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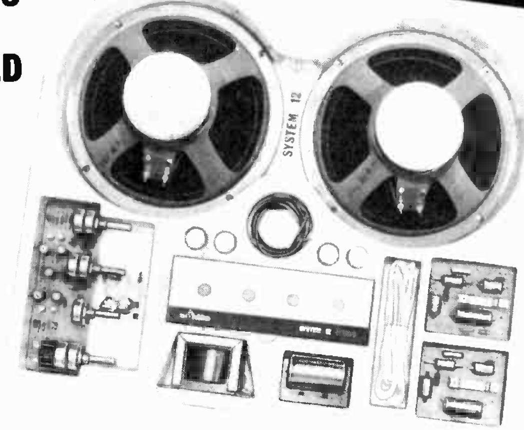

The Bi-kits "SYSTEM 12 STEREO" is a kit form modular stereo amplifier system of modern design, providing an output of 12 watts peak (6 watts RMS minimum) from two remarkable amplifiers which have a frequency response from 20 Hz to 50 kHz. Assembled pre-amplifier and power supply module together with mains transformer plus two 8in round twin-cone speakers matched to the system are included in the kit which also contains all the necessary connecting wire and such items as the silver anodised front panel and 4 matching control knobs. Inputs for tuner or tape recorder, ceramic or magnetic cartridges are provided. Stereo balance better than 2dB, plus separate bass and treble controls are typical of the "SYSTEM 12 STEREO" specification.

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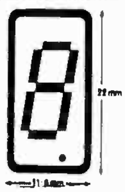

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R.328 STEREO HEADPHONE
If you're starting in hi-fi, and you discover the need for a pair of really good stereo headphones. The R.328 is ideal, at a price you can afford. They have padded ear cushions, a 6-foot cord and jack plug. Frequency range 30-15,000 Hz. Impedance 8 ohms per channel.
ROC PRICE £2·95

EAGLE SE-30 STEREO HEADPHONE
This model is for the more discriminating listener. For a start the frequency range extends from 30 to 16,000 Hz. And you can adjust the volume of each earpiece independently. There's also a mono/stereo switch. For maximum comfort, the ear cushions are covered in soft leathers. **ROC PRICE £7·05**

EAGLE SE-80 STUDIO STEREO HEAOPHONE
Here's the ultimate in headphone design! Apart from its fantastic ability to reproduce all the frequencies from 20 to 20,000 Hz, the SE-80 has eliminated the discomfort and strain associated with traditional headphone design. Eagle have designed and produced a pair of headphones which breaks with all previous concepts. You hear all the sounds crisp and clear. In fact, the reproduction is so good, that it compares favourably with the most expensive hi-fi speaker systems. Separate slider volume control on each earpiece. Impedance: 8 ohm per channel.
ROC PRICE £14·90

TEC HR-007 HEADPHONE RADIO
When you want to listen to the radio all by yourself. Then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs. Frequency range is 535 to 1605 kHz medium wave band. Maximum output is 300 mW.
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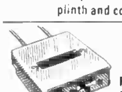
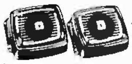
Transcription Turntable. Complete with pick up arm, plinth and cover. £52·31



R 186 STEREO HEADPHONE JUNCTION BOX
If you want easy, fingertip control of headphones *and* loudspeakers, here's the ideal solution to the problem. All you do is connect it to your speakers and amplifier, plug in your headphones – and you're ready to take over! At the flick of a slide switch, you can have headphones alone, or speakers alone, or both together. Input: suitable for use with amplifiers rated up to 20 watts. Size: 2 15/16" × 3 3/16" × 1 7/64".
ROC PRICE £1·50



R.151 STEREO CAR SPEAKERS
Smart black, tough, plastic cases, each containing a high flux 110mm diameter speaker unit. Just what you need to go with the CS.8 Cartridge Player or any other car stereo system. Fitted with over three yards of connecting cable. Dimensions: 6 11/16" × 5 13/16" × 3 3/16". Impedance: 8 ohms per speaker. Rating: 5 watts max per speaker. **ROC PRICE £3·72**

EAGLE 8-TRACK CAR STEREO PLAYER, CS.8
Drive to the sound of music – with this fabulous 8-Track Cartridge Player. It gives you superb tone and power to fill the car with stereo sound. Ideal for use with R.151 or R.152 speakers. Complete with all mounting accessories. For negative earth electrical systems only. Output: 2·5 watts per channel. Frequency range: 70-10,000 Hz. Wow and flutter: less than 0·3%. Tape speed: 3·5 cm/sec. Channel selector: automatic with manual over-ride. Mounting dimensions: 5 13/16" × 5½" × 2 11/16". **ROC PRICE £27·20**

R.152 STEREO CAR SPEAKERS
These sloping front speakers match the CS.8 Cartridge Player or any other car stereo system. Fitted with high flux 110mm diameter speaker unit, and over three yards of connecting cable. Dimensions: 6 11/16" × 6 13/16" × 3⅜". Impedance: 8 ohms per speaker. Rating: 5 watts max. per speaker.
ROC PRICE £4·96

EAGLE LC.05 STEREO MAGNETIC CARTRIDGE
For fabulous reproduction at a very low price, you'll find it hard to beat. 0·7 mil diamond stylus. Output: 6mV per channel. Frequency range: 30-18,000 Hz. Channel balance: ± 1·5dB. Channel separation: 20dB. Recommended stylus pressure: 2-4 grams. Compliance: 9 × 10-6 cm/dyne. **ROC PRICE £4·75**

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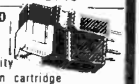
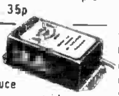
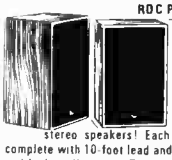


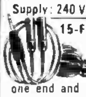
EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE
Here's your opportunity to own a transcription cartridge for the price of a ceramic! Is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0·7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: ± 1dB. Channel separation: 28dB. Compliance: 12 × 10-6 cm/dyne.
ROC PRICE £6·37



R.307 TRANSISTORIZED STEREO PRE-AMPLIFIER
Now your amplifier that could only reproduce ceramic or crystal pick-up cartridges, can accept signals from moving-magnet cartridges! The R.307 steps up signals from between 5-20mV to 200-800 mV. Input: 5-20mV. Equalisation: RIAA. Output: 200-800mV flat. Frequency range: 20-22,000 Hz. Dimensions: 3¾" × 1⅞" × 2 9/16". Supply: 240 VAC. **ROC PRICE £4·92**



R.088 MATCHED STEREO LOUDSPEAKERS
Here's real value in stereo speakers! Each unit comes complete with 10-foot lead and phono plug, and look really smart. Power handling per speaker: 4 watts rms, 8 watts peak. Frequency range: 40-16,000 Hz. Flux density: 8,500 gauss. Impedance: 8 ohms. Dimensions: 9" high, 5½" wide, 4¾" deep. Finish: oiled walnut.
ROC PRICE £9·50 pair



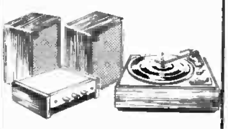
15-FOOT STEREO HEADPHONE EXTENSION CORD R.362
Fitted with heavy duty 3-circuit stereo plug at one end and a matching stereo socket at the other. **ROC PRICE £1·30**

STEREO HEADPHONE "Y" ADAPTOR
R.361 Enables you to use two sets of stereo headphones from a single socket. Fitted with male plug and two female sockets. **ROC PRICE £1·30**

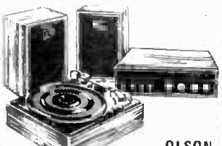
EAGLE DL.67 HIGH COMPLIANCE 3-WAY TEAK SPEAKER SYSTEM
From a rich, deep, 35 Hz bass to above the limit of human hearing – this fantastic response comes from such a small size – only 10" × 6" × 6½"! The DL.67 is the end product of several years effort into the problems of full frequency response from small cabinets. The DL.67 has a dual cone high compliance bass mid range unit, and a horn tweeter. The speaker has a variable brilliance control to suit individual rooms – a feature normally only found on very expensive speaker systems. Power handling capacity: 10 watts rms, 20 watts peak. Frequency range: 35-20,000 Hz. Flux density: 11,000 gauss. Impedance: 8 ohms. Dimensions: 11¾" high × 8" wide × 6¾" deep. Finish: oiled teak. **ROC PRICE £18·80 each**

HERE'S A RANGE OF AUDIO SYSTEMS BUILT AROUND EXCLUSIVE ROC AMPLIFIERS AND TUNERS

Now run your eye over the prices, select the System nearest to your budget – and you've hit on the best value that your money can buy! Supplied with all necessary leads and plugs, ready to use.

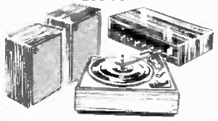


REALISTIC SA-100B SYSTEM
Realistic SA-100B Stereo Amplifier, Garrard 2025TC Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers. Matching TM-100 Stereo Tuner £23·25 extra if required.
Normal Price £63·98
ROC PRICE £47·60



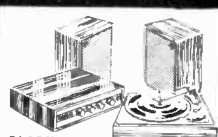
OLSON AM-395 SYSTEM
Olson AM-395 Stereo Amplifier, Garrard SP25 Mk III Record Player with Eagle LC07 Stereo Magnetic Cartridge, plinth and cover and a pair of Eagle DL.67 Speakers. Matching RA.310 Stereo Tuner £39·95 extra if required.
Normal Price £106·65
ROC PRICE £92·60

OLSON AM-357 SYSTEM
Olson AM-357 Stereo Amplifier, Garrard 2025 T/C Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.088 4 watt Speakers.
Normal Price £45·28
ROC PRICE £36·70



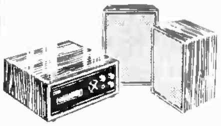
PALACE SYSTEM
Palace SSA-16 Stereo Tuner Amplifier, Garrard 2025 T/C autochanger with stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers.
Normal Price £84·98
ROC PRICE £66·30

REALISTIC SA-500 SYSTEM
Realistic SA-500 Stereo Amplifier, Garrard SP25 Mk III Single Record Player with Eagle LC.07 Stereo Magnetic Cartridge, plinth and cover and a pair of Crysler CE-5b Speakers. Normal Price £157·95
ROC PRICE £124·00



OLSON AM-372 SYSTEM
Olson AM-372 Stereo Amplifier, Garrard 2025 T/C Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers.
Normal Price £68·18
ROC PRICE £51·53

REALISTIC 12-694 SYSTEM
Realistic 12-694 Stereo Tuner Amplifier with matching speakers and Garrard SP25 Mk III with Eagle LC.07 Stereo Magnetic Cartridge and plinth and cover.
Normal Price £144·05
ROC PRICE £124·50



ROC E1 SYSTEM
ROC E1 8 track Stereo Cartridge Player complete with a pair of ROC R.088 4 watt Speakers.
Normal Price £59·10
ROC PRICE £49·45

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Garrard SP25 Mk. III
Goldring G800H **£18**
Teak plinth and tinted cover.
Ready wired for immediate use.
Please add £1·25 for P. & P.

TURNTABLES

Please add 75p post & packing

Garrard SP25 Mk. III	£9·95
Garrard AP76	£19·95
Garrard SL65B	£13·25
Garrard 1025T + cart.	£5·97
Garrard 401	£27·00
Garrard Zero 100 (Auto)	£39·95
Garrard Zero 100 (Single)	£37·25
BSR MP60	£10·00
Goldring GL72	£22·50
Goldring GL72/P	£29·25
Goldring GL75	£27·50
Goldring GL75/P	£35·50
Leak Delta	£55·00
Wharfedale Linton + cart.	£27·75
Thorens TD125	£57·75
Thorens TD125AB	£90·00
Thorens TD150 Mk. II	£28·00
Thorens TD150A Mk. II	£33·75

AMPLIFIERS

Please add 75p post & packing

Amstrad 8000 Mk. II		£16·95
Amstrad IC2000		£27·90
Armstrong 521 (Teak cased)		£43·95
Alpha Highgate 212		£25·00
Alpha Highgate FA300		£27·95
Alpha Highgate FA400		£31·95
Cambridge P100		£116·00
Cambridge P40		£65·95
Cambridge P50		£71·00
Ferrograph F307 Mk. II		
(Wood cased)		£47·50
(Metal cased)		£45·00
Leak Delta 30		£48·00
Leak Delta 70		£56·00
Metrosound ST20E		£24·75
Metrosound ST60		£47·25
Pioneer SA900		£92·00
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Rogers R/brook (Chassis)		£35·00
Rogers R/brook (Cased)		£37·00
Rogers R/bourne (Chassis)		£41·50
Rogers R/bourne (Cased)		£46·50
Scaneltra HT58		£29·75
Sinclair PR060 2	Z30/PZ5	£15·25
Sinclair PR060 2	Z30/PZ6	£17·50
Sinclair PR060 2	Z50/PZ8/	
Trans		£21·75
Sinclair AFU (Filter Unit)		£4·40
Sinclair 605		£18·75
Sinclair 2000 Mk. II		£21·75
Sinclair 3000 Mk. II		£29·75
Sugden A21/11		£51·50
Sugden A51/C51		£102·00
Wharfedale Linton		£39·95
Goodmans Max Amp		£37·95
Teleton SAQ206B		£21·50
Teleton SAQ306		£22·95
Europhon 10 + 10		£16·95

TUNERS

Please add 75p post & packing

Armstrong 523	£39·50
Armstrong 524	£31·00
Rogers R/brook FET4 (Chassis)	£31·00
Rogers R/brook FET4 (Cased)	£35·00
Rogers R/bourne FET4 (Chassis)	£43·00
Rogers R/bourne FET4 (Cased)	£48·00
Sinclair PR060 (Module)	£18·50
Sinclair Cased Tuner	£34·00
Philips RH690	£33·00
Leak Delta FM (Cased)	£55·50
Leak Delta AM/FM (Cased)	£66·50

TUNER/AMPLIFIERS

Please add 75p post & packing

Armstrong 525 (Teak cased)	£68·50
Armstrong 526 AM/FM (Teak cased)	£78·50
Leak Delta 75	£130·95
Philips RH781	£50·00
Philips RH882 (+cass. head)	£72·00
Philips RH702	£82·50
Teleton 2100	£29·95
Goodmans One Ten	£105·00
Rogers Ravensbrook (Teak cased)	£80·00
Rogers R/brook (Chassis)	£74·50
Scaneltra 1515 AM/FM	£102·50
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Scaneltra 1515 FM	£74·50

SPEAKERS

Please add £1·25 for post & packing Price per pair

Amstrad 138	£20·00
Wharfedale Denton 2	£29·00
Wharfedale Linton 2	£37·00
Wharfedale Melton 2	£47·95
Wharfedale Dovedale 3	£61·50
Celestion Ditton 120	£39·00
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Goodmans Double Maxim	£48·50
Goodmans Mezzo 3	£45·75
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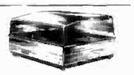
Sinclair Q16	£12·50

CARTRIDGES

Please add 10p post & packing

Goldring G850	£3·65
Goldring G800	£6·25
Goldring G800E	£10·35
Goldring G800 Super E	£15·75
Shure M3D	£4·50
Shure M44E	£6·25
Shure M55E	£6·75
Shure M75E Type 2	£12·25
Sonotone 9TAHC	£1·85

£3·20*



Plus 35p P. & P.
Finished in teak veneer with tinted dust cover. (Fully assembled). For Garrard SP25; 2025TC; 3000; AT60; 2000; 2500; 3500; 5100; 102S; SL65B; Also for BSR, McDonald MP60 and others.
For AP76; AP75; SL72B; SL75; SL95B*. **£4·20** plus 35p P. & P.
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2N3391A	Si NPN Hi Gain (250 – 500) low noise transistor	3 for 50p
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The "Diacrom" is a metal spatula upon which diamond powder has been deposited by a special process. No deep scratches are possible because density is controlled and the polishing of the contacts is achieved by a gentle brushing motion. With coloured nylon handle for complete insulation and easy size identification.

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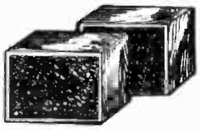
FANTASTIC! WHARFEDALE

SPEAKER BARGAINS DENTON 2 SAVE £8·40



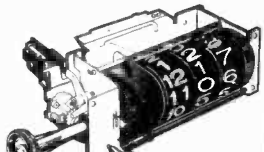
Sold in matched pairs. Each Denton contains an 8in. bass unit with 3in. pressure unit, coupled by a Wharfedale crossover network. Rated input: 18 watts maximum. Frequency response: 65-17,000 Hz. Impedance: 4/8 ohms. Cabinet 9¾in. × 14in. × 8¼in.

List Price £39·90 Per Pair. C. & P. £2·00

LASKY'S PRICE **£31·00**

	List Price	Lasky's Price	C & P
LINTON 2 Pair	£49·90	£38·75	£2
TRITON 3 Pair	£65·00	£51·50	£2
MELTON 2 each	£35·00	£25·50	£1
DOVEDALE 3 each	£45·00	£33·00	£1
ROSEDALE each	£65·00	£50·00	£1
UNIT 3 each	£12·50	£9·50	50p
UNIT 4 each	£18·00	£12·50	50p
UNIT 5 each	£26·00	£18·50	50p

LASKY'S DIGITAL CLOCK

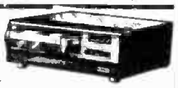


The clock measures 4½ W × 4¾H × 3¾ D (overall from front of drum to back of switch). SPEC.: 210/240V a.c., 50Hz operation; switch rating 250V, 3A. Complete with instructions. **Hundreds of applications: Complete with knobs. Features: ● Mains operation ● 12-hour alarm ● Auto "sleep" switch ● Hours, minutes and seconds read-off ● Forward and backward time adjustment ● Silent operation ● Shock and vibration proof ● Built-in alarm buzzer**

SPECIAL QUOTES FOR QUANTITIES LASKY'S PRICE **£6·50** C. & P. 25p

BSR TD8S

8-TRACK STEREO CARTRIDGE PLAYER



The unit is switched on and off by the insertion of the cartridge. The TD8S is suitable for use with most modern stereo amplifiers and delivers a pre-amp output of 125mW. Power requirements: 210/250V a.c., 50Hz. Frequency response: 50Hz–10kHz. 4 pole dynamically balanced synchronous motor maintains unwavering speed accuracy—independent of mains fluctuations. Compact in size the TD8S is housed in black and woodgrain plastic cabinet. Size 8½ (W) × 3¾ (H) 10½ (D) in. C. & P. 35p

List Price £24·20 LASKY'S PRICE **£17·95**

BELTEK C5700 8-TRACK

Stereo Car Player

Accepts all standard pre-recorded 8-track stereo cartridges. Other features include automatic head cleaner, channel select and channel repeat push buttons, slider type volume and tone controls, channel balance control. Tech. spec. max. output 10W (5 watts per channel), frequency response 50Hz–10kHz. Output imp. 4 ohms. Size 4¾ (W) × 1½ (H) × 6½ (D)in. Operates on 12V d.c. negative earth systems. Beautifully styled with black, ivory and chrome trim finish.

