 4,180 bits. The control board below can control eight memories. There are several i.c.s scattered on

the two boards, but there are also several discrete components—a considerable assembly and wiring task.

INTEGRATED CIRCUITS

Mullard (among others) are still producing several new electrolytic capacitors, transistors and diodes and one wonders whether the possible range of semiconductor performance parameters must be fast approaching saturation point.

To their credit the new MSI series coded FJB9300 onward looks like a step in the right direction. This series contains 59 TTL circuits that have been selected to satisfy the future needs for medium-speed circuits with complex functions. This is fine for digital techniques, but the needs of linear circuit designers are much more diverse and could be satisfied given a similar approach.

Specially designed MOS integrated circuits are largely responsible for the reduction in size and cost of calculators to pocket proportions, such as that shown by Hewlett-Packard. One example is the Siemens picture showing an MOS i.c. before case moulding.

There is an apparent future in MOS techniques as illustrated by Siemens of West Germany who are planning large scale production of a further 50 circuit types in 1972. They are also producing the SAS560 and SAS570 switching amplifier i.c.s that will select television channels at the touch of a contact button. It is expected that these devices will bring the cost down for remote switching of common low price television receivers.

Mullard have also produced a 1024-bit MOS random access memory; each bit is contained in a simple capacitor charge circuit with three transistor elements. These and the projected 4096-bit version will make magnetic core memories totally redundant through cost effectiveness and size. It is confidently expected that the basic memory cell will be reduced to one capacitor element and one MOS transistor for each bit with an access time of 150ns. Computer aided design techniques are used to produce these memories.

Current mode logic i.c.s combine high speed (around 2ns) with high fan-out capability (about 50); Mullard displayed the new GX series of gates, drivers, receivers, and latches, which could make conventional DTL and TTL gates obsolete.

HALL EFFECT RELAY

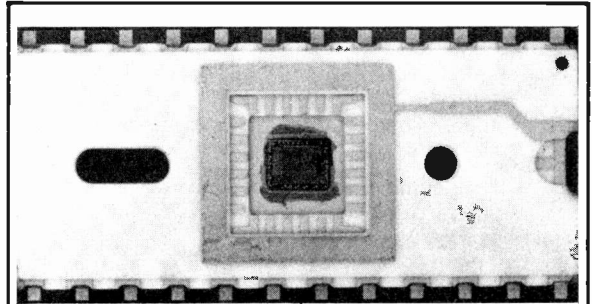
A new series of integrated circuits has been produced which is like a very fast operating relay. These devices depend on the proximity of an external magnet whose flux path is through a Hall Effect cell. The high speed switching effect operates an internal Schmitt trigger at up to 100kHz. This breakthrough by Sprague eliminates the bounce and buffering problems of reed switches.

The output is of grounded emitter open-collector configuration for direct drive of DTL or TTL logic circuits, with current sinking of 20mA. This device is coded ULN-3000 and is available in dual-in-line, flat-pack or single-ended package as shown in the photograph.

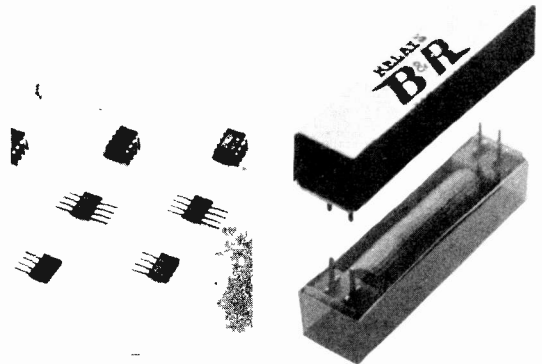
Whilst on the subject of DIL style packaging, reed relays are made in this form now, but a new line by B & R relays, known as the "G" range, follows 14-pin DIL connection dimensions although only two pins at each end are provided.

It is worth mentioning the very small pulse transformers Type 66Z by Sprague that attempt to follow similar lines and are only about $\frac{1}{4}$ inch square by $\frac{1}{8}$ inch (see photograph). These transformers are available in a very wide range of lead styles, volt-microsecond capability and turns ratio and complete specifications are available.

These are just a few areas where standardised component packages go a long way to simplify equipment design and cut manufacturing costs. We are bound to see further developments before the Components Show next May.

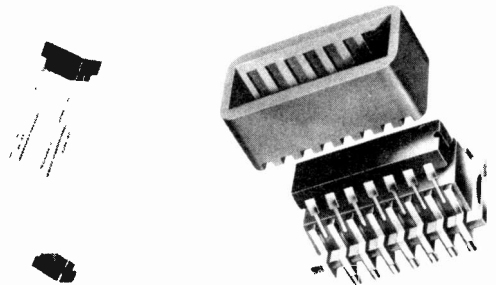


Almost completed MOS i.c. before encapsulation and lead trimming by Siemens



Magnetically operated Hall effect relay by Sprague

B & R Relays i.c.-style reed relay package



Two examples of the Sprague 66Z miniature pulse transformers for printed circuit board assembly

Prototype model of the Jermyn DIL i.c. clamping connector with the i.c. seated in position and shroud retainer poised ready to be fitted on the saddle

HARDWARE

Unlike the Components Show, I.E.A. does not usually display masses of hardware accessories. However, of the products on show, one of the most interesting and versatile was the Critchley 19 card frame system.

This racking or cabinet system is designed specifically for printed circuit cards which slot into plastics guide runners and plug into sockets at the rear. The essential advantage is the versatility of assembly arrangements to accept a wide range of card sizes. The assembly is very simple because the plastics guide runners can slide along a specially shaped cross-support rail.

Also on our list of hardware ideas is the Jermyn "no-socket" 14-pin DIL contact mounting. Contact is made gently by sitting a 14-pin DIL i.c. on the top and push-fitting a clamping shroud. By so doing the i.c. pins are gripped and contact effected through plated copper lands on the moulded plastics mounting saddle.

HIGH-DIELECTRIC CONSTANT CAPACITORS

A new material is being used by Siemens to manufacture capacitors with a dielectric constant of 50,000. This material, titanate ceramic, will be a significant factor in reducing the bulk so far experienced for capacitors in a.f. circuits. Values up to 220nF with base dimensions of 2.5mm × 5mm are now available. Voltage ratings are usefully 40V d.c.

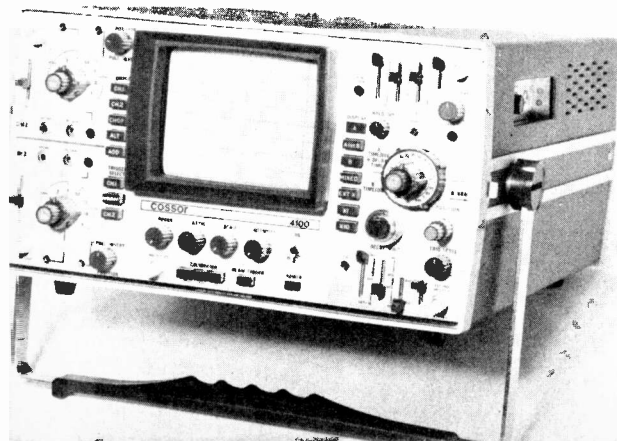
BRITISH 'SCOPE TO CHALLENGE U.S.

A quick look round any well-equipped research or development laboratory will show the tremendous hold that America has on the instrumentation market. When it comes to high quality test equipment, particularly oscilloscopes, the first choice is often Tektronix or Hewlett-Packard, both American firms.

At long last a British firm now intends to launch a "direct attack on U.S. equipment" with the new Cossor Model 4100 oscilloscope.

With a bandwidth of 75MHz, this model is aimed primarily at the computer and digital equipment service market. It has a bigger display than any other 'scope on the market—eight by ten centimetres.

The new Model 4100 oscilloscope from Cossor



The transformerless power supply type SSU 1050 from A.P.T. Electronic Industries



The cathode ray tube was specially chosen for its short length, Cossor being the first firm to use it.

The Sales Manager has high hopes for this instrument asserting that "with the price advantage Cossor has in this important market, there is very little that can compete directly"

GOOD DESIGN

One of the most noticeable features of modern electronic equipment is that a great deal of attention is paid to pleasing external appearance as well as to the technical efficiency of the internal apparatus.

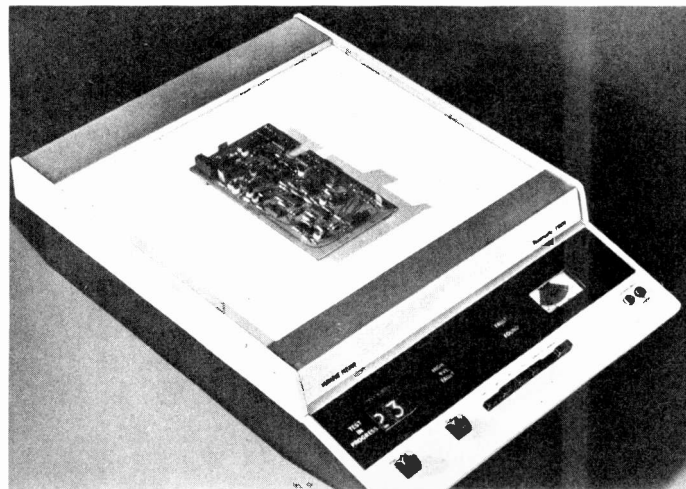
Take, for example, the Wayne-Kerr automatic circuit tester shown in the photograph.

In its automatic mode this machine can test 30 points on a circuit board, indicating whether the voltage at each point is within preset limits or is high or low.

Although the instrument is designed to be used at the end of a production line, the case is of an extremely pleasing design. Controls are kept to the absolute minimum for ease of operation by unskilled staff, all being brought to the neat, uncluttered control panel at the front of the instrument.

This was by no means the only example of good design in appearance as well as performance and it seems we are at the end of the era where the outer covering of apparatus is merely to keep the dust off of the works.

Automatic circuit tester type TM30 manufactured by Wayne-Kerr



TRANSFORMERLESS POWER SUPPLIES

A recent innovation which, no doubt, will soon be making its impact on the electronics industry is the transformerless power supply.

The SSU 1050 laboratory Supply Unit from A.P.T. Electronic Industries produces a fully variable output and affords the facility of either constant-current or constant-voltage output between 0-10 amps and 0-50 volts.

It operates by first full-wave rectifying the mains input to produce coarse d.c. then converting this into a.c. at 20kHz. This, in turn, is full wave rectified and smoothed to give a d.c. voltage, the level of which is closely controlled by the duty cycle of the d.c. to a.c. inverter. There is a final series regulator which gives the low impedance, low ripple, stabilised d.c. output.

The elimination of the transformer means a reduction in both size and weight, and the increased performance and efficiency provides higher powers at a more economic cost.

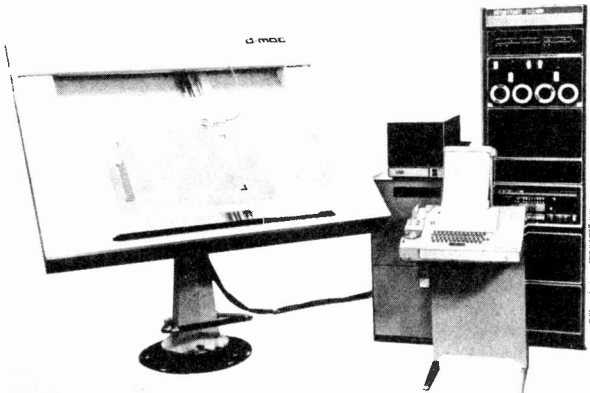
COMPUTER AIDED GRAPHICS

The days when a company bought a computer and then looked around for something to do with it have long since passed. The modern company first employs a systems analyst to assess what type of computer, if any, is necessary to fulfil his needs then looks around for the computer best suited to his particular requirements. Manufacturers are thus confronted with building a computer system rather than just the computer itself; "software" is just as important, if not more so, than hardware.

One computer system designed to be used specifically for graphics is the CADMAC system from D-MAC. For graphics work, use of a large general-purpose computer would mean delays which would cause unnecessary difficulties in design work. CADMAC is a fully interactive system enabling the designer to check for errors and make corrections virtually simultaneously.

The designer first makes a preliminary sketch then digitises salient coordinates on the drawing table, and enters descriptive data into the computer. The entered information is displayed simultaneously on a cathode ray tube for verification or amendment. The designer then selects which details he wants committed to permanent memory and which he

The CADMAC interactive graphics system showing drawing table with integral plotter, computer, teletype and display terminal



wants redrawn. He can then produce a hard copy of the finished drawing using the plotter which is an integral part of the drawing table.

Main areas of application for this system are in printed and integrated circuit design, civil engineering and architectural planning, plant layout, and aerospace and shipbuilding.

CASSETTE DATA HANDLING SYSTEM

Today's computers operate at such astronomical speeds that one of the biggest problems is feeding in the information at a rate sufficient to keep up with them. The standard way of entering data at the moment is through cumbersome "peripherals" which handle either punched cards or paper tape.

Now a new system has been developed which replaces these with magnetic tape contained in a compact cassette. One of these cassettes can store as much information as 2,000 punched cards and according to the makers, editing (i.e. amending a piece of information within the whole) and data retrieval are much easier. The only disadvantage of tape over punched cards would seem to be that it cannot be read without the aid of a machine as cards can. However the durability and speed of handling would seem to more than compensate for this.

The firm which developed the system, Computer Electronics Ltd., recognise that they will have a hard fight to get their product accepted since so many of the large computer firms have vested interests in mechanical data handling systems but they feel that users will see the great advantages of this low-cost, high performance cassette tape handling system.

CHANGES TO COME ?

Finally, although this year's I.E.A. showed some trends to future electronics marketing ventures, there was a conspicuous shortage of revolutionary innovation in electronics designs, which are the usual fruits of pure research.

There was still a "Monday morning" feeling in the air after a very depressing period of financial squeeze over the past few years. Perhaps this stage of stock-taking will result more in organisational changes that would in future be better prepared to cope with credit restrictions. ★

The new cassette tape handling unit produced by Computer Electronics



SCIENTIFIC REWARD

A special hope of the moonquake team at Houston, Texas, was that there would be a major meteorite strike on the moon. This hope was realised on May 13, twenty-two days after the last of the four seismic stations was set up by the crew of *Apollo 16*.

The impact occurred at 09.49 G.M.T. and the effect of the meteorite was equal to an explosion of about 100 tons of high explosive. It should have made a crater the size of Trafalgar Square.

A meteorite of this size hits the Moon once in several years and scientists were resigned to the fact that the instruments may have ceased to work before an event took place. There was considerable excitement, therefore, at the monitoring station when the impact was recorded. It is the largest and longest impact recorded.

Information has been coming in continuously since the first station was set up by the crew of *Apollo 11*. This station has now ceased to function because the solar power unit no longer functions. However, the present stations continue because they have nuclear power units.

There are four such stations on the moon; one at the Ocean of Storms set up by the *Apollo 12* mission; the next in the Fra Mauro area by the crew of *Apollo 14*; a third at the Hadley Rille by *Apollo 15*; and the fourth at the Descartes site by *Apollo 16* on April 21. The Hadley Rille site is the most northern and the Descartes site the most eastern position. Because the other two sites are close together they are regarded as one.

The stations are set up in a triangular configuration with sides about one hundred kilometres in length. The sites of these stations allow accurate analysis of the data transmitted to Earth. Some of the impacts of small meteorites have been such that they have not been detected by more than one station.

APOLLO 17

The *Apollo 17* moon mission is the sixth and last of the moon missions and is due to be launched on December 11, 1972. It is therefore not surprising that the choice of site has been chosen with great care. The landing site is some 20 miles south of the Taurus mountains in a valley known as Taurus Littrow. The name is derived from the Taurus mountains in the north and the Littrow crater to the south.

Observations, made by *Apollo 15*, show that this site is covered with cinder cones and volcanic ash. There are not many craters in the area, which indicates that those that are there are fairly recent in the 4,500 million years of the moon's existence.



The crew for the *Apollo 17* mission will be Ronald Evans, command module pilot, Eugene Cernan, mission commander and geologist Dr H. Schmitt, who will accompany the mission commander to the surface of the moon. The initial launch will take place at night and this will be the first time that astronauts have done this.

ISOTOPE POWER SOURCES

The report of the American Atomic Energy Commission contains details of progress made in the use of isotope power sources. The increasing use of these systems for experimental packs left on the moon and for future probes has brought the techniques to a high level of development.

The operation of these isotope generators makes use of the heat produced by decaying radio-isotopes. Thermo-couples, two dissimilar metals joined together, convert the heat into electricity. In these thermoelectric systems there are no moving parts and they are able to operate for long periods unattended.

Two Snap-27 isotope power sources were deployed on the moon during 1971, by the *Apollo 14* and *15* missions. These two units, in addition to one placed on the moon in 1969 by *Apollo 12*, are providing the power for the network of scientific experiments at different locations.

The design life of each station is for one year. However, the Snap-27 set up by the *Apollo 12* astronauts was still giving an output in excess of its design power of 63 watts after more than two years in operation.

Additional Snap-27 units were supplied for *Apollos 16* and *17*. The unit for *Apollo 16* is already in operation on the moon.

Three other power units aboard vehicles launched during the 1960's continue to operate though at reduced levels of output. These are the Snap-3A, Snap-9A, and the Snap-19.

The Snap-3A is about the size of a grapefruit and was the first isotope generator to be sent into space. The other two units also have a long life; the Snap-9A launched in 1963 aboard a defence satellite, and the Snap-19 on the *Nimbus 111* weather satellite in April 1969.

Modified Snap-19 generators are to be used for the Jupiter fly-by in 1973. One is already operating successfully on the *Pioneer* fly-by launched in 1972. They will also be used in the *Viking* missions for the Mars landing, scheduled for 1975.

HEAT UNIT

The heat unit is a sphere of molybdenum covered plutonium-dioxide 238 particles. A cermet sphere of 1.6 inches diameter gives 100 watts. In the multi-hundred watt units a number of spheres are arranged in a cylinder with graphite lining and packing. These larger units which can reach powers of 1,000 watts are for use in the communication satellites.

Work is continuing on generators with different types of fuel, although plutonium continues to be the major choice for all future space applications. Variations of this fuel, such as plutonium-molybdenum cermet and pressed plutonium-oxide are being tested. For outputs at a slightly reduced level size for size, curium-244 is being studied as it is considerably cheaper.

SPACE REACTOR SYSTEMS

The practical approach to high power systems would seem to be by using reactors. There are two primary avenues being studied at the present time. These are the zirconium hydride reactor for powers up to 100kW and the in-core thermionic reactor for power levels over 100kW.

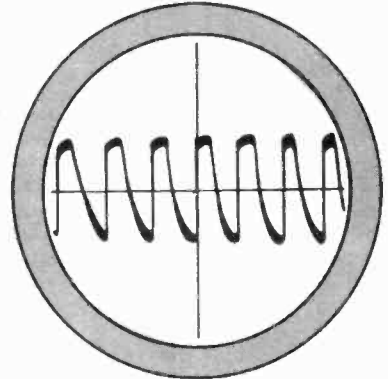
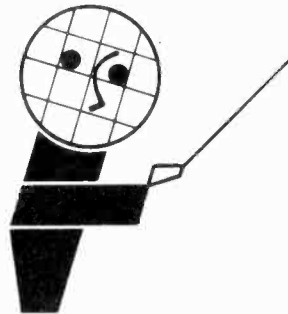
The zirconium reactor can be used with several conversion systems and is particularly useful for the units producing 30 to 40kW. It can provide a system of an economic level that makes it well worth while for high powered unmanned satellites. A similar but more heavy system of reactor-thermoelectric type of unit will be considered for the manned missions of the 1980's.

The thermionic reactor will be based on the use of fuel elements which convert heat to electricity within the reactor core. These are capable of long periods of operation and will be especially suitable for the missions to the other planets and the rendezvous with comets such as Halley's Comet. For this a launch would be required in 1983.

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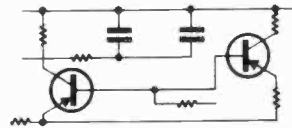
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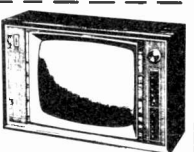
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Rp		Sp		Sp		Sp		Sp	
1N21	0-7	AF212	1-00	BY210	0-85	0AZ211	0-82	Z8170	0-10
1N23	0-20	ASY26	0-25	BY211	0-32	0AZ222	0-45	Z8271	0-18
1N66	0-88	ASY27	0-32	BY212	0-80	0AZ223	0-45	ZT21	0-25
1N263	0-50	ASY28	0-25	BY213	0-25	0AZ224	0-45	ZT43	0-25
1N266	0-60	ASY29	0-20	BY214	1-00	0AZ241	0-22	ZTX107	0-15
1N645	0-25	ASY36	0-25	BY215	1-00	0AZ242	0-22	ZTX108	0-12
1N726A	0-20	ASY50	0-17	BY216	0-62	0AZ244	0-22	ZTX300	0-12
1N914	0-07	ASY51	0-20	BY288C3V3	0-15	0AZ246	0-22	ZTX304	0-25
1N4007	0-20	ASY53	0-20	C111	0-65	0AZ290	0-25	ZTX300	0-18
18113	0-15	ASY55	0-20	CR81/05	0-25	OC16	0-60	ZTX304	0-25
18130	0-12	ASY62	0-25	CR81/40	0-45	OC18T	0-38	ZTX503	0-17
18131	0-13	ASY86	0-28	C84B	2-60	OC20	0-85	ZTX531	0-25
18202	0-22	ASZ21	0-42	GD14	3-12	OC22	0-60		
20371	0-22	ABZ23	0-25	DD000	0-15	OC23	0-60		
20381	0-25	ATV10	0-60	DD003	0-15	OC24	0-60		
20414	0-30	AT101	1-60	DD007	0-18	OC25	0-37	7400	0-20
20417	0-22	BC107	0-10	DD008	0-18	OC26	0-25	7401	0-20
2N404	0-20	BC108	0-10	DD008	0-38	OC28	0-80	7402	0-20
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2N708	0-15	BC116A	0-20	DD008	0-38	OC36	0-60	7407	0-30
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AF119	0-20	BSY95	0-12	DD008	0-38	OC45M	0-12	7482	0-65
AF124	0-20	BT102/500R	0-21	DD008	0-38	OC45M	0-12	7483	0-65
AF125	0-20	BT102/500R	0-21	DD008	0-38	OC45M	0-12	7484	0-65
AF126	0-17	BTY42	0-75	DD008	0-38	OC45M	0-12	7485	0-65
AF127	0-17	BTY79/100R	0-75	DD008	0-38	OC45M	0-12	7486	0-65
AF139	0-30	BTY79/100R	0-75	DD008	0-38	OC45M	0-12	7487	0-65
AF178	0-65	BTY79/400R	0-75	DD008	0-38	OC45M	0-12	7488	0-65
AF179	0-65	BTY79/400R	0-75	DD008	0-38	OC45M	0-12	7489	0-65
AF180	0-65	BTY79/400R	0-75	DD008	0-38	OC45M	0-12	7490	0-65
AF181	0-42	BY126	0-16	DD008	0-38	OC45M	0-12	7491	0-65
AF186	0-40	BY127	0-17	DD008	0-38	OC45M	0-12	7492	0-65
AFY19	1-18	BY182	0-85	DD008	0-38	OC45M	0-12	7493	0-65
AFZ11	0-60	BY213	0-25	DD008	0-38	OC45M	0-12	7494	0-65

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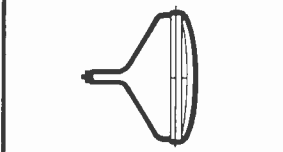
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Strictly

by K. Lenton-Smith

WHEN you think about it, the wheel has turned a full circle in this—now complex—subject of music electronics. Forty years back, when the electronic organ pioneers were getting their ideas assembled, the essential purpose was to imitate existing instruments, either electrically or by electronics.

Today, with the organ and synthesiser established as orchestral instruments in their own right, standard string, wind, and percussion instruments are being processed by means of "black boxes" and multi-track recording methods to produce sounds akin to the Moog!

The plain fact is that much music today could not exist without the aid of electronics and, needless to say, this particularly applies to the field of "pop". The organ has long been established in light music, and more recently the synthesiser and electric piano have become accepted as quite normal musical instruments. Indeed, practically every traditional orchestral instrument can now be treated electronically, in some way or another.

BUGGED INSTRUMENTS

Because "electrified" instruments can overpower brass and reed instruments, controversy has arisen on whether or not it is proper to use "bugs". These are tiny pick-ups which can be fitted to saxophone or clarinet, for example, without defacing the instrument by boring extra holes, and they have a number of advantages over the standing microphone. Movement of the instrument does not affect the electrical output and, clipped to the bell of a trumpet, such a device can pick up all the natural overtones.

Once an electronic signal has been produced, this of course, can be further processed by standard frequency dividers. For example, the "Varitone", used by Sonny Stitt on tenor sax, blends the reed's sawtooth output with the square wave sub-octaves tolerably well: even so, the Eccles-Jordan flavour comes through strongly.

Wah-Wah can be applied to brass or reed derived signals, though the advantages are somewhat dubious. *Bizarre* RSLP 2030 includes Ian Underwood playing "Chunga's Revenge" on Electric Sax with Wah-Wah, the result reminding one of Donald Duck having his tantrums!

Other than the guitar itself, the Electric Violin and Baritone Viola are two examples of the electronic treatment of strings.

DEAFENING

The musical purist might query the advantages conferred on music by electronic technology, firstly by the inventions of Fleming, and later by the Bell Laboratories "transfer-resistor". All too often the only apparent result has been an increase in decibels: Grand Funk Railroad uses 7 kilowatt of power, while Frank Zappa uses 200W for his guitar alone fed into a 16 channel stereo mixer.

