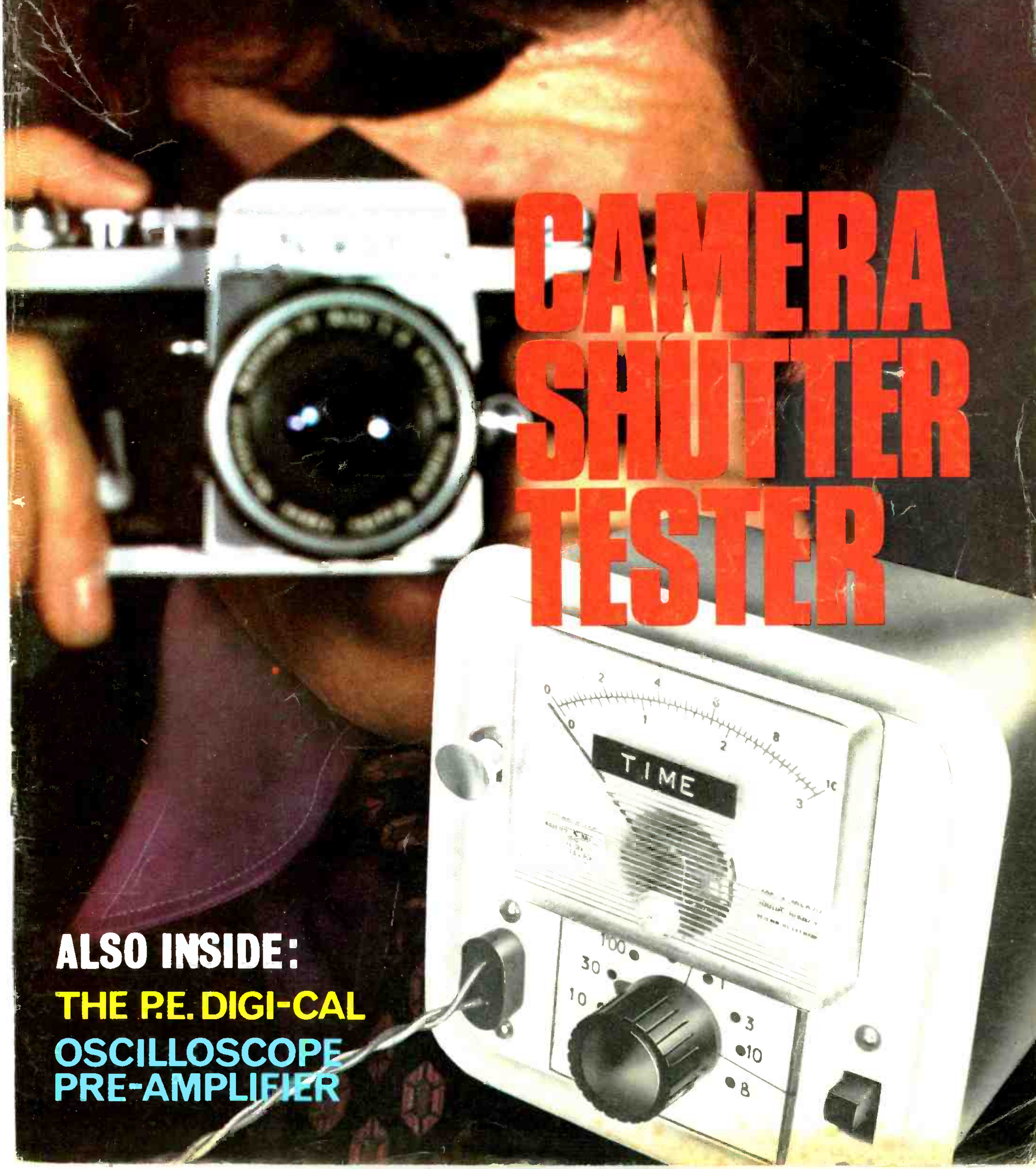
PRACTICAL

ELECTRONICS

AUGUST 1972

20p



CAMERA SHUTTER TESTER

ALSO INSIDE:

THE P.E. DIGI-CAL

OSCILLOSCOPE PRE-AMPLIFIER

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 multivibrator. 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, MTTL 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.

RESISTORS

¼ 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.

POLYSTYRENE CAPACITORS

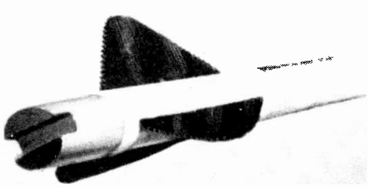
VALUE	*PRICE*
100 pf	3p
150 pf	3p
220 pf	3p
330 pf	3p
470 pf	3p
560 pf	3p
680 pf	3p
820 pf	3p
1000 pf	3p
1500 pf	3p
2200 pf	3p
3300 pf	3p
4700 pf	3p
5600 pf	3p
6800 pf	3p

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.



You'll get the point in September!

Shoot me the details in September!! PE1

Name ....

Address ....

LST Electronic Components Ltd
7 Coptfold Road, Brentwood, Essex
Telephone: Brentwood 226470

PE1

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 FROM US!

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

PORTABLE RADIO & COMMUNICATIONS RECEIVER

"MAGIC EYE" tuning level indicator

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.)

*COMPARE ITS PERFORMANCE with £80 RADIOS!

WE COULDN'T EVEN MAKE THEM FOR THIS PRICE!

BATTERY MODEL £20·75 BOX POST ETC. 50p

MAINS/BATTERY ELIMINATOR £1·48 extra

FIRST TIME EVER! *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!

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.

MOTORING SENSATION! SAVE £24·50!

LIST PRICE £39·97!

8-TRACK CAR STEREO PLAYER

ONLY £12·97 CARR. ETC 33p

Plus 2 MATCHED SPEAKERS FOR ONLY £1·25 EACH!

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 6¾in × 6¼in × 2¾in 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, fitments, etc. Designed for fast, easy mounting. Complete with simple instructions & WRITTEN GUARANTEE. **BUT WAIT!** For only £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.

THIS FANTASTIC OFFER ONLY FROM US! SAVE £20·25 NOW!

fabulous BRAND NEW SOLID STATE

This equipment's got EVERYTHING!

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

RECOMMENDED RETAIL PRICE £44

WITH REMOTE CONTROL MICROPHONE

OUR PRICE £23·75 CARR ETC. 35p

Shopertunities "thunder" ahead with an offer that's FANTASTIC (even by our standards!) We've snapped up 500 magnificent machines. **Latest sensation in the world of sound!** First-class makers! Fabulous **VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined & it also runs off standard batteries or mains.** (Simply plug in the 220/240V. AC line cord.) Record and play back anything, **anywhere! Even tape direct from the Radio as you listen! RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE!** Wonderful features: **★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/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 VHF, 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 £ £ £'s 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.

SHOPERTUNITIES LTD.

Dept. PE/19, 164 UXBRIDGE ROAD (facing Shepherds 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.**

A QUARTER TURN RIGHT!

...opens a world of real stereo sound

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. 13¼in × 9in × 3¾in.

SPEAKERS Duo Type II. Size: Approx. 17in × 10¾in × 6¾in. 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 × 8¼in 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.

Goods not despatched outside U.K.

R T-V C

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

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″ × 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.

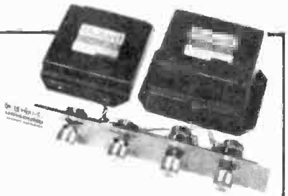
See opposite page for addresses

£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**

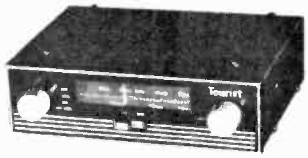
R T V C

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 screwdriver 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 × 4½in 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

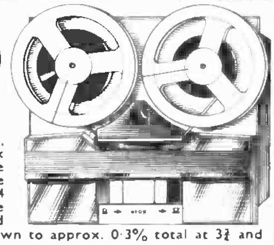
The Reliant Mk.IV provides a high standard of sound reproduction, with full mixing facilities. Its versatility makes it suitable for: Discotheque, P.A., Home Entertainment Applications, etc.

★ Five Electronically Mixed Inputs
★ Three Individual Mixing Controls
★ Separate bass and treble controls common to all five inputs
★ Mixer employing F.E.T. (Field Effect Transistor)
★ Solid State Circuitry
★ Attractive Styling

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: 12½in × 6in × 3½in.

PRICE
£10·50
Plus P. & P. 60p

CONTINENTAL 4-TRACK, 3-SPEED TAPE DECK



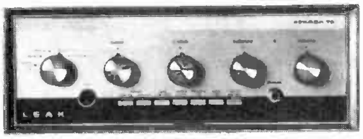
with high impedance heads

R.C. 74 tape deck. Three speeds—7½, 3¾ and 1⅞ 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 3¾ and 7½ 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.
The R.C. 74 comes with an attractive moulded deck cover, which has positions for tone and volume controls. The unit is built into a rigid die-cast frame, and overall size of the whole unit is 12¾ × 11¼ × 6in. Every single deck fully tested before dispatch. Spools not supplied. £15. Plus 75p P. & P.

R T V C

See opposite page for addresses

LEAK AMPLIFIER BARGAINS



STEREO 70 Amp. (Cased). LIST PRICE £75·00 — LASKY'S PRICE **£55·00** each

STEREO 30 plus Amp. (Cased). LIST PRICE £62·50 — LASKY'S PRICE **£45·00** each C & P £1

LEAK TEAK CASES

Rosewood case for Stereo 30 or Stereo 70, please state which is required.

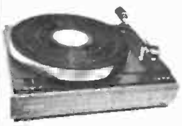
LIST PRICE £7·37 — LASKY'S PRICE **£2·75** C & P 25p

Teak case for Stereofetic tuner only.

LIST PRICE £7·37 — LASKY'S PRICE **£2·50** C & P 25p

Double case to hold Stereo 30 or Stereo 70 and Stereofetic tuner in Teak.

LIST PRICE £10·37 — LASKY'S PRICE **£4·95** C & P 35p



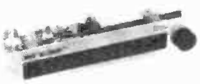
LEAK TRUSPEED

2-speed 45 and 33⅓ rpm belt drive turntable complete with plinth, cover and Shure cartridge.

LIST PRICE £69·50

LASKY'S PRICE **£47·50** C & P £1·50

SINCLAIR PHASE LOCK LOOP STEREO FM TUNER

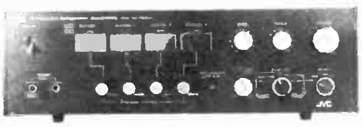


Incorporates varicap diodes, printed circuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to be mounted into any cabinet you choose. It may be used with any High Fidelity Amplifier. Power requirements 25/30V DC.

LIST PRICE £25·00 — LASKY'S PRICE **£16·95** C & P 25p

NIVICO MCA-V7E

4-CHANNEL AMPLIFIER

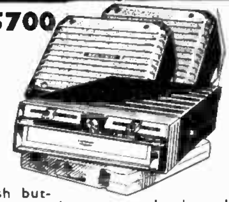


USE IT AS A 4-CHANNEL AMP
USE IT AS A STEREO AMP
USE IT WITH SYNTHESISED 4-CHANNEL SOUND FROM 2-CHANNEL SOURCE

The MCA-V7E can be used as a true 4-channel integrated amplifier from discreet 4-channel source using four speakers or have synthesised 4-channel sound using only two speakers. The MCA-V7E can also be used as a conventional stereo amplifier with two speakers only. Output 4 x 12·5W or 2 x 25W.

LIST PRICE £115·00 — LASKY'S PRICE **£78·00** C & P £1·00

BELTEK C5700 8 TRACK



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 4¾(W) x 1 1/16(H) x 6¼(D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.

BELTEK C5700 complete with mounting brackets and 8 track pre-recorded demonstration cartridge.

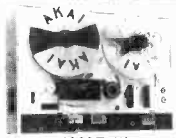
£19·75 C & P 30p

BELTEK R5310 FM TUNING ADAPTOR

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.



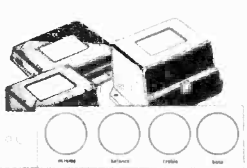
AKAI TAPE RECORDER SCOOP!

(C & P 75p on all Tape Decks.)

AKAI 4000D illustrated List Price £93·65	Lasky's Price £61·50
AKAI 1720L List Price £87·36	Lasky's Price £58·95
AKAI X1800SD List Price £162·79	Lasky's Price £111·50
AKAI X200D List Price £157·93	Lasky's Price £106·50
2 CSS-8 Speakers List Price £25·00	Lasky's Price £15·95 C & P 50p

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.

MULLARD UNILEX KITS



CONTROL Fitted with bass, treble, vol. and balance controls. All wires fitted for connecting. Size 9in x 1¾in x 1in. **£2·25.**

EP-9001 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.**

EP 9000 AMP. Output 4W per channel into 12 ohms. Output imp. 12–15 ohms or 8 ohms with series resistors. Freq. resp. 50Hz–16KHz. Size 3¾in x 4in x 1¾in. **£2·25.**

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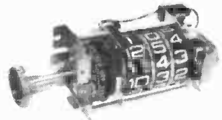

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The clock measures 5¾" (W) x 2¼" (H) x 3" (D) (overall from front of drum to back of switch). SPEC.: 210/240V a.c. 50Hz operation; switch rating 250V, 3A. Complete with instructions. **NOW WITH ILLUMINATED DIAL COMPLETE WITH KNOBS FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER**

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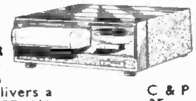

8 TRACK STEREO CARTRIDGE PLAYER

The TD8S is suitable for use with most modern stereo amplifiers and delivers a pre-amp output of 125mW. Power requirements: 210/250V AC, 50Hz. Frequency response: 50Hz-10KHz. 4 pole dynamically balanced synchronous motor. Black and woodgrain plastic cabinet. Size: 8¼(W) x 3¾(H) x 10¼ (D) in.

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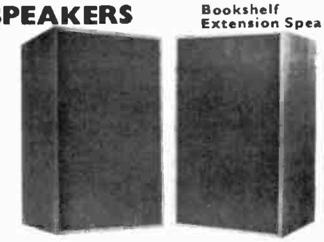

An attractive bookshelf speaker system with teak veneer finish. Imp. 8 ohms. Max. Power 12W. Size 14½ (H) x 9 (W) x 7½ (D) in.

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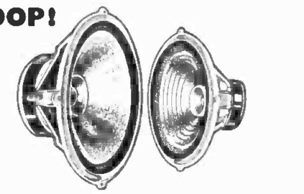

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2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
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FCH191	105p	SN7406	80p	TAD100	150p
FCH201	130p	SN7408	20p	TAD110	150p
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FCJ131	275p	SN7417	84p	UA710C	125p
FCJ141	525p	SN7420	20p	UA716	187p
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FCJ211	275p	SN7427	48p	UA730C	160p
FCK101	430p	SN7428	80p	UA741C	80p
FCL101	280p	SN7430	20p		
FCY101	102p	SN7432	48p		

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		50PIV 4A	40p
		100PIV 4A	50p
		200PIV 4A	55p
		400PIV 4A	65p
		600PIV 4A	70p
600PIV 1A	50p	50PIV 6A	45p
50PIV 2A	45p	100PIV 6A	55p
100PIV 2A	50p	200PIV 6A	65p
200PIV 2A	55p	400PIV 6A	75p
400PIV 2A	60p	600PIV 6A	85p

SILICON RECTIFIERS MINIATURE WIRE ENDED PLASTIC

SERIES	IN 1 AMP	PL 1·5 AMP	CL 3 AMP
4001 50PIV	7p	8p	19p
4002 100PIV	7p	9p	20p
4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
4005 600PIV	10p	12p	26p
4006 800PIV	12p	15p	27p
4007 1000PIV	15p	16p	30p

50+ less 15% 100+ less 20%

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100PIV	—	45p	50p	£1·22
200PIV	25p	50p	55p	£1·42
400PIV	30p	55p	62p	£1·77
600PIV	32p	60p	72p	£2·12
800PIV	35p	75p	87p	£2·47
1000PIV	40p	85p	£1·05	£2·77

50+ less 15% 100+ less 20%

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1S5	30p	30C18	80p	EM87	70p
1T4	25p	30F5	85p	EY51	40p
1U4	30p	30FL1	75p	EY86	40p
1U5	60p	30FL12	120p	EY87	42p
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3Q4	50p	30L15	85p	EZ41	50p
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6AK5	35p	50B5	50p	PC97	45p
6AK6	60p	50C5	50p	PC900	48p
6AL5	20p	80	55p	PCC84	40p
6AM6	30p	85A2	50p	PCC85	40p
6AQ5	38p	807	50p	PCC88	55p
6AS6	40p	1625	50p	PCC89	50p
6AT6	35p	5763	70p	PCC189	55p
6AU6	25p	6146	160p	PCF80	30p
6AV6	30p	AZ31	55p	PCF82	34p
6BA6	25p	CY31	35p	PCF84	60p
6BE6	30p	DAF91	30p	PCF86	60p
6BH6	75p	DAF96	45p	PCF800	80p
6BJ6	50p	DF91	22p	PCF801	50p
6BQ7A	40p	DF96	45p	PCF802	50p
6BR7	90p	DK91	40p	PCF805	80p
6BR8	70p	DK92	55p	PCF806	70p
6BW6	85p	DK96	55p	PCF808	75p
6BW7	80p	DL92	35p	PCL82	35p
6BZ6	40p	DL94	48p	PCL83	65p
6C4	33p	DL96	45p	PCL84	45p
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6F13	45p	EABC80	35p	PL82	45p
6F14	70p	EAF42	35p	PL83	45p
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6F18	50p	EBC41	55p	PL500	75p
6F23	85p	EBC81	30p	PL504	80p
6H6	17p	EBF80	40p	PY32	55p
6J4	50p	EBF83	40p	PY33	63p
6J5	25p	EBF89	32p	PY80	40p
6J5GT	30p	EBL21	60p	PY81	30p
6J6	20p	EC86	60p	PY82	35p
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6L6GT	45p	ECC84	30p	PY800	40p
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6Q7	40p	ECC88	40p	U25	80p
6SA7	40p	ECF80	35p	U26	80p
6SG7	40p	ECF82	35p	U50	40p
6SJ7	40p	ECF86	65p	U52	35p
6SK7	40p	ECH21	57p	U191	75p
6SL7	35p	ECH35	100p	U281	40p
6SN7	35p	ECH42	75p	U282	40p
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6V6G	25p	ECL80	45p	UABC80	40p
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6X4	35p	ECL83	70p	UBC41	50p
6X5G	30p	ECL86	40p	UBC81	40p
6X5GT	40p	EF37A	120p	UBF80	40p
10C2	50p	EF39	50p	UBF89	35p
10F1	75p	EF40	50p	UCC84	49p
10P13	60p	EF41	65p	UCC85	40p
10P14	110p	EF42	70p	UCF80	55p
12AT6	30p	EF80	25p	UCH21	60p
12AT7	30p	EF85	35p	UCH42	70p
12AU7	30p	EF86	30p	UCH81	40p
12AX7	30p	EF89	28p	UCL82	35p
12AV6	40p	EF91	30p	UCL83	60p
12BA6	40p	EF92	35p	UF41	60p
12BE6	40p	EF183	35p	UF80	35p
12BH7	45p	EF184	35p	UF85	40p
19AQ5	35p	EH90	40p	UF89	40p
20D1	50p	EL34	50p	UL41	65p
20F2	65p	EL41	60p	UL84	40p
20L1	110p	EL42	65p	UY41	48p
20P1	50p	EL81	55p	UY85	40p
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AA129	10p	BAY38	15p	OA10	22p
AAZ13	10p	BY100	15p	OA47	8p
AAZ15	10p	BY103	22p	OA70	7p
BA100	15p	BY122	37p	OA73	10p
BA102	30p	BY124	15p	OA79	7p
BA110	25p	BY126	12p	OA81	8p
BA111	27p	BY127	15p	OA85	7p
BA112	70p	BY164	52p	OA90	7p
BA115	7p	BY210	35p	OA91	7p
BA141	32p	BYZ11	30p	OA95	7p
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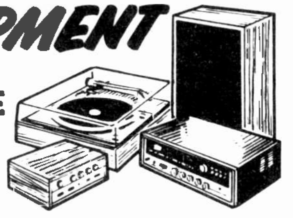

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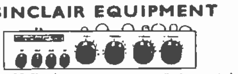
*Also available with silver metal plinth £1 extra.