BELTEK C5700 complete with mounting brackets and 8-track pre-recorded demonstration cartridge. **£19·75** C. & P. 30p

BELTEK C5700 with pair SP24 speakers. **£24·95** C. & P. 30p

Beltek SP24 speakers are available perfectly matching the C5700 in performance and finish—specially designed for optimum performance in heavily damped car interior. Size: 7½in. (W) × 6in. (D) × 4¾in. rear, 2½in. front (H). Comp. with leads. £5·95 pair. C. & P. 30p

TM-1 TEST METER

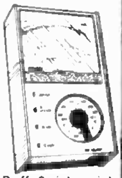
1,000 ohms/volt

Lasky's new look top value TM-1 is a really tiny pocket multimeter providing "big" meter accuracy and performance. Precision movement calibrated to +3% of full scale. Click stop range selection switch. Beautifully designed and made impact resistant black case with white and metallic red/green figuring. Ohms zero adjustment. **1,000's IN USE. SIZE ONLY** 2⅜ × 3⅝ × 1⅛in. ● DC/V: 0–10–50–250–1000 at 1K/ohms/V. ● AC/V: 0–10–50–250–1000 at 1K/ohms/V. ● DC Current: 0–1mA, 100mA. ● Resistance: 0–150K/ohms. ● Decibels: −10 + 22dB. ● Complete with test leads.

LASKY'S PRICE £1·85 C. & P. 15p

TM-5 TEST METER

5,000 ohms/volt



Another pocket multimeter from Lasky's. The "slimline" impact resistant case—size 4⅞in. × 2¾in. × 1¼in. fitted with extra large 2¾in. square meter. Readability is superior on all low ranges, making this an excellent instrument for servicing transistorised equipment. Zero ohms adjustment. Buff finish with crystal clear meter cover. ● DC/V: 3–15–150–300–1,200 at 5K ohms/V. ● AC/V: 6–30–300–600 at 2·5K/ohms/V. ● DC Current: 0–300μA, 0–300mA. ● Resistance: 0–10K/ohms, 0–1M/ohms. ● Decibels: −10dB to 16dB. ● Complete with test leads, battery and instructions.

LASKY'S PRICE £2·55 C. & P. 35p

BSR McDONALD MP60

High precision low-mass counter-balanced pick-up arm, heavy balanced turntable, simple to operate controls, viscous cueing device, slide in cartridge carrier, 4 pole motor.

LASKY'S PRICE £10·95 C. & P. 50p

BSR McDONALD UNITS & PACKAGES

A. Chassis only. **B.** Complete with Lasky's plinth and cover. **C.** Complete with Lasky's plinth, cover and AD76K cartridge. **D.** Complete wired on BSR plinth with cover. **E.** As D plus AD76K cartridge.

MODEL	A	B	C	D	E
MP60	10·95	15·50	18·50	18·75	22·00
HT70	15·90	19·90	23·50	23·75	27·00
610	14·50	18·75	23·00	22·25	25·50
510	12·10	16·50	18·85	20·00	22·85
310	9·75	14·00	16·50	17·25	20·25

210 complete with plinth, cover and BSR cartridge, £9·95

MP60 TPD2 styrene base 17·50 21·00

FANTAVOX CAR RADIO

W1/700 MW/LW

A new two waveband all transistor car radio that covers full medium and long wavebands with slide switch wave change. Large easy to grip controls. Illuminated dial with "easy to read" lining scale. Externally adjustable aerial trimmer ensures maximum output. Powerful output stage gives perfect reproduction through either one or two speakers. Operates on all 12 volt D.C. systems. Negative or positive earth. Standard size 6¾ in. (W) × 4¾in. (D) × 2in (H). Black with chrome trim. Complete with speaker, baffle, leads, mounting brackets and instructions. Fully guaranteed.

LASKY'S PRICE £7·50 C. & P. 25p

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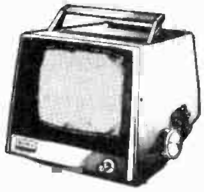
EMI 2,400ft Professional Tape on 10½in metal NAB spools. Fully guaranteed brand new.

Today's value over £5·00 each.

£1·25 each 5 for £5·00 C. & P. each 20p. 5 for 50p

SONY TV SCOOP

TV-720UK—the world in 7in

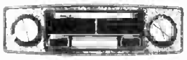


This miniature portable TV can be operated by household current, rechargeable power pack or 12V car/boat battery. The special anti-glare screen gives a perfect picture even in sunlight. Brief Spec. ● Screen size 7in. measured diagonally. ● System: 625 UHF. ● Antenna system: Built-in loop aerial. External 300 and 75 ohm switchable. ● 23 transistors, 15 diodes, 3 thermistors, 1 EHT rectifier (selenium). ● Power source: AC 240V, 50Hz; DC 12V. ● Power consumption: AC17W, DC 11W. ● Dimensions: 9in. × 9⅜in. × 11¼in. ● Weight: 8lb. 13oz. ● Accessories: Earphone; loop aerial; polishing cloth.

List Price £59·75. C. & P. £1·50 **LASKY'S PRICE £42·00**

CAR RADIOS FROM PHILIPS

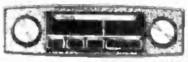
MODEL RN 214/15



The RN214 is a triumph of micro-miniaturisation. So compact and light, mounted on its spindles only, it needs no real support. The RN214 can be fixed quickly and easily. **Spec.:** Power supply: 13 volt D.C. negative earth operation only. Power output: 5 watts. Wave ranges: Medium wave: 185m–586m (1622–512kHz). Long wave: 1030m–2000m (290–150kHz). Intermediate frequency: 470kHz. Size: 7in × 1·6in × 3·6in. EN8893/05 general purpose mounting kit with loudspeaker **£2·70** extra.

List Price £19·25 **LASKY'S PRICE £15·50** C. & P. 25p

MODEL RN 314/15



The RN314 gives you big sound because of the high sensitivity from the tuned RF stage. Due to its compact size it can be mounted without any rear support. Spec.: Power supply: 12V D.C. neg. earth only. Power output: 5 watts RMS. Wave ranges: Medium: 185m–585m (1622–512kHz): Long: 1030m–2000m (290–150kHz). Intermediate frequency: 470kHz. Size: 7in. × 1·6in. × 3·6in. EN8893/05 general purpose mounting kit with loudspeaker **£2·70** extra.

List Price £25·25 **LASKY'S PRICE £21·00** C. & P. 25p

BARGAIN SCOOP

PYE S.W. CAR RADIO CONVERTER

High quality transistorised and ultra compact Shortwave Converter for use with any suitable MW (AM) Car Radio. Self-powered for use on 12V positive or negative earth systems. The model 2649 is simply connected to the radio via the aerial socket and provides shortwave coverage in 9 push-button selected band spread ranges (13, 16, 19, 25, 31, 41, 49, 60 & 90 M) combined with the normal radio tuning to give full cover from 3·2MHz–21·75MHz. On/off switch and by-pass switch for normal M.W. radio use. Complete with mounting bracket fitting and alignment instructions. Black hammer crackle finished case—size: 6(W) × 1¼(H) × 3¼(D)in. **Made to sell at approx. £20.**

LASKY'S PRICE £8·75 C. & P. 20p

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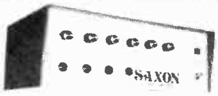

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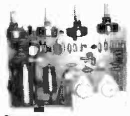

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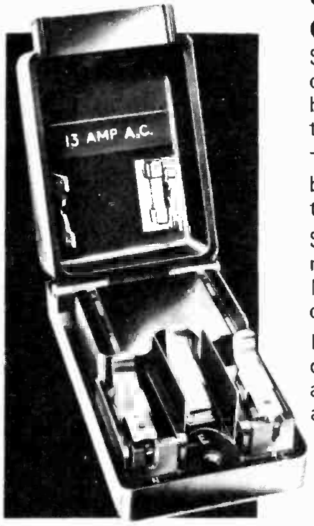

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2N696	15p
2N697	15p
2N698	25p
2N699	30p
2N706	10p
2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
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2N1091	22p
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2N1507	17p
2N1613	20p
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2N1632	30p
2N1637	30p
2N1638	27p
2N1639	27p
2N1701	162p
2N1711	24p
2N1889	32p
2N1893	37p
2N2147	72p
2N2160	57p
2N2193	40p
2N2193A	42p
2N2194	27p
2N2194A	30p
2N2217	25p
2N2218	20p
2N2219	20p
2N2220	20p
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2N2222	20p
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2N3011	20p
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2N3390	25p
2N3391	20p
2N3391A	30p
2N3392	17p
2N3393	15p
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2N3606	27p
2N3607	22p
2N3638	18p
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2N3641	18p
2N3642	18p
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2N3859	27p
2N3859A	32p
2N3860	30p
2N3866	150p
2N3877	40p
2N3877A	40p
2N3900	37p
2N3900A	40p
2N3901	97p
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2N3905	30p
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2N4061	12p
2N4062	12p
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2N4254	42p
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2N4289	17p
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2N5305	37p
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2N5310	42p
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2N5355	27p
2N5356	32p
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28501	32p
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3N128	70p
3N140	77p
3N141	72p
3N142	55p
3N143	67p
3N152	87p
40050	55p
40250	50p
40251	32p
40309	32p
40310	45p
40311	35p
40312	47p
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40316	47p
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40319	55p
40320	47p
40323	32p
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40410	62p
40412	50p
40467A	57p
40468A	35p
40528	72p
40600	57p
40603	50p
AC107	30p
AC126	20p
AC127	24p
AC128	20p
AC151	18p
AC152	22p
AC154	22p
AC176	20p
AC187	25p
AC188	25p
ACY17	27p
ACY18	24p
ACY19	24p
ACY20	20p
ACY21	20p
ACY22	10p
ACY28	17p
ACY39	47p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	47p
AD149	47p
AD150	62p
AD161	35p
AD162	35p
AF109	45p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF121	30p
AF124	22p
AF125	15p
AF126	19p
AF127	19p
AF139	28p
AF178	42p
AF179	45p
AF180	50p
AF181	47p
AF186	39p
AF239	30p
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AF280	47p
AFZ11	32p
ASY26	25p
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ASY29	27p
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BC114	15p
BC115	15p
BC116	15p
BC118	15p
BC119	30p
BC121	20p
BC122	20p
BC125	15p
BC126	20p
BC134	12p
BC135	12p
BC136	15p
BC137	15p
BC138	20p
BC140	35p
BC141	35p
BC147	10p
BC148	10p
BC149	12p
BC152	17p
BC153	20p
BC154	20p
BC157	15p
BC158	11p
BC159	12p
BC160	35p
BC167	11p
BC168B	10p
BC168C	11p
BC169B	11p
BC169C	12p
BC170	12p
BC171	15p
BC172	15p
BC175	15p
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BC179	20p
BC182	10p
BC182L	10p
BC183	9p
BC183L	9p
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BC186	25p
BC187	27p
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BDY10	125p
BDY20	105p
BDY61	125p
BDY62	100p
BF115	25p
BF117	47p
BF152	23p
BF154	20p
BF158	15p
BF159	35p
BF163	35p
BF167	18p
BF170	33p
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BF196	15p
BF197	15p
BF198	15p
BF200	35p
BF224	15p
BF225	19p
BF237	20p
BF238	22p
BF244	22p
BFW61	47p
BFW87	25p
BFW88	23p
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BFX30	25p
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BFX44	37p
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BFX84	25p
BFX85	30p
BFX86	25p
BFX87	25p
BFX88	20p
BFX89	62p
BFX93A	70p
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BFY21	42p
BFY24	45p
BFY29	40p
BFY30	40p
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BFY43	62p
BFY50	20p
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BFY77	57p
BFY90	65p
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BSY28	17p
BSY29	17p
BSY32	25p
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BSY53	37p
BSY54	40p
BSY56	90p
BSY79	45p
BSY90	57p
BSY95A	12p
C424	15p
C450	15p
GET102	30p
GET113	20p
GET114	20p
GET118	20p
GET120	25p
GET873	12p
GET880	30p
GET887	20p
GET889	22p
GET890	22p
GET896	22p
GET897	22p
GET898	22p
MAT100	25p
MAT101	25p
MAT120	25p
MAT121	25p
MJ400	107p
MJ420	80p
MJ421	80p
MJ430	102p
MJ440	85p
MJ480	97p
MJ481	125p
MJ490	100p
MJ491	137p
MJE340	50p
MJE370	80p
MJE371	80p
MJE520	60p
MJE521	70p
MPF102	42p
MPF103	35p
MPF104	37p
MPF105	37p
MPS3638	32p
NKT124	42p
NKT125	27p
NKT126	27p
NKT128	27p
NKT135	27p
NKT137	32p
NKT210	30p
NKT211	30p
NKT212	30p
NKT213	30p
NKT214	20p
NKT215	22p
NKT216	35p
NKT217	40p

Type	Price
NKT219	30p
NKT223	27p
NKT224	22p
NKT225	22p
NKT229	30p
NKT237	35p
NKT238	25p
NKT240	27p
NKT241	27p
NKT242	20p
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NKT244	17p
NKT245	20p
NKT261	20p
NKT262	30p
NKT264	20p
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NKT274	20p
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NKT404	55p
NKT405	75p
NKT406	62p
NKT451	62p
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NKT453	47p
NKT713	20p
NKT717	42p
NKT734	27p
NKT736	35p
NKT773	25p
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OC75	22p
OC76	22p
OC77	30p
OC78	20p
OC81	20p
OC81D	20p
OC82	25p
OC82D	15p
OC83	25p
OC84	25p
OC139	25p
OC140	32p
OC170	25p
OC171	30p
OC200	40p
OC201	60p
OC202	75p
OC203	40p
OC204	40p
OC205	75p
OC206	95p
OC207	75p
OCP71	42p
ORP12	50p
ORP60	40p
ORP61	42p
P346A	22p
ST140	15p
ST141	20p
TI834	62p
TI843	40p
TI844	10p
TI845	27p
TI846	11p
TI847	11p
TI848	12p
TI849	12p
TI850	12p
TI851	10p
TI852	11p
TI853	22p
XB112	12p
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CA3012	88p
CA3013	105p
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CA3020A	160p
CA3021	156p
CA3022	130p
CA3023	126p
CA3026	100p
CA3028A	74p
CA3028B	105p
CA3029	87p
CA3029A	165p
CA3030	137p
CA3035	122p
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CA3042	109p
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CA3045	122p
CA3046	81p
CA3047	137p
CA3048	204p
CA3049	160p
CA3050	185p
CA3051	134p
CA3052	165p
CA3053	46p
CA3054	109p
CA3055	240p
CA3059	165p
CA3064	120p
FCH101	85p
FCH111	105p
FCH121	105p
FCH131	50p
FCH141	105p
FCH151	105p
FCH171	105p
FCH181	105p
FCH191	105p
FCH201	130p
FCH211	130p
FCH221	130p
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FJH251	25p
FJJ101	50p
FJJ111	50p
FJJ121	60p
FJJ131	60p
FJJ141	125p
FJJ181	75p
FJJ191	65p
FJJ211	125p
FJJ251	125p
FJL101	125p
FJY101	25p
IC10	250p
IC12	250p
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L914	40p
L923	40p
LM380	122p
MC724P	60p
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MC792P	66p
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MC1552G	461p
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PA246	150p
PA424	235p
PA264	190p
PA265	200p
SN7400	20p
SN7401	20p
SN7402	20p
SN7403	20p
SN7404	20p
SN7405	20p
SN7406	80p
SN7408	20p
SN7409	20p
SN7410	20p
SN7411	23p
SN7413	30p

Type	Price
SN7420	20p
SN7430	20p
SN7440	20p
SN7441AN	75p
SN7442	75p
SN7446	100p
SN7447	135p
SN7448	125p
SN7450	20p
SN7451	20p
SN7453	20p
SN7454	20p
SN7460	20p
SN7472	30p
SN7473	40p
SN7474	40p
SN7475	45p
SN7476	45p
SN7483	87p
SN7486	33p
SN7490	87p
SN7492	87p
SN7493	87p
SN7495	87p
SN7496	87p
SN74107	58p
SN74153	135p
SN74154	200p
SN74160	180p
SN74161	260p
SN74164	220p
SN74165	225p
SN74192	175p
SN74193	175p
TAA241	162p
TAA242	425p
TAA243	150p
TAA263	75p
TAA293	97p
TAA300	175p
TAA310	125p
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6AG7	40p
6AK5	35p
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6AT6	35p
6AU6	25p
6AV6	30p
6BA6	25p
6BE6	30p
6BH6	75p
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6SA7	40p
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6SK7	45p
6SL7	35p
6SN7	35p
6SQ7	40p
6U4	65p
6V6G	25p
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6X5GT	40p
10C2	50p
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30L17	80p
30P12	80p
30P19	85p
30PL1	75p
30PL13	93p
30PL14	90p
35L6	50p
35W4	35p
35Z4	35p
35Z5	50p
50B5	50p
50C5	50p
80	55p
85A2	50p
807	50p
1625	50p
5763	70p
6146	160p
AZ31	55p
CY31	35p
DAF91	30p
DAF96	45p
DF91	22p
DF96	45p
DK91	40p
DK92	55p
DK96	50p
DL92	35p
DL94	48p
DL96	45p
DM70	40p
DY86	32p
DY87	33p
E88CC	100p
E180F	100p
EABC80	35p
EAF42	35p
EB91	20p
EBC41	55p
EBC81	30p
EBF80	40p
EBF83	40p
EBF89	32p
EBL21	60p
EC86	60p
EC88	60p
ECC40	65p
ECC84	30p
ECC85	40p
ECC88	40p
ECF80	35p
ECF82	35p
ECF86	65p
ECH21	57p
ECH35	100p
ECH42	75p
ECH81	30p
ECH83	45p
ECL80	45p
ECL82	35p
ECL83	70p
ECL86	40p
EF37A	120p
EF39	50p
EF40	50p
EF41	65p
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EF80	25p
EF85	35p
EF86	30p
EF89	28p
EF91	30p
EF92	35p
EF183	35p
EF184	35p
EH90	40p
EL34	50p
EL33	125p
EL41	60p
EL42	55p
EL81	55p
EL84	25p
EL85	45p
EL91	35p