These sound levels are well over 100dB near the speakers and enough to permanently damage the ability to hear quiet sounds after a few seconds exposure. Could this be the reason for the constant need for higher amplification? Audiences could slowly be going deaf!

DELIBERATE DISTORTION

It is somewhat amusing to consider the care with which amplification equipment is carefully selected for minimum distortion, only to be negated by means of fuzz boxes, etc.! To get away from reality is one way of selling recordings, which is now very big business: there are enough "pop" enthusiasts only too willing to spend their money. And so the deliberate introduction of distortion is a very much favoured way of creating "new sounds".

AN IDEAL MARRIAGE

If all this appears to criticise the marriage of music to electronics, we should acknowledge the fact that the tastes of a large section of the recording-buying public have influenced the application of electronic techniques. In principle, the marriage is ideal.

Many electronic sounds have no orchestral counterpart, and, apart from being new to listeners, can be beautiful and fascinating. To play a synthesiser well calls for special skills and basically requires a trained musician with a full grasp of the instrument's technicalities.

Dick Hyman and Walter Carlos can be singled out as experts in their

respective fields of light and classical music. The trumpet fanfares that Walter Carlos can coax out of his Moog are extremely lifelike; then he can change to percussion effects that are tasteful and suited to the seriousness of his music. Having originally collaborated with Robert Moog in 1966, it is hardly surprising that he has featured the instrument in "Switched on Bach", "The Well-Tempered Synthesiser" and more recently in "Clockwork Orange".

HAMMOND ORGAN

The Hammond Organ was one of the very first successful ventures in electronic music, though Laurens Hammond always preferred to term it an "electric" organ because the generators were electro-mechanical. In recent years there has been a move away from tone wheels throughout because of the weight involved: the master generators are now tone wheels, but the other frequencies are derived from dividers.

From its inception, the Hammond has used harmonic drawbars which enable the player to obtain the required sound by (Fourier) synthesis. Many of the earlier organs had fixed stops similar to entertainment or church pipe organs, but the Hammond has always allowed the player to synthesise his sounds. Because of this fact and the fairly rapid attack (characterised by noticeable key clicks), it became a standard instrument in the field of lighter music.

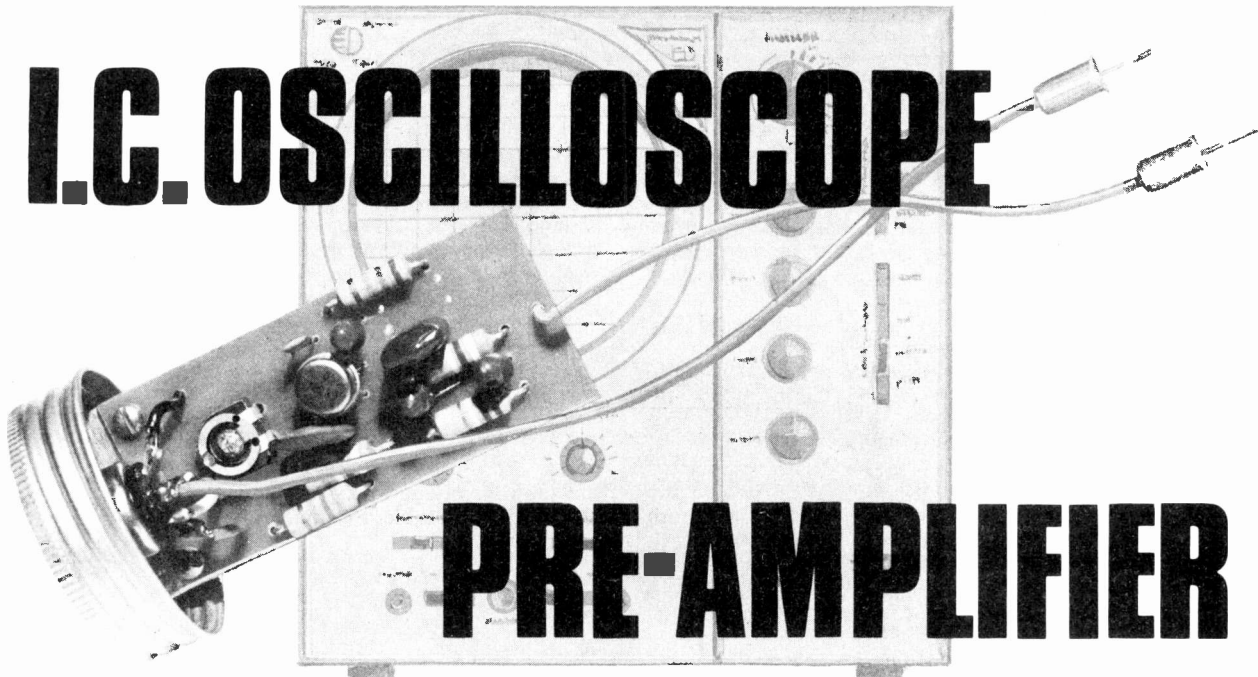
According to the model, each manual may have between eight and eleven drawbars for harmonic mixing: in turn, each drawbar has eight settings, so that the permutations are almost unlimited.

The system has been copied by other manufacturers, thus proving the success of the idea. Like the synthesiser, it is important to have a good working knowledge of the principles to play a Hammond well.

TAPED

The tape recorder is a merciless critic, playback soon proving to be one of the greatest spurs to improving one's playing technique. With the ability to feed the output signal from the electronic instrument directly into a tape recorder, extraneous noises picked up by microphones are obviated. Any reader living near a busy airport will appreciate this point. Key clicks or transients will be accentuated by direct connection, but most rhythmic players will not object to this bonus.

I.C. OSCILLOSCOPE



PRE-AMPLIFIER

Extend the sensitivity range of a low cost 'scope by adding this simple pre-amp

By T. G. READ

INEXPENSIVE oscilloscopes, although having a reasonable bandwidth, usually suffer from the limitation of low sensitivity. The author's oscilloscope, for example, which has a bandwidth from 2Hz to 3MHz (3 dB points), has a maximum sensitivity of only 250mV per cm on a three inch screen. A pre-amplifier giving a gain of, say, ten times would be a useful accessory for such an instrument, making possible investigation of much lower signal levels.

The specification of a suitable pre-amplifier can be quite involved, but the design criteria for the circuit described in this article have been limited to three points.

- (i) Amplification of ten times (20 dB voltage gain)
- (ii) Bandwidth in excess of oscilloscope's existing amplifier.
- (iii) A high input impedance.

BOOTSTRAPPED DIFFERENTIAL AMPLIFIER

Positive feedback by the "bootstrapping" technique has often been used to increase the input impedance of transistor amplifiers—Fig. 1 shows a typical example. In Fig. 2 the technique is applied to a differential amplifier, several types of which are available in integrated form. Negative feedback is applied via R3 to the inverting input of the amplifier to reduce the overall gain to the required value, and positive feedback is applied via C1 and R1 to the non-inverting input.

The values of the circuit components are easily obtained from three equations which define the circuit characteristics and ensure minimum offset between the differential amplifier's inputs.

(a) The closed loop voltage gain A_v is given (approximately) by

$$A_v = \frac{R_2 + R_3}{R_2}$$

(b) For minimum offset the resistances of the two d.c. paths from the input terminals of the differential amplifier should be equal.

$$\text{i.e. } R_3 = R_1 + R_2$$

(c) The input impedance of the amplifier (Z_{in}) is given by

$$Z_{in} = \frac{A_{vo}}{A_v} \times R_1 // R_{i(diff)}$$

where A_{vo} is the open loop gain of the amplifier and $R_1 // R_{i(diff)}$ is the parallel combination of R_1 and $R_{i(diff)}$ (the differential input resistance of the amplifier).

$$R_1 // R_{i(diff)} = \frac{R_1 \times R_{i(diff)}}{R_1 + R_{i(diff)}}$$

In choosing resistor values for a particular circuit it is best to select first a reasonable value for the feedback resistor R3. From (a), calculate R_2 which gives the required gain; calculate R_1 from (b); check that substituting the resistances into (c) gives an acceptable input impedance.

The capacitor is large enough to present negligible reactance at signal frequency, when compared with the resistances.

PRACTICAL CIRCUIT

The integrated circuit used in this design is the μ A702C, which is readily available, has an adequate

gain and bandwidth, but is not prohibitively expensive. The base diagram of and connections to the i.c. are given in Fig. 3.

The practical circuit of the oscilloscope pre-amplifier is shown in Fig. 4, in which the basic circuit is easily identified. A preset potentiometer VR1 is connected in series with R3, allowing gain adjustment; the bootstrapping capacitor is formed by C2 and C3 connected back-to-back to form a non-polarised capacitor. With the component values given (gain 10) and a typical i.c. (input resistance 32 kilohms, open loop gain 3400) the pre-amplifier input impedance is 10 megohms. In the worst case (input resistance 10 kilohms, open loop gain 2000) the input impedance is 1.9 megohms.

The power supply is derived from an 18V source applied to a potential divider (R4 and R5). The required voltages of +12V and -6V are obtained by selecting appropriate values for the resistors. It is necessary to bypass R5 with a large capacitor (C7) to give the signal a low impedance path to the negative rail. It is also advisable to decouple both supply lines to earth by 10nF capacitors, which protect the i.c. against spikes that may occur on the supply lines, particularly at switch-on and switch-off. The capacitors should be disc ceramic and positioned as close as possible to the i.c.

FREQUENCY COMPENSATION

The $\mu A702C$, like all early designs of integrated circuit high gain amplifiers, requires some form of external frequency compensation. This arises from the amplifier's wide bandwidth (useable gain up to 30MHz) and its phase characteristic. The phase difference between the signal at the non-inverting input and that at the output increases with increasing frequency, until at about 14MHz the phase shift is 180 degrees. Thus, at this frequency, any negative feedback becomes positive and if the overall loop gain of the circuit is greater than unity, instability and oscillation result. There are several methods of overcoming this problem. A number of these will now be described in turn and the reasons for their use, or non-use, explained.

The usual recommendation of the manufacturer is to connect a series resistor-capacitor network between the lag pin and ground. This severely limits the output voltage swing at high frequencies which, although acceptable in many circumstances, is not acceptable here.

An alternative recommendation is to connect a small capacitor between the lead and lag pins. This allows a good output voltage swing up to several megahertz and has been adopted in this circuit. A

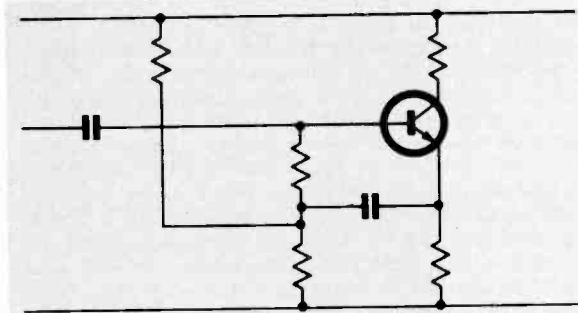


Fig. 1. Basic arrangement of a bootstrapped input transistor amplifier

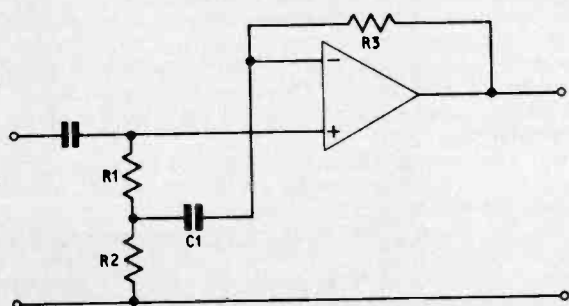


Fig. 2. The bootstrap principle applied to a differential amplifier



- 1 Ground
- 2 Inverting input
- 3 Non-inverting input
- 4 Negative supply voltage
- 5 Lead } frequency compensation
- 6 Lag }
- 7 Output
- 8 Positive supply voltage

Fig. 3. Wire connections of the $\mu A702C$ integrated circuit (TO-5 can) looking at the wire ends

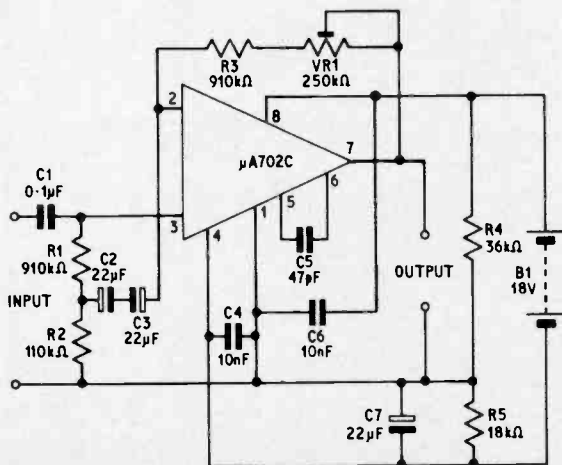
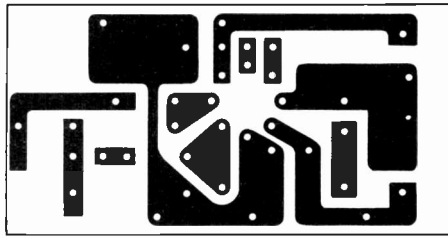
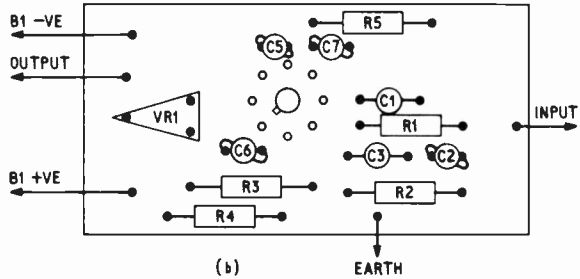


Fig. 4. The oscilloscope pre-amplifier circuit in full

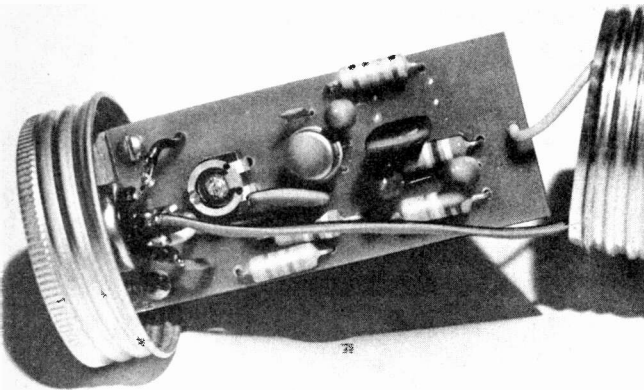


(a)



(b)

Fig. 5. Suggested printed circuit layout. Capacitor C4 is not shown. It is best mounted on the copper side of the board and connected to the pads as close to pin 1 and 4 of the i.c. as possible



single capacitor, however, is often not sufficient to ensure stability under all circumstances.

Stability may be ensured by shunting the differential input of the amplifier with a series resistor-capacitor network. While reducing the amount of feedback at higher frequencies this also reduces the effective input impedance of the amplifier which is obviously not acceptable.

The arrangement finally adopted is to use the lead-lag capacitor together with a high value of feedback resistor. This ensures that the overall loop gain of the circuit is less than unity at phase reversal frequency.

CONSTRUCTION AND USE

The pre-amplifier can be built into a very small volume and the actual housing may be left to the constructor. A suitable printed circuit pattern and component layout diagram are given in Fig. 5: Note that C₄ is positioned on the foil side of the board. If the layout is to be changed substantially ensure that all component leads and interconnections are kept as short as possible and input and output are kept well apart to avoid instability and oscillation. The circuit is certainly small enough to be put inside the cabinet of an oscilloscope, but a better arrangement would be to build the preamplifier into a probe, thus avoiding the reduction of input impedance by shunting with capacitive input cables. In this case miniature electrolytic capacitors (tantalum bead) and resistors (1/8 watt) should be used, and R3 and VR1 replaced by a single 1 megohm resistor. A major problem in this arrangement is to provide a physically small power supply—it may be necessary to have the battery external to the probe.

The pre-amplifier is designed to be connected to an a.c. input of an oscilloscope. If the circuit is to be used with a d.c. instrument then a 0.1 μF blocking capacitor should be connected between the output of the pre-amplifier and the input to the oscilloscope.

After calibration (setting the gain to exactly ten times by adjusting VR1) the pre-amplifier is quite straight-forward to use. There are however a couple of points worth noting in connection with the phase characteristic.

(i) The pre-amplifier is non-inverting (at low frequencies)—an important point to note when measuring phase angles by Lissajous figures.

(ii) The phase angle of the output, relative to the input, increases with increasing frequency. Typical values are 10 degrees at about 100kHz, 60 degrees at about 1MHz, 100 degrees at about 3MHz. This should again be noted when measuring phase angles, and also when investigating signals which are a mixture of high and low frequencies.



COMPONENTS . . .

Resistors

- R1 910kΩ
- R2 110kΩ
- R3 910kΩ
- R4 36kΩ
- R5 18kΩ
- All ±5%, 1/8 watt carbon

Potentiometer

- VR1 250kΩ miniature skeleton preset

Capacitors

- C1 0.1μF mylar film
- C2 22μF tantalum 16V
- C3 22μF tantalum 16V
- C4 10nF disc ceramic
- C5 47pF ceramic
- C6 10nF disc ceramic
- C7 22μF tantalum 16V

Integrated Circuit

- IC1 μA 702C

Miscellaneous

- Printed circuit board 2 3/8 in × 1 1/4 in
- Power supply or battery B1 18V

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AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GE7880	27p	ORP61	40p	2N929	22p	2N2904	25p	2N3705	12p	
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p	2N930	25p	2N2904A	30p	2N3706	12p	
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p	2N1131	20p	2N2905	25p	2N3707	13p	
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TT543	40p	2N1132	22p	2N2905A	30p	2N3708	8p	
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p	2N1302	17p	2N2906	25p	2N3709	8p	
AC128	17p	AF126	20p	BC148	13p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p	2N1303	20p	2N2906A	27p	2N3710	10p	
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p	2N1304	20p	2N2907	25p	2N3711	10p	
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p	2N1305	20p	2N2907A	30p	2N3819	40p	
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p	2N1306	22p	2N2923	13p	2N3820	£1	
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	15p	2N1307	22p	2N2924	13p	2N3903	25p	
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p	2N1308	27p	2N2925	13p	2N3904	27p	
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p	2N1309	27p	2N2926	25p	2N3905	25p	
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p	2N1711	20p	2N2926(Y)	11p	2N3906	27p	
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p	2N1889	35p	2N2926(O)	10p	2N4058	15p	
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p	2N1890	45p	(O)	10p	2N4059	10p	
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p	2N1893	37p	2N3010	80p	2N4060	12p	
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p	2N2160	60p	2N3011	20p	2N4061	12p	
AC169	14p	AL103	85p	BC169	13p	BF122	35p	BSX20	15p	OC36	40p	2G345	15p	2N2147	75p	2N3053	20p	2N4062	12p	
AC176	23p	ASV26	25p	BC170	17p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p	2N2148	60p	2N3054	50p	2N5459	43p	
AC177	20p	ASV27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p	2N2192	30p	2N3055	63p	2S034	75p	
AC187	30p	ASV28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p	2N2193	30p	2N3391	17p	2S301	50p	
AC188	30p	ASV29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	15p	2G377	27p	2N2194	27p	2N3391A	20p	2S302A	45p	
ACY17	25p	ASV50	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p	2N2217	20p	2N3392	17p	2S302	60p	
ACY18	20p	ASV51	25p	BC175	22p	BF160	30p	BSY30	15p	OC71	9p	2G382	15p	2N2219	27p	2N3393	15p	2S303	60p	
ACY19	25p	ASV52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p	2N2220	20p	2N3395	20p	2S305	£1-10	
ACY20	20p	ASV54	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G414	20p	2N2221	22p	2N3402	22p	2S306	£1-10	
ACY21	20p	ASV55	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p	2N2222	27p	2N3403	22p	2S307	£1-10	
ACY22	19p	ASV56	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388	30p	2N2368	17p	2N3404	32p	2S321	60p	
ACY27	18p	ASV57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p	2N2369	15p	2N3405	45p	2S322	50p	
ACY28	19p	ASV58	25p	BC182	10p	BF173	22p	BU105	£3-90	OC81	15p	2N404	22p	2N2369A	15p	2N3410	20p	2S323	60p	
ACY29	30p	ASV59	25p	BC182L	10p	BF176	35p	C111E	60p	OC81D	15p	2N404A	30p	2N2411	50p	2N3415	20p	2S324	£1-20	
ACY30	25p	ASZ24	40p	BC183	9p	BF177	35p	C400	30p	OC82	15p	2N524	55p	2N2412	50p	2N3417	37p	2S324	£1-20	
ACY31	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p	2N2413	50p	2N3525	74p	2S325	£1-20	
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ACY35	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p	2N2712	22p	2N3703	12p	2S327	£1-20	
ACY36	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p	8A	AA119	8p	BYZ11	32p	OAB1	7p
ACY40	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p	8A	AA120	8p	BYZ12	30p	OAB5	7p
ACY41	18p	BC115	30p	BC200	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p	8A	BA116	22p	BYZ13	25p	OA90	6p
ACY44	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p	8A	BA126	22p	BYZ16	35p	OA91	7p
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p	8A	BY100	15p	BYZ17	35p	OA95	7p
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p	8A	BY101	12p	BYZ18	30p	OA200	6p
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p	8A	BY102	12p	BYZ19	35p	OA202	7p
AD161	43p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	25p	2N717	42p	8A	BY103	12p	BYZ20	35p	OA209	4p
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p	8A	BY104	12p	BYZ21	35p	OA219	4p
AD161/162(MP)	63p	BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p	8A	BY105	15p	BYZ19	25p	OA202	7p
ADT110	50p	BC135	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p	8A	BY114	12p	OA5	17p	SO10	4p
ADZ11	£2	BC136	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p	8A	BY126	15p	OA0	22p	SO19	4p
ADZ12	£2-10	BC137	35p	BC318	12p	BF257	35p	C762	17p	P357	45p	2N743	17p	8A	BY127	17p	OA47	7p	IN914	6p
AF114	17p	BC139	45p	BCY30	20p	BF270	25p	C764	60p	OC771	43p	2N744	17p	8A	BY130	15p	OA70	7p	IN916	6p
						BF271	17p	EC401	15p	ORP12	43p	2N914	17p	8A	BYZ10	35p	OA79	8p	IN4148	6p

DIODES & RECTIFIERS

8A	AA119	8p	BYZ11	32p	OAB1	7p
8A	AA120	8p	BYZ12	30p	OAB5	7p
8A	BA116	22p	BYZ13	25p	OA90	6p
8A	BA126	22p	BYZ16	35p	OA91	7p
8A	BY100	15p	BYZ17	35p	OA95	7p
8A	BY101	12p	BYZ18	30p	OA200	6p
8A	BY105	15p	BYZ19	25p	OA202	7p
8A	BY114	12p	OA5	17p	SO10	4p
8A	BY126	15p	OA0	22p	SO19	4p
8A	BY127	17p	OA47	7p	IN914	6p
8A	BY130	15p	OA70	7p	IN916	6p
8A	BYZ10	35p	OA79	8p	IN4148	6p

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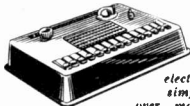
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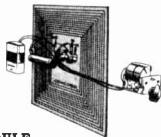


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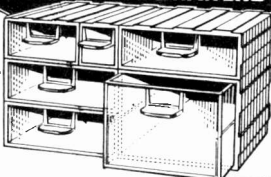


Anyone from 9 years up can follow the step-by-step, easy as ABC, fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins—Rusia, Africa, USA, Switzerland, etc. Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Size only 3in x 4 1/2in x 1 1/2in. ONLY £2.75 + 20p p. & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately.)

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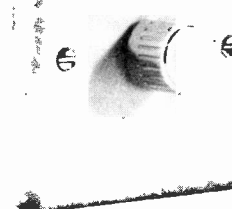
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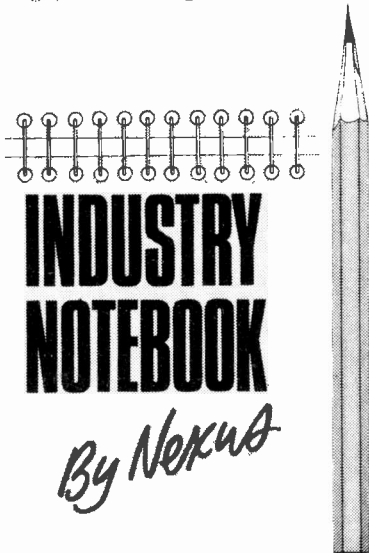
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D.F. SIXTY YEARS ON...

Sixty years ago the Marconi Company bought the Bellini-Tosi patents and put radio direction finding (r.d.f.) on the commercial map. It was only after the first world war, in 1920, that it was publicly revealed that it was British supremacy in the art of r.d.f. in 1916 that alerted the Admiralty to the fact that German warships were moving in the Wilhelmshaven area and resulted in the British Grand Fleet being ordered to sea and make for the German Bight. The following day the two fleets were engaged in the historic battle of Jutland.

The interesting point of this story is that Wilhelmshaven was 300 miles away from the British shore-based d.f. stations, well out of range, or so thought the Germans,



of British radio snoopers. The German ships in home waters were thus allowed to use low-power radio quite freely. But not only did the British observers note a sudden increase in radio traffic from a certain vessel but that during the afternoon it took up a new position some seven miles away.

Accuracy of the equipment was good enough to show a change of bearing of only 1.5 degrees. It was deduced, rightly, that the German fleet was receiving sailing orders and were taking up start positions.

Now let's move on to today's equipment. At a well equipped airport control tower, the controller can see at a glance the bearing of any aircraft which calls up control. He can have either a digital read-out or a compass-type display, sometimes both. And this was the sort of equipment that Guy Fernau was working on at STC's Radio Division up to May, 1970, when the decision came to close the Division down.