Carriage 50p any item

SINCLAIR EQUIPMENT



Project 60. Package offers. 2 × Z30 amplifier, stereo 60 pre-amp. PZ5 power supply, **£15·95**. Carr 37½p. Or with PZ6 power supply, **£18·00**. Carr. 37½p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply, **£20·25** Carr. 37½p. Transformer for PZ8, **£2·97** extra. Add to any of the above **£4·45** for active filter unit and **£13·80** for pair of Q16 speakers. Project 60 FM Tuner **£16·95**. Carr. 37½p. New Project 605 **£20·97**. Carr. 37p. All Sinclair products in stock. IC12 **£1·80**. P. & P. 10p. 2,000 amplifier, **£23·50**. Carr. 37½p. 3000 Amplifier, **£30·95**. Carr. 37½p. Neoteric amplifier. **£43·95**. Carr. 37½p.

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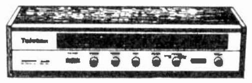
TELETON F.2000 AM/FM STEREO TUNER AMPLIFIER

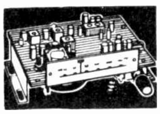


Probably the most popular budget Tuner/Amp. and now offered at a ridiculous low price. 5 watts r.m.s. per channel. Tape/Cer phono inputs. AFC/Built-in MPX. **OUR PRICE £28·25.** Carr. 50p.

SUGGESTED SYSTEM

F.2000, Garrard 2025T/C Changer fitted stereo cartridge, with plinth and cover and pair of G.W.S. Speakers. **OUR PRICE £52·95.** Carr. £1.

★ TRANSISTORISED FM TUNER ★



6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108 MHz. Ready built ready for use. Fantastic value for money. **£6·37½.** P. & P. 12½p. Stereo multiplex adaptors **£4·97½.**

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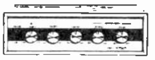
List Price £2·98

OUR PRICE **£1·80** P. & P. 10p.

NS-1,600W STEREO AMPLIFIER



Exceptional budget price amplifier. All silicon transistor. Handsome walnut case. Switched input selector, separate balance, volume, treble, bass controls. Output 2 × 6W R.M.S. Inputs Mag, Tape, Xtal, Tuner, Tape Out. **£14·75.** Carr. 37p.

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Moving coil. Ideal for language teaching, communications. Headphone imp. 16 ohms. Microphone imp. 200 ohms. **£4·62.** P. & P. 15p.

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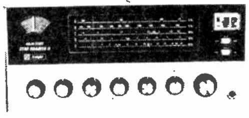

Solid state. Coverage on 5 bands 200-420 KHz and 0·55 to 30 MHz Illuminated slide rule dial. Bandspread. Aerial tuning. BFO. AVC. ANL. 'S' meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V AC or 12V DC. Size 325 × 266 × 150mm. Complete with instructions and circuit. **£28·50.** Carr. 50p.

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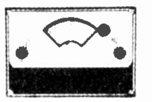
Input 88–125 VAC. Output 120 VAC or 176–250V input output 240 VAC. 200 VA rating. **£11·97.** Carr. 50p.

BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR



Sine 18–200,000Hz: Square 18–50,000Hz. Output max +10dB (10kΩ). Operation internal batteries. Attractive two-tone case 7⅝in × 5in × 2in. Price **£17·50.** Carr. 17½p.

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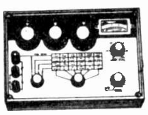

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1%. L.1 μH – 111 HENRYS 6 Ranges −2%. C. 10pF – 1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¼ × 5 × 2in. **£20.** P. & P. 25p.

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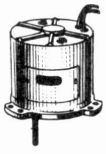

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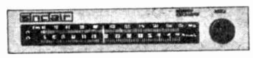
SPECIAL OFFER! SINCLAIR PROJECT STEREO FM TUNER



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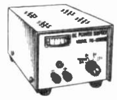

Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240V AC. Size 4in × 3¼in × 6¼in. **£11·97.** P. & 25p.P.

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4 Bands covering 550KHz 30MHz. B.F.O. Built in Speaker 220/240V a.c. Brand new with instructions. **£15·75.** Carr. 37½p.

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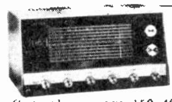

General coverage 150 400KHz, 550KHz-30MHz. FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, S Meter, Bandspread. RF Gain. 15in × 9½in × 8¼in. 18lb. 220/240V a.c. or 12V d.c. Brand new with instructions **£50.** Carr. 50p.

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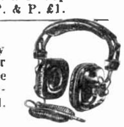

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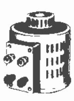

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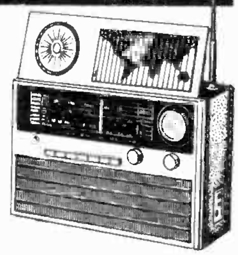

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1	50	3p	100	50	8p
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2	25	2½p	250	10	4p
2·5	50	3p	250	15	6p
4	10	3p	250	25	8p
4	25	3p	400	10	5p
5	25	3p	500	10	5p
6·4	50	3p	500	12	8p
8	15	3p	500	25	10p
8	25	3p	640	10	8p
10	6	3p	1000	3	6p
10	15	3p	1000	6	8p
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16	15	3p	2000	12	10p
16	25	3p	2000	25	15p
20	25	3p	2500	12	10p
25	15	3p	2500	25	30p
25	25	3p			
25	50	4p			
32	25	4p			
32	50	4p			
40	6	3p			
40	15	3p			
50	10	3p			
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60	750	2p
75	750	2p
100	750	2p
120	750	2p
220	750	2p

pF	V	
1000	50	2½p
4700	30	2p
0·01	30	3p
0·01	350	2p
0·022	30	2p
0·047	30	2p
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mF	V	
0·001	400	2p
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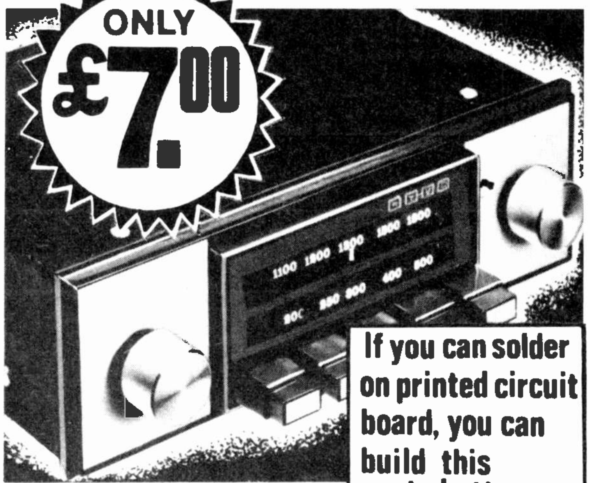

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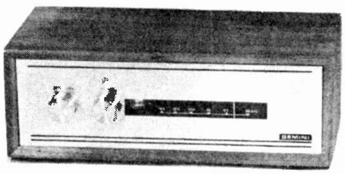

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400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
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U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0·50
U37	30 Sil. alloy trans. SO-2 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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2N3055
115 WATT SIL POWER NPN
50p EACH

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OC22 30p	OC29 40p	AL102 85p	BD132 80p	BD140 85p
OC23 33p	OC35 33p	AL103 85p	BD135 70p	BD155 75p
OC24 45p	OC36 40p	BD121 60p	DB136 80p	BU105 £3
OC25 25p	AD140 40p	BD123 75p	BD137 70p	2N3054 45p
OC26 25p	AD142 40p	BD124 70p	BD138 80p	

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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 2N2926 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 Madt's 2 MAT 100 & 2 MAT 120	0·50
Q19	3 Madt'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. coded	0·50
Q23	10 OA202 sil. diodes sub-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 10A 600PIV sil. rects. IS45R	0·50
Q28	2 Sil. power rects. BYZ13	0·50
Q29	4 Sil. trans. 2 × 2N696, 1 × 2N697, 1 × 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 × 2N1131, 1 × 2N1132	0·50
Q33	3 Sil. NPN trans. 2N1711	0·50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0·50
Q35	3 Sil. PNP TO-5 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7 2N3646 TO-18 plastic 300MHZ NPN	0·50
Q37	3 2N3053 NPN sil. trans.	0·50
Q38	7 PNP trans. 4×2N3703, 3×2N3702	0·50
Q39	7 NPN trans. 4×2N3704, 3×2N3705	0·50
Q40	7 NPN amp. 4×2N3707, 3×3N3708	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×BC108, 3×BC109	0·50
Q45	3 BC113 NPN TO-18 trans.	0·50
Q46	3 BC115 NPN TO-5 trans.	0·50
Q47	6 NPN high gain 3×BC167, 3×BC168	0·50
Q48	4 BCY70 NPN trans. TO-18	0·50
Q49	4 NPN trans. 2×BFY51, 2×BFY52	0·50
Q50	7 BSY28 NPN switch TO-18	0·50
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BP02 = SN7402	0·15	0·14	0·12	BP91 = SN7491AN	0·87	0·84	0·78
BP03 = SN7403	0·15	0·14	0·12	BP92 = SN7492	0·67	0·64	0·58
BP04 = SN7404	0·15	0·14	0·12	BP93 = SN7493	0·67	0·64	0·58
BP05 = SN7405	0·15	0·14	0·12	BP94 = SN7494	0·77	0·74	0·68
BP07 = SN7407	0·18	0·17	0·16	BP95 = SN7495	0·77	0·74	0·68
BP08 = SN7408	0·18	0·17	0·16	BP96 = SN7496	0·77	0·74	0·68
BP09 = SN7409	0·18	0·17	0·16	BP100 = SN74100	1·75	1·65	1·55
BP10 = SN7410	0·15	0·14	0·12	BP104 = SN74104	0·97	0·94	0·88
BP13 = SN7413	0·29	0·26	0·24	BP105 = SN74105	0·97	0·94	0·88
BP16 = SN7416	0·43	0·40	0·38	BP107 = SN74107	0·40	0·38	0·36
BP17 = SN7417	0·43	0·40	0·38	BP110 = SN74110	0·55	0·53	0·50
BP20 = SN7420	0·15	0·14	0·12	BP111 = SN74111	1·25	1·15	1·00
BP30 = SN7430	0·15	0·14	0·12	BP118 = SN74118	1·00	0·95	0·90
BP40 = SN7440	0·15	0·14	0·12	BP119 = SN74119	1·35	1·25	1·10
BP41 = SN7441	0·67	0·64	0·58	BP121 = SN74121	0·67	0·64	0·58
BP42 = SN7442	0·67	0·64	0·58	BP141 SN74141	0·67	0·64	0·58
BP43 = SN7443	1·95	1·85	1·75	BP145 = SN74145	1·50	1·40	1·30
BP44 = SN7444	1·95	1·85	1·75	BP150 = SN74150	1·80	1·70	1·60
BP45 = SN7445	1·95	1·85	1·75	BP151 = SN74151	1·00	0·95	0·90
BP46 = SN7446	0·97	0·94	0·88	BP153 = SN74153	1·20	1·10	0·95
BP47 = SN7447	0·97	0·94	0·88	BP154 = SN74154	1·80	1·70	1·60
BP48 = SN7448	0·97	0·94	0·88	BP155 = SN74155	1·40	1·30	1·20
BP50 = SN7450	0·15	0·14	0·12	BP156 = SN74156	1·40	1·30	1·20
BP51 = SN7451	0·15	0·14	0·12	BP160 = SN74160	1·80	1·70	1·60
BP53 = SN7453	0·15	0·14	0·12	BP161 = SN74161	1·80	1·70	1·60
BP54 = SN7454	0·15	0·14	0·12	BP164 = SN74164	2·00	1·90	1·80
BP60 = SN7460	0·15	0·14*	0·12	BP165 = SN74165	2·00	1·90	1·80
BP70 = SN7470	0·29	0·26	0·24	BP181 = SN74181	2·75	2·60	2·40
BP72 = SN7472	0·29	0·26	0·24	BP182 = SN74182	0·97	0·94	0·88
BP73 = SN7473	0·37	0·35	0·32	BP190 = SN74190	3·50	3·25	3·00
BP74 = SN7474	0·37	0·35	0·32	BP191 = SN74191	3·50	3·25	3·00
BP75 = SN7475	0·47	0·45	0·42	BP192 = SN74192	2·10	1·95	1·75
BP76 = SN7476	0·43	0·40	0·38	BP193 = SN74193	2·10	1·95	1·75
BP80 = SN7480	0·67	0·64	0·58	BP125 = SN74195	1·10	1·05	0·95
BP81 = SN7481	0·97	0·94	0·88	BP196 = SN74196	1·80	1·70	1·60
				BP197 = SN74197	1·80	1·70	1·60
BP82 = SN7482	0·97	0·94	0·88	BP198 = SN74198	5·50	5·00	4·00
BP83 = SN7483	1·10	1·05	0·95	BP199 = SN74199	5·50	5·00	4·00

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Type No.	Price 1–24	25–99	100 up
BP 201C—SL201C	63p	53p	45p
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BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	53p	45p	40p
BP 709P—μA709C	53p	45p	40p
BP 710—72710	53p	45p	40p
BP 711 μA711	58p	50p	45p
BP 741—72741	75p	60p	50p
μA 703C—μA703C	43p	35p	27p
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BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity. price. Larger quantity prices on application. (DTL 930 Series, only.)

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F
Anode voltage (Vdc)	170 min	175 min	5 min
Cathode current (mA)	2·3	14	8
Numeral 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

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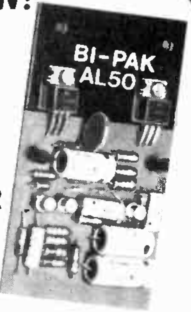

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Pak No.			Pak No.		
UIC930	= 12 × μA 930	50p	UIC948	= 8 × μA 948	50p
UIC932	= 12 × μA 932	50p	UIC951	= 5 × μA 951	50p
UIC933	= 12 × μA 933	50p	UIC961	= 12 × μA 961	50p
UIC935	= 12 × μA 935	50p	UIC9093	= 5 × μA 9093	50p
UIC936	= 12 × μA 936	50p	UIC9094	= 5 × μA 9094	50p
UIC944	= 12 × μA 944	50p	UIC9097	= 5 × μA 9097	50p
UIC945	= 8 × μA 945	50p	UIC9099	= 5 × μA 9099	50p
UIC946	= 12 × μA 946	50p	UICX9	25 Assorted 930 Series	£1·50

Paks cannot be split but 25 Assorted Pieces (our mix) is available as PAK UICX9. Data Booklet available for the BP930 Series, PRICE 13p.

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UIC02	= 12 × 7402N	50p	UIC48	= 5 × 7448N	50p	UIC83	= 5 × 7483N	50p
UIC03	= 12 × 7303N	50p	UIC50	= 12 × 7450N	50p	UIC86	= 5 × 7486N	50p
UIC04	= 12 × 7404N	50p	UIC51	= 12 × 7451N	50p	UIC90	= 5 × 7490N	50p
UIC05	= 12 × 7405N	50p	UIC53	= 12 × 7453N	50p	UIC91	= 5 × 7491N	50p
UIC10	= 12 × 7410N	50p	UIC54	= 12 × 7454N	50p	UIC92	= 5 × 7492N	50p
UIC13	= 8 × 7413N	50p	UIC60	= 12 × 7460N	50p	UIC93	= 5 × 7493N	50p
UIC20	= 12 × 7420N	50p	UIC70	= 8 × 7470N	50p	UIC94	= 5 × 7494N	50p
UIC40	= 12 × 7440N	50p	UIC72	= 8 × 7472N	50p	UIC95	= 5 × 7495N	50p
UIC41	= 5 × 7441AN	50p	UIC73	= 8 × 7473N	50p	UIC96	= 5 × 7496N	50p
UIC42	= 5 × 7442N	50p	UIC74	= 8 × 7474N	50p	UIC121	= 5 × 74121N	50p
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VOL. 8 No. 8
August 1972

PRACTICAL ELECTRONICS

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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

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

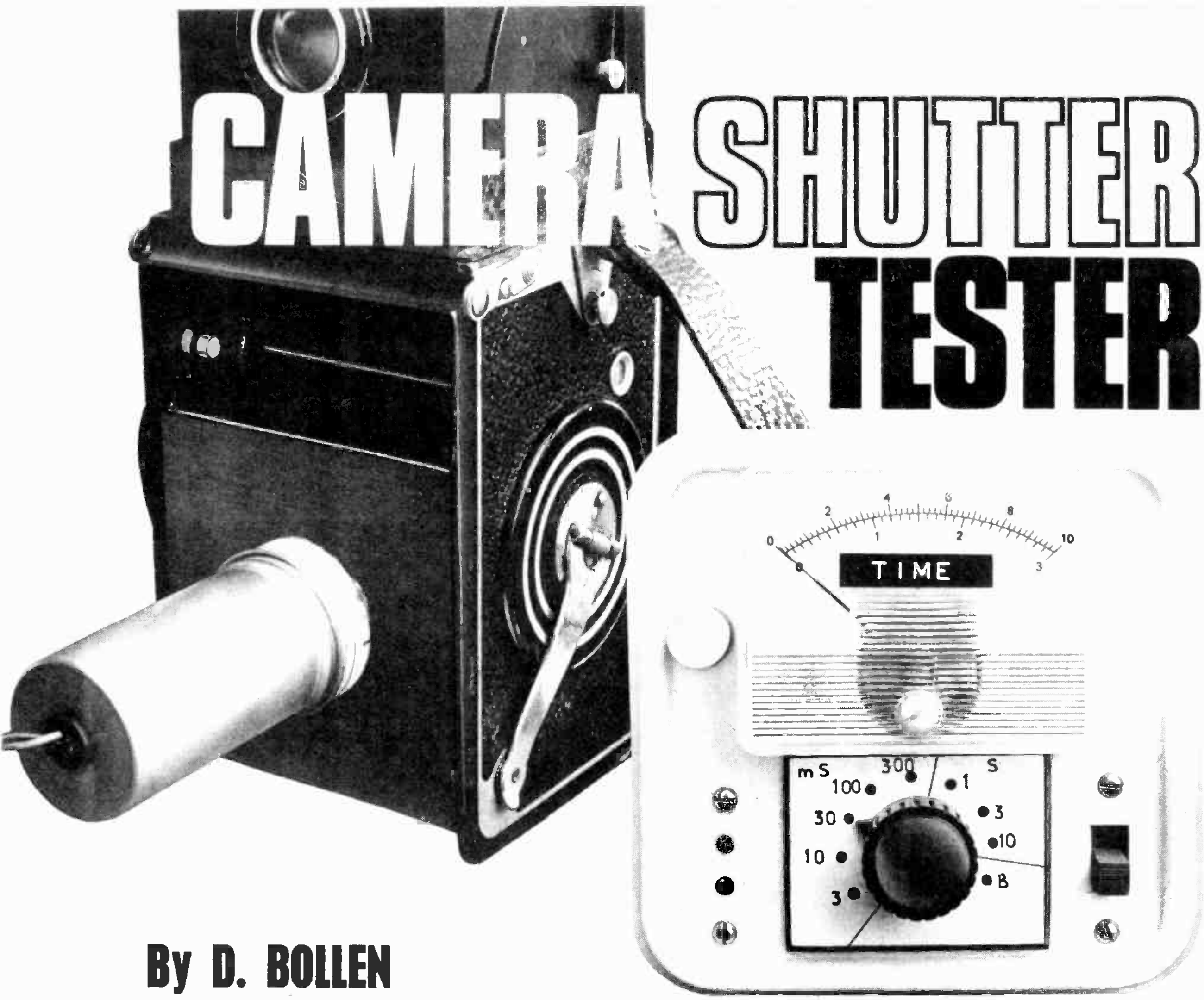
GENERAL FEATURES

NEWS AND COMMENT

Our September issue will be published on Friday, August 11

Practical Electronics, Fleetway House, Farringdon St., London, E.C.4. Phone: *Editorial* 01-634 4452; *Advertisements* 01-634 4202

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 rage 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.