Type	Price
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EM80	45p
EM81	60p
EM84	35p
EM85	100p
EM87	70p
EY51	40p
EY86	40p
EY87	42p
EZ40	55p
EZ41	50p
EZ80	27p
EZ81	29p
GZ32	48p
GZ34	60p
KT66	205p
KT88	200p
MU14	75p
PABC80	40p
PC86	60p
PC88	60p
PC97	45p
PC900	48p
PCC84	40p
PCC85	40p
PCC88	55p
PCC89	60p
PCC189	55p
PCF80	30p
PCF82	34p
PCF84	40p
PCF86	60p
PCF800	80p
PCF801	50p
PCF802	50p
PCF805	80p
PCF806	70p
PCF808	75p
PCL82	35p
PCL83	65p
PCL84	45p
PCL85	40p
PCL86	45p
PFL200	65p
PL36	55p
PL81	50p
PL82	45p
PL83	45p
PL84	40p
PL500	75p
PL504	80p
PY32	55p
PY33	63p
PY80	40p
PY81	30p
PY82	35p
PY83	38p
PY88	40p
PY800	40p
PY801	50p
U25	80p
U26	80p
U50	40p
U52	35p
U191	75p
U281	40p
U282	40p
U301	40p
U801	180p
UABC80	40p
UAF42	55p
UBC41	50p
UBC81	40p
UBF80	40p
UBF89	35p
UCC84	49p
UCC85	40p
UCF80	55p
UCH21	60p
UCH42	70p
UCH81	40p
UCL82	35p
UCL83	60p
UF41	60p
UF80	35p
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AA119	7p	BAY31	7p	OA9	10p
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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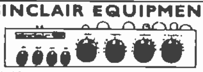

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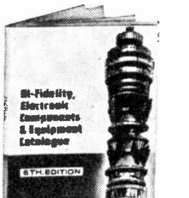

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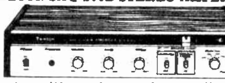

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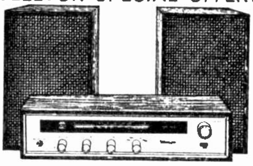

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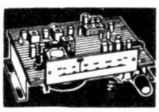

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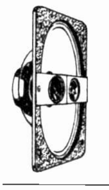

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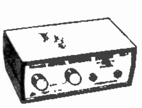

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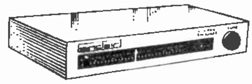

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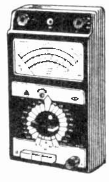

Extremely sturdy instrument for general electrical use. 667 o.p.v.
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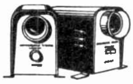

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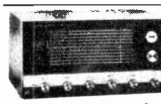

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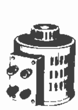

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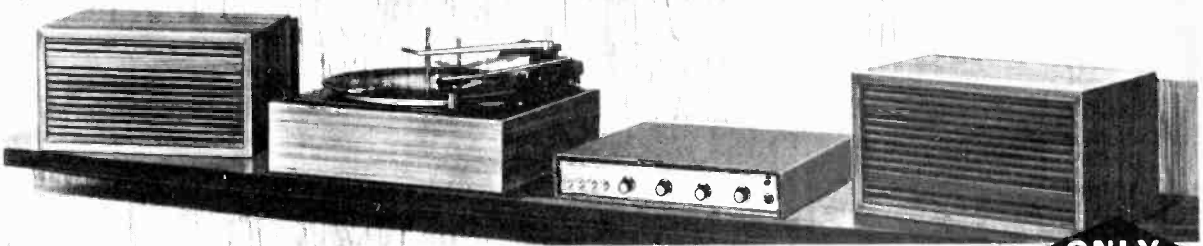

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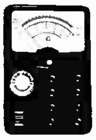

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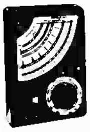

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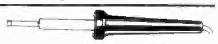

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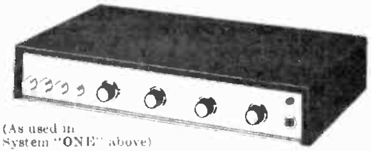

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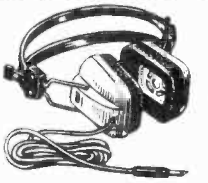

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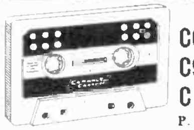

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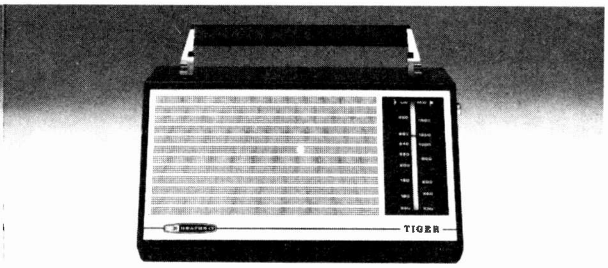

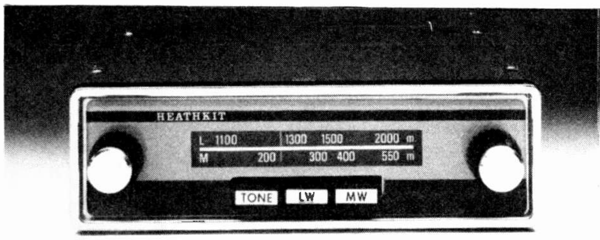

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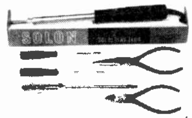

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VOL. 8 No. 5
May 1972

PRACTICAL ELECTRONICS

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ESSENTIAL SERVICE

With commendable boldness and confidence in the future growth of telecommunications for domestic purposes, the Post Office is currently involved in the installation of a "communication main" system in the new city of Milton Keynes, now arising in Buckinghamshire. Every house in the new city will be linked to this communication system. The cables will, so far as possible, be laid in a communal trench, with the other essential services, water, gas, electricity, and drainage.

A standard telephone pair forms part of this "main". This cable is accompanied throughout, right up to every front door, by a high performance coaxial cable. Besides being capable of carrying radio and television signals, this widebrand coaxial cable provides for the transmission of two-way signals such as could be employed to operate viewphones and computer data terminals, and permits the carrying out of other useful functions, like the remote reading of gas and electricity supply meters.

What happens in Milton Keynes *may* become the pattern for the future throughout the country. At any rate, this pioneer installation is worth noting and musing upon.

The advancement of computerised data techniques makes it fairly safe to conjecture that the day will come when every home will be able to have access to a wide range of data services, via sophisticated readout devices. But in the meanwhile, it would seem that further technical improvements are necessary, mainly to overcome the shortcomings of human operators, to make these advanced amenities fully acceptable to the general user.

At present, many people have a rather jaundiced view of computers, usually based upon their experience of incorrect statements of account issued by public supply authorities and other business concerns. The prevailing public mistrust of computerisation (however falsely based) does not provide the ideal climate for introducing more extensive and more complex computerised data systems; especially if these are to be linked directly with our homes to perform (above all!) such functions as the remote reading of domestic gas and electricity meters.

Elevation of the "communication main" to an essential domestic service status would certainly provide a great fillip to the electronics industry. It could herald another technological explosion making direct impact upon the domestic or "consumer" section. We don't doubt that fertile minds will seize eagerly the opportunity it promises for further imaginative and useful exploitation of electronics.

F.E.B.

THIS MONTH

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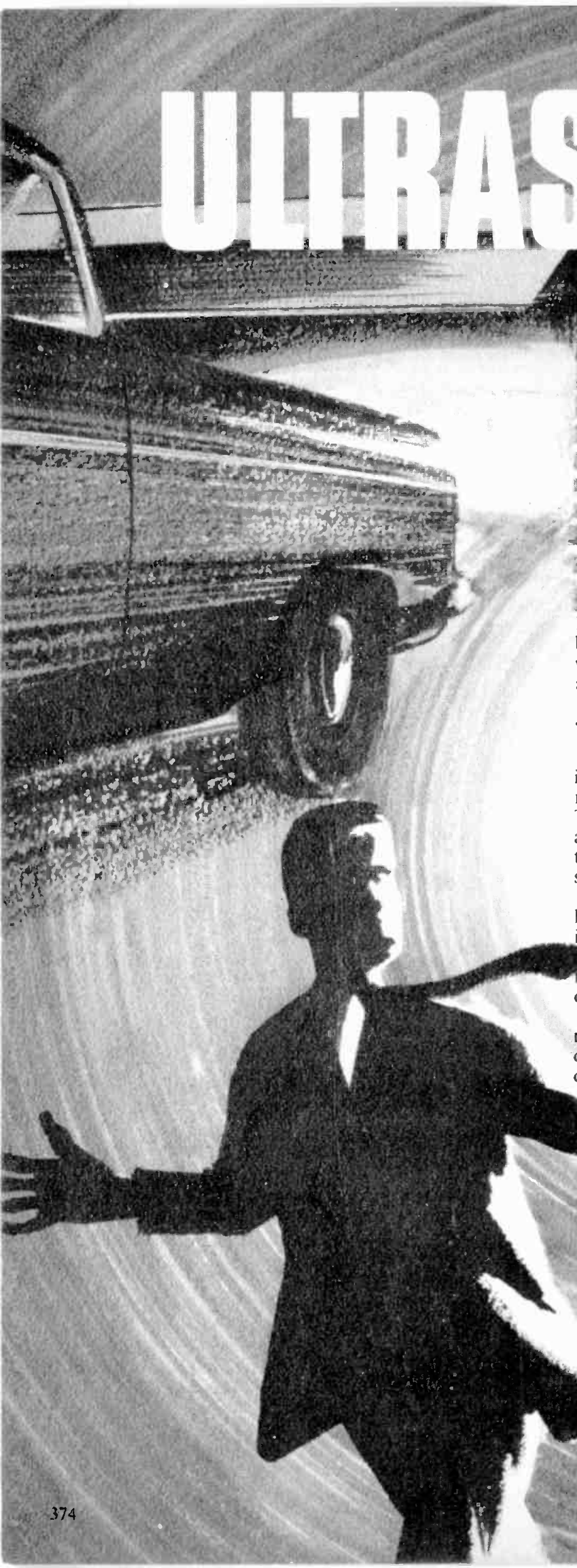
ULTRASONIC TRANSMITTER RECEIVER



By J. B. DANCE, M.Sc.

One might expect that it would be very expensive to generate and detect ultrasonic waves. However, this article shows that simple circuits can be used to construct a portable low-power system which has many applications for both the amateur and industrial user.

TRANSDUCERS

The transducers used with the circuits described in this article contain piezo-ceramic elements which resonate at the ultrasonic frequency to be employed. They are essentially like loudspeakers which operate at one particular narrow band of frequencies above the audible range and they are therefore given the same circuit symbol as a loudspeaker.

The equipment to be described employs two similar transducers, one in the transmitter and the other in the receiver. These two transducers must resonate at approximately the same frequency, but they do not have to be specially selected so that they match one another in frequency.

The transducers chosen for the prototype equipment are the relatively new type 808-40 which operate at about 40kHz. When an electrical signal of about this frequency is applied to a transducer,

SOME TYPICAL APPLICATIONS—

ultrasonic waves of the same frequency are emitted through the small metal grille in the face of the transducer. If these waves fall on another transducer, a 40kHz electrical signal will be generated across the terminals of the second transducer. This signal may be amplified, rectified and used to operate a relay. The relay contacts can then be used to actuate any other type of device.

THE TRANSMITTER

The circuit of a simple transmitter which will generate an ultrasonic beam is shown in Fig. 1. It consists of a simple astable multivibrator which employs two low current *npn* silicon transistors.

The preset potentiometer, VR1, can be used to adjust the frequency of oscillation of the circuit so that it matches the resonant frequency of the transducer; maximum power output is then obtained from the unit. Details of the adjustment of this potentiometer will be discussed later.

The circuit shown applies a rectangular waveform of about 8·5V amplitude to the transducer. This is quite suitable for most applications, but the use of a higher supply voltage with suitable transistors in the same circuit will provide a greater power output

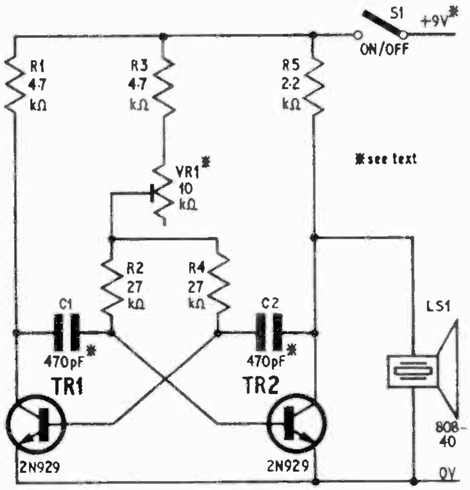


Fig. 1. Circuit diagram of the ultrasonic transmitter. The values of the components are those for a 40kHz transducer

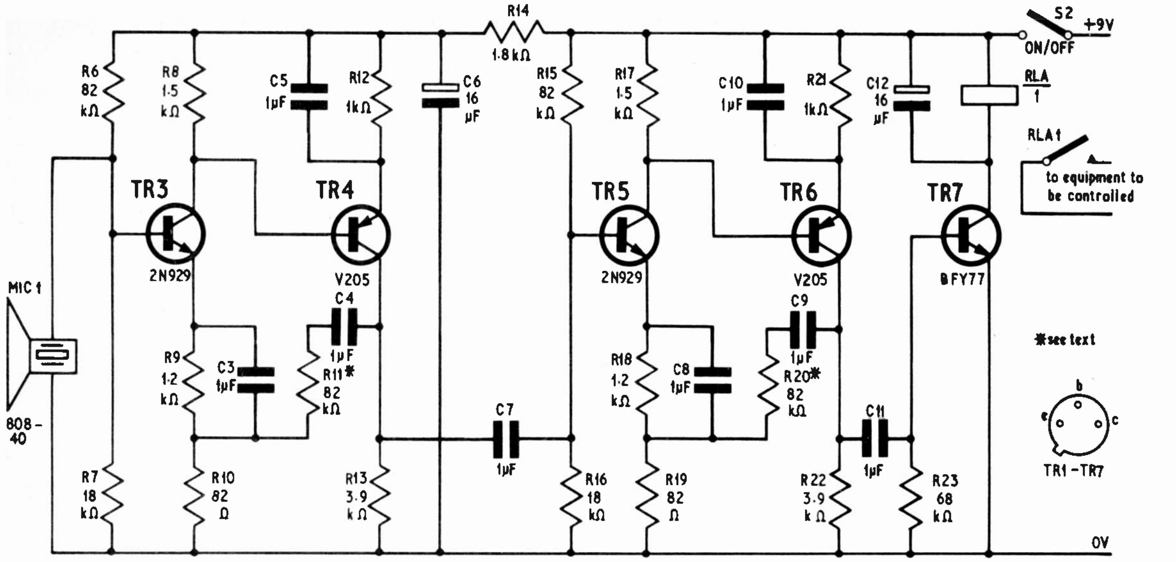


Fig. 2. Circuit diagram of the ultrasonic receiver. The values of the components marked with an asterisk can be altered if a reduced range is required

and therefore an increased range of operation. The maximum permissible voltage which can be applied to the "808" transducers is 20V r.m.s. with continuous operation or 30V r.m.s. under pulsed conditions.

The prototype took a current of 3·7mA from a 9V supply, but with an 18V supply the current was 7·5mA.

THE RECEIVER

The circuit of the receiver used in the prototype equipment is shown in Fig. 2. It is not necessary to employ a frequency selective amplifier, since the transducer itself will respond only to those ultrasonic frequencies which are near to its resonant frequency. The receiver is quite insensitive to loud audible noise.

The transducer converts the incoming energy into a signal which is amplified by transistors TR3 and TR4 in the first amplifier stage. The output from this circuit is coupled through C7 to a second similar amplifier stage containing TR5 and TR6. The output from TR6 is an alternating signal of the same frequency as the incoming ultrasonic waves. This signal is applied to the base of TR7 through C11.

Positive going parts of the signal drive TR7 into conduction and cause a current to pass through the reed relay coil in the collector circuit of this transistor. No bias is applied to TR7; the collector current of this transistor is therefore normally very small and it will be unaffected by negative going pulses applied to its base.

The circuit of TR7 thus acts as a rectifier or demodulator of the amplified 40kHz signal. When ultrasonic energy falls on the receiver transducer, the rectified current passes through the relay coil and TR7. If the intensity of the ultrasonic waves exceeds a certain limiting value, this current is great enough to cause the relay to close. The value of the limiting intensity is set by the sensitivity of the transducer, the gain of the two amplifier stages, the current gain of TR7 and the relay sensitivity.

FEEDBACK RESISTORS

The gain of each amplifier stage is determined by the current gain of the two transistors used and by the value of the feedback resistor (R11 or R20). If a value of 82 kilohms is employed for each of these feedback resistors, the amplification obtained with high gain transistors will approach the maximum which can be obtained with stability.

Lower values, such as 27 kilohms, can be used if the transmitter and receiver are to be used with a maximum separation of some 10 to 15 feet. Indeed, if the units are to be placed fairly close together, a lower value of feedback resistor may be necessary to prevent the operation of the relay by stray scattered radiation from the transmitter.

When no ultrasonic energy was incident upon the transducer in the receiver, the first two stages of amplification (TR3 to TR6) consumed a total of 2·4mA, whilst the current in the output transistor was very small. However, if the receiver transducer was placed very close to the transmitter transducer, the first two amplifier stages passed a total of 3·7mA, whilst the total receiver current increased to about 10·5mA.

COMPONENTS

Five *npn* and two *pnp* small signal silicon transistors are required. All of the transistors used in the receiver should have a fairly high current gain (at least about 50, but preferably over 100).

The *npn* transistors used in the prototype at first were the medium gain type 2N929, but many other types (such as those shown in the components list) are equally suitable. Similarly two medium gain *pnp* transistors type V205 were employed in the prototype, but other possible type numbers are given in the components list.

The medium gain transistors were subsequently replaced with transistors of a far higher gain (the *npn* type 2N2484 and the *pnp* type 2N2605) in order to carry out experiments on the maximum reliable range of operation. The circuit worked well with both sets of transistors.

The two capacitors C1 and C2 in the transmitter may be mica or polystyrene types, but it is best to avoid the uses of ceramic types intended for decoupling applications in this position, since they may have a value of 50% or more above their marked value.

THE REED RELAY

The reed relay used in the prototype is fully encapsulated in a moulded outer case for use in the temperature range 0 to 70°C. The contacts close with 3·5V or less across the coil, so one may take 4·5V as being the minimum operating voltage in order to allow for tolerances or a low battery voltage.

It was found that the contacts of the CPR1/J closed at a current of 2·8mA and re-opened when the current fell to 1·8mA; this difference prevents the relay "chattering" when minor fluctuations take place in the ultrasonic beam intensity.