A new generation of solid state v.h.f./u.h.f. radio direction finding equipment for airport use was well on in development. STC had pioneered many developments including wide-aperture aerial systems which minimise the effects of unwanted reflections from hills or hangars. It was a pity to see it all wasted so Fernau set up on his own, with STC blessing, to continue the development.

So was born Fernau Avionics Ltd., now installed in a country house with six acres of ground (for free-space aerial experiments) at Potters Bar.

The British Ministry of Defence is evaluating the equipment for the Royal Navy and a lot of interest was generated at the International Airport Construction and Equipment Exhibition at Geneva in June.

Some estimates put the quantity of valve equipment still in airport service as high as 97 per cent. Fernau's solid state equipment of equivalent performance is only a quarter of the price so there is clearly a big replacement market as well as a market for new airports now under construction.

... C & W 100 YEARS ON

Tuesday June 6 saw the 100th Anniversary of the formation of The Eastern Telegraph Company Ltd., an amalgamation of four existing companies. This, and dozens of other companies, eventually became the massive Cable & Wireless Ltd. in 1934.

The earliest C & W company was actually formed in 1868 so the largest international telecommunications company in the world put down its first roots 104 years ago. Today C & W is still looking for expansion of business and I can reveal that one area being examined very seriously is airport services. Not only communications but all the electronics that goes into a modern airport, including navigational aids such as radar and ILS systems.

The company won the contract for equipping the new Seychelles International Airport, opened officially by Her Majesty the Queen earlier this year.

During the next five years equipment requirements for new or expanding airports are likely to exceed £40 million in value and another £8 million will be spent on updating old equipment. C & W could well capture a fair percentage of the market, especially in the developing areas of Africa, Central and South America, and the Far East.

One of C & W's strengths is the ability to train indigenous labour. Emergent countries like to have their own people running things. In Hong Kong, where C & W manage all the general telecommunications as well as the airport

electronics, no less than 97 per cent of the staff of 1,650 are Chinese and the largest single sector is that of technicians and engineers.

It would be foolhardy to predict what the pattern of events will be in the second century of C & W's life but expansion in airport services looks like a good bet.

INTERNATIONAL OEM COMPONENT SUPPLY

And now for a really new company whose life is still measured in days. This is Neltronic (UK) Ltd., headed by John Williams who sees a big future in procuring components world-wide for Original Equipment Manufacture (OEM).

Williams has recently concluded a world tour during which he appointed purchasing agents in Japan, Hong Kong, Thailand, Singapore and Sweden. So Neltronic (UK) will be a big importer of overseas components for British manufacturers. But plans are also afoot for a two-way trade in which British components will be procured for overseas manufacturers.

Neltronic (UK) has been set up as part of the Auriema Group, American-based but operating in 17 countries and with the bulk of trade in Europe. So Williams has a flying start with a multi-national group, albeit small (400 employees), behind him but with big opportunities for expansion. The Soviet bloc countries constitute a market in which Williams has good contacts. He also sees good opportunities in Australia.

POST OFFICE PROMOTES DATA LINKS ON FILM

Keep an eye open for "Communicate to Live", a new Post Office film now coming on general release to your local cinema. It has won two major awards at film festivals, one in the U.S.A. and one in the U.K.

At the London preview I sat fascinated for the whole 23 minutes running time. Ronnie Whitehouse, who wrote and directed the film, has done a fine job on a difficult subject.

Real life applications of data transmission in the film included shots of youngsters at Monks Walk School, Welwyn Garden City, using a teletype computer terminal, students at Hatfield Polytechnic using computer visual displays, and a gruesome operating theatre sequence shot at St. Peter's Hospital, London.

Data transmission is the biggest growth area for the Post Office. Whether this film will sell more of it may be debatable but as sugar-coated education the film is certainly a success.



BULK COMPONENT LIST . . .

Below is the complete list of components used in Digi-Cal (excluding the power supply).

Individual component lists will, of course, be published with circuit diagrams as they appear.

The estimated total price for all components is £110, assuming bulk purchase.

Prices can be kept to a minimum by buying in large quantities and the

following firms have kindly agreed to supply all digital integrated circuits and display devices at a reduced price, if bought as one package: Bi-Pak Semiconductors, Chromasonic Electronics, Electro-value, Henry's Radio, L.S.T. Electronic Components, A. Marshall & Son, G. W. Smith & Co. (Radio), and Trampus Electronix. (For addresses see advertisements)

Integrated Circuits	Quantity	Resistors	Quantity	Plug-in Logic Cards	
SN7400	11	47Ω	15	Shirehall Dualine:	
SN7401	23	560Ω	3	DL109/22	5
SN7402	1	1.2kΩ	25	DL109/44	7
SN7404	2	3.9kΩ	1	DL107/44 (optional)	1
SN7405	6	5.6kΩ	26		
SN7408	1	15kΩ	1		
SN7410	7	180kΩ	1		
SN7413	1			Edge Connectors	
SN7420	1			Shirehall DPK165	12
SN7440	8			DL131 card guides	3 packets
SN7442	3	Capacitors			
SN7445	1	0.001μF	4		
SN7446	1	0.01μF	1	Seven Segment Indicators	
SN7450	4	0.047μF	21	Minitron 3015F	8
SN7474	21	0.1μF	7		
SN7475	6	10μF 15V elect.	17	Key Switches	
SN7483	3	22μF 15V elect.	2	Bulgin type MP22 white	12
SN7486	8	150μF 15V elect.	1	black	9
SN7490	12			Lampholder	
SN7493	1	Transistors		Bulgin type D22	
SN7494	8	E5200	9		
SN7496	8	E5201	10	Thumbwheel Switch	
SN74119	1			Birch-Stolec type	1
SN74121	2	Diodes		EB10N 1248+ a pair of	
SN74151	1	General purpose silicon	145	end plates	
SN74154	2	(West Hyde type "red")			
SN74191	1				

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PART 2

By R.W. COLES

CONSTRUCTION OF MAIN CHASSIS AND POWER SUPPLIES

AT THE VERY beginning of the design of Digi-Cal it was recognised that a simple and reliable system to house the logic circuitry would be required, and at the same time a pleasing appearance had to be guaranteed so that the completed calculator would not only behave in a professional way, but also look the part.

With the large number of i.c.s involved it was considered essential that as far as possible the individual sections of the calculator should be easily separated by means of plugs and sockets to allow component accessibility, and it was eventually decided that the best way of achieving this was to use a versatile plug-in card system.

Finding a case for the design which would allow the use of plug-in cards and also be easily modified to incorporate a keyboard was quite difficult but eventually the "Contil" Mod-2 type "0" was chosen as the only design type which would fit the bill at a reasonable price.

MAIN CHASSIS CONSTRUCTION

The case for Digi-Cal consists of a "Contil" Mod-2 case with a sloping keyboard attached to the front. The case is supplied in seven sections; four blue panels which form two sides and the top and bottom; two grey panels forming the front and back; and an aluminium chassis plate. An extra grey panel is used to construct the keyboard.

CHASSIS PLATE

The large plate chassis which forms part of the Mod-2 case is a very important structural component of the design because it not only acts as a support for all the logic boards, but also forms a "ground-plane" for the logic interconnections.

The plate is mounted "upside down", that is with the flanges uppermost, in the lowest of the available fixing positions, so as to give sufficient room above it for the plug-in cards.

A large cut-out is made to accommodate the 12 edge connectors used in the design, although, in fact, an extra edge connector position is fully provided for, making 13 in all, to allow for any extra logic circuitry which may be added at a later date (see Fig. 2.1).

Two aluminium sheets are mounted above the chassis to act as supports for the logic cards, the edges of which slide in small plastic guides which are press fitted to the aluminium. In the prototype these aluminium sheets were cut from an extra "Contil" chassis plate, thus removing the need to bend accurate flanges, which are, of course, part of the chassis construction (see Fig. 2.2).

This is a rather uneconomic way of producing these supports although it does yield four quick-release fasteners which were put to good use in the prototype as fasteners for the display and programme Veroboard panels.

At the front of the plate two cuts are made into the aluminium, and the resulting flange is bent down at an angle. This is done to drop the fixing level of the display panel which is mounted in a sloping position to give easy readability from steep viewing angles.

PLUG-IN CARD SYSTEM

The plug-in cards used in the Digi-Cal are Shire-hall Dualine type DL109. These are small boards with gold-plated edge connectors of 22 or 44 ways, each having positions for nine dual-in-line integrated circuits.

Integrated circuits with either 14 or 16 pins can be used and each pin position is provided with a printed three hole pad to facilitate wiring up with ordinary connecting wire. In addition to the printed pads, two power rails are incorporated which run past every i.c. position.

Some of the circuits used in Digi-Cal, namely the display, the keyboard, and the programme, did not lend themselves to the Dualine format, and in these cases special designs were made from 0.1in Veroboard which, while requiring extra wiring and hole cutting, provides quite a neat base for the logic.

The edge connectors best suited to the Dualine cards are the type DPK165 which have a full complement of 44 contacts.

The edge connectors are fixed under the chassis plate so that the cards plug in from above. For each socket two $\frac{1}{4}$ in 6B.A. bolts should be used, with two extra nuts and washers acting as spacers to bring the mouths of the sockets flush with the plate and allowing sufficient room for the cards above the chassis.

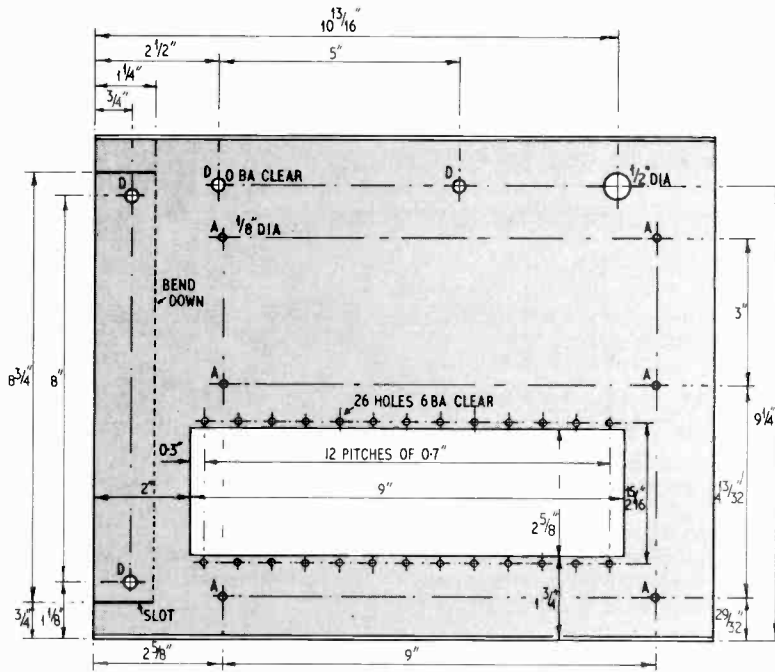


Fig. 2.1. Cutting and drilling details for the main chassis plate. The front is bent down about half an inch to bring the display panel (to be described in Part 3) in line with the front panel

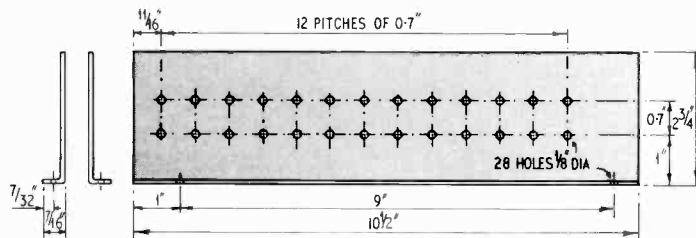


Fig. 2.2. These two plates support the plastic card guides

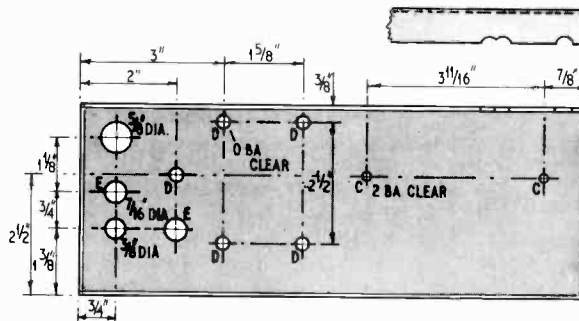


Fig. 2.3. The rear grey panel drilling details viewed from the flange side. Note the semicircular cutouts in the upper flange to allow access to the potentiometers on the power supply board

FRONT AND BACK PANELS

The rear grey panel supports the complete power supply and the drilling is quite straightforward, as shown in Fig. 2.3.

A rectangular hole must be cut in the front panel through which to view the display and the cutting of this should be done carefully. A "nibbling" tool is ideal for this job but if care is taken, sawing and filing will produce satisfactory results (see Fig. 2.4).

OPTICAL FILTERS

The seven-segment incandescent readout devices used on the Digi-Cal display board give the familiar white light output and can be used with a contrast enhancing filter of any colour. The filter material used in the prototype was obtained from West Hyde Developments, the red being found the most appropriate.

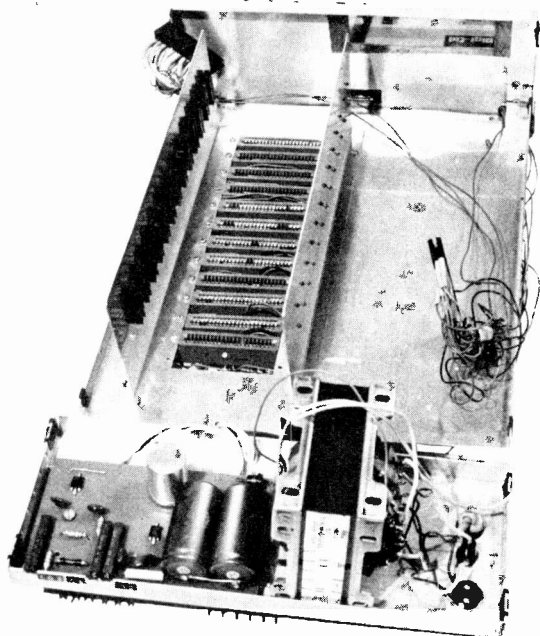
Two sheets of filter material are required to give sufficient contrast, one mounted on the inside of the front panel, and the other attached to the front of the display devices themselves.

After the display cut-out has been made in the front panel, the sheet of filter can be glued to the inside with contact adhesive, care being taken not to get any of the adhesive on the visible surfaces, and also to keep the filter as bump free as possible.

If the finishing of the display cut-out has been done carefully there will be no need to use an escutcheon to decorate the outside edges, but a trim can be incorporated if desired.

KEYBOARD CONSTRUCTION

The sloping keyboard attached to the front of Digi-Cal is made from $\frac{3}{8}$ in plywood and an extra



A photograph of the power supply unit in the prototype (Note that the bridge rectifier and mains fuse were not included)

The main chassis plate can be seen in this photograph and also the method of mounting the card guide supports

"Contil" type "0" front panel. The cutting and drilling details for the keyboard are shown in the diagrams (Figs. 2.5 and 2.6) and thanks to the simple fixing method used by the 22 push keys, this potentially tedious task is made easy.

The wooden keyboard frame is fastened to the front panel of the case by means of four wood screws, and provides the necessary solid support for the keyboard proper which is only lightly attached to the frame by two more wood screws to permit its removal when required.

The individual keys are snapped home into the oblong slots in the aluminium, the edges of which may need bevelling to allow them to easily slot into the recesses in the switches.

The lettering and numerals on the key switches is done with Letraset and protected with clear varnish, some experimentation being needed in the number of coats to produce a really durable finish.

The hole for the "decimal point" thumbwheel switch is cut in the same way as the key slots but it is recommended that the holes for the fixing bolts be marked and drilled after the thumbwheel has been inserted as a guide.

VEROBOARD PANEL

Nearly all the panel interconnections are made under the chassis, and to facilitate this, and to provide spare space for possible additional circuitry, an 11in \times 3.7in sheet of 0.1in Veroboard is mounted face up under the chassis alongside the edge connector array.

This panel is spaced from the chassis by two 6B.A. nuts on each of the supporting bolts, the proximity of the chassis being necessary to take full advantage of its ground plane properties.

A sheet of adhesive plastic stuck to the aluminium is advisable to prevent any short circuits when the panel is wired up.

POWER SUPPLY

The construction of the power supply is the first part of Digi-Cal which should be built since the plug-in cards to be constructed need reliable, well regulated power supplies.

The power requirements of Digi-Cal are straightforward: a well regulated five volt supply at 2.5 amps for the logic circuitry; and a 20 volt supply at 200mA for the "Minitron" display devices.

The back panel acts as a support for the entire power supply assembly which is therefore a removable module, only three wires being necessary to connect it to the rest of Digi-Cal.

POWER SUPPLY COMPONENTS

The circuit of the power supplies is shown in Fig. 2.7 and as can be seen, two integrated circuit regulators form the heart of the design.

These devices are both cheaper to buy and simpler to use than their equivalent in discrete components; at about £1.25 each they represent excellent value for money.

The mains input is applied to the fuse and transformer via a "rocker" on/off switch mounted in the extreme corner of the back panel, making operation from the front of the calculator a simple proposition, and retaining the integrity of the power supply "module".

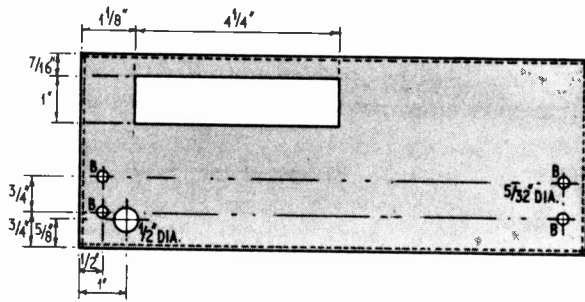


Fig. 2.4. The front grey panel cutting details as seen from the front

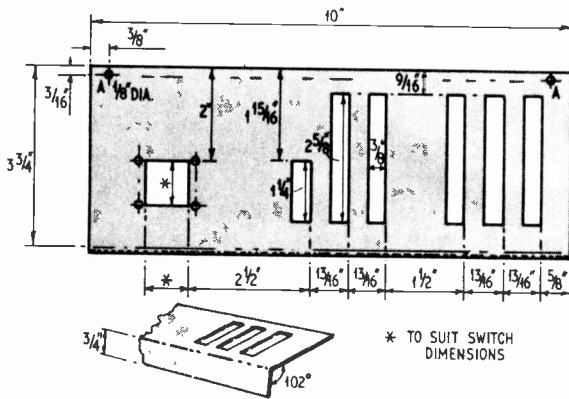


Fig. 2.5. The cutting and drilling details of the keyboard panel which is made from an extra front panel. All flanges should be sawn off except one long edge which is bent as shown in the smaller diagram



The finished keyboard

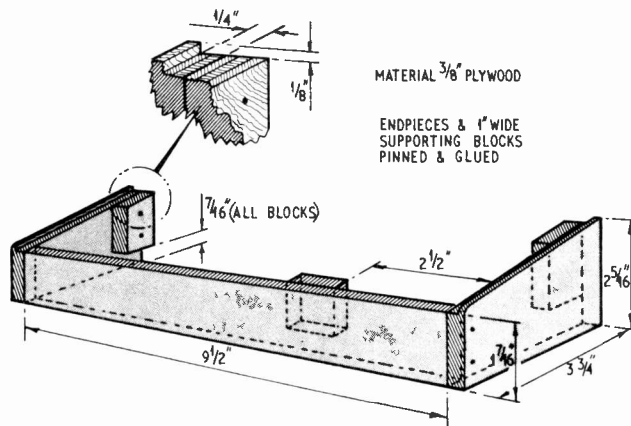


Fig. 2.6. The keyboard supports are constructed from 3/8 in plywood cut as shown

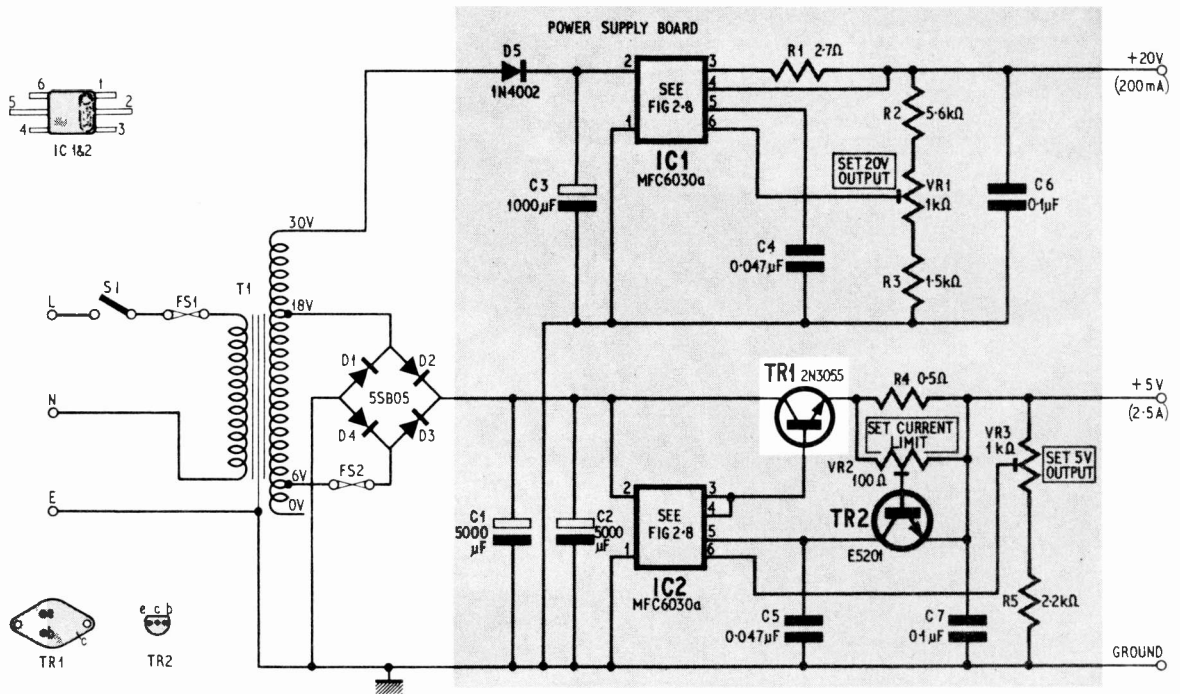


Fig. 2.7. Circuit diagram of the power supply. The internal circuit of the integrated circuits is shown in Fig. 2.8

The transformer itself provides all the necessary voltages and has an internal screen which, when earthed, prevents the capacitive coupling of high-frequency interference into the secondary.

The low voltage supply is rectified by a bridge-rectifier module, which is heat-sunk to the back panel, alongside the transformer.

The circuit diagram of the i.c. regulator is shown in Fig. 2.8. It is a 1 watt regulator, with variable output voltage and current-limiting in a package the size of a pea.

THE 20 VOLT SUPPLY

The 20V supply uses the MFC6030a in its standard configuration, the 24V supply being half wave rectified by diode D5, smoothed by C3 and applied to pin 2 of the i.c. where it is reduced to a stable 20V by the emitter follower action of TRB and TRC.

The base of this compound transistor is driven by the output of the error amplifier TRD and TRE, which compares a fraction of the output voltage provided by the potentiometer chain, R2, VR1 and R3 with a stable reference voltage generated by a Zener and diode/transistor combination, DA, TRA, DB, C and D. Any difference detected by the error amplifier causes either more or less base current to be supplied to the compound transistor to bring the output voltage back to its preset level.

Current-limiting is provided by TRF working in conjunction with an external programming resistor, R1, which is chosen so that when the desired maximum current is reached, the voltage across the resistor is sufficient to turn on TRF and divert the drive current which would otherwise feed the base of TRB.

Capacitors C4 and C6 help to stabilise the regulator so that no high frequency oscillation can occur under transient conditions.

THE FIVE VOLT SUPPLY

The basic i.c. regulator can only supply a maximum of 200mA to an external load, so with the five volt supply the output of the i.c. is used to drive the base of a 2N3055 power transistor, thus expanding the current handling capacity of the circuit up to the required 2.5 amps. The 2N3055 has to dissipate about 15 watts under operational conditions and is therefore mounted outside the case on a substantial heatsink.

The internal current limiting circuit cannot easily be used with an external power transistor, but by using a single *npn* transistor (TR2) current limiting can be retained.

In this supply variable current limiting is achieved by tapping off a variable fraction of the

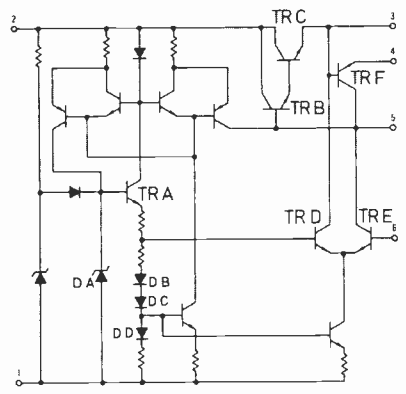


Fig. 2.8. The internal circuit diagram of the Motorola MFC6030a regulator i.c.