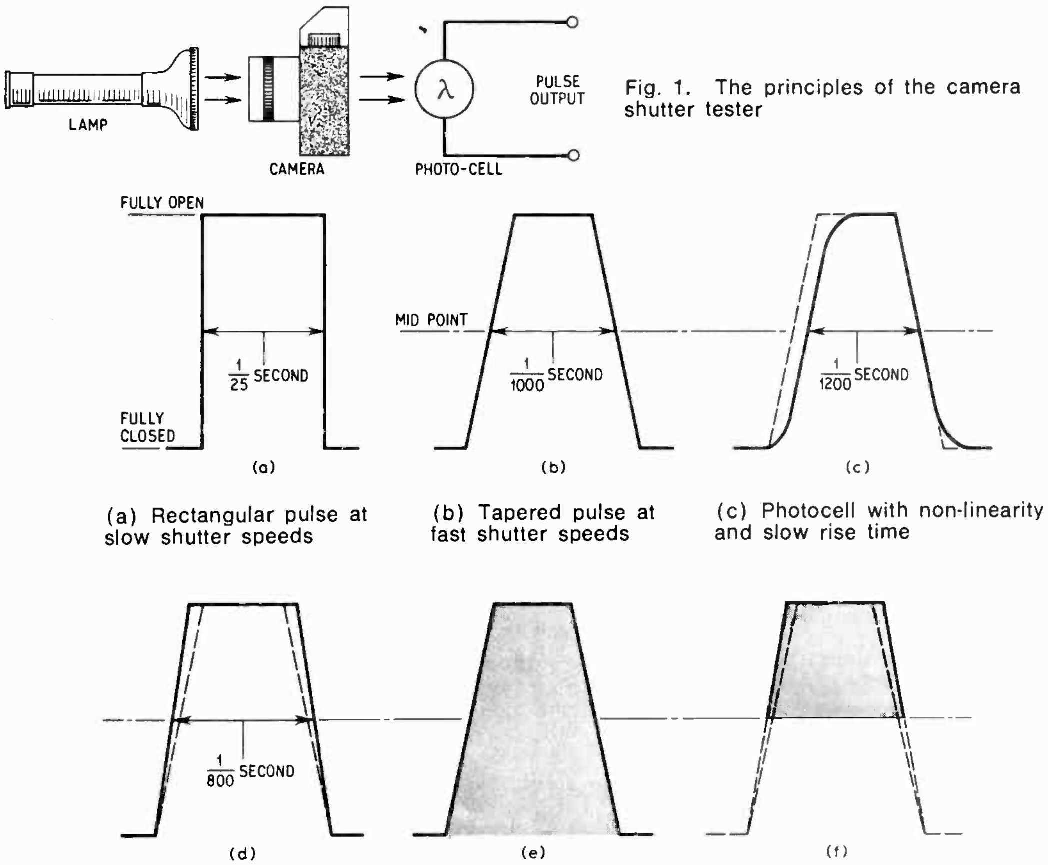


Fig. 1. The principles of the camera shutter tester

(a) Rectangular pulse at slow shutter speeds

(b) Tapered pulse at fast shutter speeds

(c) Photocell with non-linearity and slow rise time

(d) Photocell saturated with light

(e) Film responds to area of pulse

(f) Shutter tester measures area above mid-point with photo cell saturated

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 threfore 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

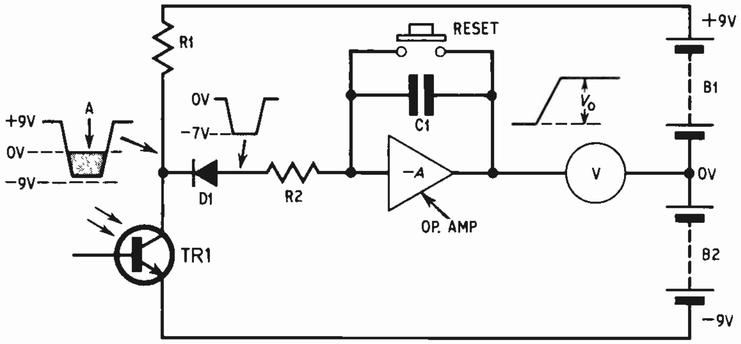


Fig. 2. Basic circuit principles of the tester

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, 10μF 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.

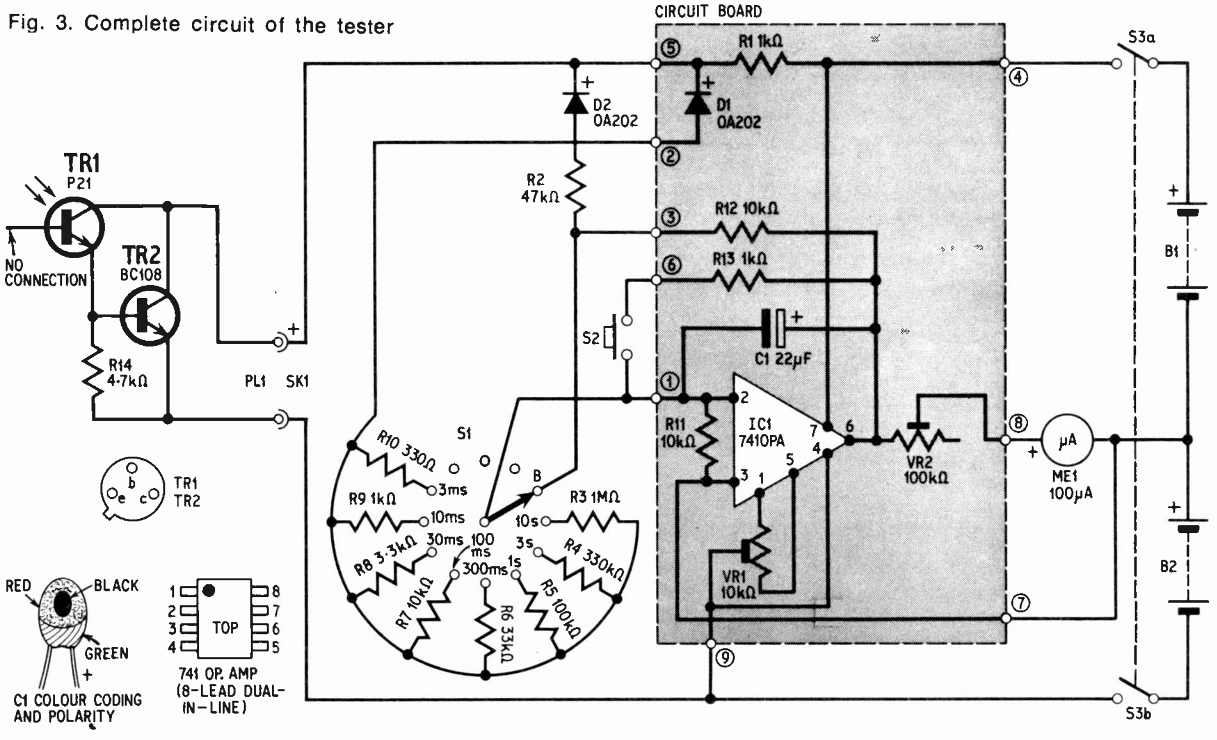
TIMING CIRCUIT

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



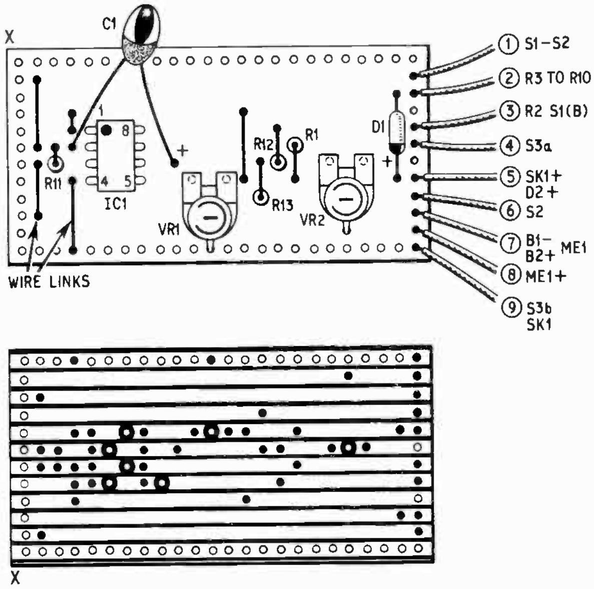
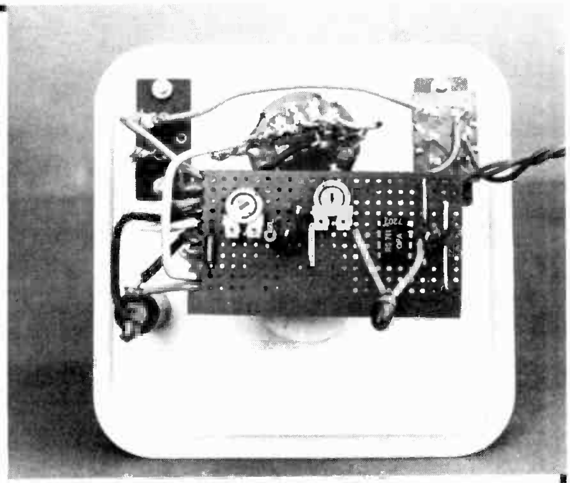


Fig. 4. The components assembled on 0·1in matrix board with the copper strip side shown below



Rear view of front panel with circuit board mounted

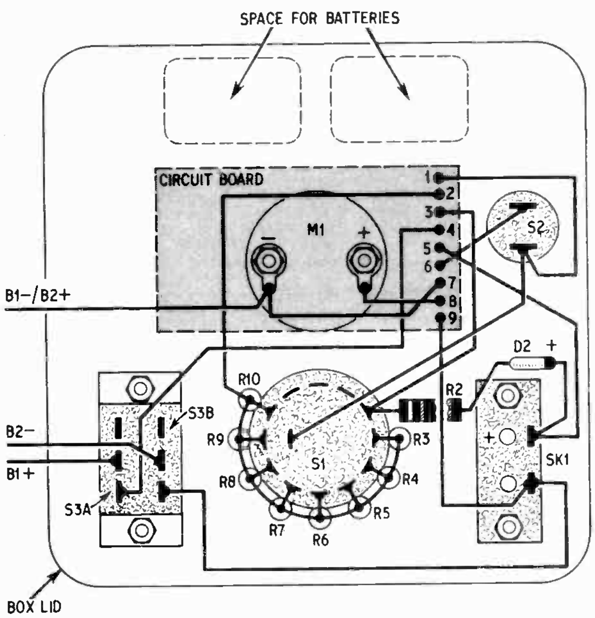


Fig. 5. The component assembly board (dotted) mounted in the box with the other controls and components

COMPONENTS . . .

Resistors

*R1	1kΩ	R8	3·3kΩ
*R2	47kΩ	R9	1kΩ
R3	1MΩ	R10	330Ω
R4	330kΩ	*R11	10kΩ
R5	100kΩ	*R12	10kΩ
R6	33kΩ	*R13	1kΩ
R7	10kΩ	*R14	4·7kΩ

All metal oxide types ±2%, ½W except where asterisk shown for carbon ±10%, ¼W

Potentiometers
VR1 10kΩ min skeleton preset
VR2 100kΩ min skeleton preset

Capacitor
C1 22μF 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 100μA 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 × 1·2in, 0·1in matrix
Screw top container with extra tops
Metal or plastics box 4in × 4in × 3in
Single core insulated wire
Knob with pointer

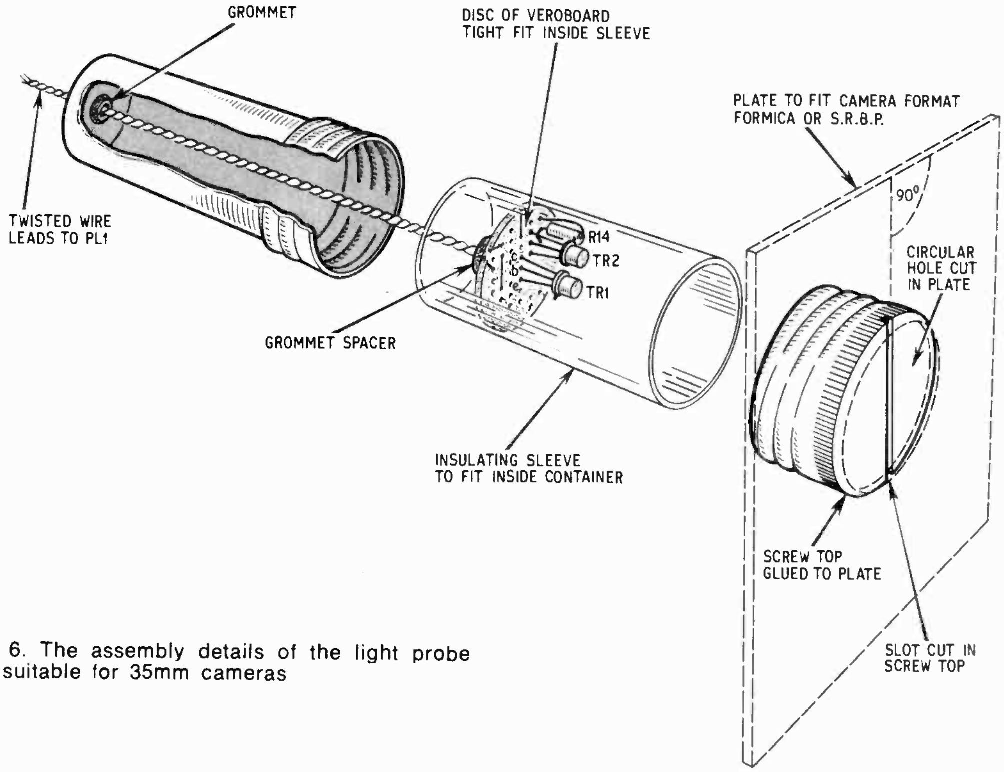


Fig. 6. The assembly details of the light probe are suitable for 35mm cameras

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.

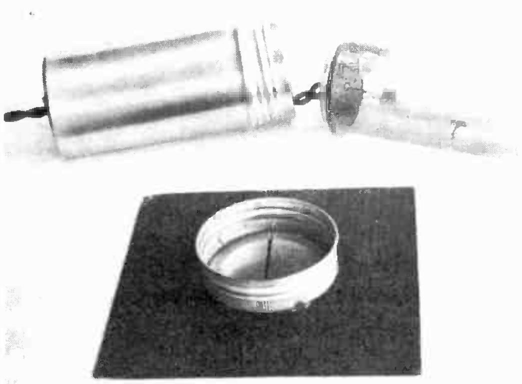
The light probe has to be a snug and accurate fit, as close to the film plane as possible, on the back of cameras of widely differing formats; this was achieved with the prototype by housing light probe components in a cylindrical container such as a 35mm film can provided with several screw tops, see 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.

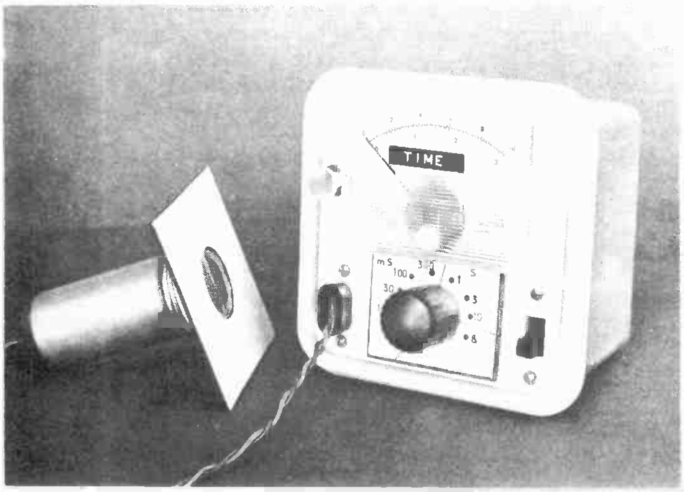
With S1 at "B," switch on the shutter tester and place a lighted torch on the table at about the same height as the camera lens. Move the torch around until the tester meter reads.

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. ★



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.

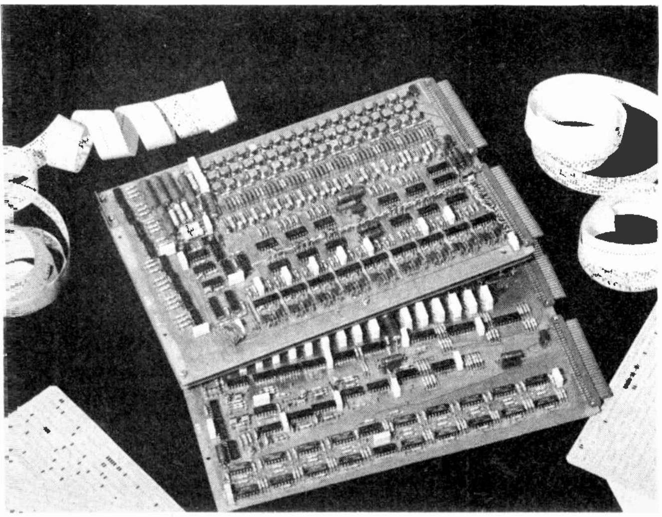
Another increasing trend is towards private shows mounted by individual companies in hotel suites simultaneous with a large exhibition elsewhere. One can look upon this as a snub to big exhibition organisers such as Industrial Exhibition Ltd. (the organisers of I.E.A. among many others), but the hard 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 aforemention 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 profusion, 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 FI-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

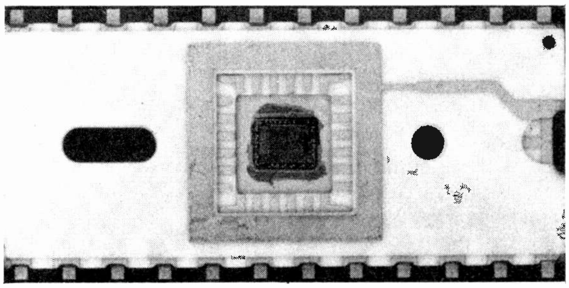
A new series of integrated circuits has been produced which is like a very fast operating relay. These devices depend on the proximity of an external magnet whose flux path is through a Hall Effect cell. The high speed switching effect operates an internal Schmitt trigger at up to 100kHz. This breakthrough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

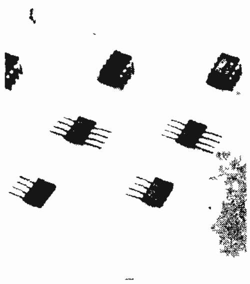
Whilst on the subject of DIL style packaging, reed relays are made in this form now, but a new line by B & R relays, known as the "G" range, follows 14-pin DIL connection dimensions although only two pins at each end are provided.