The CPR1/J has one pair of normally open contacts which can switch up to 10W of power to a device which does not require more than 200V nor more than 0·5A.

It should be noted that tungsten filament lamps have a much lower resistance when cold than when hot and therefore a relatively large current flows when they are first switched on. Thus relay contacts rated at 0·5A maximum should not be used to switch on a lamp rated at more than about 0·05 to 0·1A of normal running current unless a suitable thermistor is placed in series with the lamp to reduce the current surge at switch-on. Care should also be taken to suppress transient voltages or currents if the load is a reactive one, since the relay contacts may be damaged.

HIGHER POWER CONTROL

If it is necessary to control more power than the miniature reed relay in the receiver is capable of switching, it is only necessary to use the contacts of the reed relay to control the current to a larger relay in an auxiliary circuit. (It would also be possible to re-design the output stage of the receiver so that a suitable transistor is used to control a larger relay, but in this case more current would be taken from the receiver battery.)

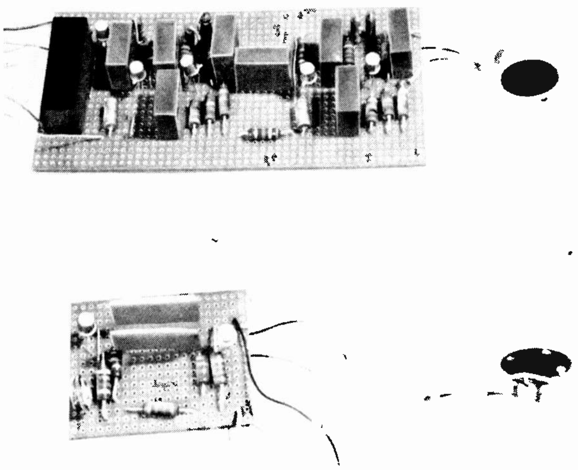
CONSTRUCTION

The transmitter was constructed on a small piece of Veroboard as shown in Fig. 3.

In the case of the receiver board, see Fig. 4, it is obviously necessary to keep the input circuit well away from the output section, hence the layout follows the theoretical circuit fairly closely. The row of cuts down the centre of the board is to provide some isolation between the input and output stages.

It is not essential to place each of the units in metal boxes but some form of box will normally be used for convenience.

The transmitter was placed in a diecast box together with a large battery. This enables the transmitter to be used for long periods without frequent replacement of the battery. If the transmitter is to be used in remote control applications where it will only be on for a few minutes a day, then a small battery (say a PP3) and hence a smaller box (e.g. a plastic torch case) will be more convenient.



The transmitter and receiver boards with the transducers before installation in their cases

STRAY PICKUP BY RECEIVER

If the receiver is not placed in a metal enclosure it has been found that about 0·5mA will pass through the relay even when the transmitter is not near. This is due to stray pickup by the high gain receiver circuit. Thus it is advisable to use a metal case with the negative line of the battery connected to the case. The quiescent current in the relay should then be very small. Incidentally the prototype receiver became unstable when the transducer was disconnected from the input even when a metal enclosure was used.

A flexible copper strip was used to hold the transducers in place. The holes in the lids of both units were made slightly smaller than the transducer so that some protection is given. Reasonable care should be taken when soldering to the transducers. It is important that the grounded pin of the transducer (shown by the adjacent metal tab) should be connected to the negative supply line; this is doubly important if a metal box is used as the transducer may be shorted out.

A small piece of foam rubber on the battery was found to be enough to hold the battery firmly when the lid is screwed down.

TESTING AND ADJUSTMENT

When the two units have been assembled, the system should be tested by placing the transducers in the two units face to face and close together. The relay in the receiver should close when both units are switched on. If it does not do so, the potentiometer VR1 should be adjusted (fairly coarsely) until the relay closes. (An ohm-meter may be connected to the relay contacts to ascertain when they close.)

If the relay still will not operate, some tests of the following type may be carried out in order to localise the fault. The transmitter unit may be tested by disconnecting the output of the circuit from the transducer and feeding this output to an a.c. voltmeter (or, preferably, an oscilloscope).

If it is found that the transmitter circuit is working, the negative power supply lines of the two units may be joined and C11 disconnected from TR6. If the output from the collector of TR2 is fed to C11 (and hence to TR7), the relay should close when both units are switched on; in this case the transmitter circuit and the output circuit of the receiver are satisfactory.

With the negative power supply lines still connected, the output from TR2 may be fed through a 0·01μF capacitor to the junction of C7 and R16; if the relay closes, the circuits of TR5, TR6 and TR7 are probably satisfactory.

If the whole receiver is functioning, the relay will close if the input wire is held between the fingers.

TRANSMITTER ADJUSTMENTS

The adjustment of the potentiometer in the transmitter is carried out more easily if a 0 to 10mA meter is connected in series with the relay coil. The transmitter and receiver should be separated and/or the transducers placed at an angle to one another so that a reading of 1 to 3mA is obtained. The potentiometer should then be adjusted so that the meter reading increases.

If necessary the units should be separated further to keep the meter current at 1 to 3mA and the potentiometer again adjusted for maximum sensitivity. Finally the transmitter should be switched off and then on again to check that the oscillator starts to function at the chosen potentiometer setting. If it does not do so, a small adjustment of the potentiometer should be made towards a lower resistance value.

OPERATING RANGE

When medium gain transistors were employed in the prototype and the value of the feedback resistors were both 82 kilohms, it was found that the maximum distance for reliable operation was some 15 feet in the open air. However, this distance was increased to some 45 feet in the open when using transistors of higher gain.

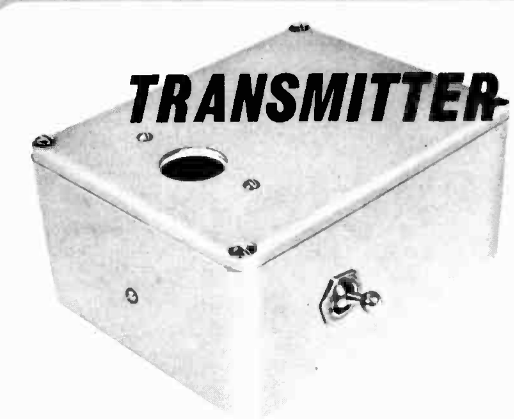
If the equipment is used in a room or in a corridor, it is found that the range of reliable operation is considerably increased. This is mainly accounted for by reflections of ultrasonic energy from the walls towards the receiver, but effects due to wind are normally avoided inside a building and this reduces random fluctuations of the current in the relay coil.

The maximum range of reliable operation inside a building may easily be double that in the open air, but much depends on the arrangement of the objects in the building and of the ability of the walls, etc. to reflect ultrasonic energy.

Still greater ranges may be obtained by applying a higher power supply voltage to the transmitter circuit provided that the transistors used in the transmitter are suitable. For example, the writer has found that an operating range of up to about 60 feet can be obtained in the open by using an 18V transmitter supply with the Fig. 1 circuit and transistors of moderately high gain in the receiver.

SHORT RANGE OPERATION

The writer has found that the first amplifier stage (TR3 and TR4) of the receiver may be omitted if the distance between the two units is to be very small. In this case C7 is disconnected from the base circuit of TR5 and the non-earthy lead of the transducer is connected to the junction of R15, R16 and the base of TR5. The decoupling components C6 and R14 can then also be omitted.



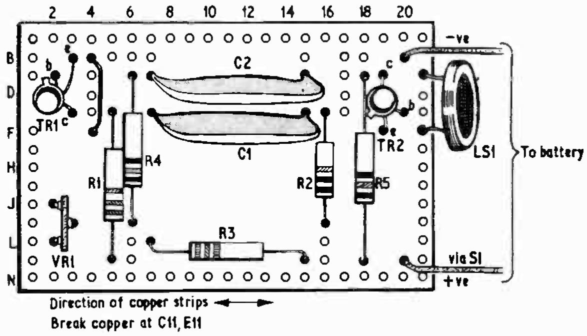


Fig. 3. Layout of the components on the transmitter board

COMPONENTS . . .

ULTRASONIC TRANSMITTER

Resistors
R1 4·7kΩ
R2 27kΩ
R3 4·7kΩ
R4 27kΩ
R5 2·2kΩ
All ±10%, ¼ watt carbon

Potentiometers
VR1 10kΩ miniature skeleton preset

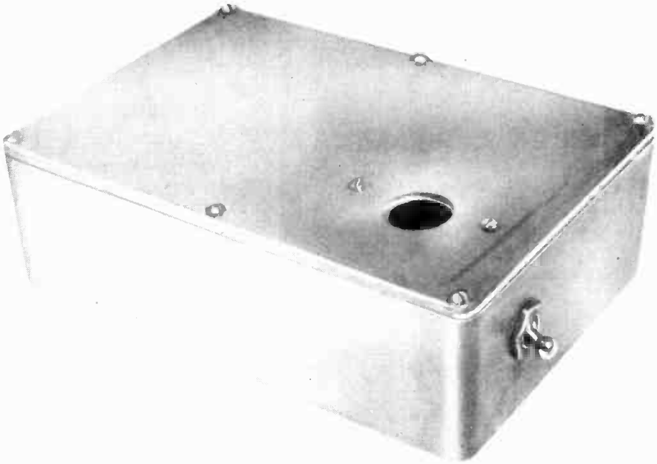
Capacitors
C1, C2 470pF silver mica *or* polystyrene

Transistors
TR1, TR2 2N929 *or* any similar *npn* high gain, low current type (e.g. BC108, BC148, BC184L, BFY77, 2N2484, ZTX108, ZTX109) (2 off)

Transducer
LS1 808–40 type 40kHz transducer (Hall Electronics, 48 Avondale Rd., Leyton, London, E.17) *or* Gulton type 1404 (from LST Components Ltd., Coptfold Road, Brentwood, Essex)

Miscellaneous
S1 Single pole on/off switch
0·1in matrix Veroboard 2¼in × 1½in
9 volt battery
4½in × 3½in × 2in diecast metal box

RECEIVER



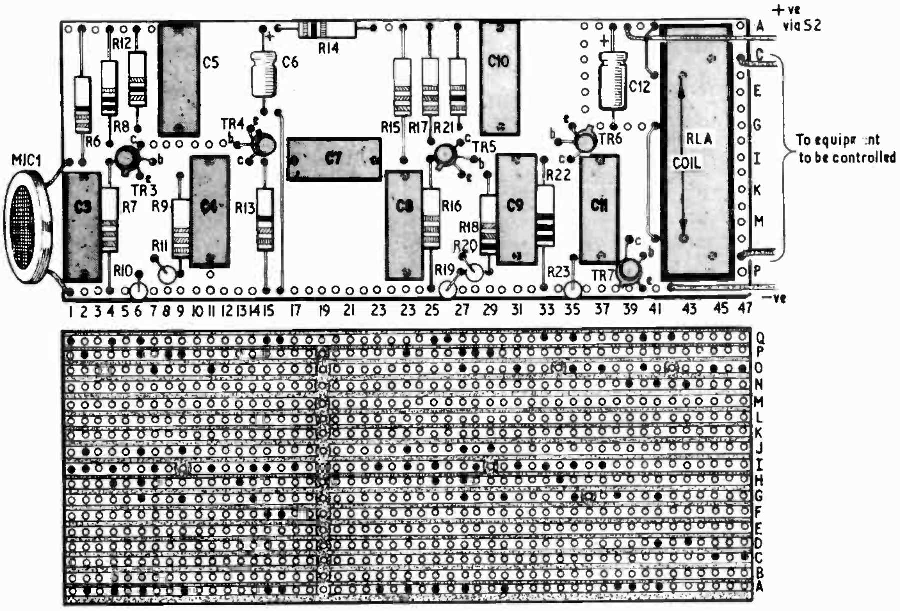


Fig. 4. Layout of the components on the receiver board

COMPONENTS . . .

ULTRASONIC RECEIVER

Resistors

R6	82kΩ	R15	82kΩ
R7	18kΩ	R16	18kΩ
R8	1·5kΩ	R17	1·5kΩ
R9	1·2kΩ	R18	1·2kΩ
R10	82Ω	R19	82Ω
R11	82kΩ	R20	82kΩ
R12	1kΩ	R21	1kΩ
R13	3·9kΩ	R22	3·9kΩ
R14	1·8kΩ	R23	68kΩ

All ±10%, ¼W carbon

Capacitors

C3 to C5 1μF polyester (3 off)
C6 16μF, electrolytic 10V
C7 to C11 1μF polyester (5 off)
C12 16μF electrolytic 10V

Transistors

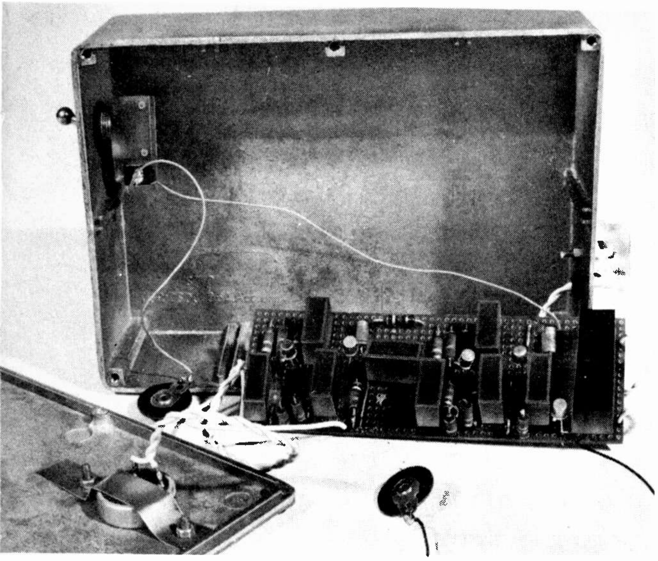
TR3, TR5 2N929 *or* similar (see TR1, TR2 in transmitter) (2 off)
TR4, TR6 V205 *or* any similar *pnp* high gain, low current type (e.g. BC158, BC214L, 2N2605, 2N3798, 2N3964, 2N4062, ZTX501, ZTX530) (2 off)
TR7 BFY77 *or* similar high gain, low current *npn* type

Transducer

MIC1 808–40 type 40kHz transducer

Miscellaneous

RLA Reed relay close current 2·8mA at 3·5V. Type CPR1/J (Alma Components)
S2 Single pole on/off switch
0·1in matrix Veroboard 4·8in × 1·8in
9 volt battery
6¾in × 4¾in × 2$\frac{5}{32}$in diecast metal box



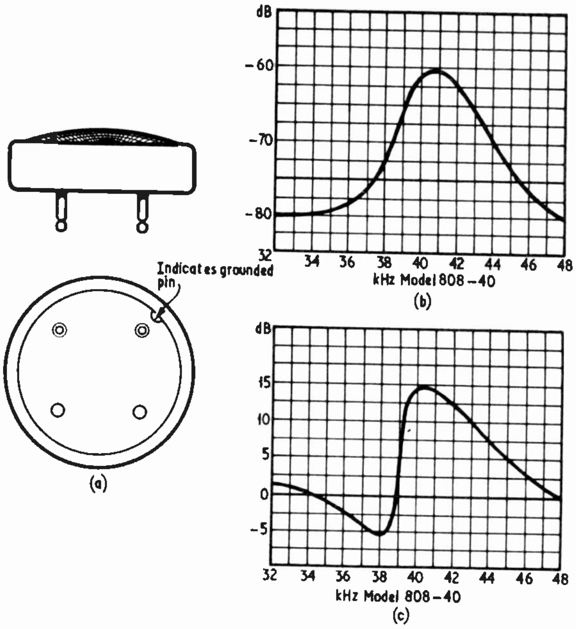


Fig. 5. The 808-40 transducer. (a) The metal tab indicates the grounded side of the transducer; (b) The acoustic response of the 808-40; (c) The electrical response of the 808-40

It was found that the maximum working range with such a simplified receiver is about 9 inches with medium gain transistors in the receiver and about 2 to 3 feet with high gain transistors.

If an 18V transmitter power supply is used, the maximum range is increased to 4 to 5 feet with the simplified receiver. It is assumed that readers will normally wish to construct the full receiver circuit of Fig. 2, since it is far more versatile than the simplified version.

Ultrasonic waves are much more directional than waves of audible sound, since they have a shorter wavelength. It has been found that if a receiver with high gain transistors is employed, the relay will close when a transmitter is placed almost anywhere in the same small room even if the two transducers are not facing one another. This is due to the reflection of waves from the walls of the room. When used in the open air, the transmitter and receiver can be placed quite close together without the relay closing, provided that the transducers do not face one another (nor nearly face one another).

TYPES OF TRANSDUCER

The circuits described in this article can also be used with the 1405 type of transducer for 40kHz operation, in which case standard phone plugs will be required as connectors for each transducer. However, the 808-40 transducer was chosen for the prototype, since it is smaller and of more recent design than the 1404 and has a somewhat greater sensitivity (about 6db) when used as a receiver. Thus the 1404 should be used only when a plug-in transducer is required.

If it is desired to work at a lower frequency, the type 808-25 transducers may be used for 25kHz operation. This type is similar to the 808-40, but the value of each of the capacitors in the transmitter circuit must be increased to about 820pF so that the oscillator can operate at the correct frequency. No other circuit changes are required for 25kHz operation. The beam is not so directional as a 40kHz beam.

The acoustic response (i.e. sensitivity as a receiver) of the 808-40 is shown in Fig. 5b, whilst the electrical response (i.e. output power when used as a transmitter) is shown in Fig. 5c. It can be seen that bandwidths of the order of 1kHz can be obtained.

APPLICATIONS

Ultrasonic systems can operate over greater distances than most photoelectronic equipment and they have the advantage that their operation is unaffected by smoke or by dirt collecting on the transducers. In addition ultrasonic beams can detect transparent objects.

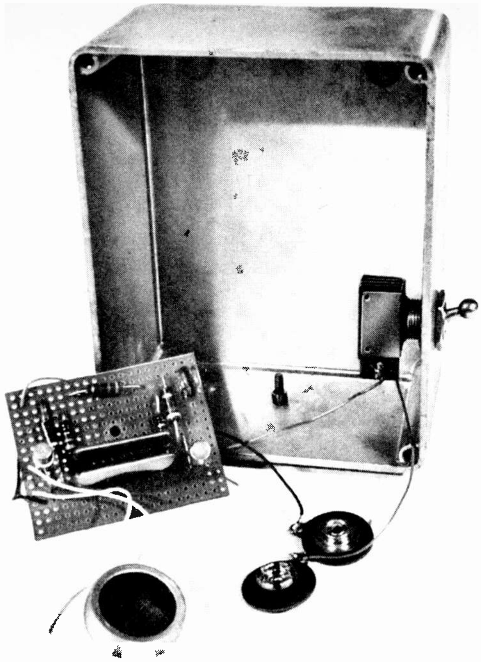
Although the range of ultrasonic equipment is less than that of radio control systems, no radio transmitting licence is required and the associated circuits are very simple. In general the ultrasonic beam will be found to be more directional than a radio beam but not so directional as the light or infra-red beam used in photoelectronic equipment.