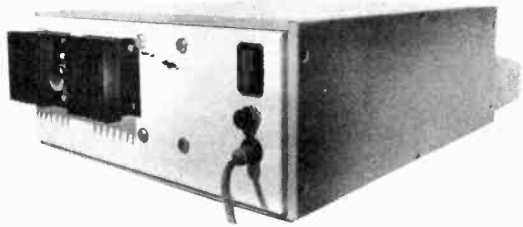
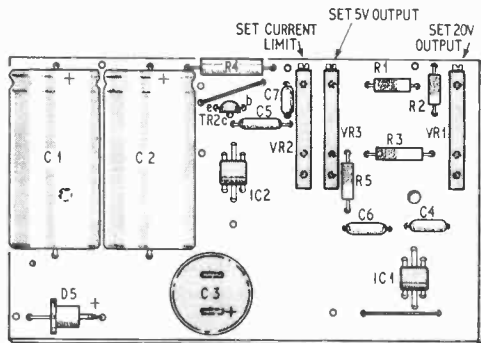
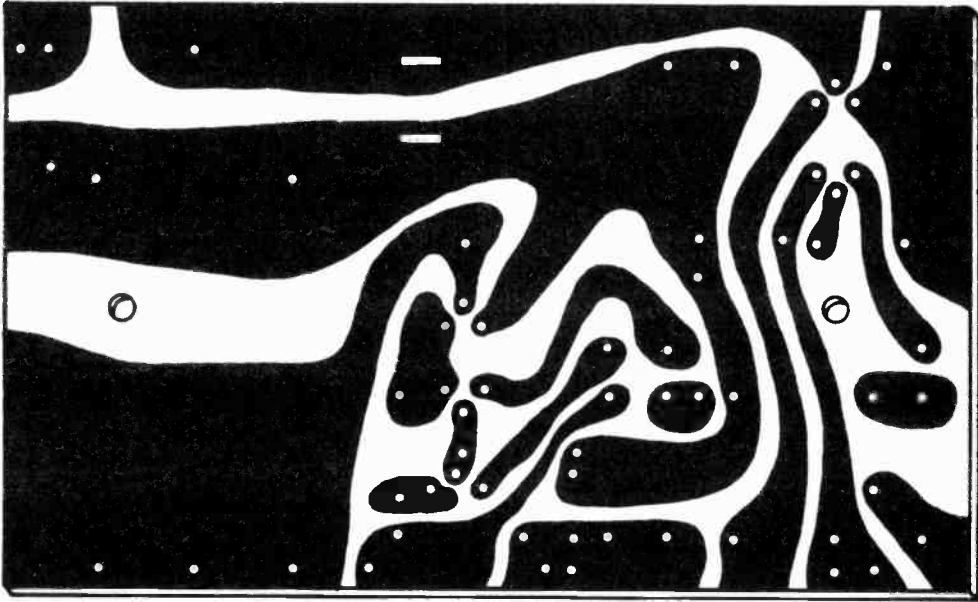


Fig. 2.9. Component layout and wiring of the board. The printed circuit pattern is shown full size above

A rear view of Digi-Cal showing the power supply transistor on its heatsink

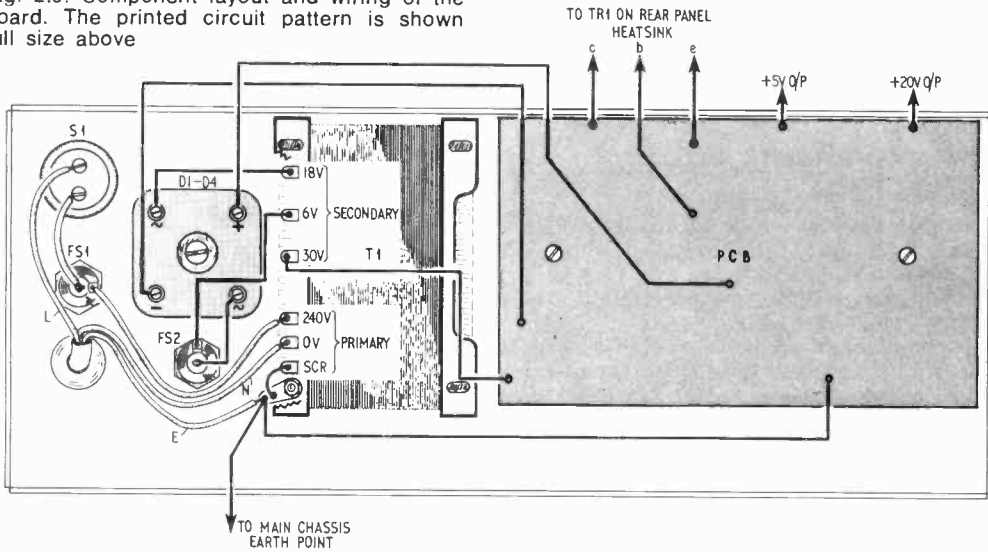


Fig. 2.10. Interwiring diagram of the complete power supply unit

voltage dropped by the current limiting sense resistor R4, by means of the potentiometer VR2.

The other components used in the 5V circuit perform similar functions to their counterparts in the 20V regulator.

PRINTED CIRCUIT MAKING

The power supply components, with the exception of the 5V series regulator transistor and transformer, are all mounted on a home-made printed circuit of simple design.

The use of a printed circuit is made necessary partly by the awkward shape of power supply components in general, and also by the high currents which are carried by some of the printed tracks.

The etching of the circuit is simply achieved by painting on the conductor pattern shown in Fig. 2.9 with quick drying paint, and then immersing the copper laminate in solution of 60% per cent ferric chloride, obtainable from good chemists.

When all the unpainted copper has been dissolved by the etchant (about half an hour) the circuit can be washed and the paint removed with scouring powder to reveal the bright copper conductors.

Hole drilling is best completed with a drill about 1mm in diameter, after the hole pattern has been checked for accuracy with the actual components to be used, as some size variation of things like electrolytics and potentiometers is inevitable.

Smoothing of the low voltage supply is achieved by two 5,000 μ F capacitors in parallel, the large total capacity being necessary because of the high currents involved. The precise total value is not critical, and anything larger than 6,500 μ F will suffice; the most critical feature of these capacitors is their size, very little room being available on the printed circuit.

MOUNTING THE BOARD

The power supply printed board is mounted above the chassis line in the back panel by means of two 2B.A. bolts, spacing from the panel being achieved with two or three extra nuts. With this amount of spacing the potentiometers are not accessible from above, and it is necessary to file three semicircular cutouts in the back panel as shown in Fig. 2.3.

The heatsink used in the prototype was one of the type commonly used in audio amplifiers to mount two output transistors, this was cut in half and mounted on the outside of the back panel by means of four 6B.A. bolts. The actual heatsink used is not important provided that it has at least 30 square inches of surface area exposed. The 2N3055 must be insulated from the heatsink using the usual mica washer and bushes provided with the device when purchased.

Interwiring is carried out as shown in Fig. 2.10.

TESTING THE POWER SUPPLY

When the power supply module has been assembled it can be tested by plugging it into the mains supply and connecting a voltmeter to the output of each supply in turn. The potentiometers should all be set to mid-travel before the mains is switched on, and the voltages measured should be fairly close to their required value, accurate setting being made with the appropriate potentiometer.

The current-limiting for the 20V supply is preset and should not be tested by shorting out the supply, as it will only safely handle brief short circuits of the type which can occur accidentally whilst wiring up.

The current limiting of the 5V supply is able to handle continuous short circuits, and the threshold value can be set by connecting an ammeter across the output terminals of the supply and adjusting the current limit potentiometer until a reading of 2.5 amps is obtained.

The 2.5 amp setting is required for the finished calculator, but if the supply is going to be used to check each separate board as it is completed the current limit can be set to suit each situation, thus avoiding any spectacular shorts!

It should be noted that several of the power supply components, including the 20V regulator i.c., do get quite hot in operation: this is quite normal and constructors can rest assured that all components are operated well within their maximum ratings.

Next month: Construction of display panel

COMPONENTS . . .

CASE AND KEYBOARD

Contil Mod-2 type "0" case with extra front panel and either an extra type "0" chassis or a sheet of 18 s.w.g. aluminium (see text), $\frac{3}{4}$ in plywood for the keyboard support

POWER SUPPLY MODULE

Resistors

R1 2.7 Ω	R4 0.5 Ω 3W
R2 5.6k Ω	R5 2.2k Ω
R3 1.5k Ω	

All $\pm 10\%$, $\frac{1}{4}$ W carbon unless otherwise stated

Potentiometers

VR1 1k Ω lin. preset	} All Bourn's "Trimpot"
VR2 100 Ω lin. preset	
VR3 1k Ω lin. preset	

Capacitors

C1, C2 5,000 μ F 15V elect. (see text) (2 off)
C3 1,000 μ F 25V elect.
C4, C5 0.047 μ F (2 off)
C6, C7 0.1 μ F (2 off)

Transformer

T1 Mains transformer, secondary 0-6-10-15-18-30 2A (West Hyde Developments type TRB)

Transistors

TR1 2N3055	TR2 E5201 (West Hyde)
------------	-----------------------

Diodes

D1-4 5SB05 bridge rectifier (I.R.)
D5 1N4002 or any 100 p.i.v. 1A diode

Integrated Circuits

IC1, IC2 MFC6030a (2 off)

Switch

S1 On/off switch (Bulgin type S1B825)

Miscellaneous

FS1 2A fuse and holder (Belling Lee L575)
FS2 2.5A fuse and holder (Belling Lee L575)
Heatsink for TR1 (Marx type 10DN0200A300 or similar)
5in \times 3in copper clad laminate

ELECTRONORAMA

TRANSISTORS FOR COMMUNICATIONS

THE Post Office Research Department receives the award for the development and production of high performance silicon planar transistors for use in undersea communications cables.

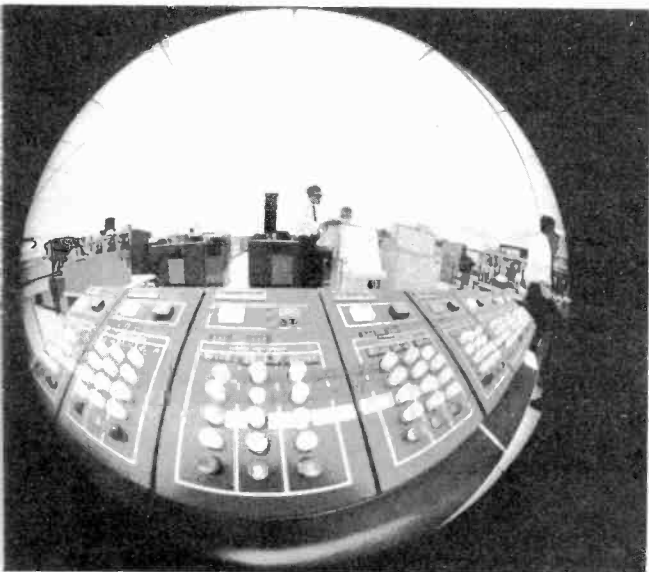
During the last 10 years the research department at Dollis Hill has perfected the transistor so that they can work non-stop without failure for not less than 20 years, and they are now the key elements in the submerged repeaters of international and intercontinental submarine cable systems.

The electrical performances of the earliest 4A-type, of the 10A-type, and of the latest 40-type all compare well with their commercial contemporaries but the most important innovation is the achievement of ultra-reliability. The submarine system will fail if a single amplifying transistor, in a total of more than 3,000 in the longest cable, fails, or if the mean gain change of all the transistors exceeds ± 3 per cent. In addition the gain change of a single transistor must not exceed ± 50 per cent.

Today the most modern submarine cable systems carry more than 1,800 telephone conversations simultaneously compared with only 100 or so in the early 1960s. Cables of even greater capacity—carrying up to 4,000 conversations at once—are on the way.



Transistor "headers" being examined for flaws



The computer hall at Boadicea House

Reservation equipment at BOAC's London air terminal



BOADICEA

THE 1972 award made to BOAC airlines management services department was for the design and setting up of a computer complex to handle all requirements for a worldwide airline.

Known as BOADICEA, British Overseas Airways Digital Information Computer for Electronic Automation, this is the first time that the Queen's Award has been bestowed for a computer system.

Technically, Boadicea represents the successful installation of probably the most advanced and varied real-time computer system in the world. More than 50 computers are linked together through a worldwide communications network, using lines at speeds ranging from 50 bauds to 9,600 bauds (a baud equals one bit per second), to serve over 200 BOAC and associated airline offices in 66 different countries.

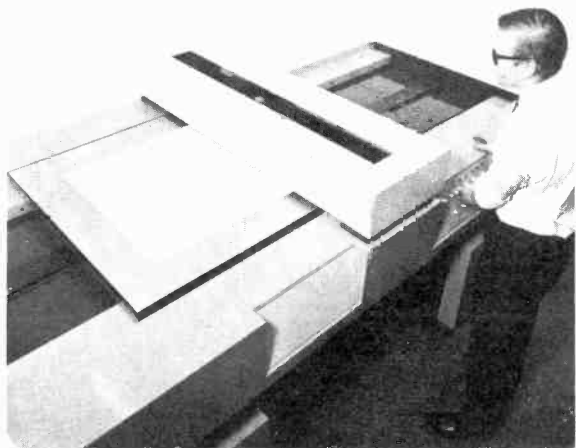
The use of TV screen terminals operating in a conversational mode, direct computer to computer links, and the use of widely varying data transmission techniques necessitated by a worldwide coverage, were all in their infancy when the system was first conceived.

Of particular significance has been the high degree of integration achieved with Boadicea. A whole range of related applications all operate together in real-time sharing the same computers, the same communications networks and the same files. Integration of real-time activities poses very severe problems particularly when it comes to adding a further real-time application to those already operational. This is particularly crucial in BOAC's case because of the 24 hours a day nature of their activities.

The main advantage to the travelling public is the reservations system which uses cathode ray tube readout and solid state keyboards for operator's use. Reservation staff in the UK, Europe and North America have, at their fingertips, instant reservation information on all flights. Seat availability on any flight can be established within seconds and four flights are displayed on request to aid passengers' selection.

Seat reservations, hotel bookings, car hire and any special requirements can be made through the computer system up to 10 months in advance.

This month *Electronorama* devotes its pages to the 1972 Queen's Award to Industry, where electronics scored notable successes for technical expertise. Nearly a third of the Queen's Awards for technological innovation was won by firms in the electronics field.



The Ferranti Master Plotter

AUTOMATED DRAUGHTING

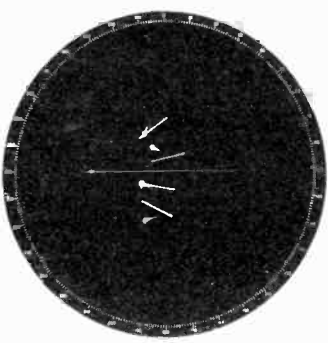
THE Scottish group of Ferranti Ltd. have won the award for their data processing range of automated draughting equipment developed and manufactured in Edinburgh.

The ADE system revolves around a computer and specialised peripheral equipment including a reader, micro-plotter and a master-plotter.

The reader is a digitiser with which an operator converts the information on a drawing into numerical form. The reader tape is used by the computer to generate a set of numerical data which defines the part and the computer programmes convert the stored data to control tapes for automatically controlling the manufacturing machines.

The ADE micro-plotter is a high speed plotter used to produce fully dimensioned, detailed drawings on microfilm and provides a processed microfilm aperture card. The input to the plotter can be in the form of paper tape or in the form of magnetic tape. Alternatively, the plotter can be connected directly on-line to a computer.

The master-plotter is a very accurate drawing machine for precision reproduction of graphical information from tape or computer input. Typical applications include printed circuit masters, graticules, templates, maps and lofted masters for ships, aircraft and automobiles.



Four Relative Motion markers have been positioned on echoes considered to be collision risks. Some minutes after the markers were aligned with the echoes, it can be seen that two of the echoes have moved off their markers and are passing well clear. The other two echoes are continuing to move along their markers and therefore are collision risks

ANTI-COLLISION RADAR

PROBABLY one of the most consistent winners of the Queen's Award over the last few years has been Decca Radar. This year they received the award for technical application in their anti-collision radar system.

This was the first marine radar to show simultaneously on one display both the relative and true information required to assess a collision situation. The electronic techniques developed by Decca to do this have proved in service to be both effective and highly reliable.

Using the time-honoured principle whereby another ship is "deemed to be on a collision course" if two or more compass bearings of her remain constant, the anti-collision radar employs up to five relative motion markers on a monitor screen. Any one of these markers may be placed with its far end on a suspect echo; the marker then remains at constant bearing and distance from its own ship, providing a relative motion reference. If the echo travels down the marker it is on a collision course, if it moves off to one side the ship concerned will pass ahead or astern as indicated.

Another company to receive an award in the field of radar was Cossor Electronics. Their system was for secondary surveillance radar for air traffic control.

At the time of going to press we had received no information from Cossor on their system.

The Decca AC 626 Anti-Collision Radar installed in the M.V. Scotia



EXPORT AWARDS

Awards for export achievement went to the following firms in the electronics industry:

- Gunsons Sortex Ltd. Electronic colour sorting equipment.
- Marconi International Marine Co. Ltd. Marine communications and navigational aids.
- National Cash Register Co. Ltd. Cash registers, computers, accounting and adding machines.
- Racal-Mobilcal Ltd. Portable radio transmitters/receivers.

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*An electronic piano tailored for
the modern home.
Authentic piano sounds from
an instrument a quarter the
size of the conventional pianoforte.*

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- ★ FIVE OCTAVE PIANO KEYBOARD FROM F TO F
- ★ VARIABLE ATTACK AND DECAY
- ★ BUILT-IN AMPLIFIER AND SPEAKERS (FACILITY FOR 'PHONES)
- ★ ALL I.C. FREQUENCY DIVIDERS

ALSO: EXPERIMENTAL LOGIC UNIT

For constructors new to logic circuits, this article describes, with the aid of a practical switching circuit, all the conventional logic functions

★★★★★

SQUARE WAVE GENERATOR

Audio frequency and transient responses are best measured with the help of a fast rise time square wave generator. This instrument provides four preset square wave frequencies to cover the pass bands in which the audio engineer is interested

PRACTICAL ELECTRONICS

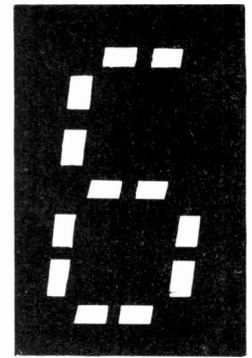
September issue on sale August 11

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Practical Electronics August 1972

ALPHA NUMERIC DISPLAYS

Part
By R.W. Coles



Practical L.E.D. Displays

LAST MONTH we looked at the exciting new Light Emitting Diode (L.E.D.) display devices and considered their basic characteristics and advantages. This month we shall be seeing how L.E.D. indicators can be incorporated into a practical readout system which could be used in digital clocks, counters, or voltmeters, and which is built using readily available TTL logic.

MULTI-DIGIT DISPLAYS

The circuit arrangement for driving a single "seven-segment" L.E.D. display was shown last month, the same basic logic array of data-store/decoder/indicator also being examined in the sections covering gas-filled and incandescent devices: there is therefore no need to spend any more time looking at this simple system, and we can continue on to a rather more complex circuit for use with the economic "multi-digit" L.E.D. packages.

As we mentioned last month, the price of L.E.D. readouts is fairly high at present, although it is dropping rapidly and the projected cost for a couple of years hence is very low indeed.

To take the fullest advantage of low L.E.D. prices an economic packaging system is essential, and the simplest way to achieve this is to put more than one digit in each moulded plastic package. This is readily done because of the small size of these devices and their similarity to integrated circuits, and the resultant readout is easier to use because of the reduced interconnections required.

At the time of writing, packages are available containing up to six "seven-segment" digits, and the number of digits will no doubt increase as demand grows and prices drop.

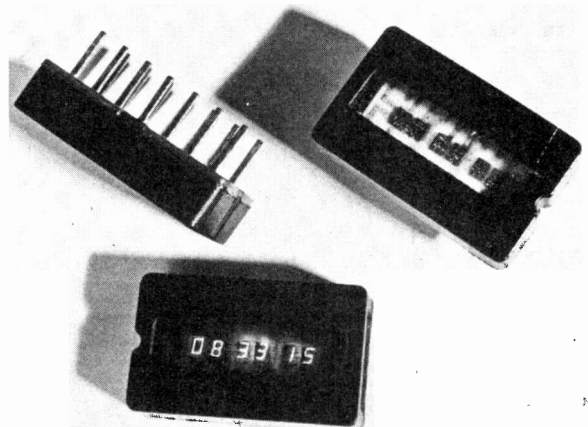
TIME-SHARING SYSTEMS

An individual L.E.D. indicator requires eight anode wires (seven segments plus decimal point) and one cathode wire, making nine in all. For a package with more than one digit the number of lead-outs required could be nine times N , where N is the number of digits, and such a large total is neither practical nor desirable.

To overcome this lead-out problem, multi-digit packages are internally wired to give eight common anode wires, to which corresponding segments of each digit are connected, and a separate cathode wire for each digit, giving a total pin-count of eight plus N , a much better state of affairs which allows up to six digits to be housed in a 14 pin dual in line pack.

The inevitable sacrifice which has to be made with this scheme is that it is not possible to "talk to" all of the digits all of the time, and the drive circuit has to work in a "time-shared", or multiplex, system where only one digit at a time is addressed and allowed to display its data.

This is not such a disadvantage as it may seem, since it also means that only one expensive seven-segment decoder is required for the whole display instead of one for each digit, and by making the scanning rate high enough the resultant readout is indistinguishable from a separately addressed scheme.



Six figures in one dual-in-line package illustrates the extreme miniaturisation that can be achieved using L.E.D. techniques. Producing yellow light, this device is intended for film annotation (Ferranti)

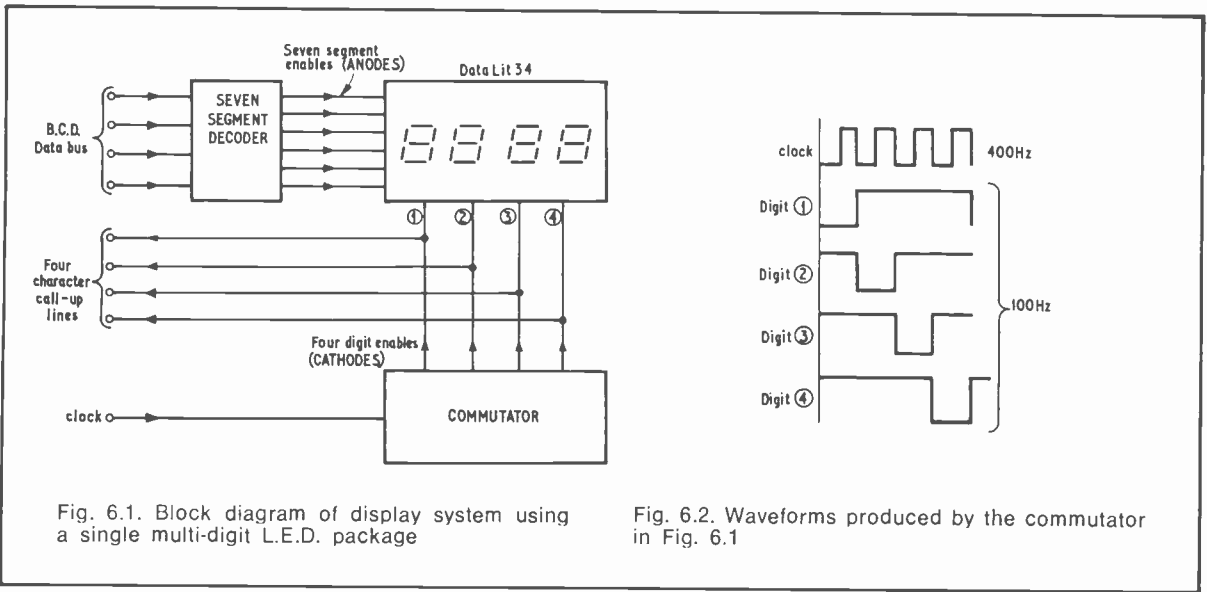


Fig. 6.1. Block diagram of display system using a single multi-digit L.E.D. package

Fig. 6.2. Waveforms produced by the commutator in Fig. 6.1

THE BASIC SYSTEM

The basic block diagram for a display system employing a single, multi-digit L.E.D. package is shown in Fig. 6.1.

With a "time-shared" system such as this only one of the four digits will be illuminated at any instant in time, each of the digits being turned on in succession by the output pulses from the commutator.

The fact that any particular digit is not continuously illuminated is not noticed by the human eye because the brain ignores flicker above a frequency of about 50Hz. In practical display systems a refresh frequency of about 100Hz is used, making the required clock frequency N times 100Hz, or 400Hz in the case of a four-digit display output. The waveforms from the commutator, which consists of a divide-by-four binary counter and a one-of-four decoder, are shown in Fig. 6.2.

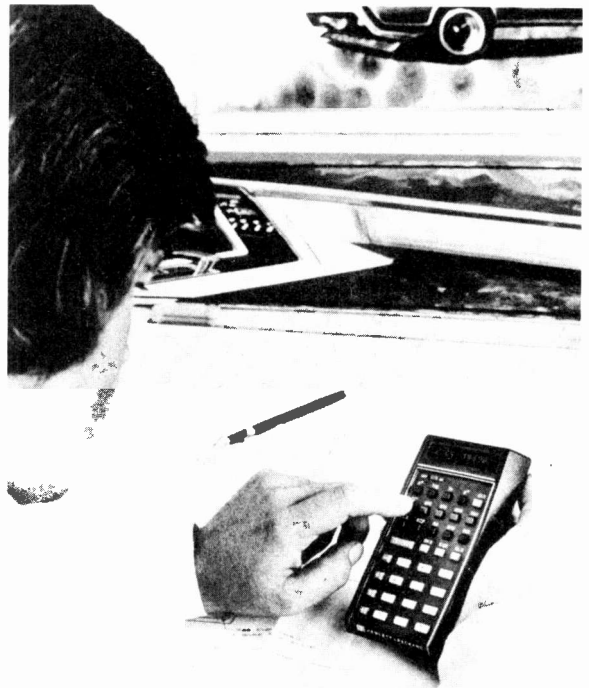
When a particular "digit-enable" strobe is present the cathode of its associated L.E.D. digit is grounded to allow the "segment enables" to turn the appropriate segments to display the data, which is simultaneously called up by the same strobe from the counter or store where it is held.