It is worth mentioning the very small pulse transformers Type 66Z by Sprague that attempt to follow similar lines and are only about $\frac{5}{8}$ inch square by $\frac{3}{8}$ 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.

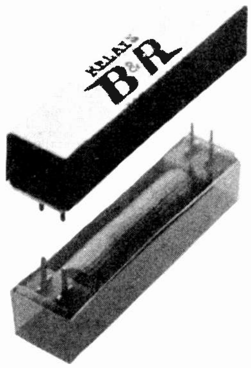
These are just a few areas where standardised component packages go a long way to simplify equipment design and cut manufacturing costs. We are bound to see further developments before the Components Show next May.



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

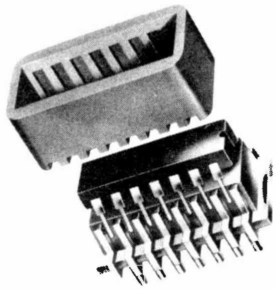


Magnetically operated Hall effect relay by Sprague



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.

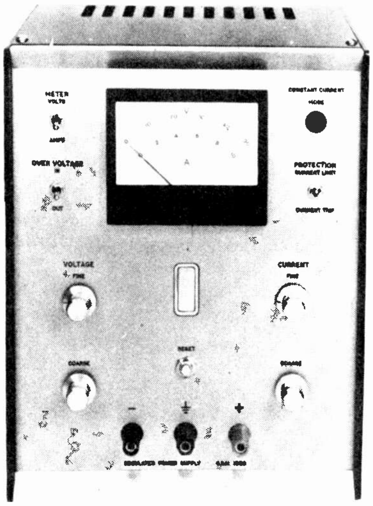
BRITISH 'SCOPE TO CHALLENGE U.S.

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 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.

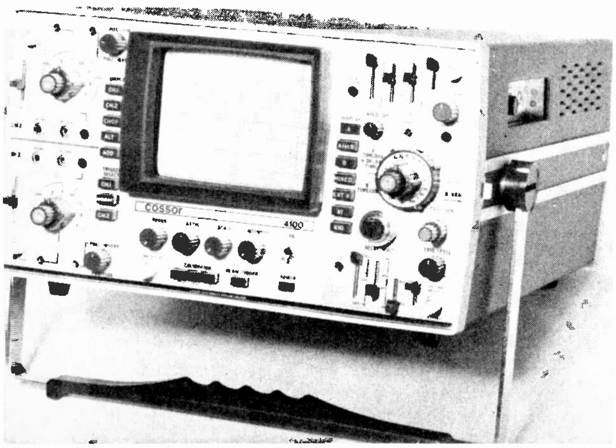
Take, for example, the Wayne-Kerr automatic circuit tester shown in the photograph.

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.

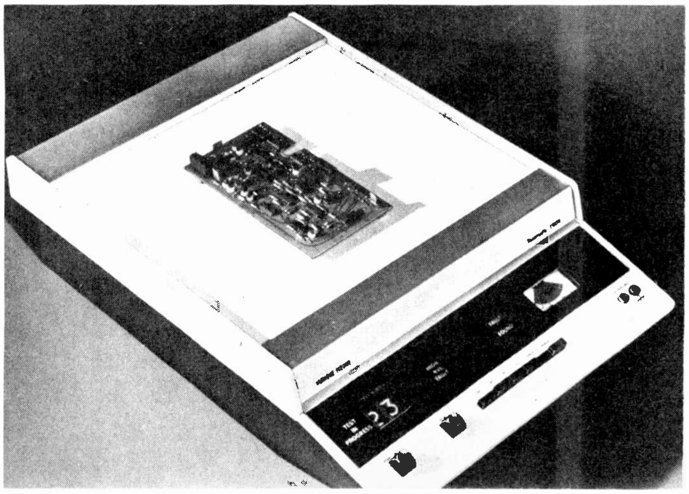
Although the instrument is designed to be used at the end of a production line, the case is of an extremely pleasing design. Controls are kept to the absolute minimum for ease of operation by unskilled staff, all being brought to the neat, uncluttered control panel at the front of the instrument.

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 out of the works.

The new Model 4100 oscilloscope from Cossor



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 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.

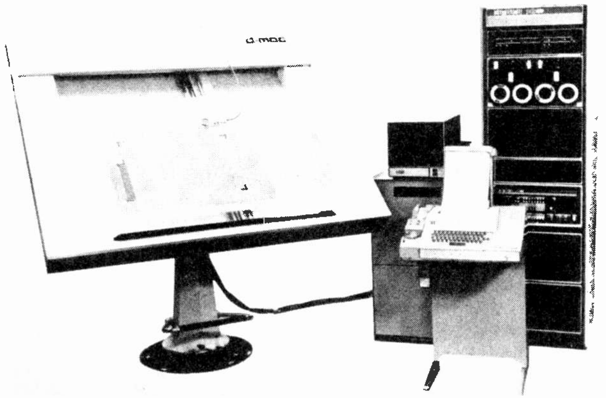
The firm which developed the system, Computer Electronics Ltd., recognise that they will have a hard fight to get their product accepted since so many of the large computer firms have vested interests in mechanical data handling systems but they feel that users will see the great advantages of this low-cost, 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 CADMAC interactive graphics system showing drawing table with integral plotter, computer, teletype and display terminal



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.

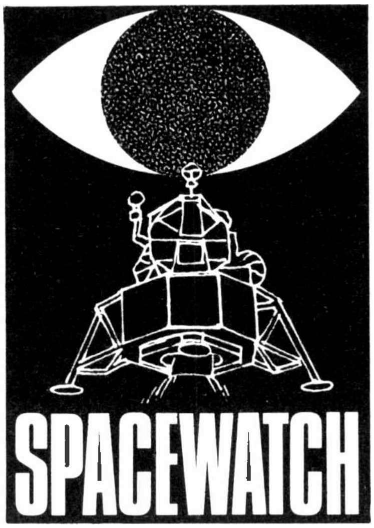
There are four such stations on the moon; one at the Ocean of Storms set up by the *Apollo 12* mission; the next in the Fra Mauro area by the crew of *Apollo 14*; a third at the Hadley Rille by *Apollo 15*; and the fourth at the Descartes site by *Apollo 16* on April 21. The Hadley Rille site is the 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.



BY FRANK W. HYDE

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 III* 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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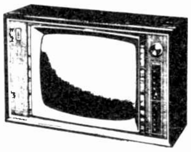

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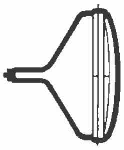

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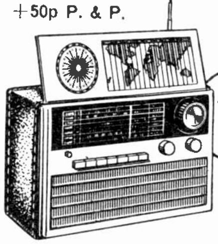

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Strictly

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 multitrack 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 suboctaves 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 Violectra 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.

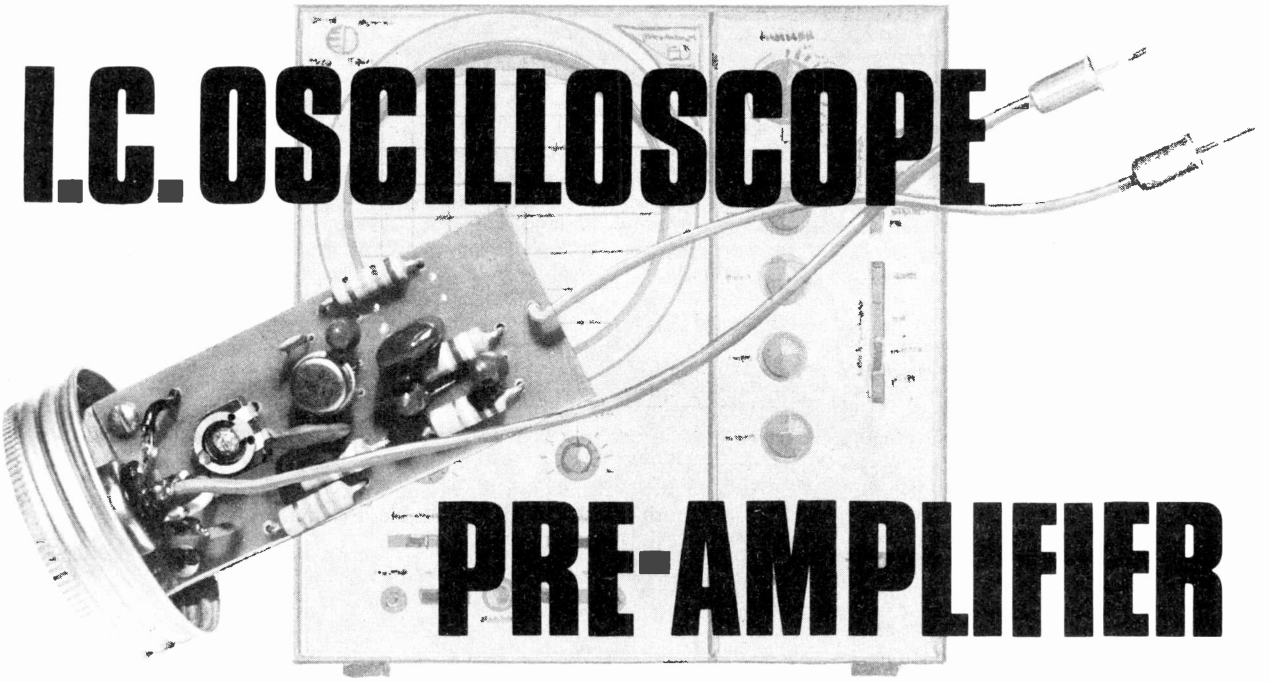
According to the model, each manual may have between eight and eleven drawbars for harmonic mixing: in turn, each drawbar has eight settings, so that the permutations are almost unlimited.

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.

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 μA702C, 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 μA702C, 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

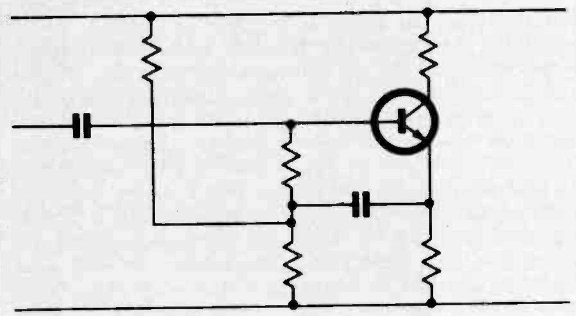


Fig. 1. Basic arrangement of a bootstrapped input transistor amplifier

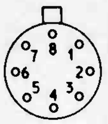


Fig. 3. Wire connections of the μA702C integrated circuit (TO-5 can) looking at the wire ends

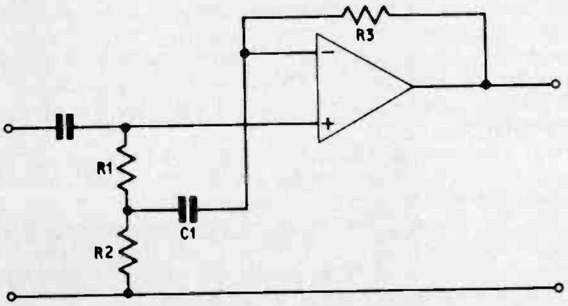


Fig. 2. The bootstrap principle applied to a differential amplifier

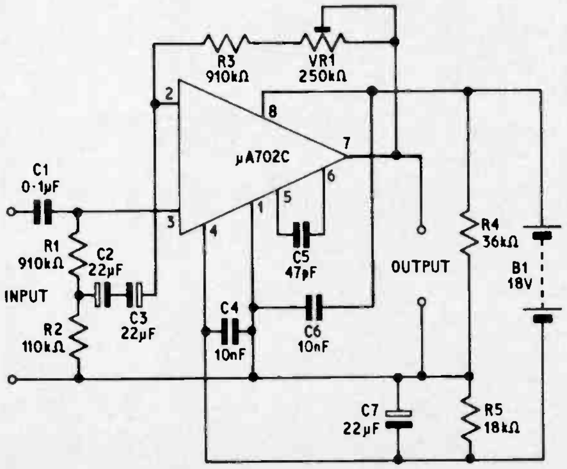


Fig. 4. The oscilloscope pre-amplifier circuit in full

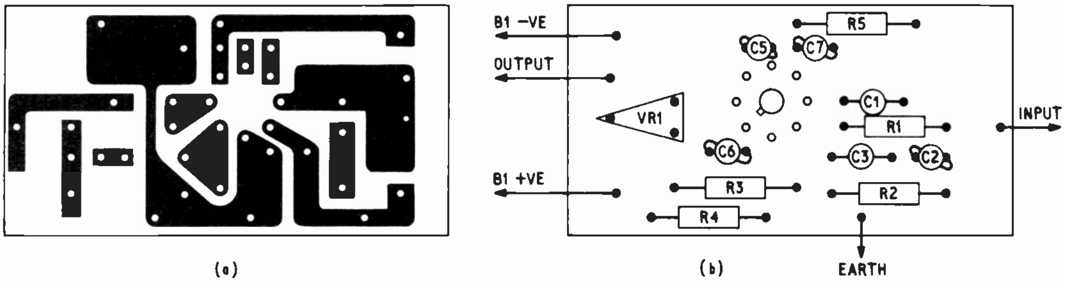
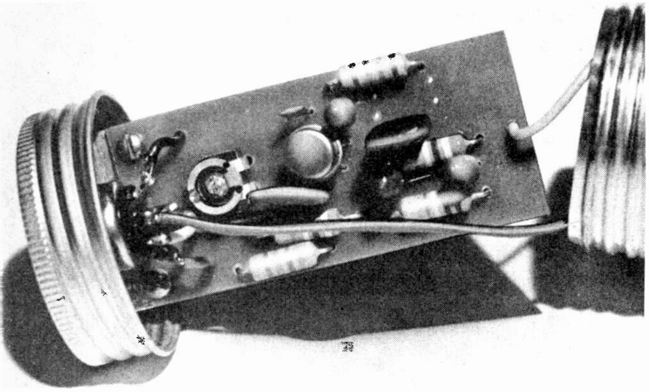


Fig. 5. Suggested printed circuit layout. Capacitor C4 is not shown. It is best mounted on the copper side of the board and connected to the pads as close to pin 1 and 4 of the i.c. as possible



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 C_4 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 0·1μF 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%, ⅛ 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 2⅜in × 1¼in
Power supply or battery B1 18V

INDUSTRY NOTEBOOK

By Nexus

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 readout 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.

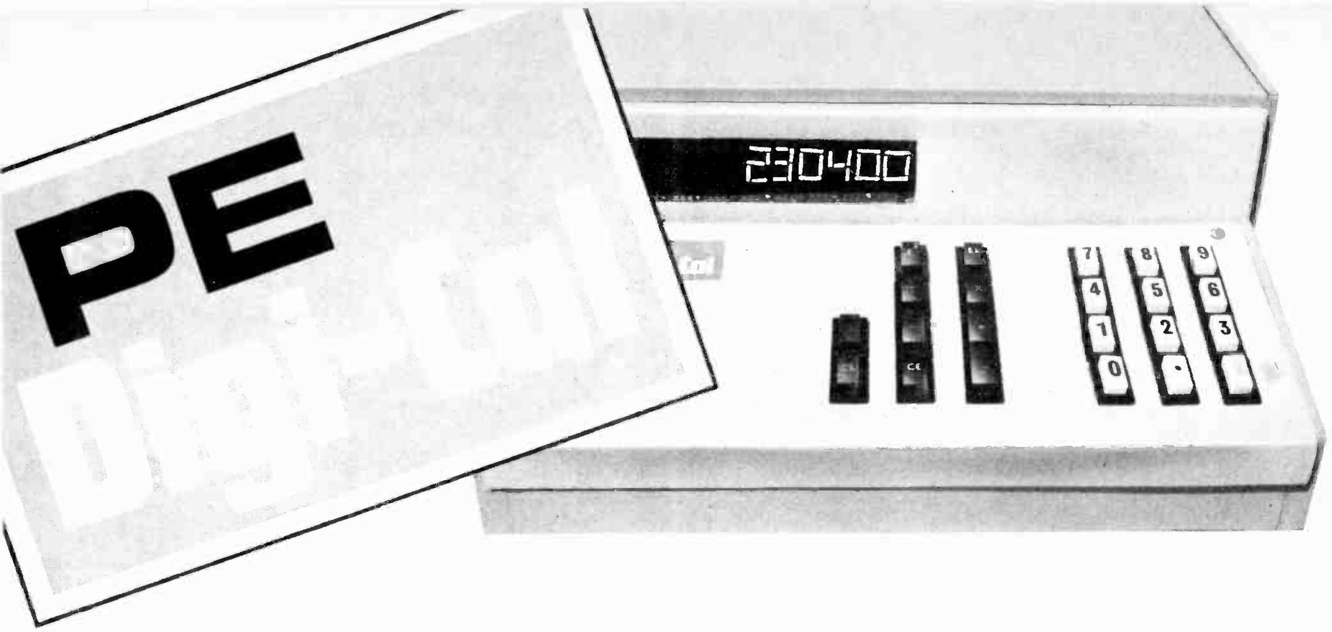
POST OFFICE PROMOTES DATA LINKS ON FILM

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, Electrovalue, 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
SN7400	11
SN7401	23
SN7402	1
SN7404	2
SN7405	6
SN7408	1
SN7410	7
SN7413	1
SN7420	1
SN7440	8
SN7442	3
SN7445	1
SN7446	1
SN7450	4
SN7474	21
SN7475	6
SN7483	3
SN7486	8
SN7490	12
SN7493	1
SN7494	8
SN7496	8
SN74119	1
SN74121	2
SN74151	1
SN74154	2
SN74191	1

Resistors	Quantity
47Ω	15
560Ω	3
1·2kΩ	25
3·9kΩ	1
5·6kΩ	26
15kΩ	1
180kΩ	1
Capacitors	
0·001μF	4
0·01μF	1
0·047μF	21
0·1μF	7
10μF 15V elect.	17
22μF 15V elect.	2
150μF 15V elect.	1
Transistors	
E5200	9
E5201	10
Diodes	
General purpose silicon (West Hyde type "red")	145

Plug-in Logic Cards	
Shirehall Dualine:	
DL109/22	5
DL109/44	7
DL107/44 (optional)	1
Edge Connectors	
Shirehall DPK165	12
DL131 card guides	3 packets
Seven Segment Indicators	
Minitron 3015F	8
Key Switches	
Bulgin type MP22 white	12
black	9
Lampholder	
Bulgin type D22	
Thumbwheel Switch	
Birch-Stolec type EB10N 1248 + a pair of end plates	1

- ENTRIES UP TO SIX DIGITS WITH FLOATING DECIMAL POINT CAN BE MADE, ANSWERS ARE PRODUCED UP TO EIGHT DIGITS LONG WITH THE DECIMAL POINT IN ONE OF FOUR PRESELECTED POSITIONS
- ENTRIES AND ANSWERS ARE DISPLAYED ON EIGHT SEVEN-SEGMENT INDICATORS WITH AN ADVANCED LEADING-EDGE ZERO-SUPPRESSION SYSTEM
- SIMPLE TO USE, PROBLEMS CAN BE ENTERED AS THEY WOULD BE WRITTEN DOWN
- EMPLOYS READILY AVAILABLE TTL INTEGRATED CIRCUITS THROUGHOUT

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 Shirehall 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 ¾in 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.