INTRUDER ALARM

Ultrasonic waves do not pass through people. If the beam from a transmitter is directed onto the receiver, the relay in the latter will close. However, when a person's body interrupts the beam, the relay will open and this can be used to sound an alarm.

This type of alarm has the same advantage as that of an infra-red alarm, namely that the intruder cannot sense the radiation from the transmitter. Such a system will give a warning if the transmitter or receiver is moved appreciably by the intruder, if either unit is switched off or if either battery is disconnected.

In a practical intruder alarm of this type, the transmitter and receiver may be fairly close together. For example, the system may be used to monitor



a corridor. In such cases it may be necessary to use smaller values of the feedback resistors (R11 and R20) in the receiver circuit so that the sensitivity is insufficient for stray reflections from the walls to keep the relay closed when an intruder interrupts the main beam.

REMOTE CONTROL

In general the units described earlier can perform any remote switching operation over a distance within their operating range. The lazy man can use such a system to switch a radio or television receiver on and off without getting up from his chair.

The reed relay in the ultrasonic receiver can be used to operate a stepping switch which alternately switches the radio or television receiver on and off.

More complicated remote control applications can be devised for use in the home of the amateur experimenter. For example, one could have a receiver in a shed in the garden and use an ultrasonic beam to operate an aerial change over relay or any other device from the house.

A good practical man could mount a transmitter unit under the front bumper of his car and a receiver near to his garage door so that a pulse of the ultrasonic beam would cause the garage door to open automatically. When the motorist takes his car away next day, a similar pulse could be used to close the garage door after the car has been reversed out.

COMMUNICATION

If a morse key is connected in the power supply line of the transmitter, the equipment can be used for communication over short distances, for example, to a house across the other side of the road. The relay in the receiver could be used to control the current to an oscillator which produces the morse signal.

The bandwidth of the beam provided by the circuits described is too narrow for it to be possible to modulate this beam with speech, but it is presumably possible to use more complex equipment operating at a high frequency to carry speech by means of an amplitude modulated ultrasonic wave. However, the range may be very limited.

RANGING

Ultrasonic systems can be used to measure the range of objects which are not too far away. The time taken for a pulse from the transmitter to travel to the object and to be reflected back to a second transducer near to the transmitter is a measure of the distance of the object. Ultrasonic beams are employed in this way in the aids used by blind people.

Although the prototype equipment has not been used for range finding, there appears to be no reason why the transmitter should not be pulsed with power and the time interval between the transmitted and reflected pulses measured with a digital counter.

LEAK TESTING

The simple transmitter and receiver described in this article can be used to detect holes or leaks in the rubber sealing of objects such as car bodies and refrigerators. The transmitter is placed in the object to be tested and the door is closed. A detector employing a milliammeter in series with the relay is moved around the edges of the doors, windows, etc. to detect any leakage of ultrasonic energy.

INDUSTRIAL APPLICATIONS

The receiver of Fig. 2 can be used without any transmitter for the detection of leaks in either pressure or vacuum pipes, since such leaks generate ultrasonic waves. Leaks can be detected in this way even in the presence of the loud noise and vibration often found in industrial plant.

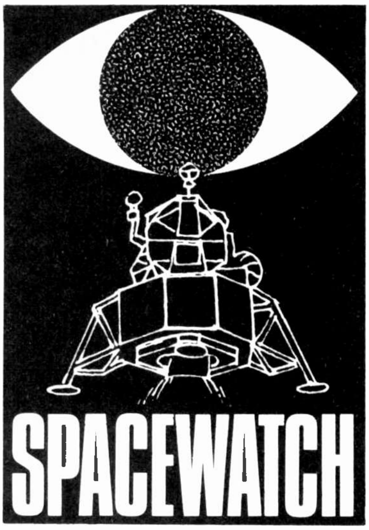
Ultrasonic beams can be used to detect the presence of an object, such as an item passing along a production line. Each item can be made to interrupt the beam to produce electrical pulses which can be counted. Alternatively the ultrasonic beam may be reflected off each object in turn. The circuits of Figs. 1 and 2 are very suitable for this application.

EDUCATIONAL APPLICATIONS

Numerous experiments can be carried out with ultrasonic waves which are suitable for educational use. For example, one may investigate the transmission and reflection of the waves by various materials.

The writer used the transmitter and receiver (at fairly low gain) on a bench top with the transducers facing each other and separated by a distance of about two feet. When an object such as one's hand was moved slowly towards the mid-point of the two transducers, a milliammeter connected in series with the relay coil of the receiver showed rapid fluctuations in its reading according to the position of the reflecting object.

This is due to interference between the waves travelling directly from the transmitter to the receiver and those taking the longer path to the reflecting object and then to the receiver. Maximum intensity occurs at the receiver when these two path lengths differ by a whole number of wavelengths. An experiment could be devised to measure the wavelength of the radiation. ★



BY FRANK W. HYDE

SOVIET AND AMERICAN CO-OPERATION

As a result of the co-operation in the exchange of samples of moondust from *Luna 16*, for *Apollo* samples, a considerable amount of new data has been obtained. It would appear that the dust forming the regolith at the landing site of *Luna 16* had not been disturbed for 3,000 million years. This site was in the Mare Fecunditatis and the dust shows an age (by radiation dating) nearly twice that of the dust recovered by *Apollo 11*. Some mechanism must exist for the transportation of dust if these measurements are reliable.

The specimens from the Soviet mission were from depths of 8cm and 28 to 32cm. There is evidence to indicate that this is about the thickness of the moondust in this area. The different teams working on this dust have produced a large number of papers and all seem in close agreement on their findings.

It seems from the electron microscopy and electron diffraction examination, that the radiation bombardment at the *Luna 16* site is very much greater than any of the material recovered from each of the *Apollo* missions.

One clue is that since the moon passes through the earth's magnetic tail for about four days every month, the right conditions could arise. The high energy electrons are sufficient to cause considerable disturbance of small grains. From this it follows that the most intense bombardment by the solar wind and other radiation would show on the other side of the moon, and that it could be there, that there would be least disturbance. If this is so, then the most disturbed area which has been noted for the *Apollo* sites offers new data about the earth's magnetic field and magnetosphere.

THE OTHER MOON

Little Toro, the earth's other moon, is in the limelight again. It will be making one of its near approaches in the next few years when it will come to within nine million miles from earth. Its period of orbit is some eight years.

It has been under close observation since it was discovered in 1964 and computers have been used to track its behaviour. Being only one mile in diameter it is not visible to the naked eye, even though it does reflect sunlight.

It could be very useful to astronomers if there was a possibility of examining its surface. Since it is not likely to attract meteoritic impact or collect cosmic debris because of its extremely low gravity, the surface should be little different from what it was early in the life of the solar system.

It is possible to get such information by using a remote controlled spacecraft. Such a craft would take about six months to make the trip. Support for such a venture has come from Nobel Prizewinner Hannes Alfven and he has suggested to NASA that this is a worth while project. If this should become a mission it would be suitable for early 1975.

As an exercise, the computer used to study the behaviour of Little Toro has checked the orbital behaviour for 200 years ahead and this shows little possibility of the moonlet getting out of hand and crashing into the earth.

NEWS FROM MARS

The wealth of information now being returned from *Mariner 9* has more than justified the project even though *Mariner 8* was lost. Many conjectures and theories regarding the red planet have had to be adjusted as a result of the present studies.

With more than 4,000 pictures already returned, much new data is revealed. The widely differing terrain is very apparent and consists of smooth craters and rough craters, large areas of furrowed and rugged surface, with many faults, channels and scarps. There are also signs of extensive and smooth lava flows.

The topography is such that it is difficult to explain the condition of branching channels which start in featureless areas, except by water erosion. It would seem that there is a continuing activity which suggests that the opinions of scientists based on the information of the previous *Mariners* have been radically revised.

After the results of 1969, Mars became of secondary interest to the moon. However, now it is back in favour. Its cratered surface shows young volcanoes and lava flows which have overlayed existing craters both volcanic and impact.

The ultraviolet spectrometer and the radiometer measurements have indicated that carbon dioxide is the predominant gas in the upper atmosphere and that the south pole is too warm for there to be a solid cap of carbon dioxide. It is also clear that the north pole could be cold enough to support solid carbon dioxide clouds which might precipitate carbon dioxide snow. At the present time the north polar cap controls the atmosphere.

MARS IN ICE AGE?

There is little similarity between the Martian atmosphere and the atmosphere of the earth. There is some atomic oxygen and some atomic hydrogen. The whole planet is surrounded by a cloud of hydrogen extending for about 25,000 miles from the surface. At heights of 90 to 100 miles the temperature is much lower than that at the same heights on earth.

The hydrogen envelope surrounding the planet increases as solar activity becomes more intense and consequently the sun must draw some 100,000 gallons of water from Mars through photodissociation.

It is possible that the planet may be in an ice age and so would have large quantities of water stored in the form of permafrost. Certainly, there is much more information to be disclosed during the years that it will take to process the data so far acquired. It is to be hoped that this will spur on the missions of manned landings to round off the knowledge accumulated from remote sensing.

As *Apollo 15* has demonstrated, in the final analysis it is the human direct observations which enable more precise conclusions to be drawn.

ORBITING SOLAR OBSERVATORY

The first photographs of a solar flare on the far side of the sun was recorded by *OSO-7*. The flare which was of type Class 2 projected some four million miles out from the sun. The photographs show the progress of the flare till its plasma clouds were sent into space at a speed of 600 miles a second.

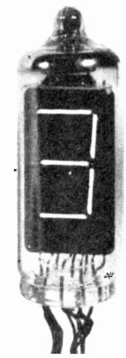
Each cloud, more than 150,000 miles in extent causes havoc to communications and triggers off auroral displays and magnetic storms when directed toward the Earth.

Even though the event recorded was in the opposite direction, some of its effects spilled round and was observed by Soviet, Australian and Phillipine radio telescopes.

ALPHA NUMERIC DISPLAYS

Part

By R.W. Coles



Incandescent Filament Displays

In the last two months we have seen how cold cathode tubes work and how their decoding and driving circuits are used. Whilst this type of tube has been the most widely used for many years, new technologies are now coming to the forefront of display systems design. Among these is the incandescent filament display. This type of display in its various forms is the subject of this month's article.

INCANDESCENT FILAMENT DEVICES

Many years of experience with incandescent filament bulbs, and the technology on which these are based, has lead, not surprisingly, to some very cheap and practical alpha-numeric readout systems, in a wide variety of ingenious designs.

Filament lamps have many advantages to fit them for display purposes: high brightness which can be controlled at will (unlike gas filled devices); long life (100,000 hours is now obtainable); and a wide range of working voltages making them simple to drive, especially important when i.c. drivers are contemplated.

Of course, there are a few disadvantages, of which heat generation is about the most serious, but all in all, filament lamps are so versatile and inexpensive that displays based on them are likely to continue in popularity for some time, despite competition from more advanced technologies.

As far as amateurs are concerned, there are already a fair number of device types available, and attention will be concentrated on these as far as possible.

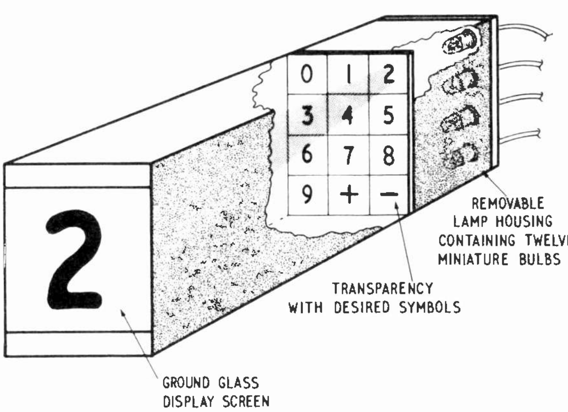


Fig. 3.1. A sectional view of a typical projection type indicator. Light from the selected bulb projects the image of the transparency onto the ground glass screen

DISCRETE CHARACTER TYPES

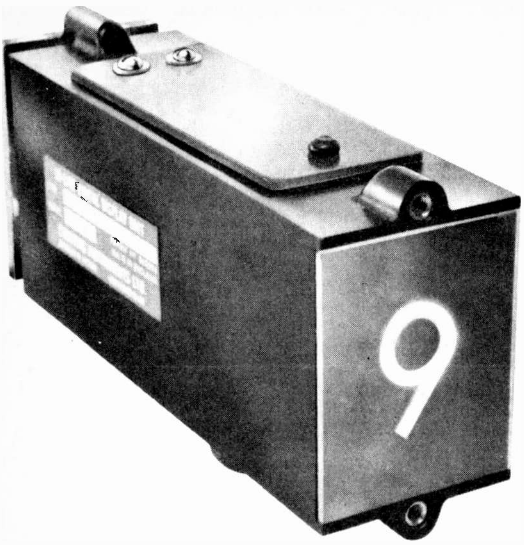
The discrete character format is very suitable for use with individual miniature bulbs, and there are many variations available. This format is preferred because of its inherent legibility, but all indicators employing it are more complex in construction than those using other schemes, and are also restricted in the character set which can be displayed.

PROJECTION TYPE

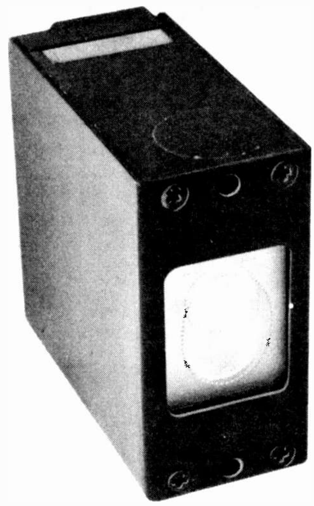
Fig. 3.1 shows a sectioned view of a typical projection type indicator, which can display twelve separate letters, numerals or symbols, depending on the transparency employed. Transparencies can be easily changed, as can the bulb holder which contains twelve individual l.e.s. lamps, the voltage ratings of which can be selected to suit the application.

In operation the selected character is illuminated by its associated lamp which may be driven by relay contacts or transistors, the illuminated section is then projected onto a ground glass screen at the front of the device where it gives a well defined image of reasonable brightness which can be in colour if required.

The complete indicator is rather long, though its frontal dimensions are very compact, making it possible to assemble multi-digit readouts with the minimum of panel space.



A rear projection type display unit. This type gives 1in characters using 6·3V pilot lamps. It will give all the numerals and a decimal point (supplied by Electronic Brokers Ltd.)



A digital indicator using the Perspex light-guide technique as described in Fig. 3.2 (supplied by Electronic Brokers Ltd.)

EDGE-LIT TYPE

Again using a battery of individual l.e.s. lamps, the edge-lit Perspex indicators really do seem clever. These indicators utilise the fact that Perspex can be made to act as a "light-pipe", transmitting the bulb illumination over quite long distances and round corners before directing it towards the observer.

Fig. 3.2 gives a rough idea of the layout of these devices, though only one Perspex sheet (and hence one character) is shown; the side view shows how the other sheets are arranged in their respective slots.

When the selected lamp is illuminated, some of the light is directed onto the edge of the high quality Perspex, and this is channelled over the top of the bulb holder block and down to the viewing area.

The light does not escape in any appreciable amount because of the difference in the refractive index between the Perspex and air, and because the angles of refraction inside the Perspex sheet are too shallow for much light to exceed the critical angle and escape.

The character to be displayed is formed on the Perspex sheet by etching a series of holes of the correct layout, and these discontinuities in the sheet cause the channelled light to be refracted out towards the observer at these points.

Note that a series of dots rather than a continuous figure must be used so that some of the channelled light can pass through the upper parts of the figure and be available to interact with the lower parts.

One noteworthy point is the obvious difference in path length between the front and the rear bulb slit, and its effect on the brightness of the rear sheet; this is neatly compensated by the fact that although the front bulb has to transmit over a short path in the Perspex, once it has been refracted at the dots it has to travel through ten or so other sheets to reach the observer; the long path length on the other hand does not travel through any other sheets after interacting with the dots.

These devices are similar in length to the projection type, but are rather taller, the display is reasonably bright and easily interpreted, but parallax problems restrict the viewing angle, a problem not shared by the previous type.