After its display period (of 2.5ms) the first digit strobe disappears and the next digit in the sequence is enabled, new data being presented to the decoder at the same time.

DRIVE CURRENTS

Because each digit is only illuminated for a quarter of the total display time (in this particular case) it is necessary to increase the L.E.D. current during the "on" period to ensure the same brightness as a continuous display.

At first sight it might appear that the current needs to be increased by a factor of four to compensate for the fact that it is off for three-quarters of the time, but in fact another advantage is gained from time-shared operation in that this system gives an apparently brighter display for the same time-averaged current.



This calculator from Hewlett-Packard uses L.E.D. devices for its ten digit display

DATA-BUS SYSTEM

An important advantage of any multiplex display system is that all the data held in the store can be transmitted to the display system by only four wires, regardless of how many separate digits are to be displayed.

Needless to say this fact becomes increasingly useful as the number of digits increases: an eight digit display requires only four wires (plus a possible eight call-up wires) instead of 32 needed for a static display, and this is in addition to the fact that a saving of seven decoders is made.

The four wires used are called the "data-bus", a name derived from the omnibus characteristic of lines which carry all the data at one time or another, but only enough data to define one digit at any particular instant.

The information carried by the data-bus must of course be synchronised with the "digit strobes" which "enable" each readout device in turn, and there are several different ways of achieving this.

The simplest system is to connect each four bit group of B.C.D. data to the data-bus via four gates which can be enabled simultaneously when required. The corresponding bit outputs from each group of gates are then wired together to form each wire of the bus, as shown in Fig. 6.3.

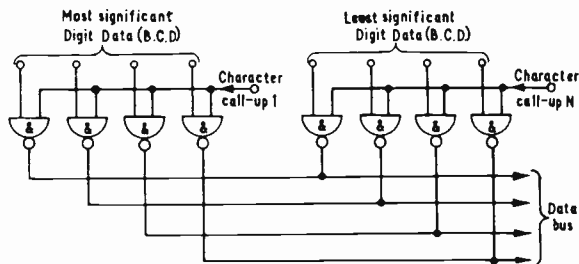


Fig. 6.3. The simplest "data-bus" system using groups of four gates "enabled" in turn for each digit

SHIFT REGISTER STORE

An alternative way of achieving the same result is shown in Fig. 6.4. Here the data for display is stored in groups of four shift-register bistables with the corresponding bits of each digit being connected together to form a serial shift-register.

Each of the flip-flops is clocked simultaneously which causes each four bit group to be propagated down the register, eventually re-entering from the left via the feedback loop. The data bus itself is taken from the extreme right-hand end, a new set of data appearing on it after each clock pulse.

With this system the character call-up lines are dispensed with and instead the commutator clock is used to clock the registers to ensure synchronism. This type of data-bus drive could be more economical if the source of data can also be used to form the shift register, but this is obviously not possible if the data comes from counters or switches, and in these cases the gating scheme is preferable.

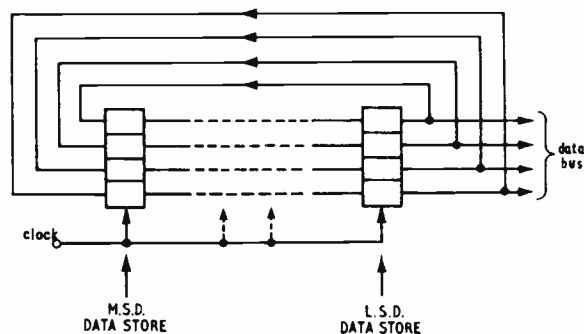


Fig. 6.4. Alternative system using a shift-register to present successive digits to the "data-bus"

A PRACTICAL SYSTEM

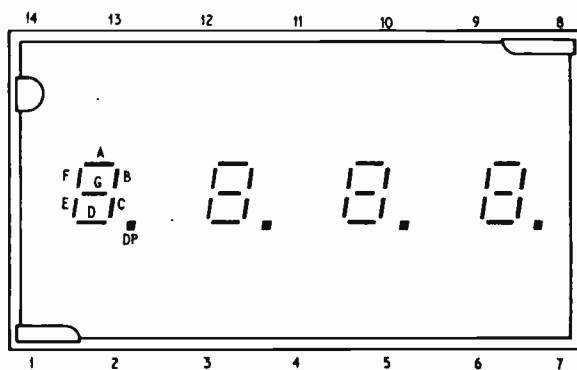
The chosen L.E.D. package for the system is the Data Lit 34, available from the Industrial Electronic Components Division of Guest International Ltd.

The DL34 contains four $\frac{1}{4}$ in digits, each with a right-hand decimal point, and is encased in a red-epoxy package with outside dimensions of 0.74in \times 0.39in, as shown in Fig. 6.5.

The pin configuration of this device is the same as that of a conventional 14 pin D.I.L. pack, and a recommended way of mounting these components is to use a D.I.L. socket of the type which are now available at low cost through the suppliers advertising in this magazine.

The circuit in which the DL34 is used is shown in Fig. 6.6; eight i.c. packages are used in all, along with five transistors and 13 resistors.

The B.C.D. data on the data-bus is decoded by an SN7448 decoder which differs from the SN7446/



PIN	FUNCTION	PIN	FUNCTION
1	Not connected	8	Not connected
2	Anode E	9	Anode B
3	Anode D	10	Cathode 3
4	Anode C	11	Anode F
5	Dec. Pt. Anode	12	Cathode 2
6	Anode G	13	Anode A
7	Cathode 4	14	Cathode 1

Fig. 6.5. The DL34 L.E.D. package shown three times actual size

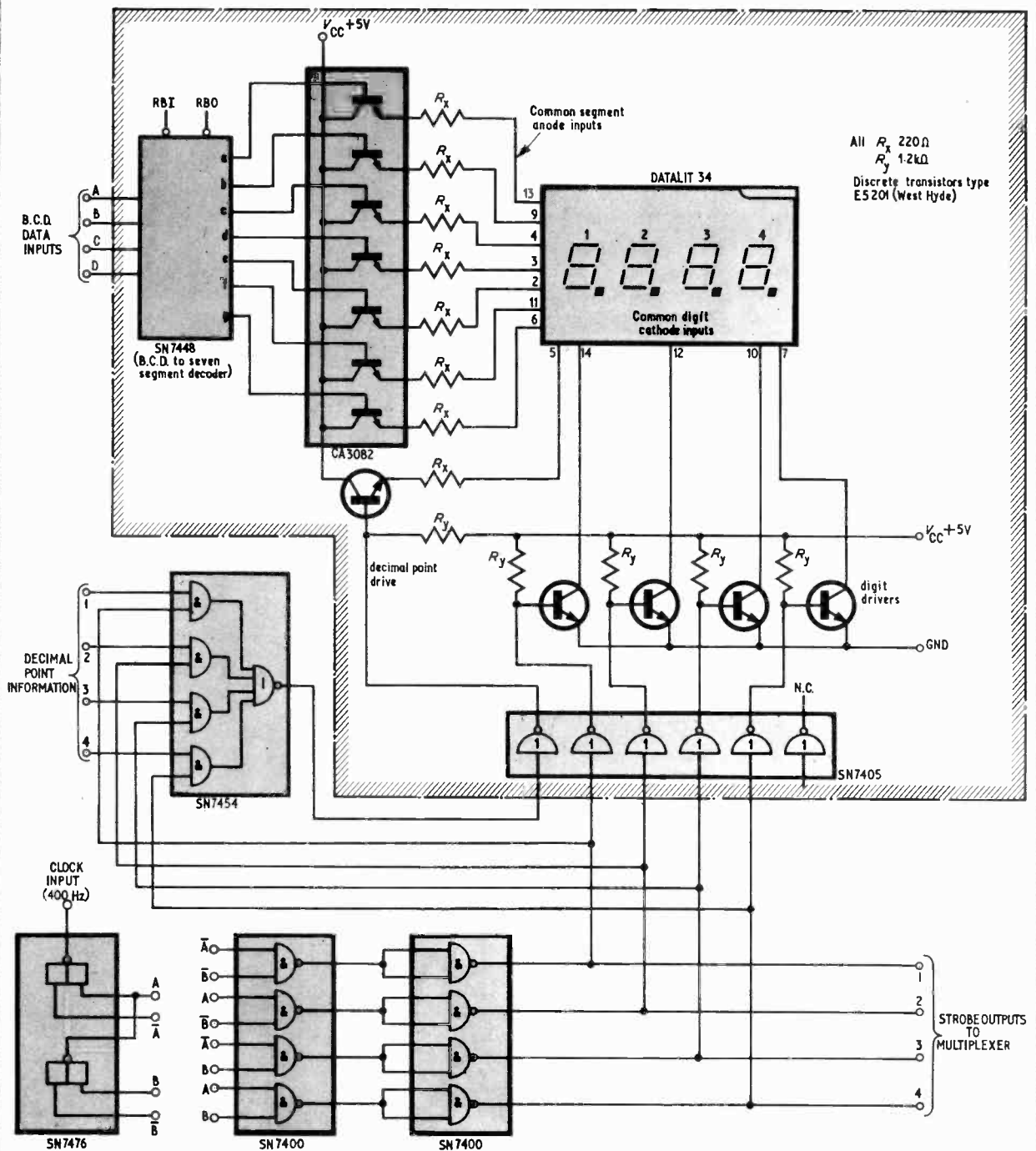


Fig. 6.6. A practical system using the DL34 in a "time-shared" mode

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7447 types we have met up to now in that it gives "active high" outputs instead of "active low". This means that when a particular segment output is activated it is at a positive potential (normally V_{cc}) rather than at ground. If it is not activated, then the opposite condition will apply.

The output impedance of the SN7448 in the high state is too high to supply the current required by the L.E.D.s directly so an emitter follower buffer stage has to be incorporated to reduce it. This need not mean a mass of discrete transistors and wiring however, since R.C.A. have kindly foreseen these requirements and packaged seven high-current *npn* transistors with a common-collector connection in a 14 pin D.I.L. pack called the CA3082.

CURRENT SETTING RESISTORS

The seven emitter outputs of the CA3082 are connected to the DL34 segment inputs (common anodes) via the necessary current setting resistors which determine the segment currents and therefore the brightness of the display.

The chosen drive current for this application is an average of 3mA, time-sharing makes this 12mA and with this value determined and the V_f of the L.E.D., the V_{be} of the emitter follower and the V_{sat} of the digit drivers all known, it is a simple matter to work out the resistance required by Ohm's law.

$$R_x = \frac{V_{cc} - (V_{be} + V_f + V_{sat})}{I} \text{ k}\Omega \text{ (where } I \text{ is the drive current in mA)}$$

$$= \frac{5 - (0.7 + 1.7 + 0.2)}{12} \text{ k}\Omega$$

$$R_x = 200\Omega \text{ (nearest preferred value is } 220\Omega)$$

COMMUTATOR ACTION

The sequencing of the display is timed by a master clock square-wave input which should have a frequency of about 400Hz to give the required 100Hz refresh rate for each digit. This clock may be already available in many systems, but if it is not it can be simply generated in a number of ways, one example being shown in Fig. 6.7.

Note that the exact frequency of the clock is not critical, 400Hz being a "nominal" value.

The clock is used to drive a simple two stage binary counter made by cascading the two J-K flip-flops in an SN7476 (or similar) i.c. The outputs from the counter are decoded by a quad two input gate (SN7400) to give the necessary strobing pulses to drive the display, and these are then inverted by a further SN7400 to make them the right polarity to drive the rest of the system.

A gating, or multiplexing system has been chosen to provide the data-bus, and the output strobes from the SN7400 are used to enable this, one digit at a

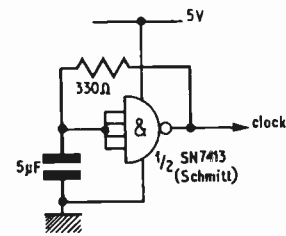


Fig. 6.7. A simple method of generating clock pulses using half of an SN7413 i.c.

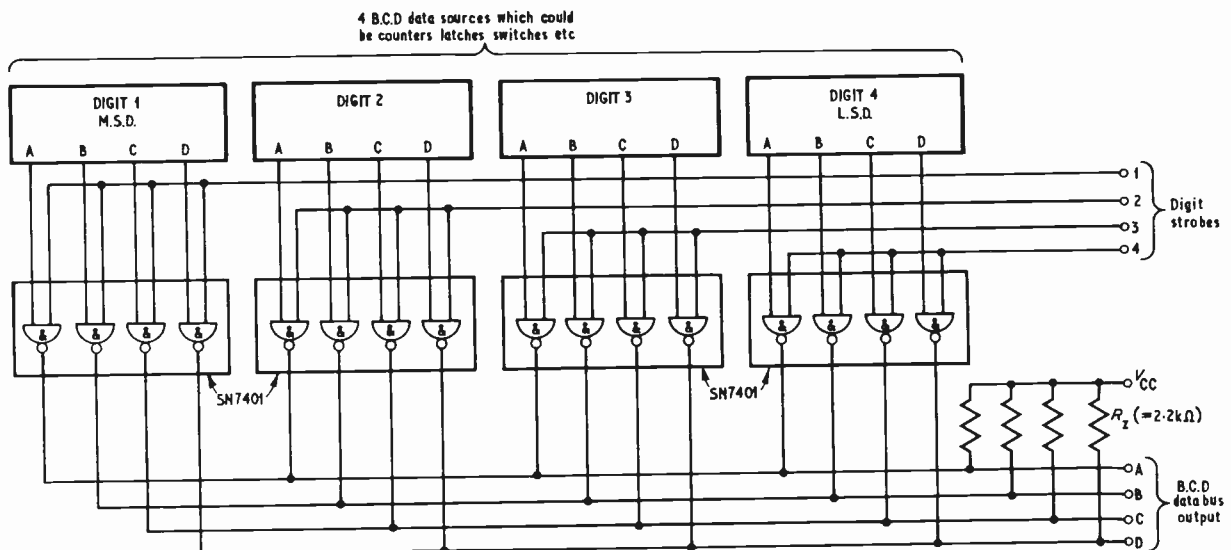


Fig. 6.8. A multiplexer for four digits using SN7401 i.c.s to present each digit in turn to the data-bus



The large L.E.D. devices used in this instrument are automatically varied in brightness by ambient light conditions (Dana)

time. The strobes are also used to control the digit-driver transistors via an SN7405 hex open-collector inverter which provides the necessary base drive.

The digit drive transistors are the economical E5201 (West Hyde) or a similar *n*pn switch with a gain of 40 or more and a current handling capability of about 200mA.

DECIMAL POINT SELECTION

If a decimal point is to be used in the display it is necessary to add another emitter follower to drive it. The SN7405 package has a couple of spare inverters and one of these can be used as the interface between the emitter follower and the required decimal point decoder gate.

The decoder gate itself can be an SN7454 four-wide two-input and-or-invert gate, its purpose being to turn on the decimal point driver only when the correct digit is being displayed.

The decimal point information is fed to the display system on four wires, one for each point position; the level on the wire corresponding to the required point will be either an open circuit or a logic "1"; all others should be at earth or logic "0". These inputs are gated with their respective strobes to ensure that the point only appears in its single correct position.

If a fixed decimal point is required, as for example in a digital clock, the SN7454 can be left out and the inverter driven straight from the desired digit strobe.

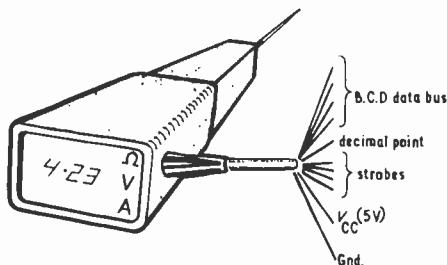


Fig. 6.9. A suggested design for a probe with an integral display

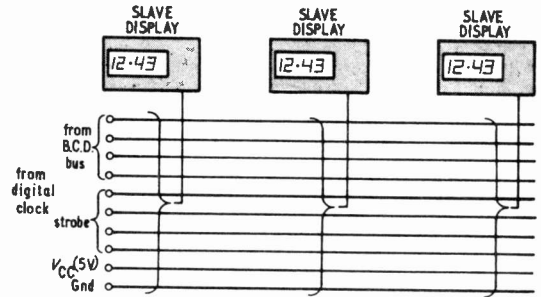


Fig. 6.10. A time-shared system which would allow many clock displays to be driven from a single source

MULTIPLEXER

A suitable multiplexer for use with the display system described is shown in Fig. 6.8. It consists of four SN7401 quad two input open collector gates and four resistors and is driven by the digit-strobes from the display system proper.

Note that open collector gates are essential for this job, and that SN7400 gates are not suitable due to the fact that the outputs of several gates are connected directly together and used to perform the "wired-OR" logic operation.

Interconnection of outputs is not permitted with the basic TTL gate because of the "active pull-up" output stage. The SN7401 is a gate specially produced to allow wired-OR in TTL systems, and has no pull-up device incorporated.

APPLICATIONS

This particular display system can be used wherever the small digit size is acceptable, but there are two particular applications where it would be of outstanding usefulness.

It will be noticed that in the circuit of Fig. 6.6 some of the components are separated by being enclosed by a shaded box. This is about the best grouping for the minimum number of components to be mounted a long way from the mother unit, and if these are carefully assembled a very small display package can result.

This small unit can be mounted in the probe of say, a digital multimeter, and in this application would eliminate a good deal of the neck twisting associated so often with the traditional "front panel" display when measuring in some inaccessible corner. A possible probe design is shown in Fig. 6.9.

Another use for this display, again relying on the remote operation of the components in the box, is as one of a number of "slave displays" all showing the same information. The most likely information here would be the time, which would be derived from a single digital clock, with or without a built-in display.

A possible wiring scheme is shown in Fig. 6.10. With this latter scheme the fan-out of the devices in the master-unit would have to be considered, and a good solution is to use non-inverting buffer gates as drivers for the eight logic bus lines.

Next month: Other types of display



DRILL CONTROLLER NEW IKW MODEL

Electronically changes speed from approximately 10 rev. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1-50** plus 13p post and insurance. Made up model also available. **£2-25** plus 13p post and p.

MAINS OPERATED CONTACTOR

220/240V. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 30 amps. Extremely well made by a German Electrical Company. Overall size 2 1/2 x 2 x 2in. **£1** each.



NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. **8p** each, **60p** doz. Plastic push-rod suitable for operating. **5p** each, **45p** doz.

AUTO-ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£5-75** plus 25p post and ins.



TOGGLE SWITCH

3 amp 250V with fixing ring 7p each, 75p doz.

MICRO SWITCH

5 amp changeover contacts, 9p each. **£1** doz. 15 amp Model 10p each or **£1-05** doz.



MINIATURE WAFER SWITCHES

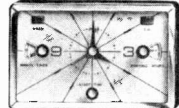
2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each, **£1-80** for ten, your assortment.



WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. **50p** post free.

15 AMP ELECTRICAL PROGRAMMER



Have radio playing and kettle boiling as you awake, switch on lights to ward off intruders, have warm house to come home to. All possible with electrical programmer clock by famous maker with 15 amp on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£1-95** + 20p p. & p. or with glass front chrome bezel 75p. extra.

TREASURE TRACER MARK II

Complete Kit (except wooden battery) to make the metal detector similar to the circuit in Practical Wireless August issue. **£3-95** plus 20p post and insurance.



QUICK CUPPA

Mini Immersion Heater, 350W, 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **£1-25**, post and insurance 14p. 12V car model also available same price. Jug heater **£1-50** plus p. & p. 14p.



SNAP ACTION SLIDE SWITCH

Rated 5a, 240V. Made by Arrow. Type fitted in the handles of electric drills, vacuum, etc. **5p** each. 10 for **45p**.



NUMERICATOR TUBES

For digital, instruments counters, timers, clocks, etc. Hi-vac XN. 3. Price **£1-45** each, 10 for **£13**.



12 WAY SUB-MINIATURE MULTI-CORE CABLE

7-0076 copper cores each core P.V.C. insulated and of different colors. P.V.C. covered overall and approx. 3/16in. thick. Price **20p** per yard.



LIGHT CELL

Almost zero resistant in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by 1in. thick. Rated at 500 MW. With model. **45p** with circuit. Also ORP 12 light cell **45p**.

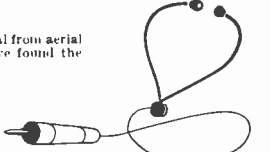
CAPACITOR DISCHARGE CAR IGNITION

ELECTRONIC IGNITION

This system which has proved to be amazingly efficient. We offer a kit of parts as PW circuit **£5-95** + 20p. De-luxe model with prepared circuit boards **£6-95**. When ordering please state whether for positive or negative systems. Also available, ready made ignition systems for 6V vehicles. **£5-25** plus 20p.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **£2**—twin stethoscope instead of earpiece **75p** extra—post and ins. 20p.



STANDARD WAFER SWITCHES

Standard size 1 1/2 wafer—silver-plated 5-amp contact standard 1/4 spindle 2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	7 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p	70p
2 poles	40p	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	95p	95p	£1-20
5 poles	40p	40p	70p	70p	70p	95p	95p	95p	£1-45	£1-45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1-70	£1-70	£1-70
7 poles	70p	70p	70p	95p	£1-20	£1-20	£1-20	£1-95	£1-95	£1-95
8 poles	70p	70p	70p	95p	£1-20	£1-20	£1-20	£2-20	£2-20	£2-20
9 poles	70p	70p	95p	£1-45	£1-45	£1-45	£2-45	£2-45	£2-45	£2-45
10 poles	70p	70p	95p	£1-20	£1-45	£1-45	£2-70	£2-70	£2-70	£2-70
11 poles	70p	95p	95p	£1-20	£1-70	£1-70	£2-95	£2-95	£2-95	£2-95
12 poles	70p	95p	95p	£1-20	£1-70	£1-70	£3-20	£3-20	£3-20	£3-20

THIS MONTH'S SNIP

13 AMP TWIN GANG SOCKETS
Offered at less than wholesale price your opportunity to replace those dangerous adaptors—brown bakelite flush mounting—standard fitting. Unswitched **20p** each, separately switched **30p** each. Separately switched and with neon on/off indicators **45p** each. Less 10% ten or more + 20p postage if order under £5.



THYRISTOR LIGHT DIMMER
For any lamp up to 1kW. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2-80**, plus 20p post and insurance.



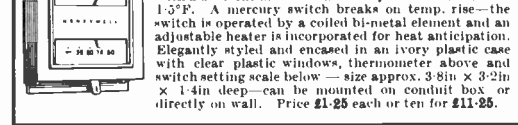
MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 500mW into ohms speakers. Input suitable for crystal mic. or pick-up. 9V battery operated. Size 2in long x 1 1/2in wide x 1in high. SPECIAL SNIP PRICE **£6p** each. 10 for **£5**.



HORSTMANN "TIME & SET" SWITCH

(A 30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time, or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around **£5**. Special snip price **£1-50**. Post and ins. 25p.



THIS MONTH'S SNIP

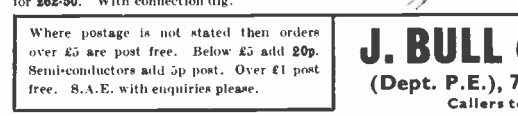
THERMOSTAT WITH THERMOMETER
Made by Honeywell for normal air temperatures 40-85°F (5-25°C). This is a precision instrument with a differential which can be adjusted to better than 1°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and an adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows, thermometer above and switch setting scale below—size approx. 3 1/2in x 3 1/2in x 1 1/4in deep—can be mounted on conduit box or directly on wall. Price **£1-25** each or ten for **£11-25**.

24-HOUR TIME SWITCH

Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2-50** post and ins. 25p. Additional time contacts **60p** pair.

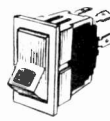
INTEGRATED CIRCUIT BARGAIN
A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro electronic devices well below cost of manufacture. The parcel contains 5 IC's all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the IC's are single silicon chip 4P amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over **£5**. Full circuit details of the IC's are included and in addition you will receive a list of many different IC's available at bargain prices 25p upwards with circuits and technical data of each. Complete parcel only **£1** post paid. **DON'T MISS THIS TERRIFIC BARGAIN.**

MULLARD I.F. MODULE
This is a fully screened intermediate frequency module for amplification and detection of fm. signals at 10-70MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self-oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. **75p** each; 10 for **£6-75**; 100 for **£62-50**. With connection dig.



ROCKER SWITCHES

3 new types to offer this month, all snap in fixing into oblong holes. Type 1 8.P. on/off 10 amp 250V. Size approx. 1 1/2in x 1 1/2in. Made by Arrow electric (93 series). Price **18p** each. 10 for **£1-08**. Type 2 D.P. on/off 10 amp 250V with neon indicator in the lever. Again Arrow 93 series. Price **25p** each or 10 for **£2-25**. Type 3 Double pole change over spring return, made by the French Russenberg Company. Size approx. 1 1/2in x 1 1/2in. Price **15p** each. 10 for **£1-35**.



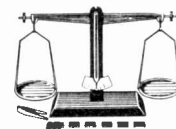
Amplifier Case. Teak veneer on zinc ply, modern appearance and design. Size—front 13in x 4 1/2in deep x 8 1/2in. Limited quantity **£1-25** each plus 25p post and insurance.

Music on Tape. A further buy enables us to offer this at an even lower price—namely **65p** each or 5 for **£2-50**. Send for list of titles. We can't repeat when sold out.

Pressure Switch. Made by Bailey and Mackey Ltd., Type 1081, adjustable up to 20lb sq.in. (instructions included). Set to trip at 8lb per sq.in. Changeover switch rated at 5 amp 250V a.c. with re-set button. Electrical connections in box with conduit entry. Price **£1-50** each plus 20p post and insurance.

20 Watt Inverter. Smart and Brown—For van lighting or camping, adjustable up to 20W using standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 1 1/2in x 2in x 1 1/2in. **£6-50** complete with lamp holders and tube clips.