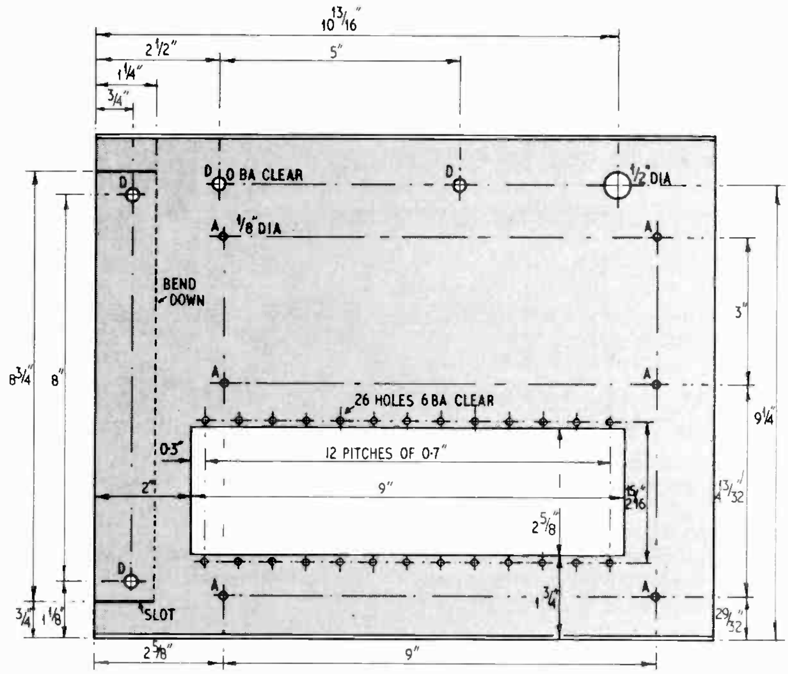


Fig. 2.1. Cutting and drilling details for the main chassis plate. The front is bent down about half an inch to bring the display panel (to be described in Part 3) in line with the front panel

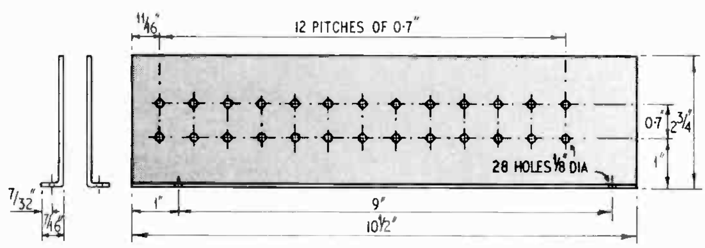


Fig. 2.2. These two plates support the plastic card guides

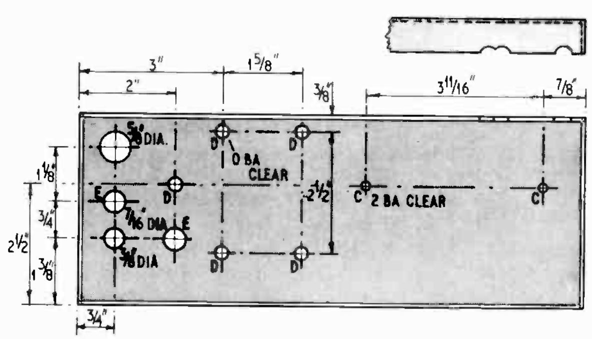


Fig. 2.3. The rear grey panel drilling details viewed from the flange side. Note the semicircular cutouts in the upper flange to allow access to the potentiometers on the power supply board

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

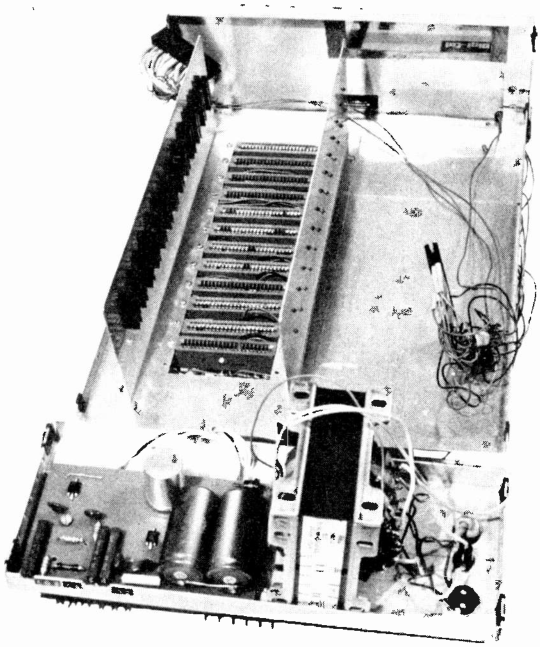
The sloping keyboard attached to the front of Digi-Cal is made from $\frac{3}{8}$in plywood and an extra "Contil" type "0" front panel. The cutting and drilling details for the keyboard are shown in the diagrams (Figs. 2.5 and 2.6) and thanks to the simple fixing method used by the 22 push keys, this 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.



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

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 × 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".

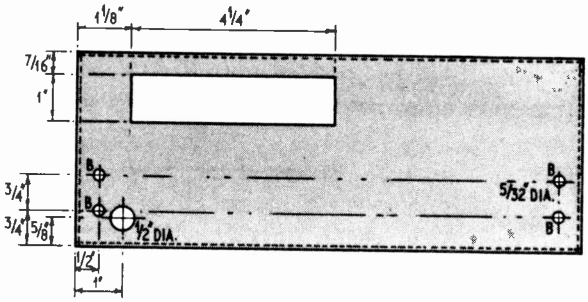


Fig. 2.4. The front grey panel cutting details as seen from the front

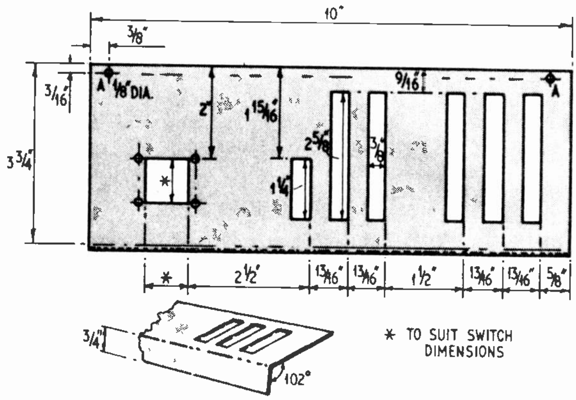
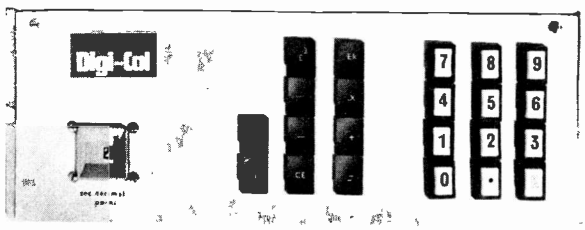


Fig. 2.5. The cutting and drilling details of the keyboard panel which is made from an extra front panel. All flanges should be sawn off except one long edge which is bent as shown in the smaller diagram



The finished keyboard

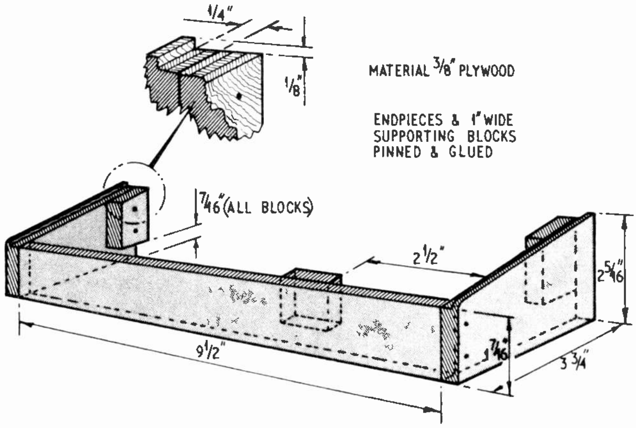


Fig. 2.6. The keyboard supports are constructed from $\frac{3}{8}$in plywood cut as shown

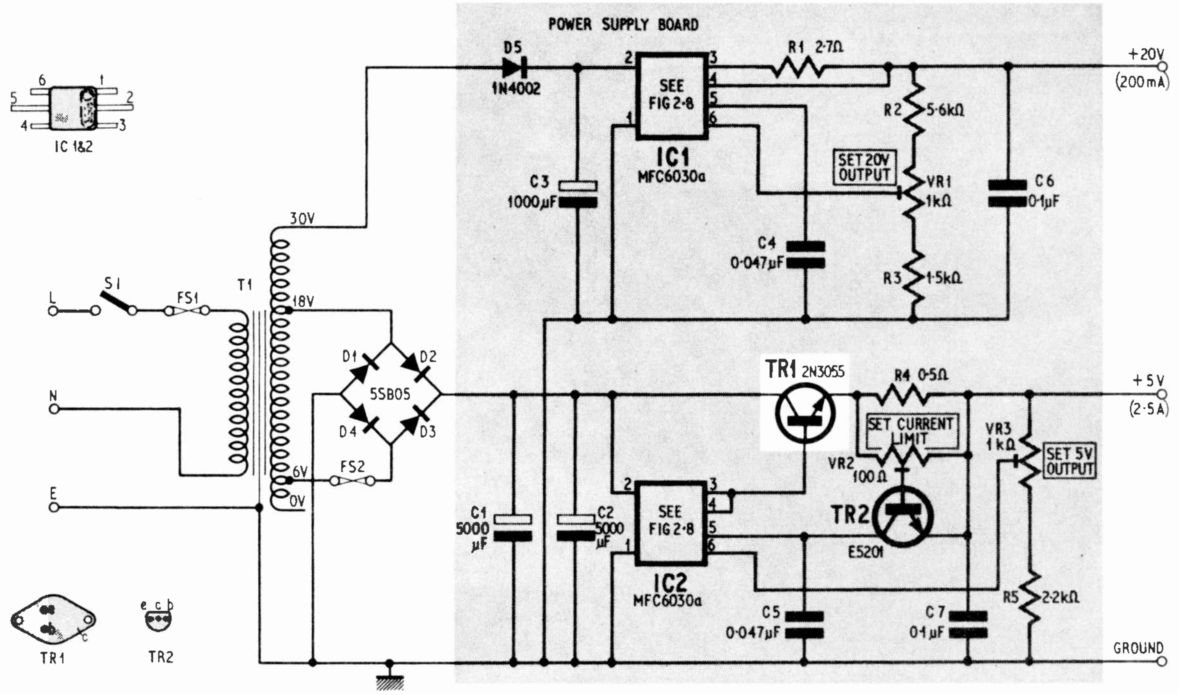


Fig. 2.7. Circuit diagram of the power supply. The internal circuit of the integrated circuits is shown in Fig. 2.8

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-sinked 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

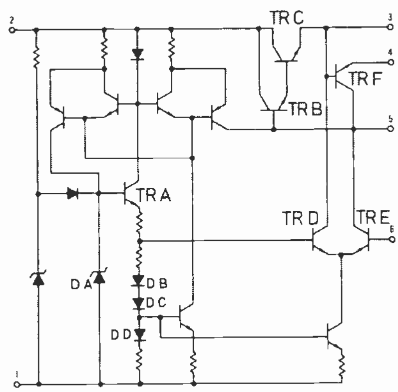
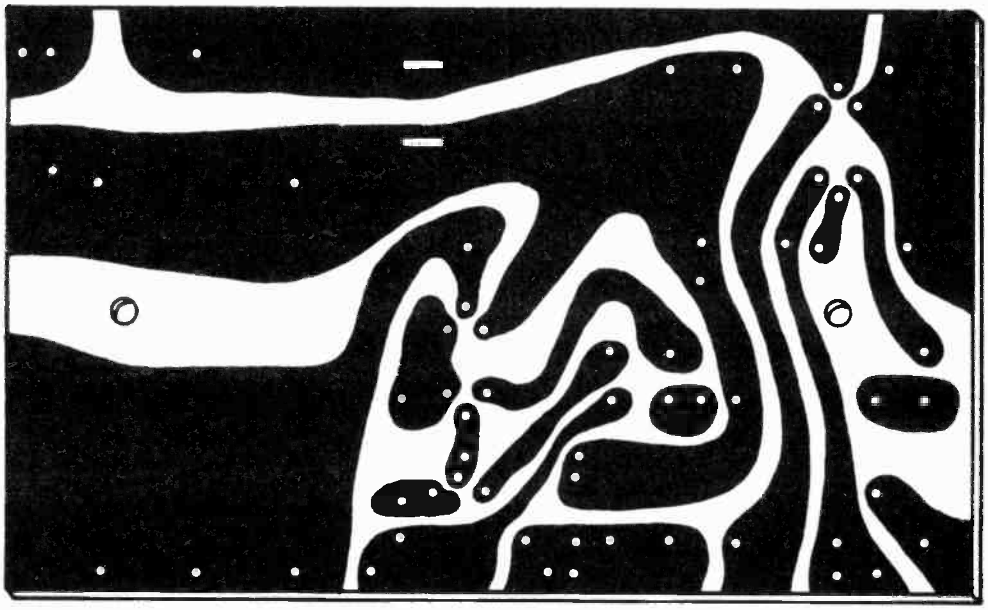


Fig. 2.8. The internal circuit diagram of the Motorola MFC6030a regulator i.c.



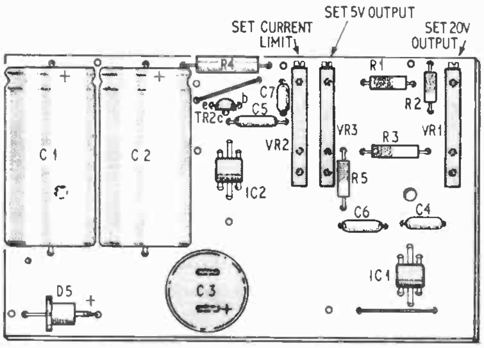
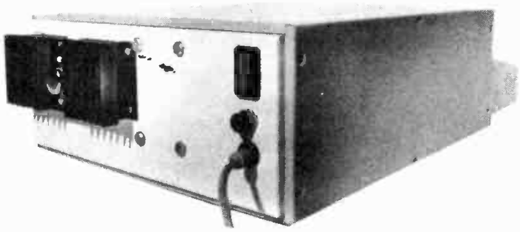


Fig. 2.9. Component layout and wiring of the board. The printed circuit pattern is shown full size above



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

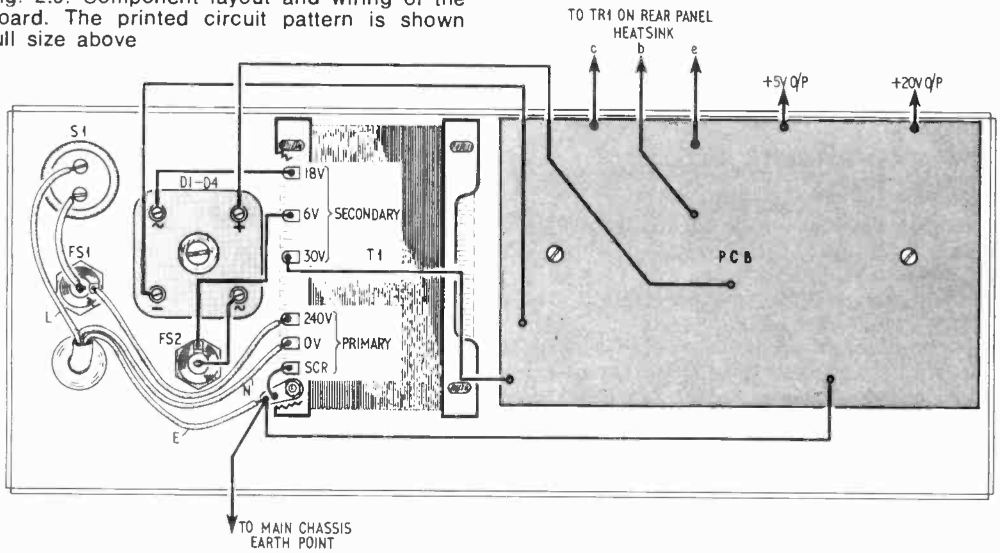


Fig. 2.10. Interwiring diagram of the complete power supply unit

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.

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), ¾in plywood for the keyboard support

POWER SUPPLY MODULE

Resistors

R1	2·7Ω	R4	0·5Ω 3W
R2	5·6kΩ	R5	2·2kΩ
R3	1·5kΩ		

All ±10%, ½W carbon unless otherwise stated

Potentiometers

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

Capacitors

C1, C2 5,000μF 15V elect. (see text) (2 off)
C3 1,000μF 25V elect.
C4, C5 0·047μF (2 off)
C6, C7 0·1μF (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 (Marex type 10DN0200A300 or similar)
5in × 3in copper clad laminate

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 5,000μF 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 6,500μF 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

ELECTRONORAMA

TRANSISTORS FOR COMMUNICATIONS

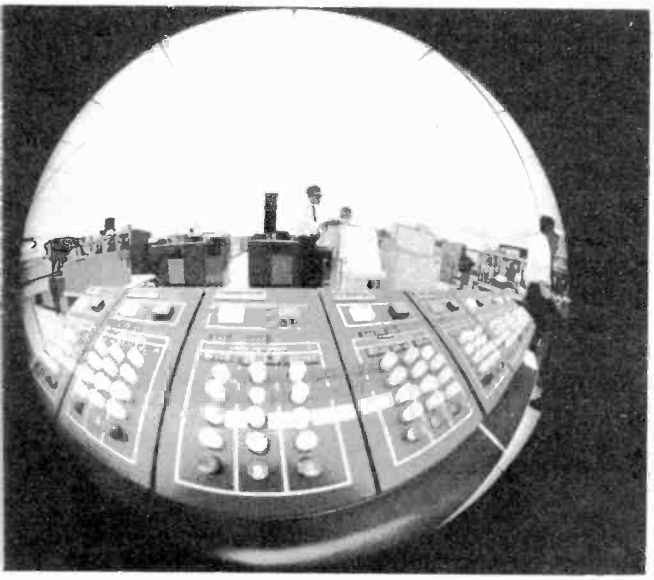
THE Post Office Research Department receives the award for the development and production of high performance silicon planar transistors for use in undersea communications cables.

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 will 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 air-line offices in 66 different countries.

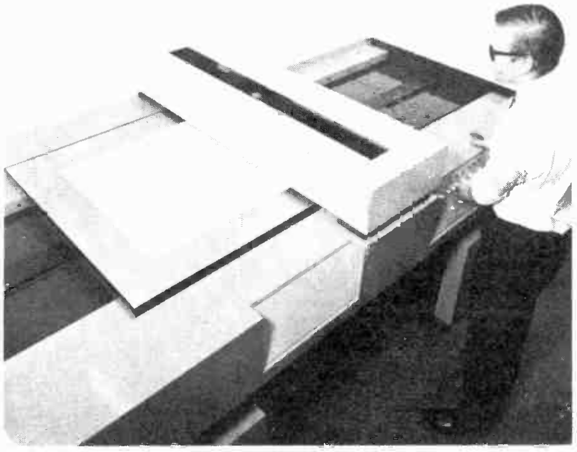
The use of TV screen terminals operating in a conversational mode, direct computer to computer links, and the use of widely varying data transmission techniques necessitated by a worldwide coverage, were all in their infancy when the system was first conceived.

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.

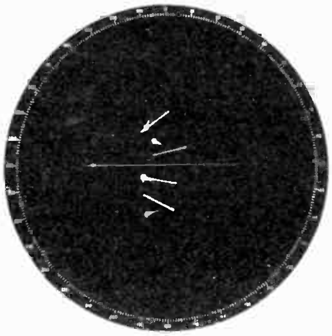
The main advantage to the travelling public is the reservations system which uses cathode ray tube readout and solid state keyboards for operator's use. Reservation staff in the UK, Europe and North America have, at their fingertips, instant reservation information on all flights. Seat availability on 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



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

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

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.