GENERAL ADVANTAGES

Both the discrete character types discussed have the advantage of almost unlimited life since if a lamp fails it can be speedily replaced, a factor

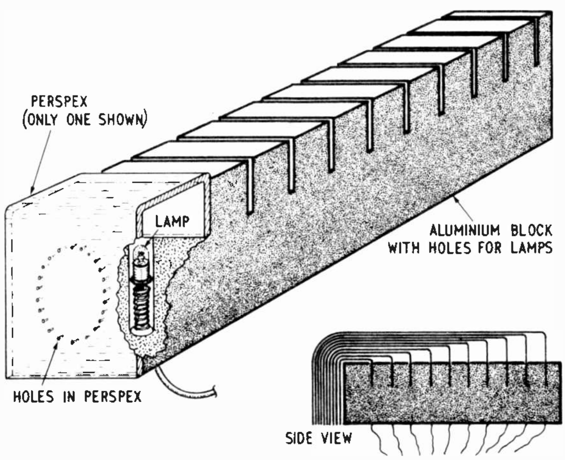


Fig. 3.2. An edge-lit indicator. Light from the selected bulb passes along the Perspex sheet and is refracted by the etched holes for viewing. The smaller drawing shows how the Perspex sheets are arranged

look! electronics really mastered

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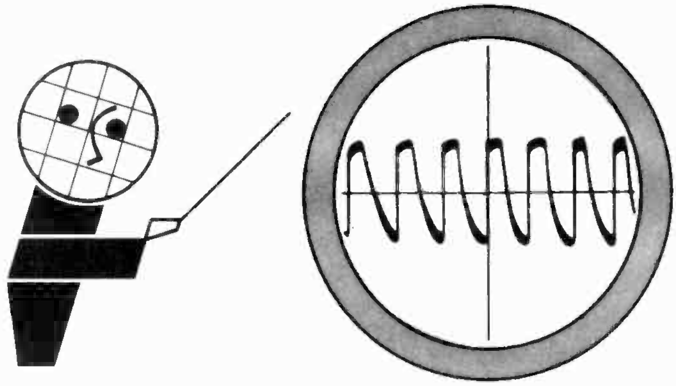
...visual
...exciting!

no previous knowledge
no unnecessary theory
no "maths"



RAPY

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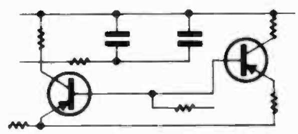

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1N5407	45p	2N3705	13p	40512	195p	ASY26	27p	BC259	9p	300R	38p	OC35	60p
1S44	9p	2N3706	13p	40602	52p	ASY27	36p	BC267	17p	C407	17p	OC36	65p
1S940	5p	2N3707	13p	40669	140p	ASY28	27p	BC268	15p	C762	19p	OC41	42p
2N696	17p	2N3708	10p	AC107	46p	ASY29	36p	BC269	17p	C1412	102p	OC42	46p
2N697	18p	2N3709	11p	AC126	20p	AU111	97p	BC300	49p	E2512	164p	OC44	42p
2N706	12p	2N3710	13p	AC127	20p	B30C250	24p	BC301	37p	EA403	10p	OC45	38p
2N930	21p	2N3711	13p	AC128	20p	B30C550/		BC303	60p	EB383	10p	OC70	21p
2N1131	29p	2N3731	120p	AC141H	34p	300	34p	BCY30	60p	EC401	18p	OC71	38p
2N1132	29p	2N3794	15p	AC141HK	37p	B1912	66p	BCY31	75p	EC402	17p	OC72	38p
2N1302	19p	2N3819	23p	AC142H	25p	B5041	72p	BCY70	18p	ER900	54p	OC75	40p
2N1303	19p	2N3820	53p	AC142HK	29p	BA102	25p	BCY71	33p	MC140	25p	OC81	25p
2N1304	26p	2N3904	35p	AC153K	22p	BA130	22p	BCY72	15p	MJ481	120p	OC81D	25p
2N1305	26p	2N3906	35p	AC176	16p	BA145	27p	BD121	105p	MJ491	135p	OC83	25p
2N1306	33p	2N4036	55p	AC176K	17p	BA155	15p	BD123	105p	MJ371	108p	OC84	25p
2N1307	33p	2N4058	13p	AC187K	17p	BA156	13p	BD124	100p	MJE521	92p	P346A	26p
2N1308	36p	2N4059	10p	AC188K	23p	BAX13	13p	BD130	50p	MJE2955	165p	S2CN1	10p
2N1309	36p	2N4060	11p	*AC187K/		BB103/B	16p	BD131	79p	MJE3055	82p	SC141D	187p
2N1596	102p	2N4061	11p	188K	40p	BB103/G	16p	BD132	86p	MPF102	37p	SC146D	247p
2N1599	122p	2N4062	12p	ACY17	31p	BC107	12p	BD135	38p	MPS6531	35p	SD1	10p
2N1613	23p	2N4124	18p	ACY18	19p	BC108	11p	BD136	44p	MPS6534	30p	SD4	12p
2N1711	26p	2N4126	27p	ACY19	23p	BC109	12p	BD141	227p	NKT211	25p	V763	28p
2N1893	54p	2N4284	24p	ACY20	20p	BC122	21p	BDY20	92p	NKT212	25p	W106B1	45p
2N2147	95p	2N4286	15p	ACY21	21p	BC125	15p	BF115	23p	NKT213	25p	W106D1	83p
2N2218	34p	2N4289	15p	ACY22	21p	BC126	22p	BF167	18p	NKT214	23p	WO2	40p
2N2218A	44p	2N4291	15p	ACY39	63p	BC140	30p	BF173	19p	NKT217	50p	WPO2	95p
2N2219	38p	2N4292	15p	ACY40	17p	BC147	10p	BF177	25p	NKT261	21p	ZTX300	14p
2N2219A	53p	2N4410	24p	ACY41	18p	BC148	9p	BF178	31p	NKT271	18p	ZTX301	16p
2N2270	62p	2N4443	111p	ACY44	31p	BC149	10p	BF194	14p	NKT274	18p	ZTX302	22p
2N2369A	19p	2N4906	305p	AD140	63p	BC153	19p	BF195	15p	NKT275	23p	ZTX303	22p
2N2483	35p	2N4915	215p	AD142	50p	BC154	20p	BF244	30p	NKT403	65p	ZTX304	27p
2N2484	42p	2N4991	62p	AD149	58p	BC157	12p	BF254	14p	NKT404	61p	ZTX330	23p
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2N2904	38p	2N5088	38p	AD161	33p	BC159	12p	BFX18	90p	NKT603F	30p	ZTX500	18p
2N2904A	42p	2N5163	25p	AD162	36p	BC167	11p	BFX29	31p	NKT613F	30p	ZTX501	21p
2N2905	44p	2N5172	18p	*AD161/		BC168	10p	BFX84	25p	NKT674F	24p	ZTX502	25p
2N2905A	47p	2N5192	125p	162	60p	BC169	11p	BFX85	32p	NKT677F	22p	ZTX503	22p
2N2924	20p	2N5195	147p	AF114	24p	BC177	14p	BFX87	29p	NKT713	30p	ZTX504	52p
2N2925	22p	2N5457	49p	AF115	24p	BC178	13p	BFX88	26p	NKT773	25p	ZTX530	27p
2N2926	11p	2N5459	49p	AF116	22p	BC179	14p	BFY50	23p	OA47	8p	ZTX531	33p
2N3053	27p	40250	71p	AF117	22p	BC182L	11p	BFY51	20p	OA90	6p		
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C	1/8W	5%	4·7 Ω–470K Ω	E24	1	0·8	0·7
C	1/4W	10%	4·7 Ω–10M Ω	E12	1	0·8	0·7
C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·9
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3·5	3
WW	1W	10% ± 1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	12 Ω–10K Ω	E12	7	7	6
WW	7W	5%	12 Ω–10K Ω	E12	9	9	8

Codes: C = carbon film high stability low loise
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 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

PUBLICATIONS

The Book of Transistor Equivalents (BP.1) **40p**
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which in some applications makes up for the slightly higher cost compared with, say, cold cathode tubes.

These indicators are also more reliable than some of their incandescent cousins which involve moving parts, a technique widely used in the early days of display design, but no longer competitive, and therefore not treated here.

DOT MATRIX INDICATORS

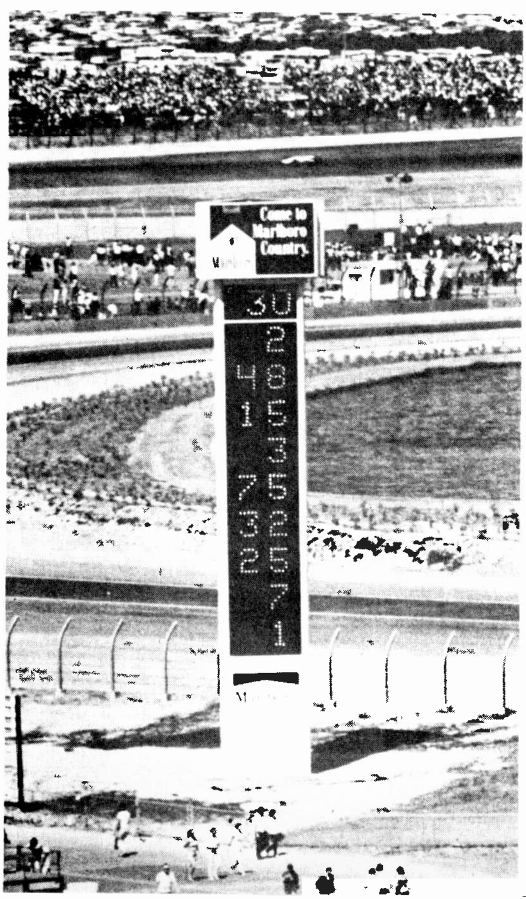
Dot matrix indicators are the second type of format mentioned in the introductory article, and it is obviously possible to build this type of display with filament lamps. There are no commercially available display devices of this type, however, and in view of the problems of mechanical design (all those bulb holders!) and the more complex decoding required, such devices are not practical in miniature form.

The general principle is used however for large moving newsreel displays where the programming can be achieved simply by controlling the matrix with punched tape.

Further examples of large displays using this principle are the motorway traffic information boards, Guinness clocks, and sports scoreboards.

This is an area amenable to "do-it-yourself" techniques, the important points to remember being: keep it big, and keep the character set simple to ease decoding problems. Of course, if there is no objection to employing complex electronics such as commutators and read-only memories, then any desired character set can be built.

A large display system using filament bulbs in a dot-matrix arrangement



A seven segment incandescent filament indicator tube. Almost any colour filter can be used unlike the cold cathode tubes which are either red or orange

BAR MATRIX DISPLAYS

The simple bar matrix display format, and in particular the "seven-segment" arrangement, is an ideal layout for use with incandescent device technology and a wide range of indicators have emerged using this combination, most of them championed in the U.S.A.

It is again possible to use individual lamps for each segment, but the real area where incandescent technology has come into its own is in the production of a complete seven segment indicator inside a single evacuated package.

These devices, often housed inside a valve type glass envelope, are capable of being mass produced, and large numbers are now being imported from Japan where most examples are manufactured.

This suitability for mass production combined with the inherent filament advantages quoted earlier and the availability of cheap decoder driver i.c.s will in future make these indicators the best choice for most amateur applications, such as digital clocks, counters, and calculators, a position held by the gas filled tubes at present.

OPERATION

A typical example of this type of device is shown in Fig. 3.3; this particular indicator has been chosen since it represents one of the types advertised for amateur use at present. Its type number is DA 133 (or DA 133D with decimal point) and it is available from West Hyde Developments under the trade name of Atron.

This indicator is housed in a glass envelope about half the size of a B7G valve, and produces characters 12mm in height. The coiled filaments are supported by wire pegs protruding from a ceramic base, and these pegs are interconnected at the rear of the ceramic according to the wiring shown, the segment, common, and decimal point each have an individual leadout through the nine pin base.

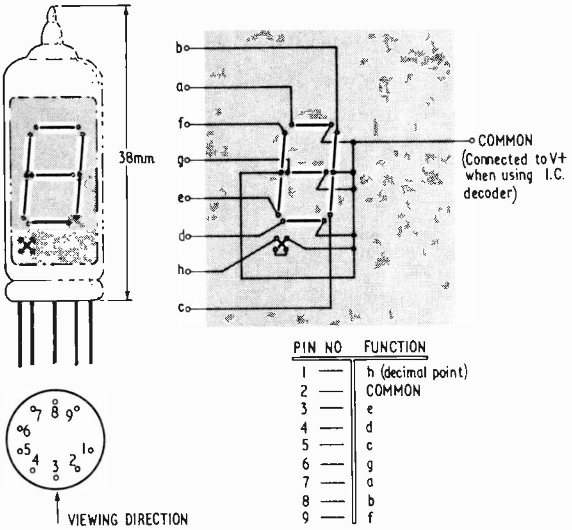


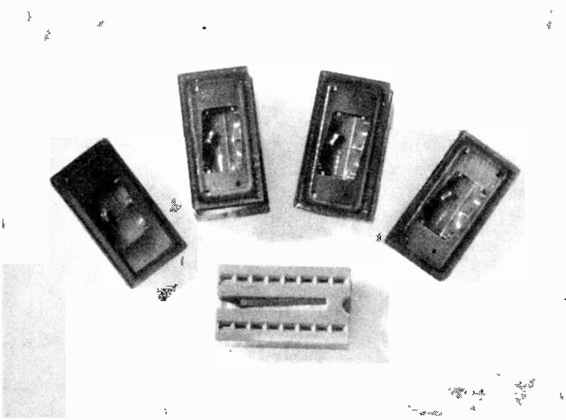
Fig. 3.3. The internal construction of a seven segment incandescent filament tube (Atron, available from West Hyde Developments)

The filaments are made of an advanced long-life, high brightness, material which gives a typical life of 100,000 hours. Each segment consumes about 120mW at the nominal supply voltage of 5V, making i.c. drivers eminently suitable, another advantage being that only one supply rail (V_{cc}) is necessary in a system using DTL or TTL.

The colour of the illuminated filament is of course the white normally associated with incandescent lamps, and this means that a filter can be positioned in front of the indicator to select any desired colour.

A filter is necessary in any case to improve contrast, but the possibility of selecting any colour is an advantage over, say, cold cathode tubes where a red or orange filter is mandatory. Green, blue, red, daylight, and neutral are the colours specifically available for use with the Atron.

Next month: Decoding and driving circuits for incandescent filament displays



Seven segment incandescent filament indicators in dual-in-line packages (Minitron 3015F, available from A. Marshall & Son)

BOOK REVIEWS

GUIDE TO PRINTED CIRCUITS

By Gordon J. King
Published by Fountain Press
140 pages, 8¾in × 5½in. Price £2·50

NOT only does this book give a guide to printed circuit making for the amateur, it also describes industrial manufacture, printed circuit substitutes (i.e. Veroboard, S-Dec, and similar arrangements), soldering techniques, the use of printed circuit methods in i.c. manufacture, and applications of i.c.s.

Whilst some of the information is interesting I can find very little of any real use to the amateur. The techniques of making printed circuits could easily be described in a few paragraphs and the rest of the book seems merely to fill out the space. Are the "enthusiastic amateurs," for whom Mr. King professes to be writing, really interested in a chapter on the construction of soldering irons and desoldering methods?

At £2·50 this book is by no means cheap and I do not feel the content warrants such an outlay by the average enthusiast.

S.R.L.

INTRODUCTION TO VIDEO RECORDING

By W. Oliver
Published by W. Foulsham & Co Ltd
109 pages, 8¾in × 5½in. Price £1·50

THE recording of events and entertainments, until fairly recently restricted to sound and cine film, promises great things for the future through the various media of electronic video processing. This book takes an outsider's view of the state of the art of video tape, disc, and hologram with ample reference to commercially exploited principles.

Although the author admits to taking a "semi-layman's" viewpoint he does describe in fundamental terms how the different systems work without becoming too embedded in technicalities. So much so that some of the earlier chapters could make rather boring reading to those already well informed on the principles of waveform propagation.

I, personally, found the section on video disc recording the most interesting as it seems that this is likely to become the commonly used technique for domestic applications—when all of the bugs have been ironed out. Tape is at present being used to a large extent, but as with sound recording, there are the attendant risks of erasure unless scrupulous precautions are taken. Bulk is also another commercial problem as is mass recording on tape.

This book is very readable but its price precludes its purchase value. Since it can be read in a couple of hours (there are many large illustrations) it is perhaps best suited to the lending and technical libraries.

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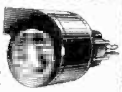

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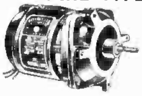

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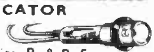
1 r.p.m. cw.	1 r.p.h. a/cw.	10 r.p.h. a/cw.
60 r.p.m. cw.	2 r.p.h. cw.	15 r.p.h. a/cw.
	3 r.p.h. a/cw.	20 r.p.h. cw.
	6 r.p.h. cw.	30 r.p.h. cw.

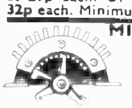
cw. = clockwise rotation; a/cw. = Anticlockwise. Fraction of makers' price. All at **75p** incl. P. & P.

200-250V A.C. NEON INDICATOR



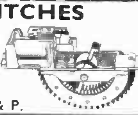
Available in red or amber at **20p** each. Or in green at **32p** each. Minimum order 3 units. P. & P. 5p.

MINIATURE UNISELECTOR



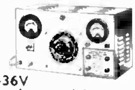
3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36V d.c. operation. Carefully removed from equipment and tested. **£1·15**, plus 15p P. & P.

UNISELECTOR SWITCHES



NEW **4 Bank 25 Way** 24V d.c. operation. **£5·88**, P. & P. 12p. **6 Bank 25 Way** 24V d.c. **£6·50**, P. & P. 12p. **8 Bank 25 Way**, 24V d.c. operation. **£7·62** plus 22p. 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.

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
This strobe has been designed and produced for use in large rooms, halls and the photographic field and utilises a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. 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.

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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.

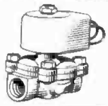
INSULATION TESTERS *NEW!*

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.

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.

240V A.C. SOLENOID FLUID VALVE

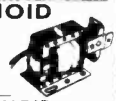


Will handle liquids or gases up to 7 p.s.i. Forged brass body, stainless steel core and spring. ¼in b.s.p. inlet/outlet. Precision made, British mfg. PRICE: **£1·75.** P. & P. 20p. Special quotation for quantity. *(New in makers' carton)*

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. NEW PRICE **£5·75.** P. & P. 25p.

230V A.C. SOLENOID

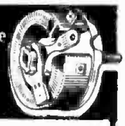


Extremely powerful with approx. 14lb pull, 1in travel. Fitted with mounting feet. Size: 4in long, 2¾in wide, 3in high. **£2·00** incl. P. & P.

230-250 VOLT A.C. SOLENOID
Manufactured by Westool Ltd. (similar in appearance to above illustration). Approx. 1½lb pull Feet size 1⅝in × 1¼in. Price **85p** incl. P. & P.

18-24 VOLT D.C. SOLENOID
Size: O.A.L. 3¾in × 1¼in × 1in. Max. push ⅞ at 1lb. approx. PRICE: **75p** incl. P. & P.

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; **5 kΩ,** 140mA. Diameter 3¼in Shaft length ⅞in, dia. 13/64in. 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. 10/25/50/100/250/500/1/1·5/2·5/3·5/5kΩ. **All at 90p each.** P. & P. 7½p.
Black Silver Skirted knob calibrated in Nos. 1-9. 1½in. dia brass bush. Ideal for above Rheostats, **18p** ea.

RELAYS SIEMENS, PLESSEY, Etc.

MINIATURE RELAYS

Col. (1) Coil ohms; Col. (2) Working d.c. volts; Col. (3) Contracts; Col. (4) Price; HD = Heavy duty; *Incl. Base; Post paid.

1	2	3	4
280	9–12	2 c/o	**73p***
410	10–18	4 c/o	**73p***
700	16–24	4M 2B	**63p***
700	16–24	4 c/o	**78p***
700	12–24	2 c/o	**63p***
700	15–35	2 c/o HD	**73p***
700	16–24	6M	**65p***
1,250	24–36	4 c/o	**63p***
2,500	36–45	6M	**63p***
2,400	30–48	4 c/o	**50p**
9,000	40–70	2 c/o	**50p***
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** including P. & P.)

MINIATURE RELAYS
9-12V d.c. operation. Two c/o 500 M.A. contacts. Size only 1in × ⅞in × ½in. Price **58p** post paid. 30-36V d.c. operation. Two c/o 500 M.A. contacts. 3,200 ohm coil. Size only 1in × ⅞in × 1⅛in. **43p** post paid.

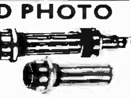
VENNER Electric Time Switch

200/250V Ex. GPO. Tested. Manually set 2 on, 2 off every 24h. Override switch: 10A **£2·75**, 15A **£3·25**, 20A **£3·75**. P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.