EDUCATIONAL KITS all with pictorial instructions



THIS BALANCE KIT FREE
Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to describe this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **40p** each. Special price for all 7 kits **£2-50** with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electro-magnetism with an automatic switch results in an operating buzzer.

KA6 8-Pole Motor Kit. Twenty-four parts, including enamel wire, armature and pole piece, etc. Motor operates from 1 1/2 volt battery. Illustrates and teaches how electro-magnetism operates a motor.

KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

PULSE GENERATORS
Sectronic, made by Smiths. Operated by single 1.5 volt battery or transformer and rectifier. Two models, one gives 10 pulses per second the other gives 8. In plastic enclosures, size approx. 2in x 1 1/2in x 1 1/2in deep. Price **£2** each 10 for **£18**.

AMPLIFIER IN CASE & SPEAKER.
Marketed by British Relay under the name Luxitor. This is in a very neat looking cabinet and is ideal around the house or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9 1/2in x 6 1/2in x 3 1/2in deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9V battery or an external 110V source. Speaker is an R.C. elliptical 6in x 3 1/2in 1000 Gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3-50** each 10 for **£31-50**. Post & insurance 20p.

MAINS TRANSFORMER SNIPS
Mains Transformer. Primary 240V, tapped 220V. Secondary 20V. 1 amp. Price **60p** each or 10 for **£5-40**.

Transformers. Primary 230-240V. Secondary 6.3-0-6.3 1 amp. With fitted primary screen **65p** each or 10 for **£5-85**.

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TRANSISTORS

Wide range. Up to date. Brand new — no 'seconds' or surplus. Highest quality and reliability.

No.	Type	Purpose	Price
2N697	Sil. NPN	General	18p
2N1304	Ger. PNP	"	26p
2N1305	PNP	"	26p
2N2646	Sil. UJT	Oscillator, SCR driver	47p
2N296A	NPN	Small sig. amp	11p
2N3055	NPN	High power	50p
2N3702	PNP	Low power	10p
2N3704	NPN	Low power	10p
AC126	Ger. PNP	Small sig./driver	28p
AC128	PNP	Low power	20p
AD149	PNP	High power	58p
AC176	NPN	Low power	10p
*AD161	PNP	Med. power	38p
*AD162	PNP	Med. power	38p
BC108	Sil. NPN	Small Signal	11p
BC109	NPN	Low noise	12p
BC168	NPN	Small signal	10p
BC169	NPN	Low noise	11p
BF194	NPN	RF amp.	14p
BFY51	NPN	Med. current	20p
OA90	Ger. (ier. diode)	RF detector	8p
OA91	"	General	5p
BD1	"	Silicon Rectifier 1 amp	9p
W02	"	Silicon bridge 1 amp	30p
*Matched pair AD161/AD162			60p

RESISTORS 10% - 5% - 2%

Code	Power	Tolerance	Range in ohms	Values 1 to 9	10 to 99	100 up
C	1/20W	5%	82-220K	E12 9	8	7
C	1/8W	5%	4.7-470K	E24 1	0.8	0.7
C	1/4W	10%	4.7-10M	E12 1	0.8	0.7
C	1/2W	5%	4.7-10M	E24 1.2	1	0.9
C	1W	5%	4.7-10M	E12 2.5	2	1.9
MO	1/2W	2%	10-1M	E24 4	3	2 net
WW	1W	10%	0.22-3.9	E12 7	7	6
			±1/20Ω			
WW	3W	5%	1-10K	E12 7	7	6
WW	7W	5%	1-10K	E12 9	9	8

Codes: C = carbon film high stability low noise
MO = metal oxide ElectroSil TR5 ultra low noise
WW = wire wound Plessey

Values: E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 73, 91 and their decades. Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of 1p on total value of resistor order.)

Minitron DIGITAL INDICATOR



TYPE 3015F Seven segment indicator compatible with standard logic modules and power supplies. Fig. 0-9 from well illuminated filament segments to give character of 9mm height plus decimal point. Power requirement 8mA from 5V d.c. per segment. A limited number of alphabetical symbols also available. In 16 lead DIL case

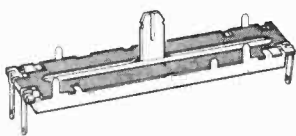
£2
Suitable BCD decoder driver type FLL121T £1.36

DIL Socket: 16 lead 80p. No. 3015G showing + or - and fig. 1 and decimal point £2.

RIVLIN PRECISION RESISTORS

0.1% to 0.01% tolerance. Prices and delivery details on request. Example: values up to 100kΩ, between £1 and £2.

SLIDE POTENTIOMETERS



Robust construction, smooth silent action. In values from 4.7kΩ to 1MΩ, linear or log. 26p each. Escutcheon, light grey. 10p.

Knobs, flat, grip type, in black/red/green/yellow/blue/lt. grey/dark grey or white. 5p each.

We are official distributors for SOLDERSTAT SOLDER IRONS

As appointed distributors for well-known Elinco-Wolf "Solderstat" irons, we offer this model HM8 in 16 or 24 watt, a.c. mains, net

INFINITELY VARIABLE TEMPERATURE CONTROLLED SOLDER IRON

Designed essentially for micro-miniature and printed circuit board assemblies. Temperature is adjusted as required by control on base and remains constant whether idling or on load. Although for working to very delicate standards, the iron is of rugged construction and is exceptionally reliable. Price, complete with base, net £20.20.

DE-SOLDER BRAID

The efficient money-saving way to de-solder soldered joints, per 6ft length, net 50p.

PUBLICATIONS

Handbook of Transistor Equivalents, 40p. Handbook of Tested Transistor Circuits (H. Ness), 40p. Radio & Electronics. Colour codes & data wall chart, 15p. Engineers Reference Handbook & Tables, 20p. (Add 3p for postage on each of above if bought separately.)

SIEMENS

TTL INTEGRATED CIRCUITS

FLH101 (7400)	20p	FLJ121 (7473)	45p
FLH201 (7401)	20p	FLJ141 (7474)	45p
FLH301 (7402)	20p	FLJ151 (7475)	45p
FLH401 (7403)	20p	FLJ131 (7476)	45p
FLH501 (7404)	20p	FLH221 (7480)	85p
FLH601 (7405)	20p	FLH321 (7481)	87p
FLH381 (7408)	25p	FLH341 (7483)	1.32
FLH391 (7409)	25p	FLH341 (7486)	33p
FLH111 (7410)	20p	FLJ161 (7490)	80p
FLH351 (7413)	35p	FLJ221 (7491A)	1.28
FLH121 (7420)	20p	FLJ171 (7492)	85p
FLH181 (7430)	20p	FLJ181 (7493)	80p
FLH71 (7440)	24p	FLJ231 (7494)	1.13
FLH101 (7414)	1.22	FLJ191 (7495)	87p
FLH281 (7442)	1.16	FLJ261 (7496)	1.48
FLH361 (7443)	1.45	FLJ301 (74100)	1.64
FLH371 (7444)	1.45	FLJ281 (74104)	43p
FLH151 (7450)	20p	FLJ271 (74107)	82p
FLH161 (7451)	20p	FLH101 (74121)	45p
FLH171 (7453)	20p	FLY101 (7468)	20p
FLH181 (7454)	20p	FLJ201 (74190)	1.80
FLY101 (7468)	20p	FLJ211 (74191)	1.80
FLJ101 (7470)	45p	FLJ241 (74192)	1.74
FLJ111 (7472)	32p	FLJ251 (74193)	1.74

NEWMARKET LINEAR I.C.s

LIC 709C/14 dual in line, 34p. 709C/5, T05 39p.
LIC 741C/14 dual in line, 40p. 741C/5, T05 42p.

CARBON TRACK POTENTIOMETERS

CARBON TRACK POTENTIOMETERS, long spindles. Double wipers.
SINGLE GANG linear 100Ω to 2.2MΩ, 12p; Single gang log, 4.7kΩ to 2.2MΩ, 15p; Dual gang linear 4.7kΩ to 2.2MΩ, 42p; Dual gang log, 4.7kΩ to 2.2MΩ, 42p; Log/antilog, 10kΩ, 22kΩ, 47kΩ, 1MΩ only 42p; Dual antilog, 10kΩ only, 42p. Any type with 2A D.P. mains switch, 12p extra.
Only decades of 10, 22 and 47 available in ranges quoted.

DUAL CONCENTRIC in any combination of P.20 values, 60p; with switch, 72p. Knobs, pair 24p.

DISCOUNTS

10% on orders £5 to £15. No discount on items marked 15% on orders over £15. No discount on items marked Net. Prices subject to alteration without notice.

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FREE, unless otherwise stated. Handling surcharge 10p on mail orders under £2. Overseas orders: carr. and insurance charged at cost. U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore, PA 19081.

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BAXANDALL SPEAKER

As designed by P. J. Baxandall and originally described in "Wireless World". Complete kit inc. spkr., equaliser and special cabinet kit (18in x 12in x 10in) cut to size. 10 watt RMS/15Ω loading. Part cost carr. in U.K. 60p.

Net £13.81

Speaker unit and equaliser kit, net. Post free 24.81. Pack flat cabinet assembly (all cut to shape), natural teak finish with instructions, 29 net. Part cost carr. in U.K. 60p.

CARBON SKELETON PRE-SETS

Small high quality, type PR linear only: 100Ω, 220Ω, 470Ω, 1K, 2K, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 5M, 10MΩ. Vertical or horizontal mounting, 5p each.

ZENER DIODES 5% full range, E24 values: 400mW: 2.7V to 36V, 14p each; 1W: 6.3V to 82V, 27p each; 1.5W: 4.7V to 75V, 48p each.
Clip to increase 1.5W rating to 3 watts (type 266F) 4p.

MINIATURE TOGGLE SWITCHES

2A/250V. DP/DT, 48p.

MAINLINE AMPLIFIER KITS

70 watt power amp module kit, £12.80 net. Power supply kit, £6.50 net. Matching pre-amp kit, £3.30 net. (Above prices for mono.) Stereo Kit, 2 power amps pre-amp kit, power supply kit and matched controls for building into your own cabinet, £38.90 net.

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Tantalum and other capacitors, etc., see latest 1972 catalogue—issue No. 6.

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INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merits.

QUIZ INDICATOR

In a quiz where the first person to raise their hand has the right to answer, a dispute can arise as to who was actually first. The circuit shown in Fig. 1 is an extremely simple method that can resolve differences much faster than the human eye. When a competitor knows the answer to the quizmaster's question he depresses his button, switching on his light and automatically barring his competitors from doing likewise.

A typical characteristic curve for a neon is shown in Fig. 2. It can be seen from the graph that before the neon will light up a flashing potential, typically 70 to 220V must be applied. Thereafter, a potential of about 50V is needed to sustain the light.

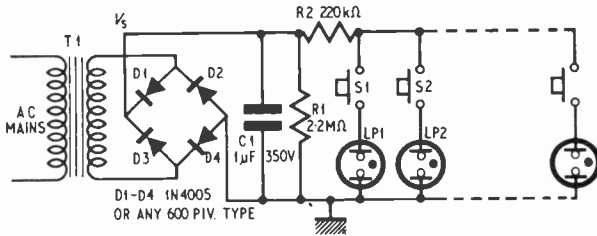


Fig. 1. Circuit diagram of the quiz indicator

It would seem at first that ordinary a.c. could be used, but if we remember that a.c. drops to zero twice a cycle, and once the voltage has dropped below the sustaining voltage we would require the flashing potential be applied again. Another competitor could supply this, thereby lighting their bulb and rendering the device useless.

This problem was overcome by using a smoothed rectified a.c. supply, see Fig. 1. A low current isolating transformer T1 is used for safety and the supply is smoothed by capacitor C1. The resistor R1 in parallel with the capacitor is used to discharge C1 when the supply is switched off.

$$\text{The discharge law of } C1 \text{ is: } v = V_s e^{-t/CR}$$

Thus after 1 second with R1 at 2.2MΩ, the voltage on the capacitor is 0.37 of its original value and after 10 seconds it is 0.02 of its original value.

The resistor R2 is used to load the lamp and once one lamp is on the resistor will conduct approximately 1mA, sufficient for most neons to maintain illumination.

The components, apart from switches, neons and transformer, can be mounted on a tagboard, but the constructor should remember that he is working with high voltages, not the normal voltages used in transistor work.

M. Vlietstra,
South Africa.

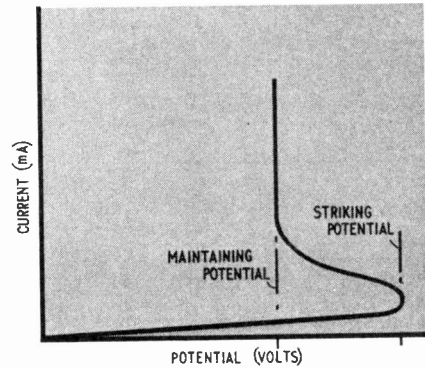


Fig. 2. Typical characteristic curve for a neon tube

BATTERY HOLDER

In a recent article you recommend soldering the battery leads direct to the battery terminals. I found this unsatisfactory, in similar projects, and suggest the method shown in Fig. 1 be adopted.

The metal tube, with a plastics cap at one end, that a well-known solder manufacturer uses to dispense solder can be used to hold two 1½V batteries. The positive and negative terminals are made up by inserting two screws in the ends of the dispenser, see Fig. 1.

Note that the 22 s.w.g. type solder tubes are required. It was found necessary to insert a rolled up piece of paper in the tube to avoid possible short circuits.

R. Dicken,
Plymouth.

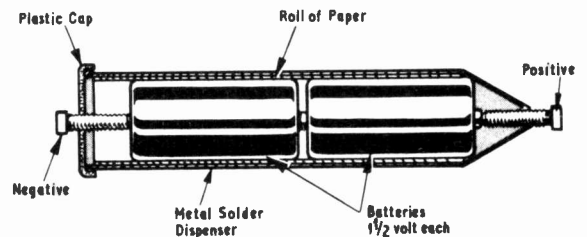


Fig. 1. Constructional detail of a simple battery holder

PATENTS REVIEW...

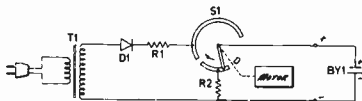
FAST CYCLE CHARGER

THE British Patent 1256 056 from Mattel Inc. of the USA not only details some useful techniques for successfully charging re-chargeable batteries but also provides a valuable clarification of the present state of this rapidly developing art.

The use of small non-aqueous re-chargeable batteries has snowballed over the past years. Many people now run their movie cameras, photo-flash units and portable radios off batteries which they re-charge when necessary, and with varying degrees of success.

Most re-chargeable "dry" batteries are nickel-cadmium, and these and other types can be damaged by incorrect charging. The main risk is of over-charging with the evolution of oxygen at the nickel electrode faster than it can be reacted at the cadmium electrode. The liberated gas causes over-heating and cell breakdown. Trickle-charging is sure but very slow.

BP 1 256 056



The main difficulty is that to sense the difference between "charged" and "discharged" can be very tricky and Mattel have recognised that it is safer to be sure that all batteries to be charged really do need charging. Thus, their logical solution to fast charging without risk of over-charging is quite simply to initially discharge every battery.

As shown in Fig. 1 the battery to be charged is connected across a d.c. supply via a motorised rotary switch S1 which can sequentially switch the battery out of circuit, in circuit with a shorting resistor to discharge it, and finally in circuit across the charger.

In the case of a 1.2V nickel-cadmium cell the motor driven rotary switch S1 first of all connects the cell across a 0.1 ohm 2W resistor R2 to discharge it at a rate of 2A for a period of approxi-

mately 40 seconds. Further rotation of the switch then cuts out the discharge resistor and allows a charge of 1A to be applied to the cell for 3.3 minutes.

In this way the cell can be charged in a matter of minutes without the risk of over-charging. Obviously a considerable advantage over some existing systems which require a very low charge rate for time periods of up to a day.

ANTI-FERROELECTRIC REGULATION

THE United States Atomic Energy Commission have patented some advances in the field of anti-ferroelectric voltage regulation (BP 1253 326).

Conventional voltage regulating equipment can take a variety of forms and these vary in factors such as reliability.

The U.S.A.E.C. invention makes use of a range of materials which are in an initial anti-ferroelectric state (with randomly oriented domains) but become ferroelectric and assume a polarisation charge during the application of a bias field. They then return to the anti-ferroelectric state when the bias field is decreased or removed. The materials behave in this way with either a positive or negative charge and have a polarisation/electric field hysteresis diagram or loop of the type shown in Fig. 1.

As the charge applied to the material rises from zero in either positive or negative direction, the material first exhibits a large and rapidly increasing voltage. Next the material exhibits a relatively small and slowly increasing voltage per unit change in applied charge. Thereafter, any increasing charge causes the voltage to increase more rapidly in a non-linear manner to saturation. Decreased charge first gives rapid voltage decrease and then slow linear decrease with a sudden drop to zero.

It has been found that such materials can be used to regulate voltages to a load within some parts of the slope, energy being stored and returned to the circuit as the material discharges.

Examples of materials of this type are ceramics such as solid solutions of lead zirconate-lead titanate; many others are listed in the patent.

At the design stage a suitable material is selected which exhibits

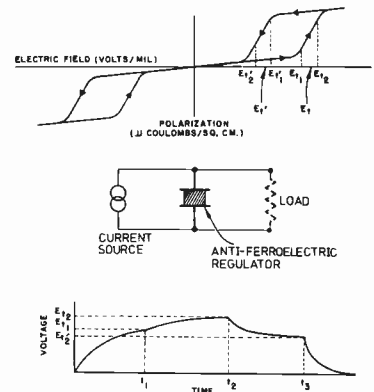
the desired hysteresis loop characteristics and account is taken of the working temperatures and energy values to be stored. Where high voltages are to be handled and a thick piece of material is required, it is usually necessary to build up from a number of separate thin elements so as to avoid physical cracking. The sum of individual element thickness provides the same regulation characteristics as a single element of the same thickness.

Connection to the anti-ferroelectric material is made by silver or gold electrodes and Fig. 2 shows a voltage regulator circuit including a current source, an anti-ferroelectric regulator of the type just described and a load.

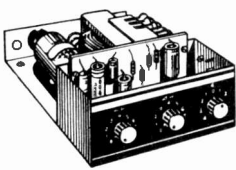
The power source supplies a generally rectangular current pulse to the circuit and either the current pulse terminates before the anti-ferroelectric charge accumulation reaches saturation, or the load uses a charge low enough to prevent saturation being reached. The load voltage will then follow the characteristic curve shown in Fig. 3. By using selected curve portions either very narrow or more extended ranges of regulations can be obtained.

Devices of this type can be used not only to regulate pulse power supplies, but also to absorb and smooth out transients in either d.c. or a.c. lines. They can also be used for piezoelectric power supplies which may be capable of generating pulses of up to 160,000V. With such sources an anti-ferroelectric device can regulate a voltage pulse of 100kV to $\pm 5kV$.

BP 1 253 326



SUPERSOUND 13 HI-FI MONO AMPLIFIER

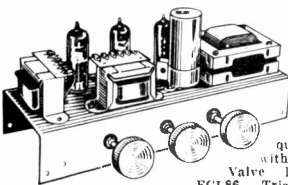


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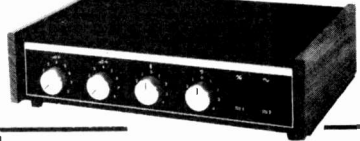
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Out- Ref. No. Price P.P. Out- Ref. No. Price P.P.

Amps.	£	Out- Ref. No.	Price P.P.	Amps.	£	Out- Ref. No.	Price P.P.
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1A	MT 79 AT*	1.55	29p	4A	MT 21 AT	3.10	40p
2A	MT 3 AT*	2.28	30p	5A	MT 51 AT	4.31	42p

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1A	MT 125 AT	2.24 28p
2A	MT 126 AT	3.18 41p
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20 VA	0-115-210-240	MT 113 CT	£0.89	15p
75 VA	"	MT 64 AT	£1.72	30p
150 VA	0-115-200-220-240	MT 4 AT	£2.15	31p
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AT indicates open universal fixing with tags; CT is open U-clamp fixing with tags; CS is open U-clamp fixing with P.C. spalls; * with interwinding screen; † untapped 240V Primary; ‡ Primary tapped at 210-240V; other Primaries tapped at 200-220-240V.
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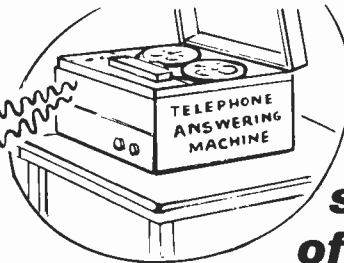
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CALLERCORD

BY J. BECKER

PART 2

THIS month, full constructional details and the setting up procedures for the Callercord are given.

BOARD CONSTRUCTION

Construction of the circuits is carried out on three Veroboards. The control circuitry is on one 0.1 matrix pitch (Fig. 4) and the relays on another (Fig. 5). Most of the power supply components are on 0.15 pitch board (Fig. 6) though it will be seen that the stabilising circuit is on the relay board as this was a later addition. The component layout on the boards is not critical and will depend on the size of the components used, though space should be left to allow for mounting. An aluminium sub-frame was used on the prototype for this purpose, but this can be dispensed with providing stand-off bushes are used with the board mounting screws.

After completion, bolt the three Veroboards and the five sockets to the metal framework, and solder on interconnecting wires, keeping these as short as possible.

MODIFICATION OF THE RECORDERS

To modify the tape recorders, remove both tape chassis from their casings, disconnect the batteries and battery housings and cut away the green wires, all of which are no longer needed. Cut away the blue wire from each amplifier panel, but leave connected to the motor. Disconnect the loudspeaker of one (Tape Recorder 1), but leave the speaker leads connected to the amplifier. Disconnect the microphone from the recorder to be used as Tape Recorder 2 by cutting through its lead about half way along.

Take one tape chassis and remove the rewind spool spindle, and the motor, complete with bracket.