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.

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.

PRESENTING THE PE ELECTRONIC PIANO

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

STAR FEATURES INCLUDE

- ★ PORTABILITY
- ★ 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

ALPHA NUMERIC DISPLAYS

Part 6

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.

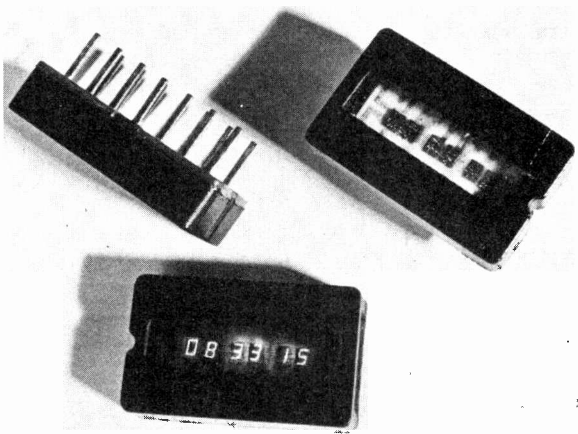
TIME-SHARING SYSTEMS

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)

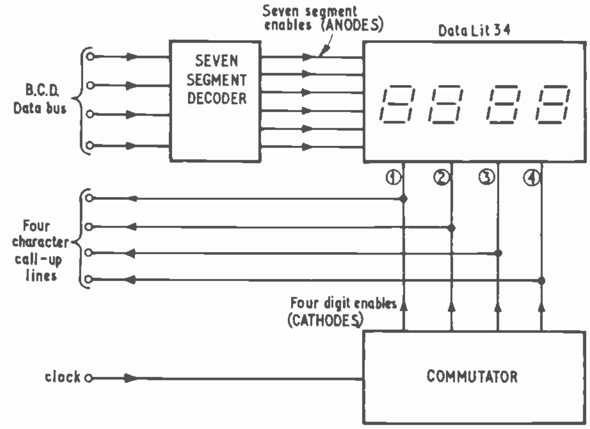


Fig. 6.1. Block diagram of display system using a single multi-digit L.E.D. package

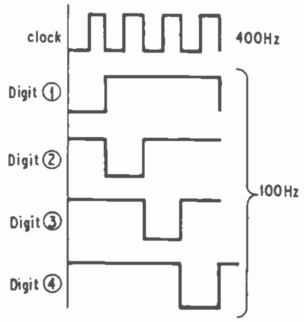


Fig. 6.2. Waveforms produced by the commutator in Fig. 6.1

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.

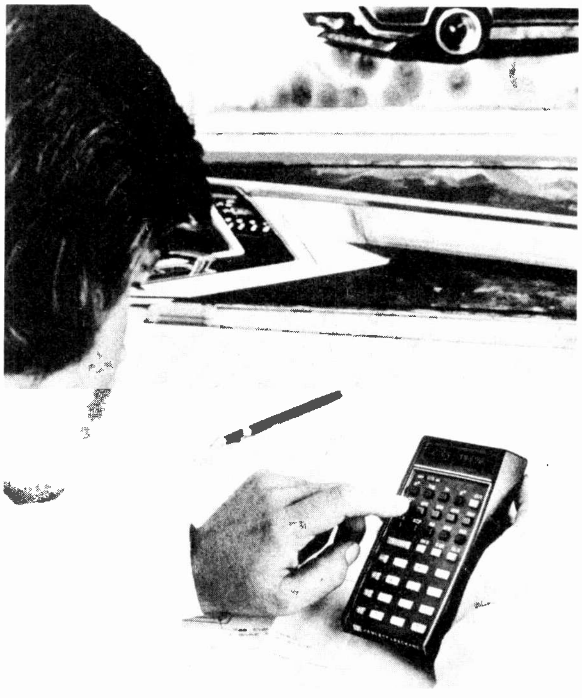
After its display period (of 2·5ms) the first digit strobe disappears and the next digit in the sequence is enabled, new data being presented to the decoder at the same time.

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.

Thus it turns out that the average current required by the $\frac{1}{8}$in digits used in multi-digit displays is only about 3mA per segment for operation in a time-shared system, whereas rather higher currents are required for static operation at the same apparent intensity. For the four-digit display, assuming an average current of 3mA, the required drive current (for each segment) is four times 3mA during the "on" period.



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.

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.

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 $\frac{1}{8}$in digits, each with a right-hand decimal point, and is encased in a red-epoxy package with outside dimensions of 0·74in × 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/

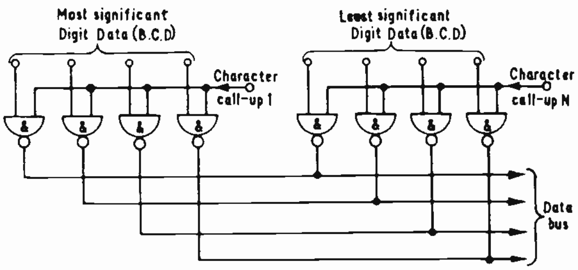


Fig. 6.3. The simplest "data-bus" system using groups of four gates "enabled" in turn for each digit

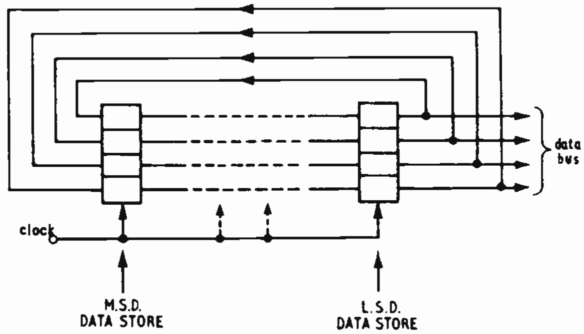
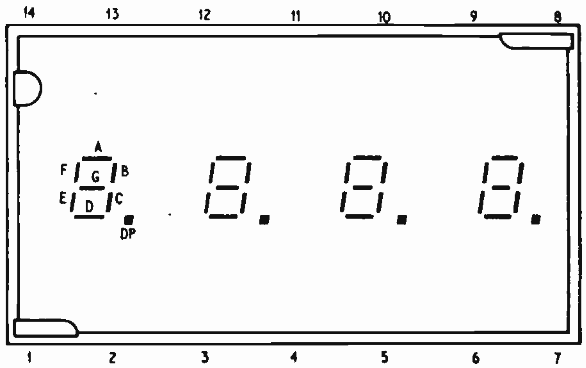


Fig. 6.4. Alternative system using a shift-register to present successive digits to the "data-bus"



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

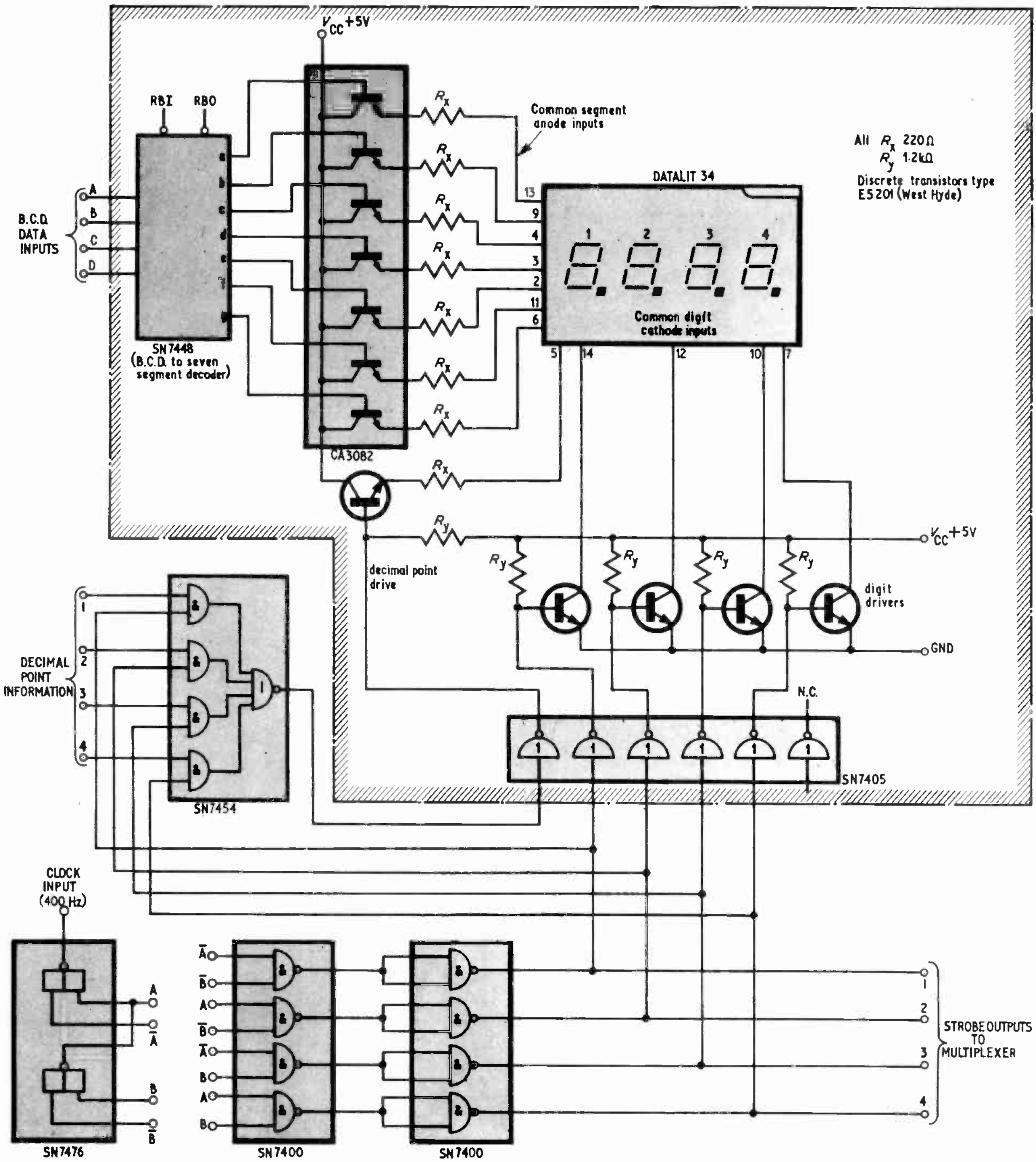


Fig. 6.6. A practical system using the DL34 in a "time-shared" mode

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.

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

$$= \frac{5 - (0{\cdot}7 + 1{\cdot}7 + 0{\cdot}2)}{12}\ \text{k}\Omega$$

$R_x = 200\Omega$ (nearest preferred value is 220Ω)

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

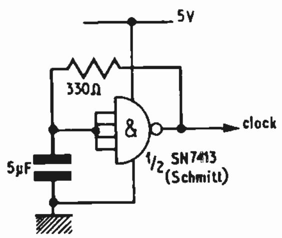


Fig. 6.7. A simple method of generating clock pulses using half of an SN7413 i.c.

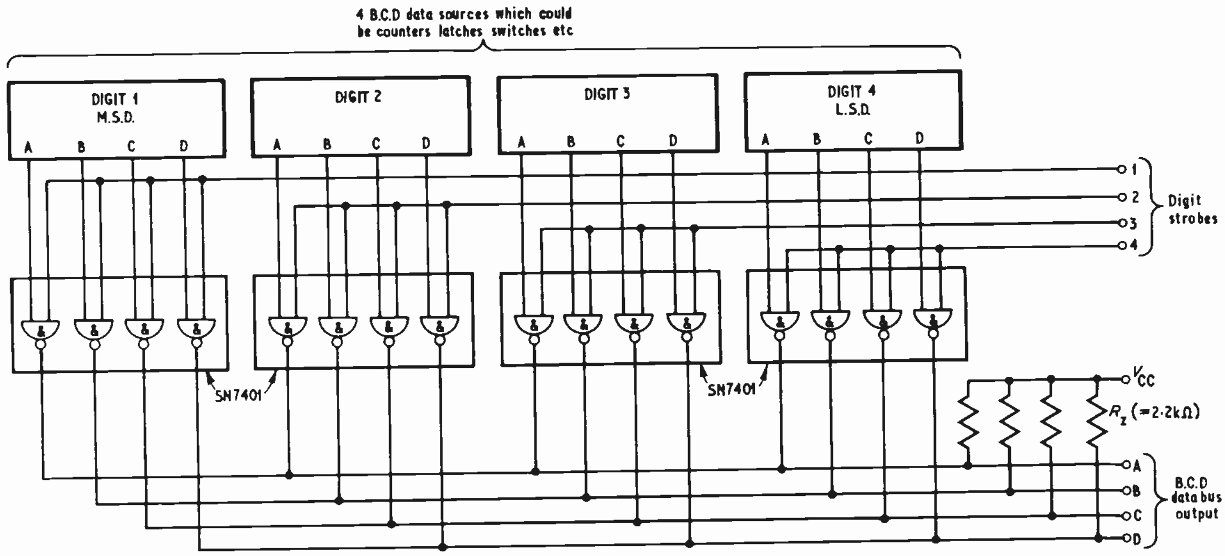
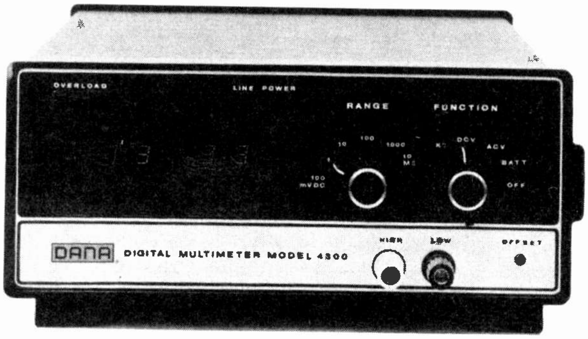


Fig. 6.8. A multiplexer for four digits using SN7401 i.c.s to present each digit in turn to the data-bus



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

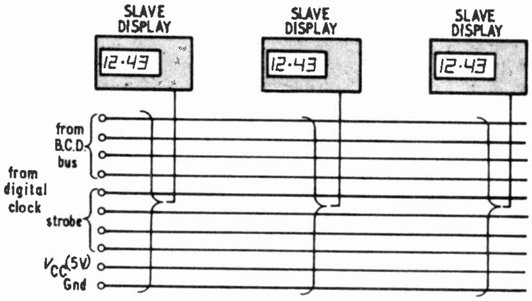


Fig. 6.10. A time-shared system which would allow many clock displays to be driven from a single source

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 *npn* 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.

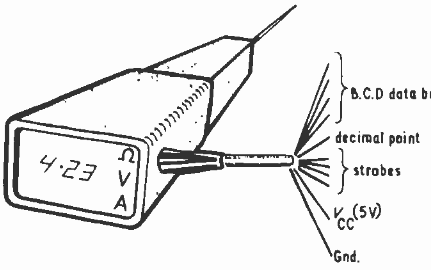


Fig. 6.9. A suggested design for a probe with an integral display

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.

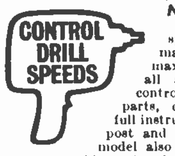
This small unit can be mounted in the probe of say, a digital multimeter, and in this application would eliminate a good deal of the neck twisting associated so often with the traditional "front panel" display when measuring in some inaccessible corner. A possible probe design is shown in Fig. 6.9.

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 revs. 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 10 amps. Extremely well made by a German Electrical Company. Overall size 2¼ × 2 × 2in. **£1** each.

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Double Leaf Contact. Very slight pressure closes both contacts. **6p** each, **60p** doz. Plastic push-rod suitable for operating, **5p** each, **45p** doz.

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MICRO SWITCH

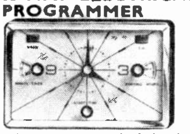
5 amp changeover contacts, **9p** each. **£1** doz. 15 amp Model **10p** each or **£1·05** doz.

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.

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QUICK CUPPA

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NUMICATOR TUBES

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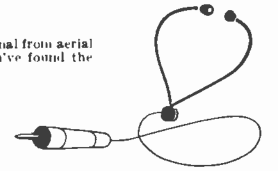
RADIO STETHOSCOPE



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 stethoset instead of earpiece **75p** extra—post and ins. 20p.

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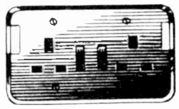
Standard size 1¼ wafer—silver-plated 5-amp contact standard ¼" spindle 2" long—with locking washer and nut.

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

THIS MONTH'S SNIP
13 AMP TWIN GANG SOCKETS



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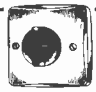

For any lamp up to 1kW. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference Price **£2·50**, plus 20p post and insurance.

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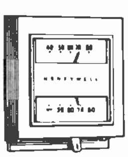
THIS MONTH'S SNIP
THERMOSTAT WITH THERMOMETER



Made by Honeywell for normal air temperatures 40–80°F (5–25°C). This is a precision instrument with a differential which can be adjusted to better than 1·5°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. 3·8in × 3·2in × 1·4in deep—can be mounted on conduit box or directly on wall. Price **£1·25** each or ten for **£11·25**.

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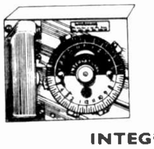

Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 25p. Additional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

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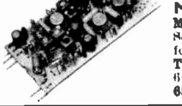
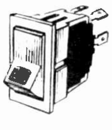


This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self-oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. **75p** 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 S.P. on/off 10 amp 250V. Size approx. 1⅛in × ⅞in. Made by Arrow electric (93 series). Price **12p** each. 10 for **£1·08**.
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20 Watt Inverter. Smart and Brown—For van lighting or camping, etc. Will light a 2ft 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11⅛in × 2in × 1½in. **£6·50** complete with lamp holders and tube clips.

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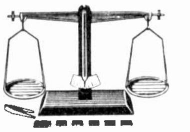
all with pictorial instructions



THIS BALANCE KIT FREE
Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat 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 post paid. 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. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism 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 1½ 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 or 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

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Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9½in × 6⅛in × 3½in 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-A eliptical 6in × 3½in 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3·50** each 10 for **£31·50**. Post & insurance 20p.

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Where postage is not stated then orders over £5 are post free. Below £5 add **20p**. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

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No.	Type	Purpose	Price
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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	23p
AC128	PNP	Low power	20p
AD149	PNP	High power	58p
AC176	NPN	Low power	16p
*AD161	NPN	Med. power	33p
*AD162	PNP	Med. power	36p
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. diode	RF detector	6p
OA91	,, ,,	General	5p
SD1		Silicon Rectifier 1 amp	9p
WO2		Silicon bridge 1 amp	30p
*Matched pair AD161/AD162			60p

(*Sil. = Silicon. Ger. = Germanium*)

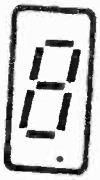
RESISTORS 10%—5%—2%

Code	Power	Tolerance	Range in ohms	Values	1 to 9	10 to 99	100 up (see note below)
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% ±1/20Ω	0·22–3·9	E12	7	7	6
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, 72, 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. Figs. 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**

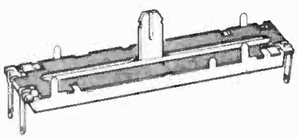
Suitable BCD decoder driver type FLL121T **£1·36**

DIL Socket: 16 lead **30p. 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 4k7Ω 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 Elenico-Wolf "Solderstat" irons, we offer this model HM8 in 16 or 24 watt, a.c. mains, net **£1·87**

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 **£9·20.**

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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.)