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

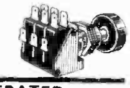


Precision engineered light source with adjustable lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP12 or similar cell. Both units are single hole fixing. Price per pair **£2·75.** P. & P. 18p.

LIGHT SENSITIVE SWITCHES

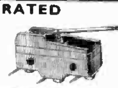
Kit includes ORP.12 Photocell, Relay Transistor Circuit. For 6 or 12V D.C. operation. **Price £1·50** plus 12p P. & P. **ORP. 12 and Circuit 63p post paid.**
220/240V A.C. MAINS MODEL
Mains transformer, rectifier, relay, 1 make 1 break H.D. contacts. price incl. circuit **£2·65.** P. & P. 20p.

"HONEYWELL" PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY



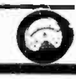
Each bank comprises a c/o rated at 10 amps 240V. A.C. Black knob 1in. Fixing hole ⅞in. ONE bank **30p**; TWO bank **40p**; THREE bank **55p**; incl. P. & P.

'HONEYWELL' LEVER OPERATED MICRO SWITCH



15 amps 250 volt A.C. c/o contacts. NEW in maker's carton. PRICE: 10 for **£1·90** including P. & P.

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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All these sets are BRAND NEW and complete in manufacturers original cartons, but may require slight attention—hence bargain prices—cheaper than kits!

•CASSETTE PLAYERS—last few only—uses standard musicassettes—possible conversion to full recorder. Deck alone worth our price of **£8·99** + p & p 55p.

•C120 Cassettes. Top quality. **75p** + p & p 7½p.

•SAVE £££'s ON BATTERIES, run your transistor, etc., from the mains with our 9V eliminator. **£1·50** + p & p 15p.

•LABGEAR "Magic Circle" indoor UHF aerial only **£1·25** + p & p 15p.

T.V.'s T.V.'s T.V.'s T.V.'s T.V.'s T.V.'s

•4 Channel 19in UHF T.V.'s Despatched tested, and in full working order. **£20.**

•19in Slimline, only requires UHF tuner for BBC2, untested, complete, **£8.**

•As above but with UHF tuner, **£12.**

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(Carriage £1·50 extra all models.)

SUMIKS

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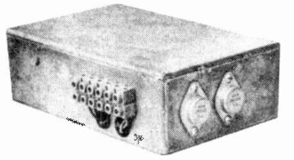
Callers Welcome

PRACTICAL ELECTRONICS "SCORPIO" ELECTRONIC IGNITION SYSTEM



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.

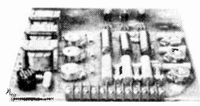
Helps to promote easier starting (even under sub-zero conditions), improved acceleration, better high-speed performance, quicker engine warm-up and improved fuel economy. Eliminates excessive contact-breaker point burning and the need to adjust point and spark-plug gaps with precision.

Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour.

A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7½in × 4½in × 2in approx.

Complete assembly and wiring manual **25p**, refundable on purchase of kit. Price: **£10·50** plus 50p P. & P. S.A.E. with all enquiries.

PSYCHODELIC LIGHTING UNIT Mk. 3



This unit represents a natural progression from our phenomenally successful Mk. I and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.

The unit is constructed on professional fibre-glass printed-circuit board material and uses latest full-wave triac circuitry. There is a master-level control, together with independent sensitivity controls for each channel. The original minimum ambient light level controls have been redesigned permitting their use as faders; allowing dimming from max. to zero at the turn of a knob. R.F.I. suppression is now incorporated as standard as well as provision for D.J. "Pulse-Flash" controls. The choice of two inputs enables operation from both high and low power amplifiers. Max. power 1·5kW per channel at 240V a.c.

Complete assembly built and tested.
Size 9in × 7in × 3in.
Price **£25** carr. paid. S.A.E. with all inquiries.

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AUTO TRANSFORMERS
0 110 200–220 240V a.c. up or down fully shrouded fitted insulated terminal blocks. 30W **£1·35**; 50W **£1·80**; 75W **£2·10**; 100W **£2·55**; 150W **£3·15**; 200W **£3·90**; 300W **£5·25**; 400W **£6·30**; 500W **£7·50**; 600W **£8·25**; 750W **£9·75**; 1,000W **£12·75**; 1,500W **£18**; 2,000W **£24·75**; 3,000W **£33**; 4,000W **£45.**

MULTIVOLT TRANSFORMERS
Prim. 200/240V a.c. OMT4/1 tapped sec. 0–60V 1A, **£2·25**; OMT4/2, ditto 2A, **£3·45**; OMT5/1 tapped sec. 0–110V 1A, **£3·45**; Duo sec. 12V 4A–12V 4A, **£3 60**; Duo sec. tapped, 0–10–20–25V 2A—0–10–20–25V 2A, **£3·60.**

LOW VOLTAGE TRANSFORMERS
Prim. 200/240V a.c., 6·3V, 1·5A, **85p**; 3A, **£1·13**; 6A CT, **£1·80**; 12V, 1·5A, **£1·13**; 3A CT, **£1·80**; 6A CT, **£2·70**; 18V, 1·5A CT, **£1·80**; 24V, 1·5A CT, **£1·80**; 3A CT, **£2·70**; 5A, **£3·75**; 8A, **£6**; 12A, **£9**; 40V, 3A CT, **£3·45.**

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For FW rect., size 1¾ × 2 × 1¾in, Prim. 200/240V a.c. output, PPT1. 9–0–9V, 0·3A, PPT2. 12–0–12V, 0·25A, PPT3. 20–0–20V, 0·15A, **£1·20** each; ditto, size 2 × 2¼ × 1¾in MTV1. 9–0–9V, 1A, **98p**; MTV2. 12–0–12V, 1A, MTV3. 20–0–20V, 0·75A, **£1·20** each.

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P.P. sec. tapped 3–7·5–15 ohms, A–A 6·6kΩ. 30W (KT66, etc.), **£4·05**; 50W, 3kΩ, A–A, **£6·75**; 100W, 3kΩ, A–A, EL34 (KT88, etc.) **£11·40** and to 400W.

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New, famous makes, 15W with tweeter, **£4·99**; 25W, **£5·60**; 35W, **£7·20**; 50W, **£10·50**; 100W, **£22·50**; E.M.I. 13¼ × 8in 10W, 3 or 8 or 15 ohms, **£2·25.** Ditto with two tweeters and Xover, **£4·00**; Horn Tweeters 2–16kHz 10W 8 or 16 ohms, **£1·50.** HI-FI, 8 × 5in 8Ω, **£1·85**; 10 6in 3 or 8 or 15Ω, **£2·10.**

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Covering valve amplifiers of 30 to 400 watts, with price list of transformers and chokes specified, **25p.**

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2¼in 16Ω, 2½in 80Ω, 2½in 25Ω, 3in 8 or 30Ω, **60p** each; 3½in 3 or 15Ω, 4in 8 or 15Ω, 5in 3, 15 or 25Ω, 5 × 3in 3, 8, 15 or 25Ω, **90p** each; 6 × 4in 25Ω, 7 × 4in 3 or 6½in 3Ω, **£1·08**; 8 × 5in 3, 8, 15 or 25Ω, **£1·50**; 8in 3Ω, **£1·85.**

SPEAKER AUTO MATCHING TRANSFORMER 12W
3 to 8 or 15 ohms, up or down, **75p.** P. & P. 15p.

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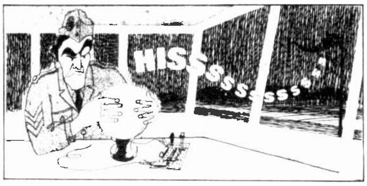
Gerry Brown . . .

ON THE FRINGE



OCCULTAPHONICS

Stick your neck out, my old man used to say, and some willing cove will come along and lop it off. True to form, and human nature being the readily predictable thing it so often is, some willing cove very nearly succeeded a month or so back! Stuart White, at that time reporting for one of the big "Sundays", brought to the attention of the public his judgements about the efficacy of an unusual electronic device then available.

Somewhat embarrassingly, this device owed its very inception to me and, to boot, represented about the nearest thing to the "popular" definition of an electronic crystal-ball that you could wish to find!

Preparation for this mis-guided event began "yonks ago" while I was yet a callow youth in the RAF. One soon discovers at an air-base, however, what a monotonous business life in a control tower can be; particularly so when all the lads have nipped off on a sortie and the only remaining company are a couple of card-playing "a/c plonks" and the idle hiss from a temporarily inactive air-radio. It was this very hiss that had, at one time or another, given rise to an effect that had both interested and perplexed us all.

As I have said, you would be sitting there contemplating your next week-end off, or maybe the one just gone, when suddenly you would be aware that through the background hash from the radio there was a signal feebly breaking through. "Unidentified aircraft, say again," you would call back, but somehow you almost knew that there would be no response, other than the steady rushing sound from the receiver. Any number of operators had witnessed this effect and, indeed, some were convinced that the voices they heard were for real!

Obviously, we must preserve a meaningful perspective and it is probably true to say that since white noise (hiss) contains just about every sound that has ever been produced (but all at once) there's a fair chance that if you listen to it long enough you might ultimately hear speech too. But

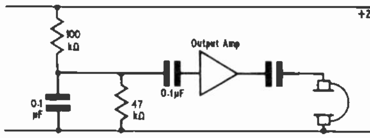
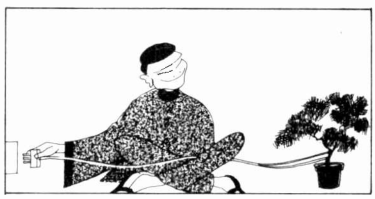


Fig. 1

there are even technical reasons for disputing this, so, apart from that "old chestnut" imagination being the culprit, from where *do* these effects originate?

It was in November 1971 with many of these unsolved questions still uppermost in my mind, that I built a simple little set-up, Fig. 1, in an attempt to discover more. The results were relatively inconclusive, although sufficiently thought provoking for work to continue. The circuit is included for your interest only; its really nothing special, just a white-noise generator followed by an amplifier. Try it if you will. .

Only days after White's report, I noticed that a sister newspaper, in direct contradiction to the apparent ethics of the one mentioned earlier, carried almost an entire page on Flying Saucers. Maybe there are "fairies at the bottom of their garden" after all!



STUDENT IC

There's an integrated circuit on the market at the moment which you can actually *teach!* This MOS device is an adaptive-logic gate, MC901, produced by the Motorola Corporation and designed, primarily, for feature-extraction in pattern-recognition applications.

In essence (Fig. 2) the MC901 comprises a 4-bit binary to 1-out-of-16 decoder, plus sixteen individual flip-flop memories and associated output gating.

Each gate also has a common connection with a "teach" input such that if it is taken to logical

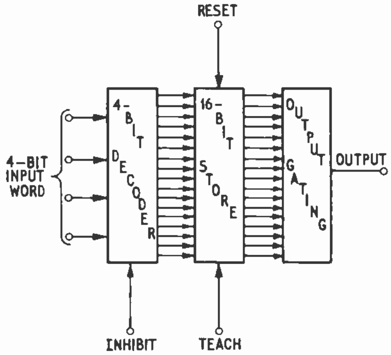


Fig. 2

"1" (for a brief moment during the time that the decoder input is present) the relevant gate will cause its associated flip-flop to change state. Since each flip-flop controls an output gate (which is also connected to the decoder) any subsequent application of the original 4-bit number will result in "recognition" and the output going to "1". A "0" at the teach input resets the memory.

The MC901 additionally embodies an inhibit facility which allows several devices to be inter-linked and so accept expansion in the size of input word. An integrated circuit of this kind would, without doubt, obviate almost all the tedium associated with building a complete learning network; trouble is you'll need seven pounds to make the idea a going proposition.

GREEN FINGERS

It shouldn't be long before G. W. Millard of the Reddiglade Nurseries in Kent publishes his paper relating to the effects of manipulation of bio-potentials in trees.

Early in 1971 he was conducting some rather interesting experiments pointing to the fact that trees sometimes increase their rate of growth

when an electric current is passed through them. Of course, rate of growth is largely dependent on the rate at which the organisms' food supplies can reach the sites of actual growth. Since, however, the nutrients are abundant in molecules having electrical charges, an applied current could exert quite a profound influence on a tree's development.

Millard, as yet, has not announced the magnitude of the potentials which need to be applied; indeed workers in several parts of the world have had no luck in establishing the validity of his claims.

It is difficult to say whether the effect is a load of old nonsense or really genuine, nevertheless, I recall some years ago hearing about a similar effect involving the control of sap by electrical potential. At that time, the voltage used was about a couple of volts or so, with negative applied to the top of the tree and positive earth to make the sap rise.

Now don't quote me on this, but I heard a tale that someone who employed this scheme last year succeeded in bringing some simply beautiful Cox's Orange to maturity real early. Trouble was they got too cute and reversed the current. The "windfalls" made great cider!!

SOLID STATE SNAP

By J. S. GRICE B.A.

SNAP is an unusual game in that mainly it tests speed of response; we have all played the game as children. There are two good reasons why the game is confined largely to children. One, it is not always easy to determine who did shout first, and two, the face of the turning card is not necessarily presented to both contestants simultaneously. For adults such uncertainty and imprecision spoil the game for serious contest.

The apparatus to be described here provides an electronic analogue of the game in which these deficiencies have been overcome. Essentially what is needed is a sudden signal presented simultaneously to the two contestants, and a mode of response such that the priority can be determined infallibly.

GENERAL DESCRIPTION

Snap consists of a small metal case, which contains the circuitry, mounted on a wooden baseboard, and two morse-keys (S1 and S2) also mounted on the baseboard—one on each side of the case. On the top panel of the case are an on/off switch (S4), the reset button (S3) and a centre-zero meter (M1), which indicates the winner.

The apparatus is switched on, the contestants take up their positions one to each key, and the reset button is pushed down and released. After a delay of about ten seconds the machine emits a high-pitched note, and the players respond by depressing their keys as quickly as possible. The meter pointer swings over towards the key which was depressed first. It is only necessary to depress and release the reset button again to initiate another "round". Perhaps ten "rounds" may be taken to constitute a game.

DESIGN POINTS

An audible signal was chosen since there is no difficulty in ensuring that such a signal is presented to both players simultaneously; also the sound can be produced with due economy of current consumption. A delay of about ten seconds between the operation of the reset button and the sounding of the signal was found to be the most effective period.

Some safeguard is necessary against the inadvertent (or deliberate) premature depressing of a key. It is therefore arranged that if a key is depressed during the delay period the signal will not sound. Nevertheless the meter indicates which key was depressed, and it is suggested that in such circumstances the point is awarded to the other side.

A minor refinement is the automatic cessation of the signal note some ten seconds after a key has been legitimately depressed.

For simplicity of control, one push of the reset button resets and recycles everything; that is, stops the signal note if necessary, initiates the ten second delay, and re-centres the meter.

BLOCK DIAGRAM

The two bistables shown in the block diagram (Fig. 1) are cross-coupled; the pulse required to reverse the condition of bistable one is obtained, via

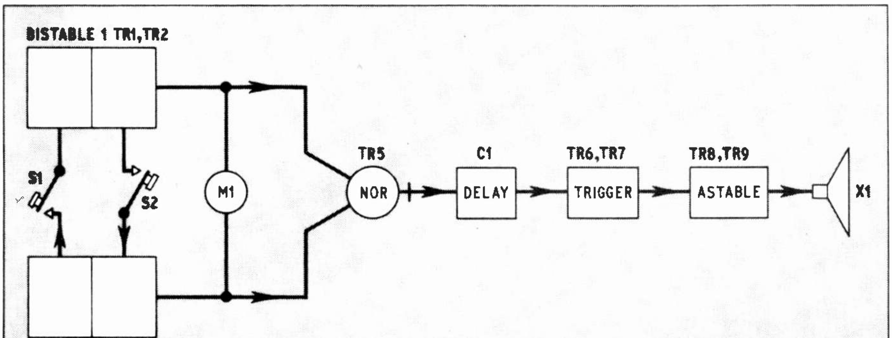
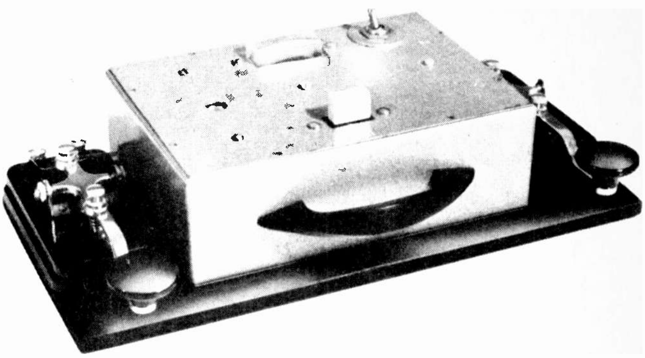


Fig. 1. Block diagram of the Electronic Snap

a morse-key (S2), from bistable two; and the pulse required to reverse the condition of bistable two is obtained, via a second morse-key (S1), from bistable one. However, as soon as the initial condition of either bistable is reversed it is unable to supply a pulse to reverse the condition of the other bistable. It is the two bistables then which determine which key was depressed first. The action is explained more fully in the next section.

Both bistables are linked with the NOR gate. The NOR gate produces an output voltage only when both inputs are zero. This is the case when both bistables are in their initial condition.

. Assuming that the bistables remain undisturbed in their initial condition for a while so that the NOR gate maintains its output voltage, then the delay capacitor will slowly charge up.