The completed Callercord showing the two Parrot recorders in position. These are simply supported on angle strips. Note the siting of the neon display panel and call counter which occupy the space normally taken by the microphones

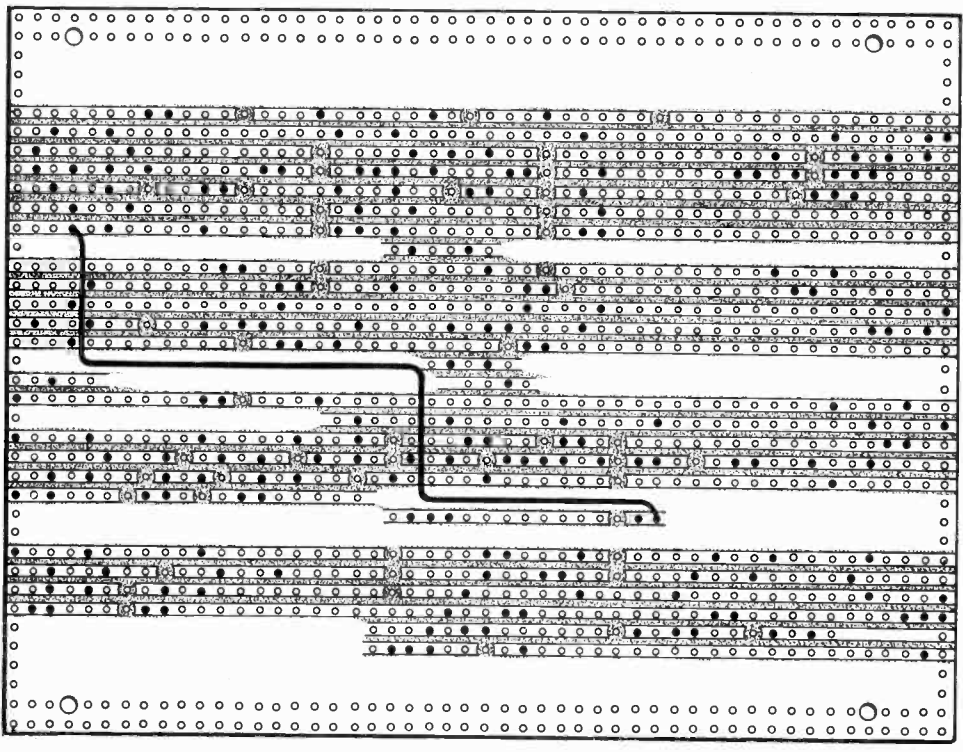
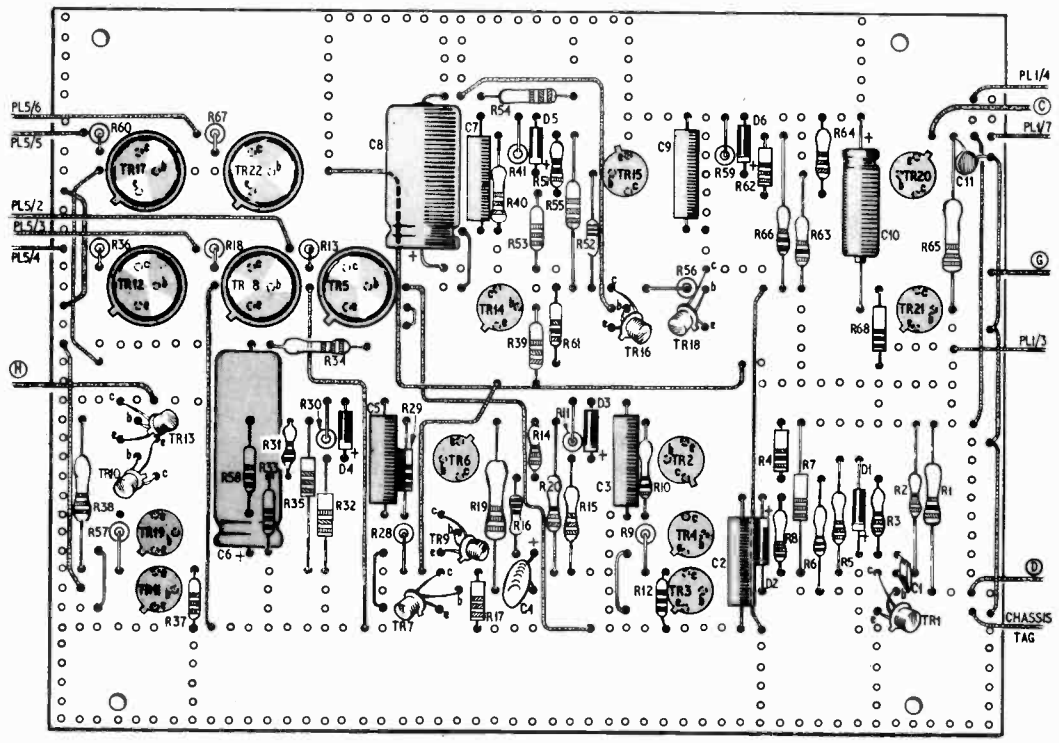
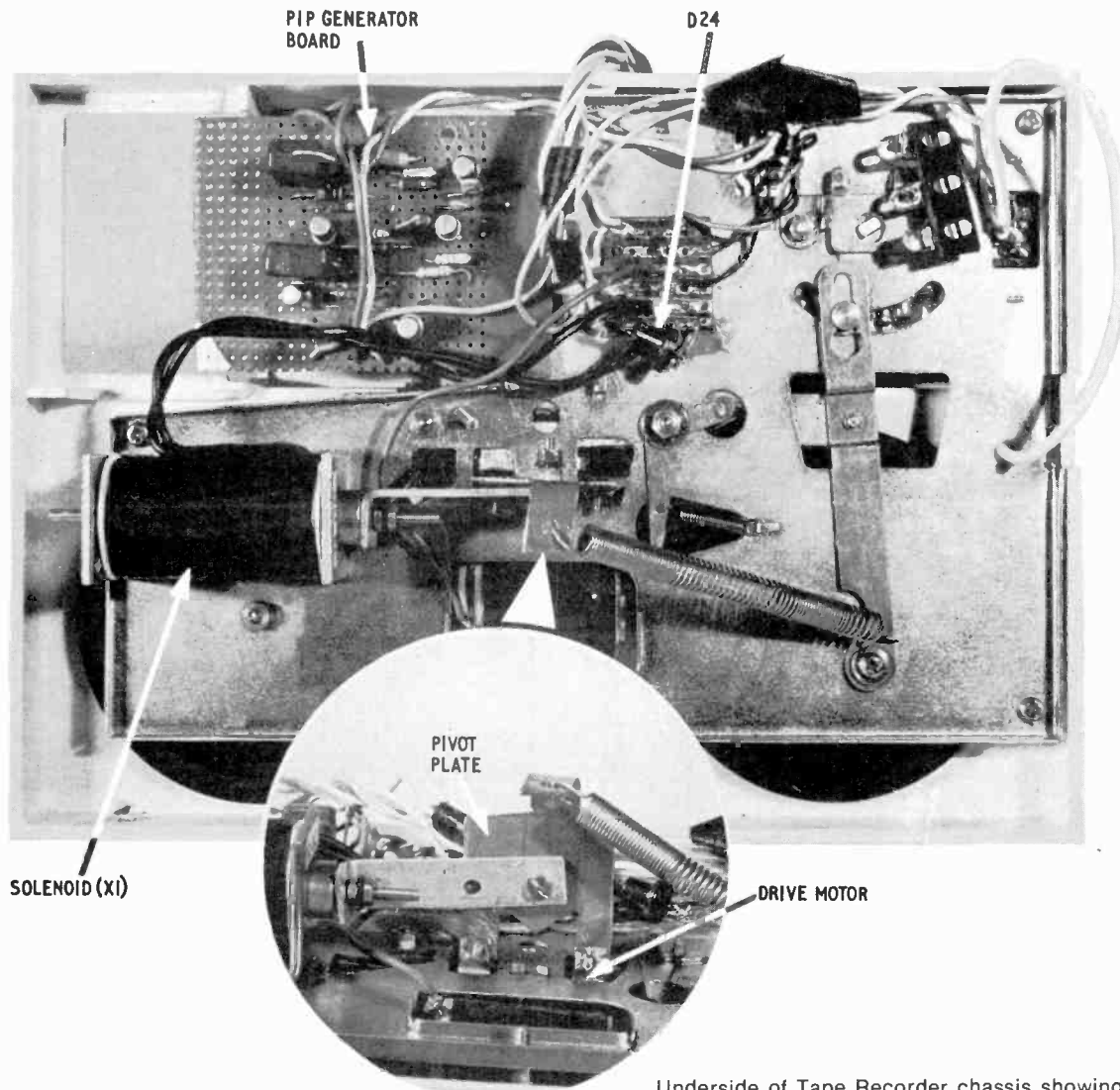


Fig. 4. Component mounting and interwiring details of control circuit board



Underside of Tape Recorder chassis showing Pip Generator board and motor rocking solenoid in position. The inset shows how the solenoid extension bar connects to the pivot plate which itself connects to the motor bracket tags. Both the bar and plate are made from 18 s.w.g. aluminium

The motor bracket has two curved tags that cause the motor to rock when the functions switch is turned; straighten these tags and drill a small hole in the end of each one, and bend them downwards so that when the motor is remounted they will protrude below the chassis.

Drill holes in the chassis to bolt on the solenoid, remount the motor, and bolt the pivot plate to the motor bracket as shown in the photograph and reconnect the rewind spindle. Connect the solenoid extension bar to the small right-angled bracket, loosely bolt this to the pivot plate and hook on a 2in spring, one end going over the bolt that connects the pivot plate to the solenoid bar bracket, the other end going across the extended bar connected to the functions switch.

Adjust the position of the solenoid bar bracket so that when the solenoid is on, the motor will drive the tape forwards, and when off will allow the spring

to pull the motor back to the rewind position. Fine adjustment is best done with the chassis the correct way up. The bolts at all moving points should be left slightly slack to permit easy movement, using two nuts and a crinkle washer to hold the plates in adjustment.

Return both chassis to their casings, making sure that all leads project below the chassis without interfering with any mechanical function, and solder the leads to Veroboard strips, glued onto the chassis of the tape recorders. Connect colour coded extension leads to the strips, twist together, and terminate on an 8-way connector plug. This is done for both recorders.

PLUG CONNECTIONS

Mount the monostable timing resistors directly onto the switch tags and bring the twisted leads to

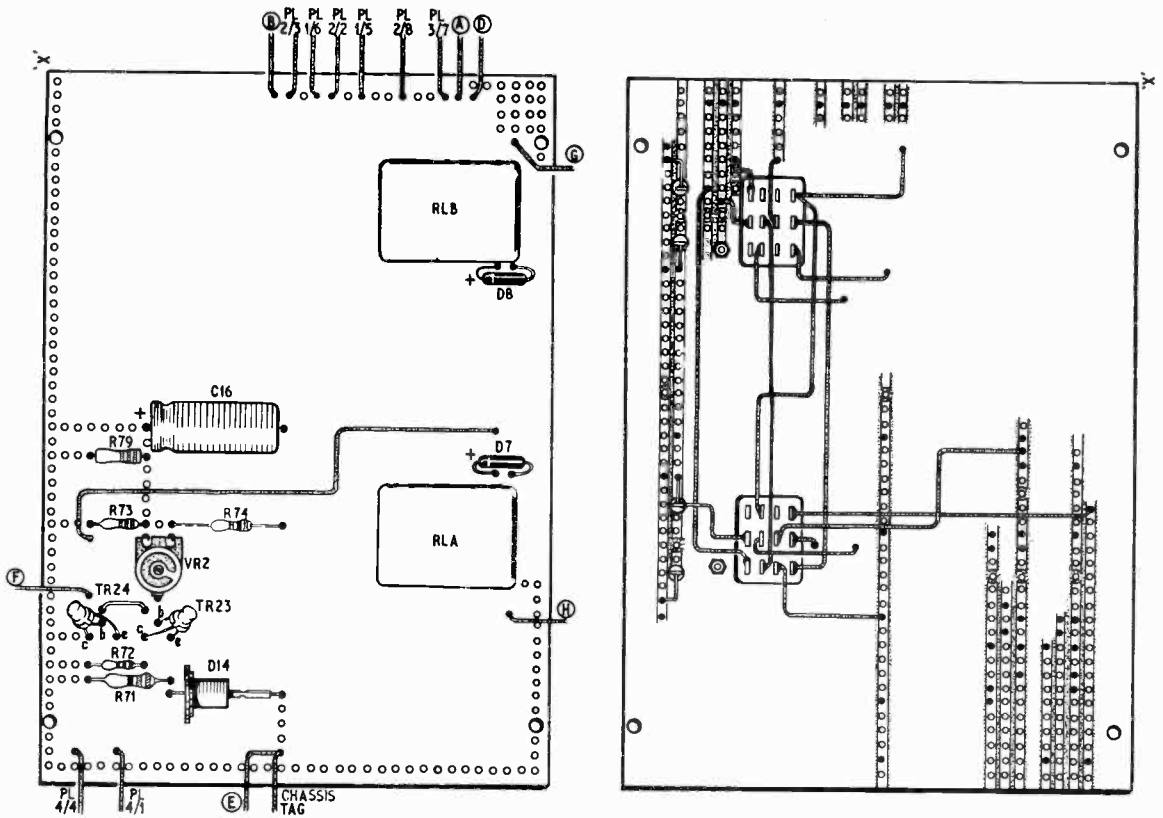


Fig. 5. Relay and stabilised power supply board (P.S.U.2). Details of component mounting and relay interwiring are given

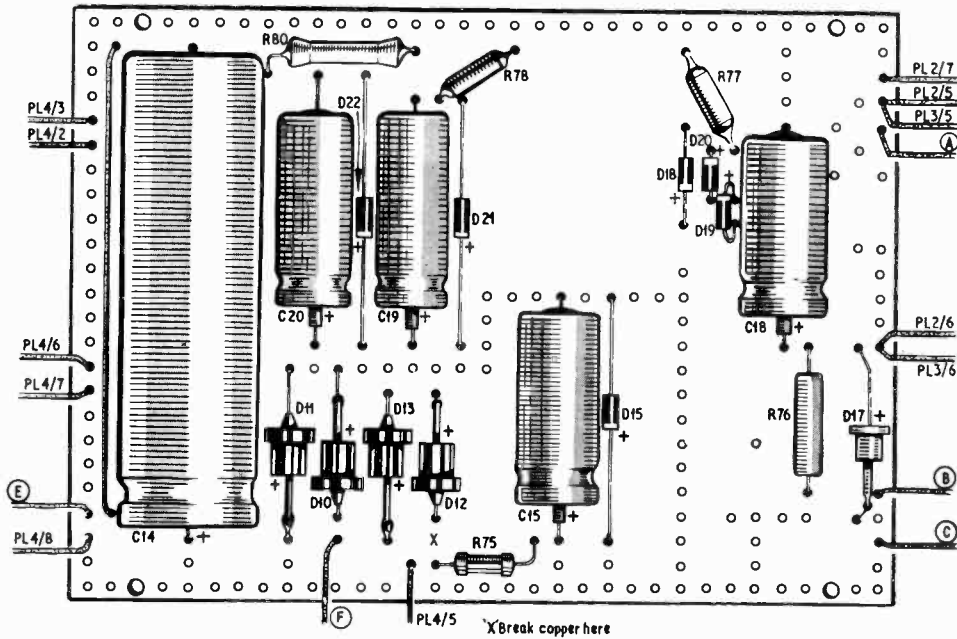


Fig. 6. Assembly details of small components making up P.S.U.2

an 8-way plug. Connection between the two parts of the Callercord is made via an octal plug and socket, the socket being mounted on the casing containing the control circuits, and the extension speaker leads from this octal socket are also brought to the third 8-way plug. All leads to LSI should be screened.

Twisted leads from the transformer secondary winding, speed control switch and counter are brought to another 8-way plug. With the exception of an octal plug and socket, the other interconnecting sockets are Radiospares 8-way edge connector sockets, and the 8-way plugs are cut from 0.15in matrix Veroboard.

SETTING UP

When everything has been wired up according to Fig. 7, check through very carefully. When satisfied, mount everything in the chassis, but make sure that the tape recorder chassis are electrically isolated from the main casing. Electrical checks can now be made.

Set the timing controls to mid-position, plug the machine into the mains and switch on. Immediately, the solenoid bolt will shoot home, the neons will probably all turn on, and both tape motors should start running. After a few seconds, one or two of the neons should go out, and in less than a minute the machine should stop, leaving only the gate neon (LP1) on.

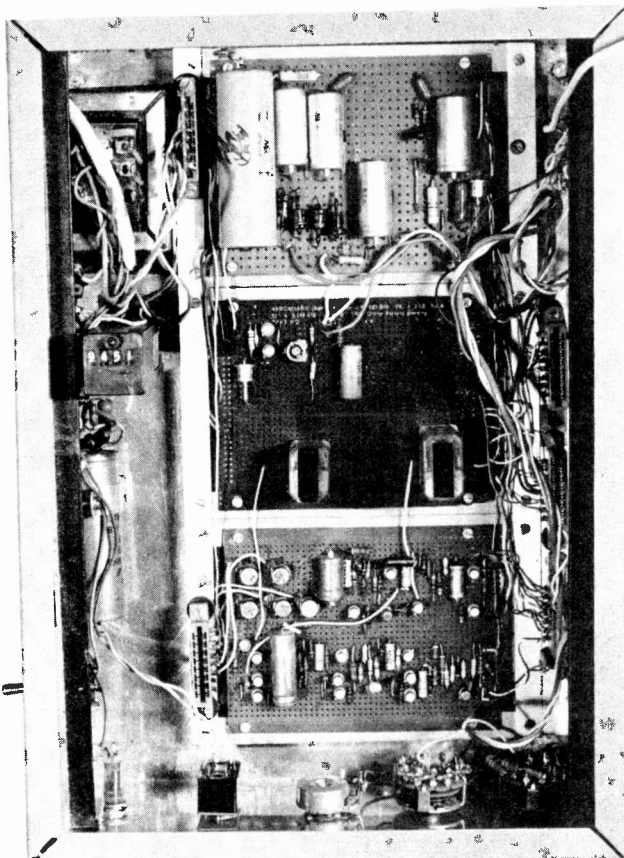
Assuming that the machine does stop, check the correct sequence of events, setting the machine in motion by pressing the bell switch. The two main timing circuits can then be calibrated by continuously recycling the machine, each time resetting the delay switches. Remember though that the PBM switch (S3) should always be set for a time shorter than the main delay, and when tapes are in use, this must allow for the complete rewinding of the PBM tape.

USING THE MACHINE

After calibration, put a spool of tape onto each recorder, the ends of the tapes being secured to the take-up spools. This is best done by looping the end of the tape around a small piece of 5A flex and sticking it with two layers of splicing tape to give greater strength. Do not use any other type of adhesive tape—it is not strong enough. It is also recommended that double or triple play tape should be used for the RCM tape, and standard play tape be used for the PBM tape. To avoid high rewind speeds for the PBM tape, the play-off spool should only be about one third to a half full.

Set Tape Recorder 1 function switch to "Record" and set the volume control to about half way. Set the PBM timing switch to give a time longer than the message length, press the bell switch, and when ready, speak into the microphone. As soon as the tape switches into reverse, set the functions switch to "Playback" otherwise the message will be erased. When the machine has cycled and stopped, set its time on the PBM timing controls and switch Tape Recorder 2 to "Record" with the volume set about half way and the speed control switch to "Slow". The Callercord is now ready for use.

For playing back messages from callers, set Tape Recorder 2 to "Rewind", the speed control to "Fast", and the main timing control to "Open". The machine will start automatically, and after playing



Interior layout of Callercord chassis. The tape recorders are mounted on the angle strips fixed to the chassis sides. For convenience, the sub-frame for the Veroboards and sockets can be dispensed with and these items connected directly to the chassis using suitable insulation bushes

back the PBM will rewind Tape Recorder 2. The motor of this will now remain on indefinitely with the "Open" setting. When it has rewound, switch the Recorder to "Playback", and put the speed control on "Slow". The RCM will now play back through the speaker.

After again rewinding, switch the timing control to its original setting, and when the machine has stopped, reset the function switch to "Record". Everything is again ready for the next caller. The best settings for the main timing control and the volume controls will eventually become obvious.

PIP GENERATOR

In practise, trouble was experienced with the effective timing of the PBM. The motors of the decks are non-synchronous and their speed varies with ambient temperature. If the room in which the machine is to be used is kept at a fairly constant temperature, this will not matter, but if not, then the PBM could cut out a couple of seconds too early or too late, depending on which way the temperature has changed. This can be compensated for by one of two ways.

CALLERCORD INTERWIRING

TAPE RECORDER
SUPPORT BRACKETS

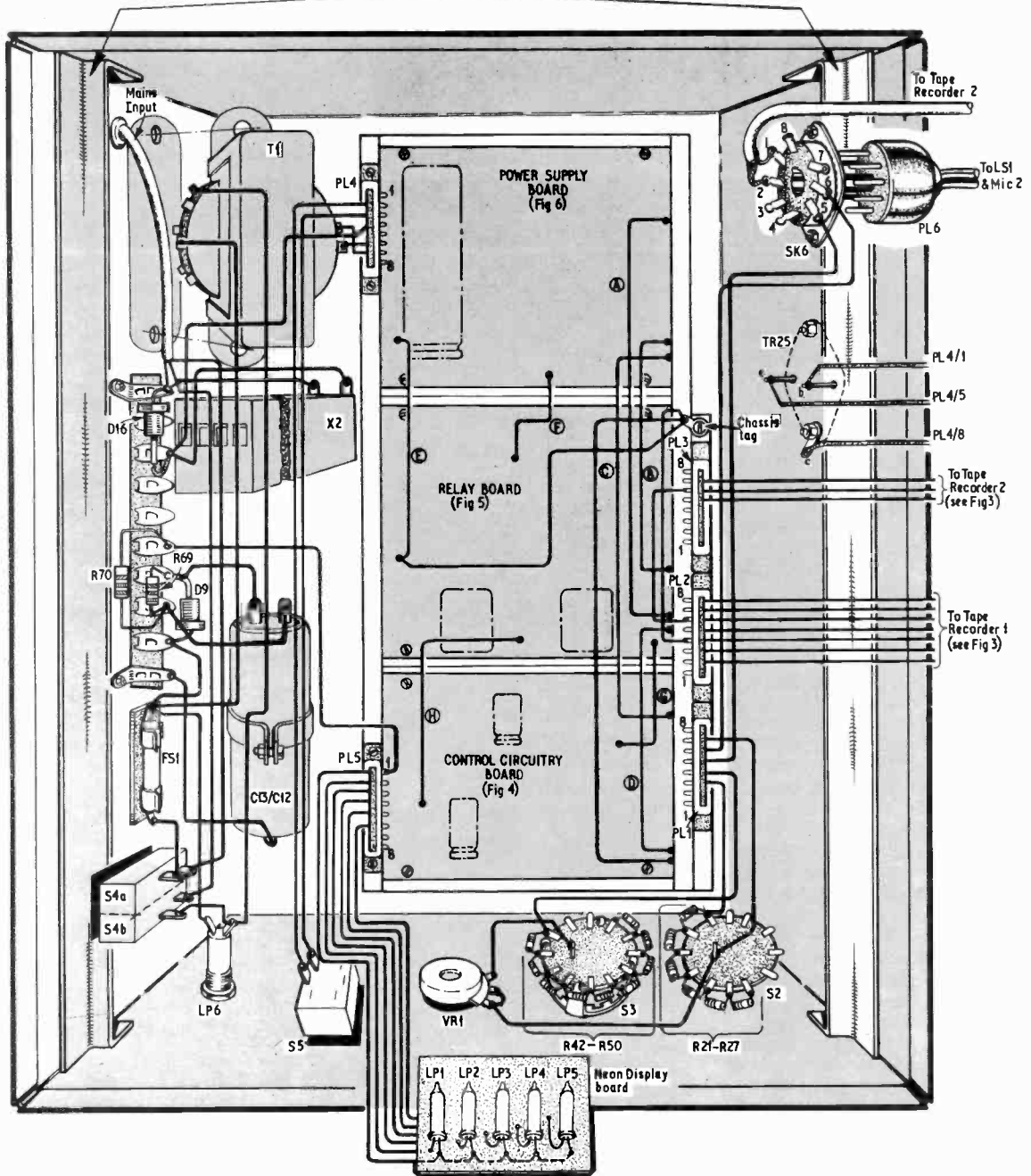


Fig. 7. Complete interwiring details for the Callercord.



BASIC ELECTRONICS COURSE

By Norman H. Crowhurst
Published by Tab Books
368 pages, 8½ in × 5½ in. Price \$5.95 paperback

BASIC electronics is, in fact, not the subject of this book. The word "basic" in the title refers to the course rather than the electronics. The fundamentals of electronics such as the nature of the electron are not covered at all.

This book takes an attitude well biased towards the engineering side of electronics rather than the science in that it provides practical rather than theoretical information. The reader is not bogged down with theory which, though it may be interesting in itself, does not really help the newcomer to electronics obtain a grasp of the significance of a particular component in the circuit situation.

Kirchoff's Laws and Thevenin's Theorem which are extremely useful aids to circuit analysis but which are usually neglected in first course books are well explained. Magnetism and electromagnetism are comprehensively dealt with as are diodes, and transistors in both linear and switching applications.

Each chapter is rounded off with a set of questions, half of which are supplied with answers.

The book is easy to read and its thoroughly practical approach makes it a worthwhile introductory volume for students or technicians.

S.R.L.

INTEGRATED CIRCUIT POCKET BOOK

By R. G. Hibberd, B.Sc., C.Eng.
Published by Newnes-Butterworths
274 pages, 7 in × 5½ in. Price £2.50

IF YOU want to know about integrated circuits, either digital or linear, then you would be well advised to get this book. Several books in the past have treated integrated circuits as an adjunct to general electronics theory. Now, at last, the subject is recognised in book form as a modern form of practical electronics that is now well passed the childhood stage.

To trainees and students, it seems best to jump straight into i.c. techniques, since here is the natural extension to transistor technology. How the integrated circuit is built up from basic silicon slices to complex circuits, requiring the utmost attention to electrical and physical parameters, makes interesting reading. The angle of approach is essentially industrial, since it is in industrial equipment that the greatest economies and task functions are needed.

The range of i.c. classes described is wide, but let it not be assumed that the full circuit descriptions are given—only the functions from a systems point of view. Of course, some previous electronics theory is required, although a glossary is provided in the appendix.

M.A.C.

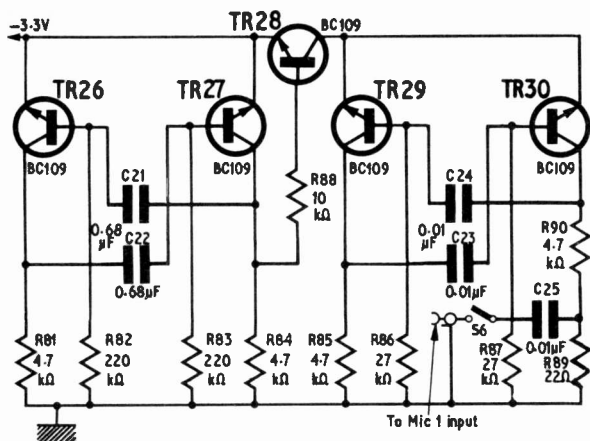


Fig. 8. Circuit diagram of "pip" generator. No assembly details are given of this as layout is not important

Recorder 2 could be made to start at the same time as Recorder 1, but this would result in excessive use of tape. A better answer is to wire in a small additional circuit. This consists of a "pip" generator that allows a series of pips to be switched in and recorded at end of the PBM with the instruction to the caller that he should start speaking only when he hears the pips stop, this only taking place when the machine switches over to Recorder 2. In use, the switch-over point would be timed to occur approximately 2 or 3 seconds after the end of the PBM speech to allow for early cut out, and the pips would last for 5 or 6 seconds to allow for late cut out.

The circuit takes the form of two astable multi-vibrator circuits coupled together—TR26/27 and TR29/30. Astable TR26/27 oscillates at only a few cycles per second, while TR29/30 runs at only a few thousand. The emitters of TR29/30 are taken to the collector of TR28 which has its emitter on the -3.3V line and its base is connected to the output of TR27. Thus TR28 switches the power to TR29/30 on and off in sympathy with the output of TR27, so giving an output from TR30 that sounds similar to the STD pips from a call-box telephone. Fig. 8 shows the circuit and its simple connections. ★

INDEX

An Index for Volume Seven (January 1971 to December 1971) is now available price 10p inclusive of postage.

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Sinclair Project 60



Active Filter Unit (A.F.U.)

Built and tested post free
£5.98

The value of an efficient filtering system cannot be over emphasized in these days of very high quality reproduction since there are so often occasions where its use can mean the difference between comfortable and uncomfortable listening. On the low pass side the Sinclair A.F.U. will effectively reduce hiss from radio or tape, cut out heterodyne whistles on A.M. reception, greatly reduce record surface noise and other imperfections; on the high-pass side it will cut out motor rumble and other spurious low frequency intrusion. The unit is for use between pre-amp (including tape pre-amps) and power amplifiers, and operates in two sections, both stereo. The cut-off frequencies are continuously variable, and since attenuation in the rejection band is rapid (12dB/octave) there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is as easy to mount as the stereo 60 pre-amp/control unit which it matches in styling, along with the Stereo FM Tuner.

SPECIFICATIONS

The A.F.U. employs two Sallen and Key type active filter stages, one rumble (high pass) and one scratch (low pass). The two stages use complementary transistors to minimise distortion.