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FLH101 (7400)	20p	FLJ121 (7473)	45p
FLH201 (7401)	20p	FLJ141 (7474)	45p
FLH191 (7402)	20p	FLJ151 (7475)	45p
FLH291 (7403)	20p	FLJ131 (7476)	45p
FLH211 (7404)	25p	FLH221 (7480)	68p
FLH271 (7405)	25p	FLH231 (7482)	87p
FLH381 (7408)	25p	FLH241 (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
FLH141 (7440)	24p	FLJ231 (7494)	1·13
FLL101 (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)	52p
FLH161 (7451)	20p	FLK101 (74121)	48p
PLH171 (7453)	20p	FLJ201 (74190)	1·80
FLH181 (7454)	20p	FLJ211 (74191)	1·80
FLY101 (7466)	20p	FLJ241 (74192)	1·74
FLJ101 (7470)	45p	FLJ251 (74193)	1·74
FLJ111 (7472)	32p		

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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.**
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0·068, 0·082, 0·1, 0·12, 0·15, **4p each.**
0·18, 0·22, **5p each.**
0·27, 0·33, **6p;** 0·39, **7p;** 0·47, **8p;** 0·56, **10p;** 0·68, **11p;** 1μF, **13p.**

ELECTROLYTIC CAPACITORS
(Values in μF/V)
0·47/100, 1/100, 2·2/63, 4·7/35, 10/25, 22/16, 47/10, 47/25, 100/10, 220/3, **5p each.**
10/63, 22/35, 47/35, 100/16, 100/25, 220/6, 220/10, 220/16, 470/3, **6p each.**
47/50, 47/63, 100/35, 470/10, **7p each;** 100/50, 220/35, **9p each;** 100/63, 470/25, 100/10, **10p each;** 220/63, 470/35, 1000/16, **14p each;** 1000/25, **16p each;** 470/63, 1000/35, **19p each;** 2200/25, **30p each;** 1000/63, 2200/35, 4700/16, **33p each.**

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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.**

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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.

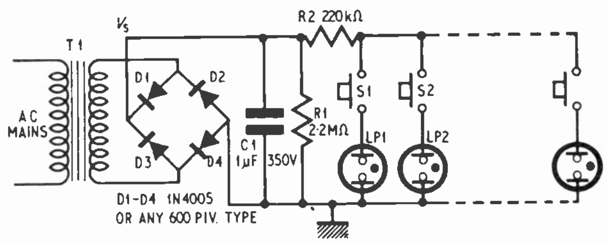


Fig. 1. Circuit diagram of the quiz indicator

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.

The discharge law of C1 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.

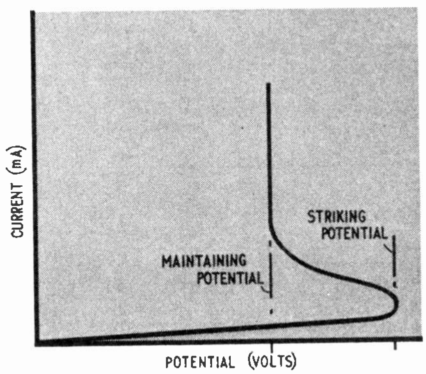


Fig. 2. Typical characteristic curve for a neon tube

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.

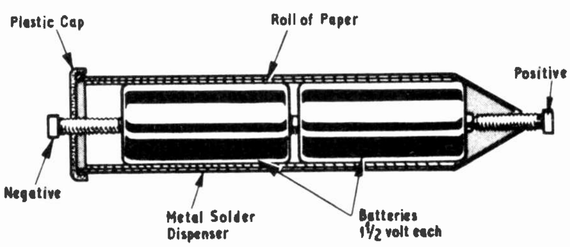


Fig. 1. Constructional detail of a simple battery holder

PATENTS REVIEW...

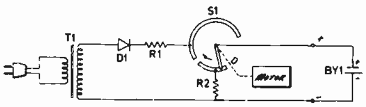
FAST CYCLE CHARGER

THE British Patent 1 256 056 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 approximately 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 1 253 326).

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.

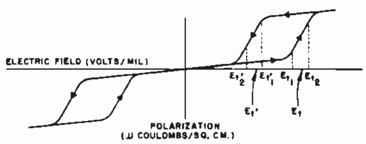
At the design stage a suitable material is selected which exhibits the desired hysteresis loop characteristics and account is taken of the working temperatures and energy values to be stored. Where high voltages are to be handled and a thick piece of material is required, it is usually necessary to build 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.

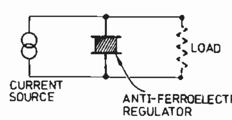
Connection to the anti-ferroelectric material is made by silver or gold electrodes and Fig. 2 shows a voltage regulator circuit including a current source, an anti-ferroelectric regulator of the type just described and a load.

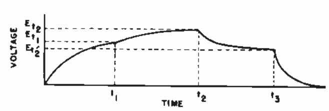
The power source supplies a generally rectangular current pulse to the circuit and either the current pulse terminates before the anti-ferroelectric charge accumulation reaches saturation, or the load uses a charge low enough to prevent saturation being reached. The load voltage will then follow the 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 ±5kV.

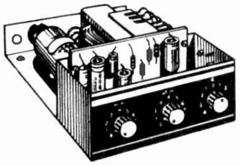
BP 1 253 326







SUPERSOUND 13 HI-FI MONO AMPLIFIER



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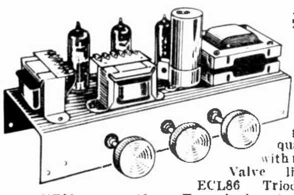
PRICE £10·50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8·92.** P. & P. 45p.

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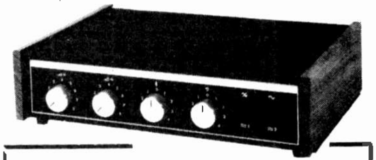

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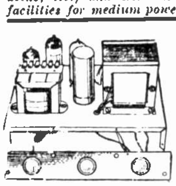

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CALLERCORD

PART 2

BY J. BECKER

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

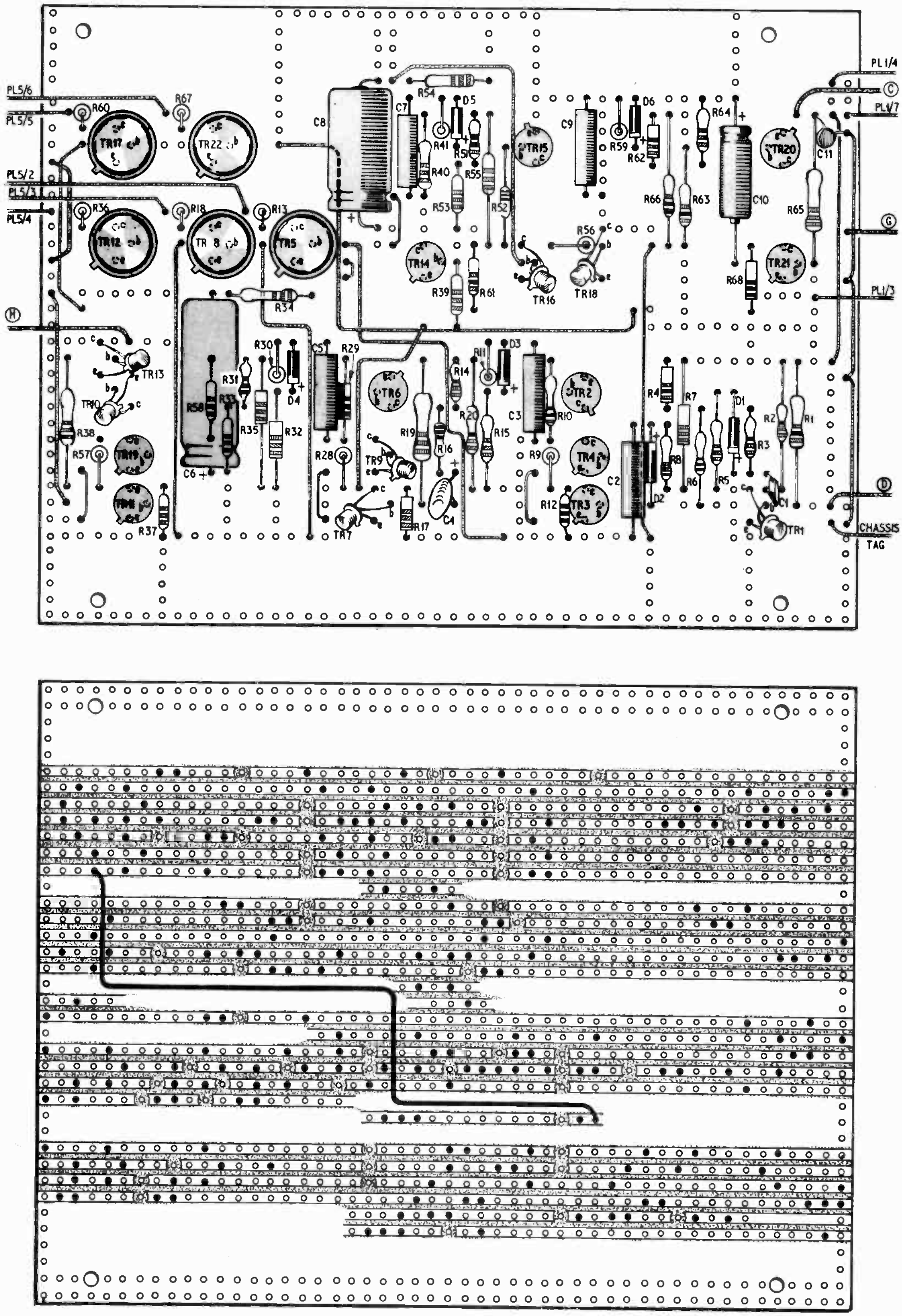
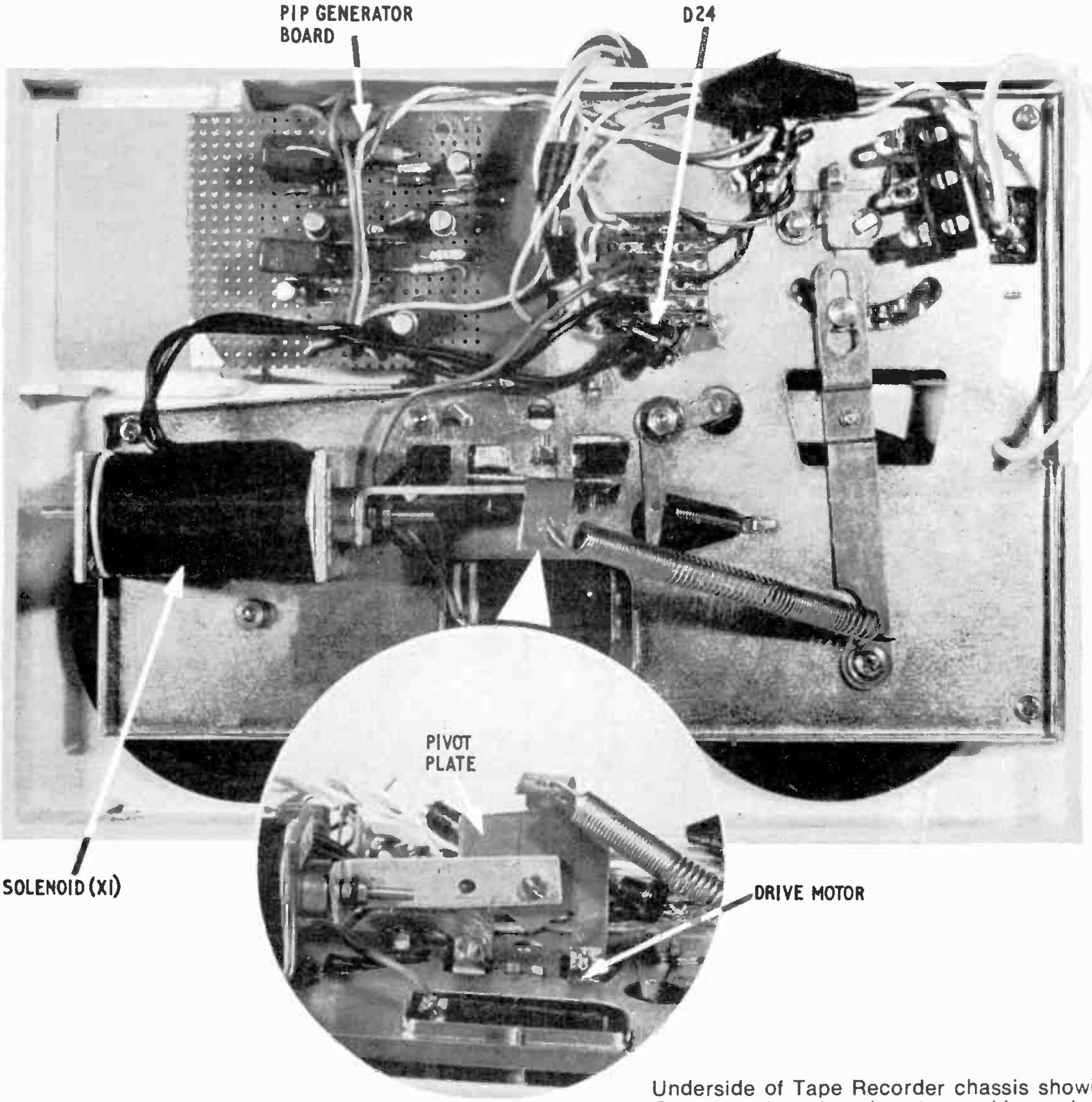


Fig. 4. Component mounting and interwiring details of control circuit board



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

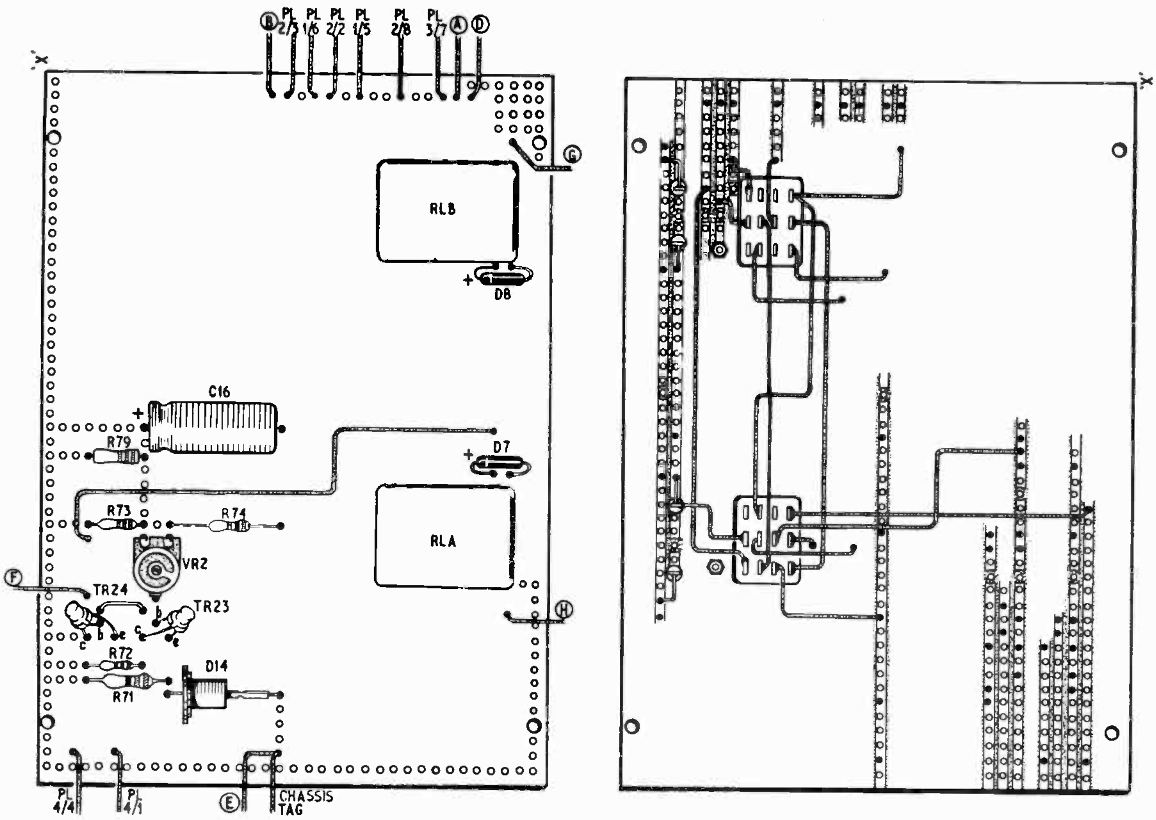


Fig. 5. Relay and stabilised power supply board (P.S.U.2). Details of component mounting and relay interwiring are given

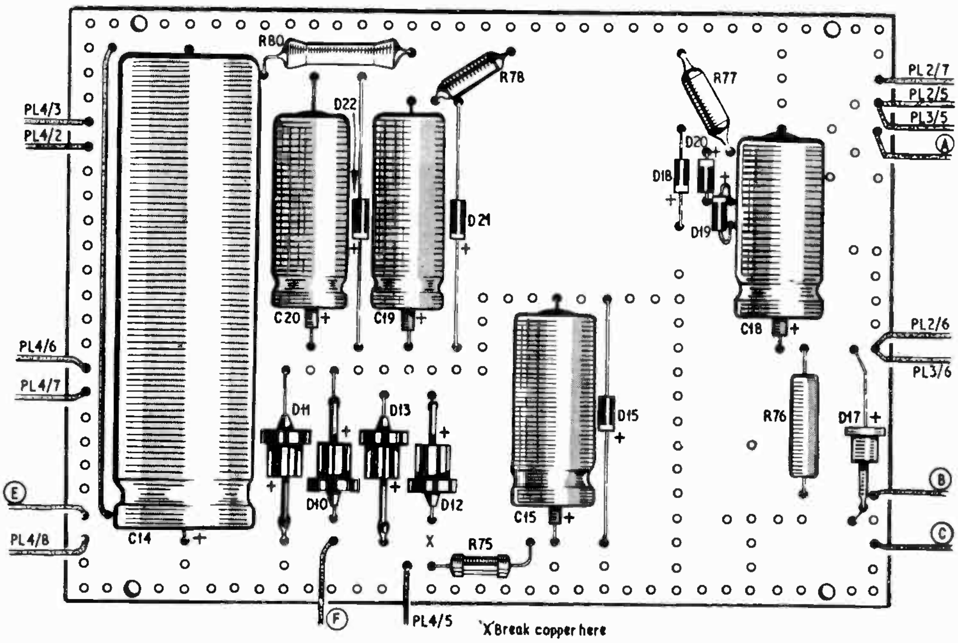


Fig. 6. Assembly details of small components making up P.S.U.2

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 LS1 should be screened.