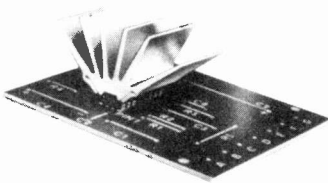
Supply voltage: 15 to 35 volts. Current 3mA maximum.

Gain at 1kHz: Filters flat 0.98 (−0.2 dB)
HF cut off: (−3dB) variable from 28 kHz to 5 kHz at 12 dB/octave.

LF cut off: (−3dB) variable from 25Hz to 100Hz at 12dB/octave.

Distortion: at 1kHz (35 volt supply) 0.02% at rated output.

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC, make possible. It is the equivalent of a 22 tran-

sistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak), 6–8Ω. **Frequency Response:** 5Hz to 100kHz ± 1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0.1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 × 45 × 28mm including pins and heat sink.

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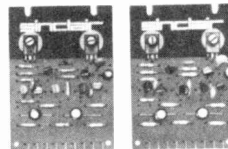
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SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications).— Power Outputs: Z.30 15 watts R.M.S. into 8 ohms using 35 volts; 20 watts R.M.S. into 3 ohms using 30 volts. **Z.50** 40 watts R.M.S. into 3 ohms using 40 volts; 30 watts R.M.S. into 8 ohms using 50 volts. **Frequency response:** 30 to 300,000Hz ± 1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.

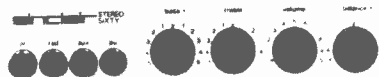


Stereo 60 Pre-amp/control unit

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Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

SPECIFICATIONS—Input sensitivities: Radio — up to 3mV. Mag. p.u. 3mV; correct to R.I.A.A. curve ± 1dB; 20 to 25,000 Hz. Ceramic p.u. — up to 3mV. Aux — up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to -12dB at 10KHz; BASS +12 to -12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.



Project 60 Stereo F.M. Tuner

Built and tested. Post free. **£25**

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and switchable squelch circuit for silent tuning between stations. In terms of high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

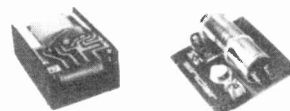
SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108MHz. **Sensitivity:** 7μV for lock-in over full deviation. **Squelch level:** Typically 20μV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10Hz — 15KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. maximum. **Operating voltage:** 25–30VDC. **Indicators:** Stereo on; tuning. **Size:** 93 x 40 x 207mm.



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Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

PZ.5 30 volts un stabilised £4.98
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Typical Project 60 applications

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12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£23.90
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Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

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CRESCENT RADIO LTD

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EA1000 3 WATT AUDIO AMPLIFIER

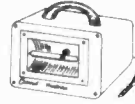
An Audio Amplifier designed around the TAA821 Linear I.C. —
Supply Voltage 9-24V
Speaker Imp. 8-16 ohm
Frequency 50Hz-25k Hz
Overall Size 2in X 3in X 1in
Ideal Amplifier for radios, record players, stereo units, etc.
Full technical data and diagrams with each module. All guaranteed and a bargain at



£2.63
+ 5p P. & P.

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Another Bargain from Crescent. 1 joule output, speed variable from 2-10 flashes per sec. and powered from a.c. mains 220V-250V. Housed in its small attractive fibreglass case (size approx 6in X 4in X 4in high). Makes an ideal Strobe Unit for Discos, Experimental Work, Photography and many other uses.



£16.50 plus 38p P. & P.

74 Series I.C.s	Price
7400	15p
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DIGITAL CLOCK KIT

24-hr. Nixie dig. clock kit. We supply a complete set of components; a complete set of easy to follow instructions; printed circuits made to make construction as simple as possible; a cabinet and front panel to give a professional finish. All for the price of the components. **£22.50** + 50p P. & P. Please send S.A.E. if you require more information.



CRESCENT CASSETTES
Best quality **LOW NOISE** Cassettes, complete in standard storage case. Please note our new low price.
C60 28p
C90 38p
C120 48p
Please include 5p P. & P.



EMI LOUDSPEAKER 450
10W 13in - 8in ± two 2-2in tweeters and cross-over. All wired and ready for use. This ever-popular 450 in 3-8-15 ohm imp.
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Plus 10p P. & P. per pair.



BRIGHTNESS CONTROL
Full control over 300 watts of incandescent lighting. Thyristor light dimmer mounted on a standard switch block ready to fit into a MK. Box. Enjoy the pleasure of having the precise amount of light you require at any time.
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A must for the experimenter interested in I.C.s. 14 pin, 20p each, 16 pin, 20p each. Please include 5p P. & P. per 3 sockets.



MINI LOUDSPEAKERS
2 1/2in 8 ohm 50p
2 1/2in 40 ohm 50p
Please include 5p P. & P. on each L.S.

2N3055
Popular power transistor now at our low price = **50p** each.
Please include 5p P. & P.

IB40K05
Bridge Rectifier (Texas). Plastic encapsulated 50V at 4A. Approx. size 1 1/2in X 1 1/2in. Our Price **80p** each.

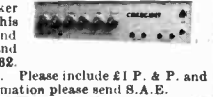
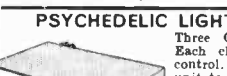
NKP CALIBRATED KNOB
0-10 calibrated plastic knob with metal insert and skirt. Fixing size 6.35mm. Skirt dia. 36mm. Our price **20p** each plus 2p P. & P.



TRI-VOLT BATTERY ELIMINATOR
Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require, 6, 7 1/2 or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2 1/2in X 2 1/2in X 3 1/2in. Our Price **£2.75** plus 10p P. & P. Same model suitably wired for the Philips Cassette **£3** plus 10p P. & P.



CRESCENT 100W STEREO
A new style 100 watt per channel stereo amplifier. All loudspeaker systems, 8-15 ohm are suitable. This amplifier is designed for the D.J. and group who must have good looking and reliable equipment. A bargain at **£82**. We also have a mono 100 watt at **£42**. Please include £1 P. & P. and insurance. If you require more information please send S.A.E.



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Spec.: 5 Section
Extended Length 100cm
Length under Fender 40cm
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Supplied complete with Fixing Bracket and Control Switch. **£5.50** plus 25p P. & P.

BARGAIN S.C.R.
Tested Thyristor.
400V, 3amp.
45p each.
5 for **£2**.
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PSYCHEDELIC LIGHT CONTROL UNIT
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 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed)
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Any 6 of the following 50p or 10p each. OC71, BFY50, 2N3702, CV8615 (BSY95A), NTG885.

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 - GOLDRING G800 **£3.65**; GOLDRING G850 **£5.70**;
 - GOLDRING G101/PT/T UNIT **£22.50**.
- ALL ABOVE POST FREE.

EX COMPUTER CIRCUIT BOARDS

- 10 Boards 50p, P. & P. 8p.
- 25 Boards £1, P. & P. 18p.
- 2 Boards with 2 Power Transistors, i.e. 4 x OC28 type, 50p, P. & P. 7p.

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All callers welcome. Hi-Fi and component specialists; J.V.C. Nivico, Sharp, Sanyo, Philips, Marconiphone, Teleton, Wharfedale, Goodmans, Eagle, Leak, Grundig, Sansui, Skandia, etc., etc.

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Input 12 volts. Output 6V, 7.5V, 9V.
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Manual **£8.50**

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Plinth and Cover suitable for Garrard SP25, **£3.25**

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Please send 25p for postage and packing

Quality Cassettes at cheapest prices

C60 35p plus 5p P. & P.

C90 47p plus 5p P. & P.

C120 60p plus 5p P. & P.

Mixed packet of resistors 25p postage paid

Pocket Transistor Radio AM with Battery, Magnetic Earphone and Carrying Case **£1.95** postage paid

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT

VARIABLE 0.260V

All Types

from ½ to 50 amp from stock.

SHROUDED TYPE

1 amp, £7.00	20 amp, £49.00
2.5 amp, £8.05	25 amp, £58.00
5 amp, £11.75	37.5 amp, £82.00
10 amp, £22.50	50 amp, £98.00
15 amp, £25.00	



(Panel Mounting) ½ amp, £4.75.
1 amp, £7.00, 2½ amp, £8.05. All carriage paid.

2.5 AMP OPEN TYPE

L.T. TRANSFORMERS

All primaries 220-240V

Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36V at 5A	£4.68	45p
2	30, 40, 50V at 5A	£6.88	45p
3	10, 17, 18V at 10A	£4.95	45p
4	6, 12V at 20A	£6.43	45p
5	17, 18, 20V at 20A	£7.28	55p
6	12, 20V at 20A	£8.88	55p
7	24V at 10A	£3.23	45p
8	4, 6, 24, 32V at 12A	£7.15	45p
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220/240 VOLT A.C.

CENTRIFUGAL FAN/BLOWER

Smooth, balanced running unit. Two pole shaded pole Mylexal motor gives approximately 90 cubic ft./min. but draws only 240mA on run. Weight 2½lb. Case dia. 3 1/8" width (case only) 3 1/2" in. overall incl. motor) 5.25in. aperture 3 1/2" in. x 1.85in. Price only £2.95. P. & P. 25p.



12 VOLT D.C. MOTOR

Powerful 1 amp. REVERSIBLE motor. Speed 3,750 r.p.m. complete with external gear train (removable) giving approx. final speed of either 125 r.p.m. or 240 r.p.m. Size: 4 1/4" x 2 1/4" in dia. Either type price 75p incl. post.



230V/240V COMPACT

SYNCHRONOUS GEARED MOTORS

Manufactured by either Sangamo, Hayden or Smith. Built-in gearbox. r.p.m. cw. 1 r.p.h./a/cw. 6 r.p.h. cw. 60 r.p.m. cw. 2 r.p.h. cw. 20 r.p.h. cw. 3 r.p.h./a/cw. 30 r.p.h. cw. cw. = clockwise rotation; a/cw. = Anticlockwise. Fraction of makers' price. All at 75p incl. P. & P.



CONSTANT SPEED. PRECISION

MADE 6 VOLT D.C. GOVERNED

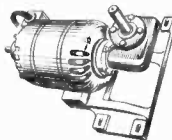
MOTOR

Seven pole armature, ballrace bearing. 2,750 r.p.m. Length 2 1/8". Dia. 1 1/8". Shaft length 1/8". Shaft dia. 5/64". No load 40 mA. Normal load 350 mA. Ideal for portable recorders, etc., etc. Price £1.25 P. & P. 10p.



PARVALUX TYPES D19 230/250 VOLT A.C. REVERSIBLE GEARED MOTORS

30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. £6.30. P. & P. 50p.



17 WAY SELECTOR SWITCH WITH RESET COIL

This fascinating electro mechanical device can be switched through 17 positions, and can be reset from any position by energising the reset coil. 110 volt A.C. operation, or 230/240V A.C. with 500 ohm, 10W resistor, or 50V D.C. Two for £1. P. & P. 10p.

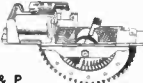
600 WATT DIMMER SWITCH.

Easily fitted. Fully guaranteed by makers. Will control up to 600W of all lights except fluorescent at mains voltage. Complete with simple instructions. £3 incl. P. & P.

UNISELECTOR SWITCHES

NEW 4 Bank 25 Way

24V d.c. operation. £5.88. P. & P. 25p. 6 Bank 25 Way 24V d.c. £6.50. P. & P. 25p. 8 Bank 25 Way, 24V d.c. operation. £7.62 plus 25p. P. & P.



230V A.C. SOLENOID

Extremely powerful with approx. 14lb pull, 1in travel. Fitted with mounting feet. Size: 4in long, 2 1/2in wide, 3in high. £2.00 incl. P. & P.



230-250 VOLT A.C. SOLENOID

Manufactured by Westool Ltd. (similar in appearance to above illustration). Approx. 14lb pull. Feet size 1 1/2in x 1 1/2in. Price 85p incl. P. & P.

18-24 VOLT D.C. SOLENOID

Size: 0.4L 3 1/2in x 1 1/2in. Max. push ½ at 1lb. approx. PRICE: 75p incl. P. & P.

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. **EXPERIMENTERS' ECONOMY KIT** Speed adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £6.30, plus 25p P. & P.

NEW INDUSTRIAL KIT Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1-80 f.p.s. Price £10.50. P. & P. 50p.

HY-LYGT STROBE MK III Designed and produced for use in large rooms, halls and the photographic field and utilises a silica tube, printed circuit, also a special trigger coil. Speed adjustable 0-30 f.p.s. Light output approx. 4 joules. £12.00. P. & P. 50p. SPECIALLY DESIGNED. FULLY VENTILATED METAL CASE. For industrial or Hy-Lyght. Including reflector. £4.00 P. & P. 45p. Post paid with kit.

THE 'SUPER' HY-LYGT KIT

Approx. four times the light output of our well proven Hy-Lyght strobe. Incorporating:
● Heavy duty power supply.
● Variable speed from 1-23 flash per sec.
● Reactor control circuit producing an intense white light.

Never before a Strobe Kit with so HIGH an output at so LOW a price. ONLY £20 plus 75p P. & P.

ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE specially designed for the Super Hy-Lyght Kit including reflector £7.00 P. & P. 45p.

7-inch **POLISHED REFLECTOR** Ideally suited for above Strobe kits. Price 53p. P. & P. 13p or post paid with kits.

6 INCH COLOUR WHEEL

As used for disco lighting effects, etc. £5.75 incl. P. & P. can be operated from our one r.p.m. synchronous motor price 75p incl. P. & P.

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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. 1,000V, 1,000 megohms, £34.00 carriage paid. 500V, 500 megohms, £28 incl. P. & P.



36V 30 AMP. A.C. or D.C. VARIABLE L.T. SUPPLY UNIT

INPUT 220/240V a.c.
OUTPUT CONTINUOUSLY VARIABLE 0-36V Fully isolated. Fitted in robust metal case with Voltmeter, Ammeter Panel Indicator and handles. Input and output fully fused. Ideally suited for Lab. or Industrial use. £68 plus £2 P. & P.



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(Mfg. by Magnetic Devices Ltd.) 240V a.c. 5 r.p.m. Croutet motor. Drives 15 cams, each operating variable, allowing innumerable combinations. Ideally suited for machinery control, automation, etc. Also in the field of entertainment, for chaser lights, animated displays, etc. PRICE £5.75. P. & P. 25p.

MOTOROLA MAC 11/6 PLASTIC TRIAC 400 PIV. 10 AMP

Now available **EX STOCK**. Supplied with full data and applications sheet. Price £1.05. P. & P. 7p. Suitable DIAC (RCA 40583) 30p each.

Superior Quality Precision Made NEW POWER RHEOSTATS



100 WATT, 1 ohm, 10A; 5 ohm, 4.7A; 10 ohm, 3A; 25 ohm, 2A; 50 ohm, 1.4A; 100 ohm, 1A; 250 ohm, 0.7A; 500 ohm, 0.45A; 1 kΩ, 280 mA; 1.5 kΩ, 230mA; 2.5 kΩ, 2A; 3.5 kΩ, 5 kΩ, 140mA. Diameter 3 1/2in. Shaft length 1 1/2in. dia. 1/16in. All at £1.65 each. P. & P. 7p.
50 WATT, 1/5/10/25/50/100/250/500/11/1/5/2/5/5kΩ. All at £1.15 each. P. & P. 7p.
15 WATT, 10/25/50/100/250/300/500/11/1/5/2/5/3/5/5kΩ. All at 90p each. P. & P. 7p.
Black Silver Skirted knob calibrated in Nos. 1-9, 1 1/2in. dia brass bush. Ideal for above Rheostats, 18p ea.

RELAYS SIEMENS, PLESSEY, Etc.

MINIATURE RELAYS

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Coil ohms				
Col. (2)	52	3-6	2 c/o	63p
Working	410	10-18	4 c/o	73p
Coil ohms	600	12-24	4 c/o	73p
d.c. volts	700	16-24	4M 2B	63p
Col. 3	700	16-24	4 c/o	78p
Contracts	700	15-35	2 c/o HD	73p
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Post paid.	15k	48-110	6M	50p

12 VOLT D.C. RELAY 140 ohm coil

Three sets c/o contacts rated at 5 amps. 78p including P. & P. (Similar to illustration below.)

'DIAMOND H' 230 VOLT A.C. RELAYS (Unused)

Three sets c/o contacts rated at 5 amps. PRICE: 50p. P. & P. 10p. (100 lots £40 including P. & P.)



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One set c/o contacts rated at 7.5 amps. Boxed. PRICE: 40p. P. & P. 5p. (100 lots £32 incl. P. & P.)

MINIATURE LATCHING RELAY

Manufactured by Clare-Elliott Ltd. Type F, 2 c/o permanent latching in either direction. Coil 1150 ohm, 15-30 Volt D.C. Size 2" high, 3" wide, 1 1/4" thick. Complete with 3' leads. New 73p, incl. P. & P.

ELECTRONIC ORGAN KIT

Easy to build. Solid State. Two full octaves (less sharps and flats). Fitted hardwood case. Powered by two penlite 1 1/2V batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. Price £3. P. & P. 22p.

G.E.C. 12 WAY 15 AMP CONNECTORS

NEW in makers carton. BAKELITE £1.25 per doz. FLEXIBLE £1.50 per doz. Post paid (Minimum 1 doz).



LIGHT SOURCE AND PHOTO CELL MOUNTING

Precision engineered light source with adjustable lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP12 or similar cell. Both units are single hole fixing. Price per pair £2.75. P. & P. 18p.



LIGHT SENSITIVE SWITCHES

Kit includes ORP.12 Photocell, Relay Transistor Circuit. For 6 or 12V D.C. operation. Price £1.50 plus 12p P. & P. ORP. 12 and circuit 63p post paid. 220/240V A.C. MAINS MODEL Mains transformer, rectifier, relay, 1 make 1 break H.D. contacts. price incl. circuit £2.65. P. & P. 20p.



50 in 1 ELECTRONIC PROJECT KIT
50 projects to build. 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. 30p.

MICRO SWITCH
5 amp c/o contacts. Fitted with removable push button assembly. Ex. P.O. 20 for £1 incl. post. (Min. order 20.)

D.C. AMMETERS **NEW!**
1A, 5A, 15A, 20A, £1.75, incl. P. & P. 0-300V a.c., £1.90, incl. P. & P.



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2G301	20p	2N3405	45p	40311	35p	BC172	15p	B8W70	271p	NKT236	25p
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2G303	20p	2N3415	221p	40314	371p	BC182	10p	B8X20	171p	NKT241	271p
2G306	421p	2N3416	371p	40320	471p	BC183	9p	B8X21	171p	NKT242	271p
2G308	30p	2N3417	371p	40323	321p	BC184	11p	B8X26	46p	NKT243	271p
2G309	30p	2N3507	11-25	40324	471p	BC121L	271p	B8X27	471p	NKT244	271p
2G371	20p	2N3670	471p	40326	371p	BCY26	30p	B8X28	321p	NKT245	271p
2G374	20p	2N3605	271p	40329	30p	BCY31	30p	B8X60	321p	NKT261	20p
2G381	20p	2N3606	271p	40344	271p	BCY32	60p	B8X61	621p	NKT262	20p
2N404	221p	2N3607	221p	40347	271p	BCY33	25p	B8X76	271p	NKT264	20p
2N696	20p	2N3702	11p	40348	521p	BCY34	30p	B8X77	271p	NKT271	20p
2N697	20p	2N3703	10p	40360	421p	BCY38	40p	B8X78	271p	NKT272	20p
2N706	181p	2N3704	11p	40361	471p	BCY39	80p	B8X78	271p	NKT274	20p
2N706A	181p	2N3705	10p	40362	571p	BCY40	50p	B8Y10	271p	NKT275	20p
2N708	181p	2N3706	11p	40370	571p	BCY42	15p	B8Y11	271p	NKT281	20p
2N709	621p	2N3707	7p	40408	571p	BCY43	15p	B8Y24	15p	NKT401	871p
2N718	20p	2N3709	9p	40408	571p	BCY56	221p	B8Y26	15p	NKT402	90p
2N728	20p	2N3710	9p	40410	621p	BCY59	221p	B8Y26	171p	NKT404	621p
2N727	20p	2N3711	18p	40410	671p	BCY60	971p	B8Y26	171p	NKT405	75p
2N914	171p	2N3715	11-25	40467A	571p	BCY70	20p	B8Y28	171p	NKT406	621p
2N916	171p	2N3716	11-20	40468A	35p	BCY71	25p	B8Y29	171p	NKT451	621p
2N918	30p	2N3791	22-06	40600	271p	BCY72	171p	B8Y32	25p	NKT452	621p
2N929	221p	2N3819	35p	40673	85p	BCZ10	271p	B8Y36	25p	NKT453	471p
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2N1131	20p	2N3856	271p	AC128	20p	BD123	821p	B8Y51	321p	NKT771F	25p
2N1132	20p	2N3856A	30p	AC154	221p	BD124	60p	B8Y52	321p	NKT773F	25p
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2N1711	20p	2N3905	371p	AD149	571p	BF177	19p	D16P2	30p	OC22	50p
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2N2193A	421p	2N4064	471p	AF116	25p	BF182	25p	GET113	20p	OC32	621p
2N2194A	421p	2N4244	471p	AF117	25p	BF185	421p	GET114	20p	OC33	621p
2N2217	271p	2N4286	171p	AF118	621p	BF194	171p	GET118	20p	OC39	621p
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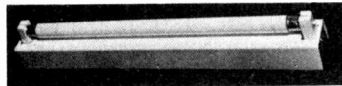
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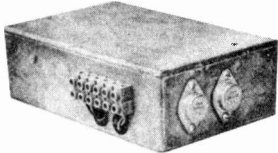
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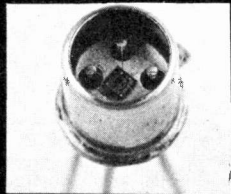
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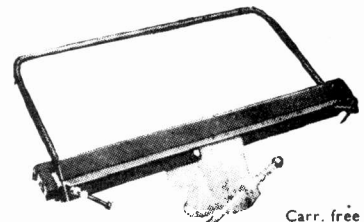


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7404	Hexuple inverters	20p	18p	14p	14p	12p
7406	Hex inverters with open collector outputs	20p	18p	14p	14p	12p
7410	Triple 3-input NAND gates	20p	18p	14p	14p	12p
7413	Dual 4-input Schmitt triggers	20p	18p	14p	14p	12p
7400	Dual 4-input NAND gates	20p	18p	14p	14p	12p
7430	Single 8-input NAND gates	20p	18p	14p	14p	12p
7440	Dual 4-input NAND buffer gates	20p	18p	14p	14p	12p
7441	BCD-Decimal decoder/Nixie driver	75p	75p	70p	60p	65p
7442	BCD-Decimal decoder (4-10-line) TTL O/P	75p	75p	70p	60p	65p
7443	Excess 3-Decimal decoder TTL outputs	11.00	9.00	90p	90p	85p
7447	BCD-Decimal 7-seg. decoder/indicator driver	11.75	11.60	11.45	11.30	11.15
7448	BCD-Decimal 7-seg. decoder/indicator TTL O/P	11.75	11.60	11.45	11.30	11.15
7450	Expand dual 2-input AND-OR-INVERT gates	20p	18p	14p	14p	12p
7461	Dual 2-input AND-OR-INVERT gates	20p	18p	14p	14p	12p
7453	Quad 2-input expand AND-OR-INVERT gates	20p	18p	14p	14p	12p
7454	4-wide 2-input AND-OR-INVERT gates	20p	18p	14p	14p	12p
7460	Dual 4-input expanders	20p	18p	14p	14p	12p
7470	Single J-K flip-flop (gated inputs)	40p	37p	34p	31p	28p
7472	Single J-K flip-flop (gated input)	30p	27p	25p	22p	20p
7473	Dual J-K flip-flop	40p	37p	35p	32p	30p
7474	Dual D flip-flop	40p	37p	35p	32p	30p
7475	Quad 2-input D flip-flop	45p	42p	40p	38p	35p
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7482	2-bit binary Full Adder	11.00	90p	85p	80p	73p
7483	4-bit binary Full Adder	90p	85p	80p	75p	71p
7484	16-bit RAN with gated write inputs	45p	41p	38p	35p	33p
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7491	8-bit shift register	11.00	95p	90p	80p	75p
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7493	4-bit binary counter	75p	70p	65p	60p	55p
7494	Dual entry 4-bit shift register	90p	75p	70p	65p	60p
7495	4-bit up-down shift register	90p	75p	70p	65p	60p
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F	9	10.65	4.00	28p	S	13	3.13	4.40	35p
G	13	3.65	3.40	28p	T	13	7.13	5.40	35p
H	13	7.65	4.00	28p	U	13	10.13	6.60	45p
I	13	10.65	4.40	35p	V	18	3.13	5.40	35p
J	18	3.65	4.00	28p	W	18	7.13	6.60	45p
K	18	7.65	5.40	35p	X	18	10.13	8.00	45p
L	18	10.65	6.60	45p	Y	22	3.13	5.40	35p
M	4.5	3.13	2.50	28p	Z	22	7.13	6.60	45p

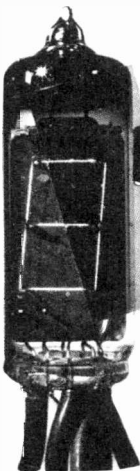
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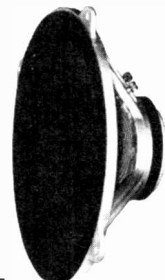
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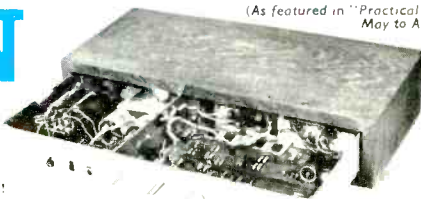
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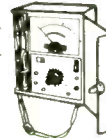
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