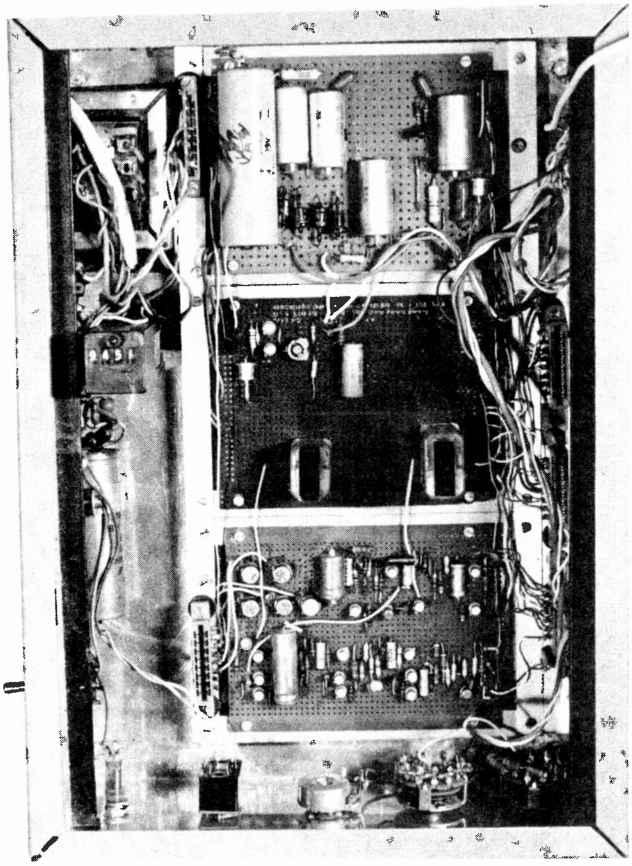
Twisted leads from the transformer secondary winding, speed control switch and counter are brought to another 8-way plug. With the exception of an octal plug and socket, the other interconnecting sockets are Radiospares 8-way edge connector sockets, and the 8-way plugs are cut from 0·15in matrix Veroboard.

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.


Interior layout of Callercord chassis. The tape recorders are mounted on the angle strips fixed to the chassis sides. For convenience, the subframe for the Veroboards and sockets can be dispensed with and these items connected directly to the chassis using suitable insulation bushes

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 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

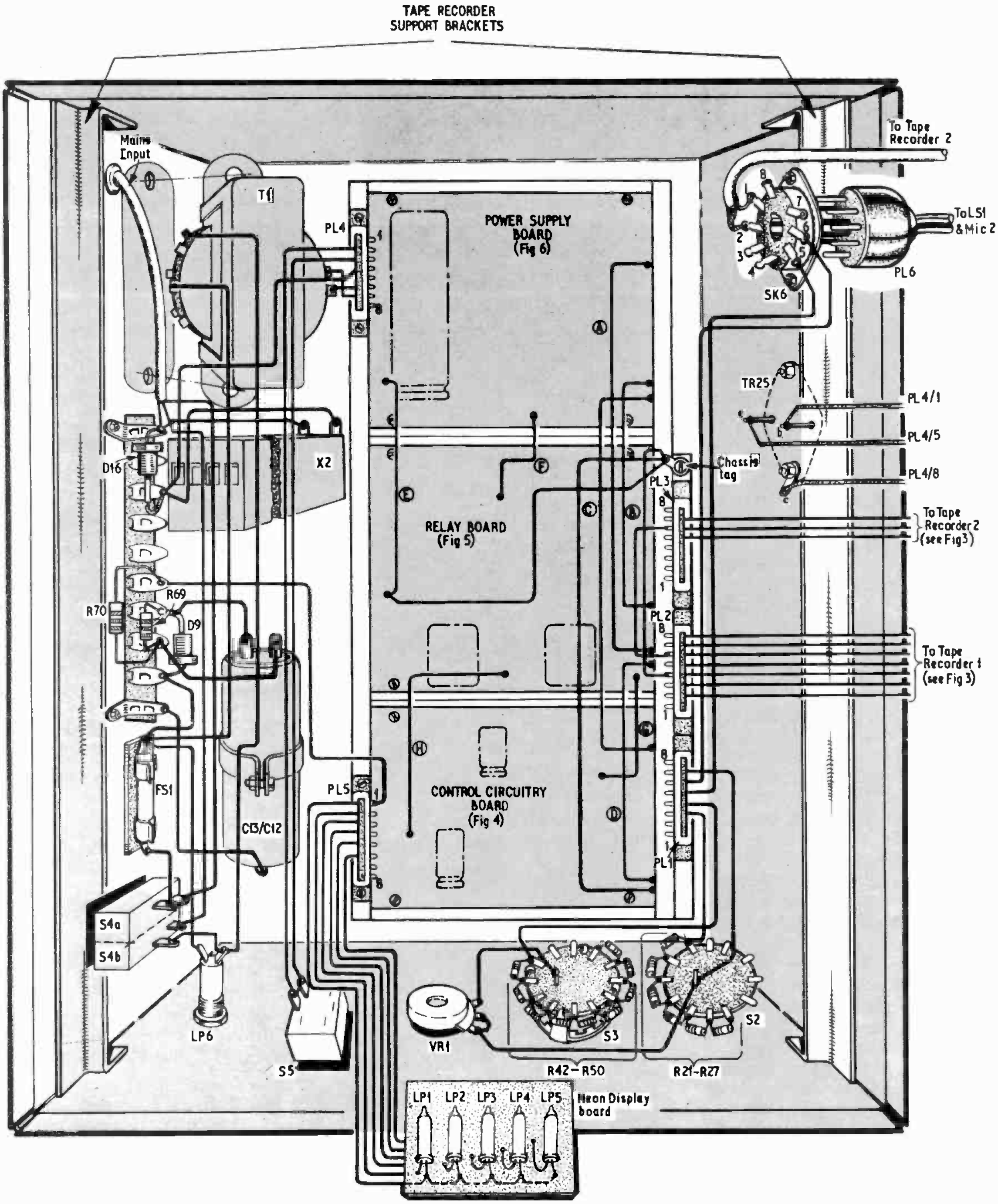


Fig. 7. Complete interwiring details for the Callercord.

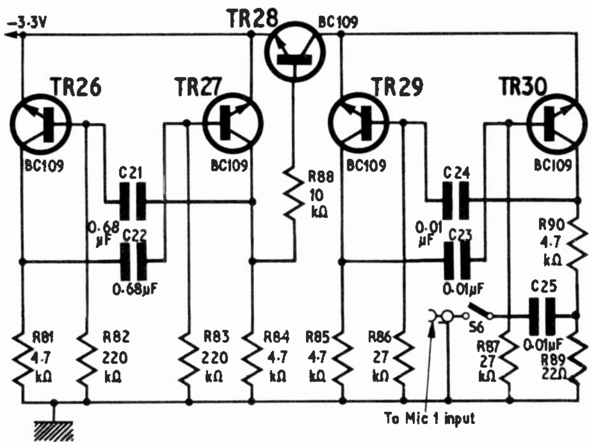


Fig. 8. Circuit diagram of "pip" generator. No assembly details are given of this as layout is not important

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 multivibrator 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 $-3{\cdot}3$V 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.

BINDERS

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BOOK REVIEWS

BASIC ELECTRONICS COURSE

By Norman H. Crowhurst
Published by Tab Books
368 pages, 8½in × 5⅜in. 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, 7in × 5¼in. 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.

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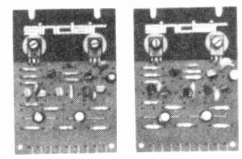
The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.



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.
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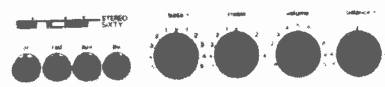
Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection 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

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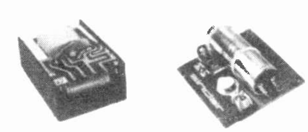

Typical Project 60 applications

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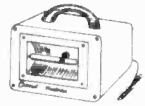
An Audio Amplifier designed around the TAA621 Linear I.C.:—

Supply Voltage	9–24V
Speaker Imp.	8–16 ohm
Frequency	50Hz–25kHz
Overall Size	2in × 3in × ¾in

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.

MINI STROBE


Another Bargain from Crescent. ½ 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 × 4in × 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.

7400	15p
7401	15p
7402	15p
7410	15p
7430	15p
7441	67p
7473	37p
7474	37p
7490	67p

Please include 5p P.&P. per 3 I.C.s.

DIGITAL CLOCK KIT

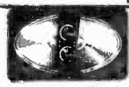

24-hr. Nixie dig. clock kit. We supply: a complete set of components; a complete set of easy to follow instructions; printed circuits made to make construction as simple as possible; a cabinet and front panel to give a professional finish. All for the price of the components. **£22·50** + 50p P. & P. 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 2·2½in tweeters and cross-over. All wired and ready for use. This ever-popular 450 in 3-8-15 ohm imp. **£3·25** plus 38p P. & P. each.

HIGH QUALITY IMPORTED HEADPHONES


1,000 Ω per phone .. .. **95p** TTC
2,000 Ω per phone .. .. **£1·05** G1105
Plus 10p P. & P. per pair.

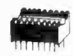
MINI LOUDSPEAKERS

2½in 8 ohm	50p
2½in 40 ohm	50p

Please include 5p P. & P. on each L.S.

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. Our Price **£2·75** plus 8p P. & P. each

INTEGRATED CIRCUIT SOCKETS


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.

2N3055
Popular power transistor now at our low price = **50p** each.
Please include 5p P. & P.

PRINTED CIRCUIT KIT
Everything for producing your own Printed Circuits. **£1·40**, plus 10p P. & P.

1B40K05


Bridge Rectifier (Texas). Plastic encapsulated 50V at 4A. Approx. size 1⅛in × 1⅛in × ¼in. Our Price **60p** each.

MK2 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, 7½ or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2⅜in × 2⅛in × 3¼in. Our Price **£2·75** plus 10p P. & P. Same model suitably wired for the Philips Cassette **£3** plus 10p P. & P.

CRESCENT 100W STEREO

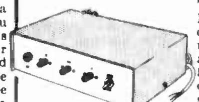

A new style 100 watt per channel stereo amplifier. All loudspeaker systems, 8–15 ohm are suitable. This amplifier is designed for the D.J. and group who must have good looking and reliable equipment. A bargain at **£62**.
We also have a mono 100 watt at **£42**. Please include £1 P. & P. and insurance. If you require more information please send S.A.E.

ADD LUXURY TO YOUR CAR
WITH A MOTOR DRIVEN CAR AERIAL


Spec.: 5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm
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**. 5p P. & P.

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) **£18·50** plus 38p P. & P.
If you require more information please send S.A.E.

NEW COMPONENTS
Post and Package free for orders over £1·50. Include 10p P.P. for each single pack under £1·50.

200 Mixed Resistors, all types, **50p**.
100 Mixed Modern and Miniature Resistors, **50p**.
10mF 64V Electrolytic Caps, 5 for **25p**; 12 for **50p**.
640mF 16V Electrolytic Caps, 3 for **30p**; 7 for **60p**.
100 New Mixed Caps, **60p**.
10mF 63V Wima non-Electrolytic, **15p** each.

TRANSISTORS
Any 6 of the following **50p** or **10p** each. OC71, BFY50, 2N3702, CV8615 (BSY95A), NTG885.

THIS MONTH'S HI-FI BARGAINS
Quadraphonic cartridge player with slider controls plus 4 speakers. Cartridges available. List on application, our price £100.
GAR SP27 Mk.3 **£11·00**; SONOTONE 9TAHCD **£2·10**; GOLDRING G800 **£8·65**; 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 × OC28 type, **50p**, P. & P. 7p.

LAWBAK ELECTRONICS
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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.
NO HALF DAY CLOSING.
Four channel specialists. Credit terms and discounts available.

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Phone 01-723 1465

EEC Product AC/DC Converter
Input 240 volts. Output 3V, 4·5V, 6V, 7·5V, 9V, 12V d.c. Current 500mA.
Price **£4·47** postage paid

EEC Car Adaptor
Input 12 volts. Output 6V, 7·5V, 9V.
Price **£5·10** postage paid

MD 800 Sound Headphones with volume control **£3·90**
Garrard 2025 with plinth cover and cartridge **£12·30**
Shira Car Radio MW/LW—
Manual **£8·50**
Twin Speaker **£8·95**
Push Button **£10·45**
Plinth and Cover suitable for Garrard SP25, **£3·25**
Headphones DHO25, **£2·25**
Siran Battery Chargers 6V and 12V, **£2·85**
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	

2·5 amp OPEN TYPE

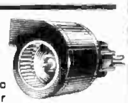
(Panel Mounting) ½ amp, £4·75. 1 amp, £7·00. 2½ amp, £8·05. All carriage paid.

L.T. TRANSFORMERS

All primaries 220–240V

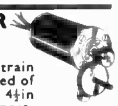
Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36V at 5A	£4·68	45p
2	30, 40, 50V at 5A	£6·88	45p
3	10, 17, 18V at 10A	£4·95	45p
4	6, 12V at 20A	£6·43	45p
5	17, 18, 20V at 20A	£7·28	55p
6	6, 12, 20V at 20A	£6·88	55p
7	24V at 10A	£5·23	45p
8	4, 6, 24, 32V at 12A	£7·15	45p
9,	6 and 12V at 10A	£3·75	45p

220/240 VOLT A.C. CENTRIFUGAL FAN/BLOWER



Smooth, balanced running unit. Two pole shaded pole Mycalex motor gives approximately 90 cubic ft./min. but draws only 240mA on run. Weight 2½lb. Case dia. 3·1in, width (case only) 3·125in, width overall (inc. motor) 5·25in, aperture 3·125in × 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: 4¼in × 2¼in dia. Either type price **95p** inc. post.

230V/240V COMPACT SYNCHRONOUS GEARED MOTORS

Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox.

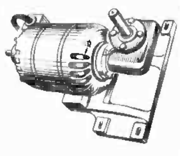
1 r.p.m. cw.	1 r.p.h. a/cw.	6 r.p.h. cw.
60 r.p.m. cw.	2 r.p.h. cw.	20 r.p.h. cw.
	3 r.p.h. a/cw.	30 r.p.h. cw.

cw. = clockwise rotation; a/cw. = Anticlockwise. Fraction of makers' price. All at **75p** incl. P. & P.

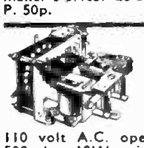
CONSTANT SPEED, PRECISION MADE 6 VOLT D.C. GOVERNED MOTOR

Seven pole armature, ballrace bearing. 2,750 r.p.m. Length 2⅞, Dia. 1⅜, Shaft length ⅜, 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.



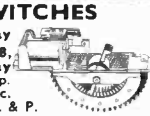
17 WAY SELECTOR SWITCH with RESET COIL

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, 2¾in 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. 1½lb pull. Feet size 1¾in × 1¼in. Price **85p** incl. P. & P.

18-24 VOLT D.C. SOLENOID

Size: O.A.L. 3⅜in × 1¼in × 1in. 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-LYGHT 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-LYGHT 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.

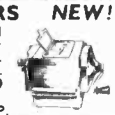
Never before a Strobe Kit with so HIGH an output at so LOW a price. ONLY **£20** plus 75p P. & P. **ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE** specially designed for the Super Hy-Lyght Kit including reflector **£7·00** P. & P. 45p.

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.

INSULATION TESTERS *NEW!*



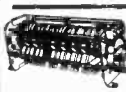
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **1,000V,** 1,000 megohms, **£34·00** carriage paid.
500V, 500 megohms, **£28** incl. P. & P.

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.

VENNER ELECTRIC TIME SWITCH

200/250V Ex. GPO. Tested. Manually set 2 on, 2 off every 24h. Override switch: 15A **£3·25,** 20A **£3·75.** P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.



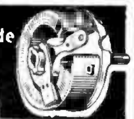
PROGRAMME TIMERS

(Mfg. by Magnetic Devices Ltd.). 240V a.c. 5 r.p.m. Crouzet motor. Drives 15 cams, each operating a 10 amp c/o micro switch. Cams are individually 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; 3·5kΩ, 5 kΩ, 140mA. Diameter 3½in Shaft length ¾in, dia. ⁵⁄₁₆in. All at **£1·65 each.** P. & P. 7½p.
50 WATT. 1/5/10/25/50/100/250/500/1/1·5/2·5/5kΩ. **All at £1·15 each.** P. & P. 7½p.
25 WATT. 10/25/50/100/250/300/500/1/1·5/2·5/3·5/5kΩ. **All at 90p each.** P. & P. 7½p.
Black Silver Skirted knob calibrated in Nos. 1-9, 1½ in. dia brass bush. Ideal for above Rheostats, **18p** ea.

RELAYS SIEMENS, PLESSEY, Etc.

MINIATURE RELAYS

	1	2	3	4
Col. (1) Coil ohms	52	3–6	2 c/o	63p*
	410	10–18	4 c/o	73p*
Col. (2) Working d.c. volts	600	12–24	4 c/o	78p*
	700	16–24	4M 2B	63p*
	700	16–24	4 c/o	78p*
Col. 3 Contracts	700	15–35	2 c/o HD	73p*
	700	16–24	6M	65p*
Col. (4) Price	700	6–12	1 c/o HD	50p*
	700	20–30	6 c/o	75p
	1,250	24–36	4 c/o	63p*
HD = Heavy duty	2,500	36–45	6M	63p*
	2,400	30–48	4 c/o	50p*
*Incl. Base	9,000	40–70	2 c/o	50p*
Post paid.	15k	85–110	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.)

230 VOLT A.C. RELAYS MFG. KEY SWITCH

One set c/o contacts rated at 7·5 amps. Boxed. PRICE: **40p.** P. & P. 5p. (100 lots **£32** inc. 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 ⅞" high, ⅞" wide, ⅜" thick. Complete with 3" leads. New **73p,** incl. P. & P.

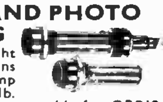
ELECTRONIC ORGAN KIT

Easy to build. Solid State. Two full octaves (less sharps and flats). Fitted hardwood case. Powered by two penlite 1½V 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.

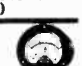
50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price **£7·75.** P. & P. **30p.**

MICRO SWITCH

5 amp c/o contacts. Fitted with removable push button assembly. Ex. P.O. **20 for £1** inc. 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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Brunel Technical College, Bristol

Ashley Down, Bristol BS7 9BU

Department of Marine and Aero-Electronics

Marine Radio and Electronic Officers

The Department offers the following Courses:

a. For prospective Radio Officers in the Merchant Navy a Course of two years and one term leading to the MPT General Certificate in Radiocommunications and the DoTI Radar Maintenance Certificate. Commences September and January.

b. For qualified Marine Radio or Electronic Officers the MNTB Additional Certificate in Marine Electronics, in two modules of three months each.

c. Short advanced technique Courses for serving Radio Officers.

d. MPT R/T Licences

Licensed Aircraft Radio Engineers

The Department provides a 2-year Full-time Course leading to a career in Civil Aviation. The Course is fully approved by the ARB so that successful students may obtain a full Category R Licence at the end of the Course. The Department's aircraft, workshops and laboratories cover:

12·1 Airborne Communication Systems
12·2 Airborne Navigation Systems
12·3 Airborne Pulse and FM Systems

Courses are also provided for Aeronautical R/T Licences and Category X Compass Licences.

Courses commence each September.

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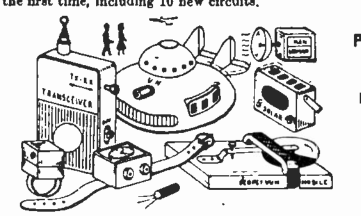

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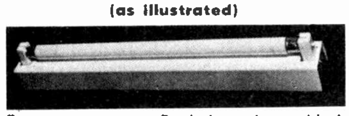

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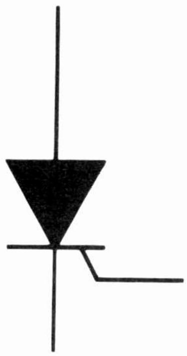

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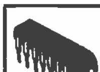

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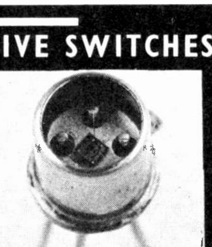

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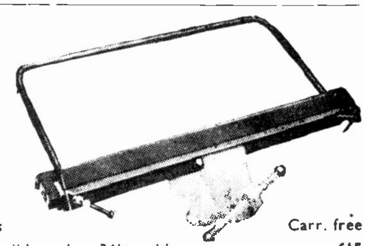

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