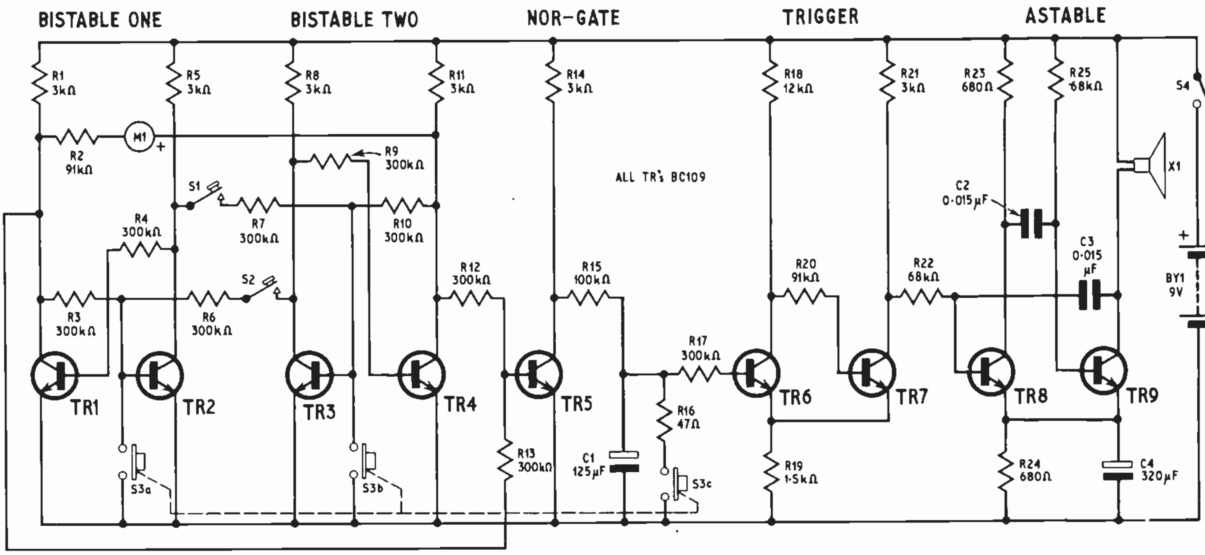


Fig. 2. Complete circuit diagram of the Electronic Snap

The slowly increasing voltage at the delay capacitor is passed to the trigger. The trigger has only two output states: a low voltage which prevents the astable from oscillating, and a high voltage which permits the astable to oscillate. When the input voltage of the trigger rises to a certain level the output switches suddenly from the low voltage to the high voltage, thus producing the signal.

If a key is depressed before the input voltage of the trigger reaches this particular level, then the signal will not be produced. This is because depressing a key reverses the initial state of a bistable thereby causing an input voltage to the NOR gate and hence no output voltage from it, so that the delay capacitor will be discharged.

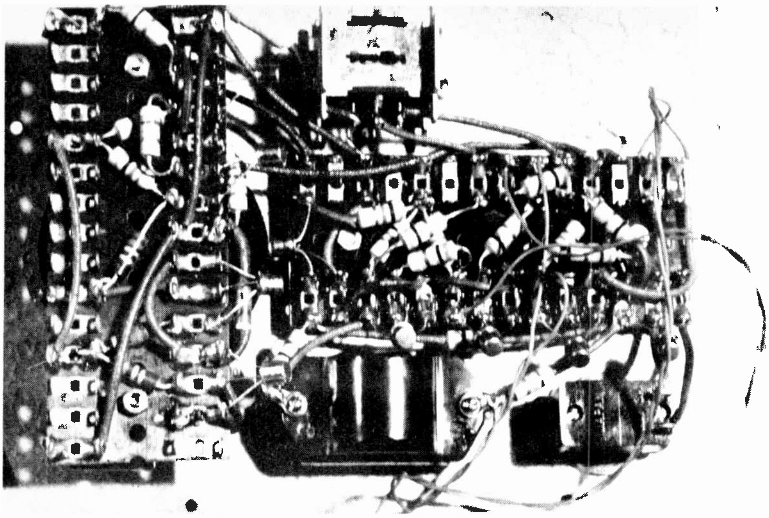
BISTABLES

Transistors TR1 and TR2 (Fig. 2) form bistable one; TR3 and TR4 form bistable two. The bistable is a familiar building-block in logic circuitry. Here it consists of two transistors, one fully conducting, the other cut-off. A pulse applied at an appropriate point reverses the roles of the transistors, and they remain reversed until another pulse is applied at an appropriate point.

When the apparatus is switched on the state of the bistables is indeterminate. The reset switch (S3) serves to establish the desired initial condition in each bistable. When S3a is temporarily closed the emitter-base junction of TR2 is shorted and this ensures that TR2 is the cut-off transistor in bistable one. Similarly the closing of S3b ensures that TR3 is the cut-off transistor in bistable two.

So, when the play cycle is initiated, in bistable one TR1 is fully conducting and TR2 is cut-off, and in bistable two TR3 is cut-off and TR4 is fully conducting. This means that the collectors of TR1 and TR4 are at near zero voltage, and the collectors of TR2 and TR3 are at approximately full supply voltage. The centre-zero meter M1 connected between the collectors of TR1 and TR4 will not register.

Now we can reverse the state of bistable one by supplying a positive pulse to the base of TR2 via S2 and R6. This will cause TR2 to become fully conducting and TR1 cut-off. Once this is done, however, it is not possible to reverse the state of bistable two in a similar manner by depressing S1 because the voltage at the collector of TR2 is now near zero. The meter pointer will swing to the left indicating that the collector voltage of TR1 is at the supply



Showing the layout of components and tag boards mounted inside the case

voltage while the collector voltage of TR4 remains near zero.

Of course, had we depressed S1 first, reversing the condition of bistable two, then the subsequent depressing of S2 would have had no effect on bistable one, and the meter pointer would have swung to the right indicating the collector of TR4 is at the supply voltage.

The two bistables measure which key was depressed first, and since the switching time of the circuitry is much faster than human reaction times, the measurement is entirely reliable.

NOR GATE

The bistables have one subsidiary function. It will be seen that the state of the collectors of TR1 and TR4 determines the state of the collector of TR5. When a play cycle is initiated the collectors of TR1 and TR4 are at near zero volts, so that there is near zero voltage supply to the base of TR5. Consequently TR5 is cut-off and its collector is at full supply voltage. Should, however, the collector of either TR1 or TR4 go positive, as happens when a key is depressed, then TR5 will become fully conducting and its collector voltage will drop to near zero. Transistor TR5 is then in effect a NOR gate, giving an output only when it has no input.

The purpose of this arrangement has already been explained. The delay capacitor (C1), which determines when the signal will sound, charges from the TR5 collector voltage. If this voltage is cut off during the build-up period, C1 starts to discharge and there is no signal. Thus the premature depressing of a key is detected. It will be noted, however, that the meter will still register in the usual way which key was depressed first.

Assuming no interruption, C1 will charge up in ten seconds to a voltage sufficient to fire the trigger.

TRIGGER

Transistors TR6 and TR7 comprise the trigger circuit. When a play cycle is initiated C1 is discharged completely by S3c so that there is zero voltage at the base of TR6; this means that TR6 is cut-off. The collector of TR6 is therefore at the supply voltage, and TR7 is fully driven via R20. Although TR7 is fully conducting, its collector is at approximately 3V because of the voltage drop across the emitter resistor, R19.

As the play cycle continues the voltage at C1 builds up until a point is reached where TR6 is conducting sufficiently for its collector voltage to fall to such a level that TR7 is less than fully driven. Then a very rapid regenerative switching action occurs so that TR6 becomes fully conducting and TR7 cut-off. The collector of TR7 is now at the supply voltage, and TR8 is driven via R22 so that the astable oscillates.

Depressing a key as already explained causes C1 to start discharging. When the voltage on C1 has fallen to such a level that TR6 is just less than fully driven, then another regenerative switching action occurs, and the trigger circuit reverts to its former state, so that the signal stops. The voltage on C1 which causes the trigger to switch off is considerably lower than the voltage on C1 which causes the trigger to switch on. It takes C1 approximately ten seconds to discharge from the higher to the lower voltage, so that there is a delay of about ten seconds between the depressing of a key and the cessation of the signal.

ASTABLE

The signal note is produced by a conventional astable multivibrator formed by TR8 and TR9. The only unusual feature is that the emitters are connected to the negative line through R24, which is bypassed for a.c. signals by C4. This establishes a voltage platform of 4·5V above which the astable works. This is necessary because the base of TR8 must be held negative with respect to the emitter when the trigger is in its off condition if the astable is not to oscillate and, as has been shown, the trigger actually outputs 3V in its off condition.

The collector load of TR9 is the transducer (X1) which produces the sound. This transducer is an earpiece from a pair of headphones—the d.c. resistance was measured at 700 ohms.

CONSTRUCTION

With this kind of circuitry there is nothing critical about component layout or wiring. The neat metal case, complete with hammer-grey finish and handle, can be obtained from Henry's Radio. All the components are mounted on the top panel except the

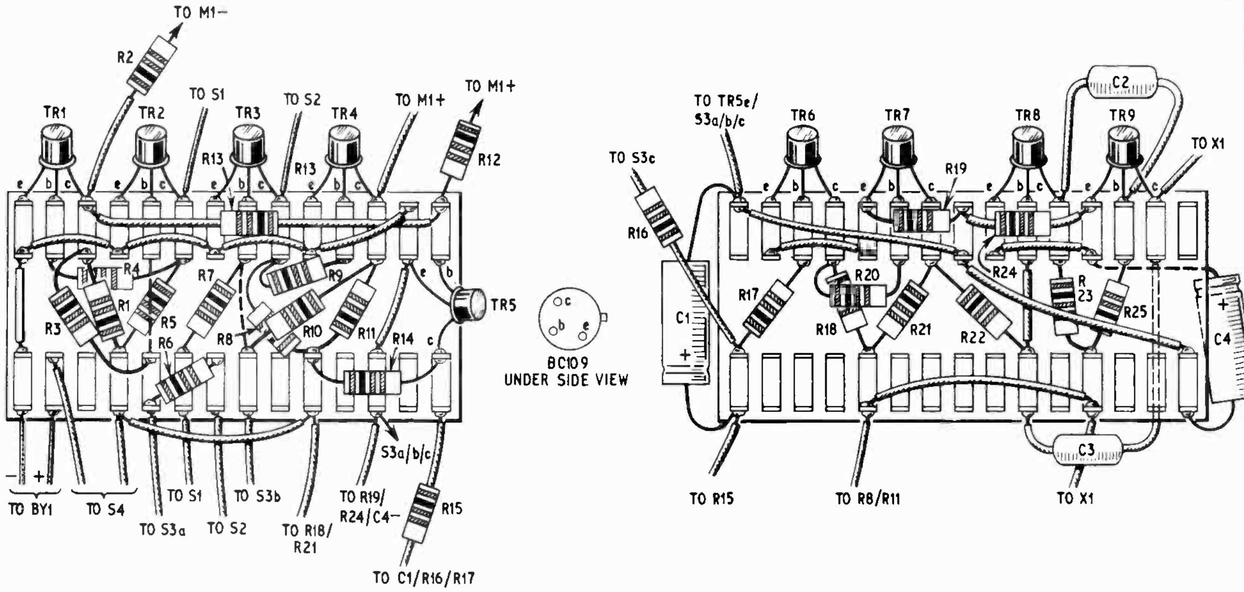


Fig. 3. Tag board wiring diagram

COMPONENTS . . .

Resistors

R1	3k Ω	R14	3k Ω
R2	91k Ω	R15	100k Ω
R3	300k Ω	R16	47 Ω
R4	300k Ω	R17	300k Ω
R5	3k Ω	R18	12k Ω
R6	300k Ω	R19	1·5k Ω
R7	300k Ω	R20	91k Ω
R8	3k Ω	R21	3k Ω
R9	300k Ω	R22	68k Ω
R10	300k Ω	R23	680 Ω
R11	3k Ω	R24	680 Ω
R12	300k Ω	R25	68k Ω
R13	300k Ω		

All $\frac{1}{2}$W, ± 5% carbon

Capacitors

C1 125μF elect. 10V
C2 0·015μF polyester
C3 0·015μF polyester
C4 320μF elect. 6·4V

Transistors

TR1–9 BC109 (9 off)

Switches

S1 Morse key
S2 Morse key
S3 3 pole push-to-make pushbutton
S4 S.P.S.T. toggle

Miscellaneous

M1 100–0–100μA moving coil balance meter
X1 700 Ω earpiece
BY1 PP6 9V battery
Case 6$\frac{5}{8}$in × 4$\frac{3}{8}$in × 2$\frac{3}{8}$in
Wooden base 11in × 5$\frac{1}{2}$in × $\frac{1}{2}$in
Tag strips 14-way and 15-way (2 off)
Wire and 4B.A. fixings

battery S1 and S2. With a total current requirement of about 18 milliamps it was found necessary to use a fairly large 9V battery; a PP6 is the largest that can be accommodated. The battery can be cemented down inside the box, taking care that there is sufficient clearance for the top panel components.

Most of the circuitry is constructed on two tag strips, shown in Fig. 3, one for the bistables and NOR gate, the other for the trigger and astable. The one for the trigger and astable is mounted over X1 and the two boards are wired to the remaining components as shown in the photograph.

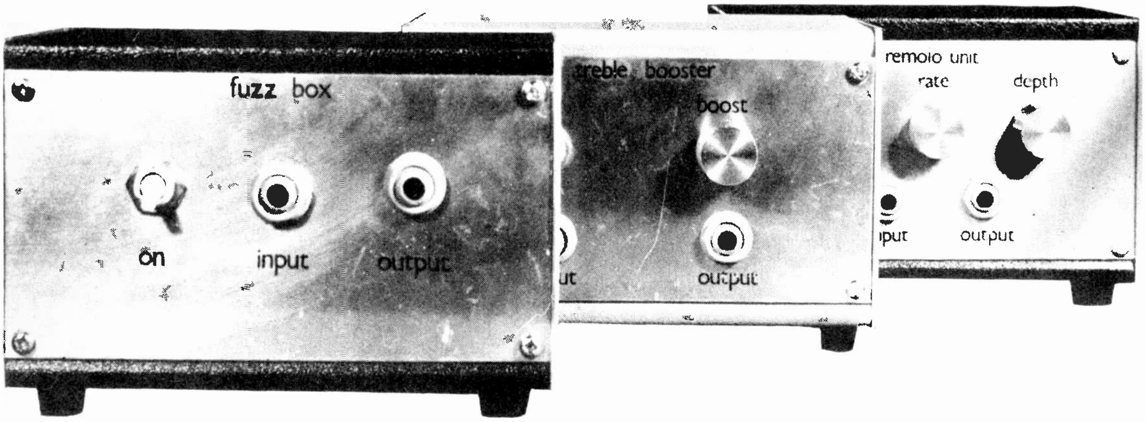
A convenient small meter was found in the form of an edgewise-reading balance meter. This is all that is necessary since it is only the direction of the pointer swing that needs to be observed. The meter must have a 100-0-100 microamp movement. Keys S1 and S2 are mounted on the right and left sides of the box respectively. The case and the keys are screwed to a piece of $\frac{1}{2}$ inch thick wood that forms a solid base. The underside of the base can be covered with material to prevent it scratching polished surfaces.

CONCLUSION

Some people are naturally quicker in their responses than others. However, nobody is entirely consistent, and with most contestants quite a number of "rounds" are necessary before one begins to establish a definite superiority. Even with ill-matched contestants, the mismatch is not evident until put to the test.

With well-matched contestants games can be very tense. Concentration appears to be the key to success.

Overall then electronic snap is an exciting game, inheriting from its predecessor the unique property, among competitive games, of testing primarily speed of response. ★



FUZZ BOX

The last of three articles on special effects units for guitars

By A. Russell

THE effect of fuzz is to provide change in the tone produced of a guitar or other sound source so adding colour or interest to a particular musical statement.

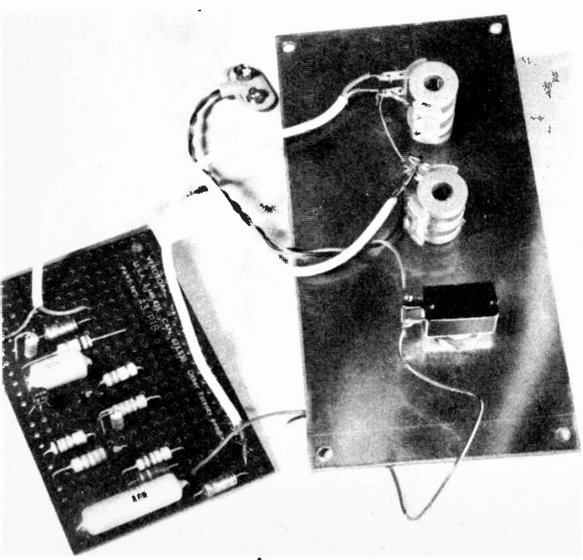
The particular unit to be described uses cheap and readily available components and compares very favourably, both in cost and performance, with its commercial counterpart.

FUZZ PRODUCTION

In the fuzz unit circuit of Fig. 1 the pre-amplifier TR1 magnifies the incoming signal via the socket JK1 and this is passed in turn to a Schmitt trigger consisting of TR2 and TR3.

The action of this circuit is to amplify and square up the signal thus adding distortion to give the characteristic fuzz sound.

To protect the base/emitter junction of TR2 from reverse bias breakdown a diode, D1, is connected.



TONAL VARIATIONS

To introduce some variation in tone a low pass filter C3 is connected to the negative line from C4. The function of this is to shunt some of the higher frequency components of the square wave and so the tone of the output depends upon its value.

In the prototype a 0·22μF capacitor was used to provide a fairly mellow tone. If the value of this is decreased to 0·1μF or lower, the tone becomes harsher. Obviously, the choice here will depend on personal requirement.

CONSTRUCTION

Small circuit components are mounted and wired on a 3¾in × 2½in piece of Veroboard as shown in Fig. 2.

It should be noted that input and output leads from the control panel sockets are screened so as to prevent hum pick-up which might cause unwanted triggering of the Schmitt circuit.

THE UNIT IN USE

When using the unit, it should be borne in mind that while the guitar volume control will not affect the level of fuzz produced, if it is set too low the Schmitt will not trigger and there will be no output to the amplifier at JK2 at all.

It is possible to make a lot of unpleasant noise with a fuzz unit. This can be avoided by never playing "fuzzed" chords or over indulging in the effect in musical passages where fuzz just does not fit in. ★

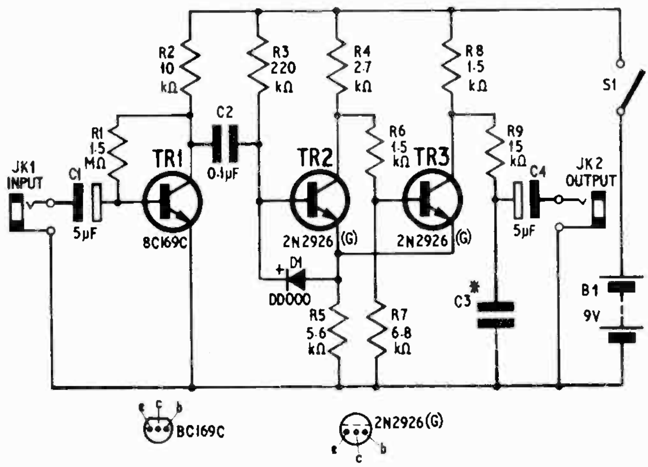


Fig. 1. Circuit diagram of Fuzz Box

COMPONENTS . . .

Resistors

R1	1·5MΩ	R6	1·5kΩ
R2	10kΩ	R7	6·8kΩ
R3	220kΩ	R8	1·5kΩ
R4	2·7kΩ	R9	15kΩ
R5	5·6kΩ		

All 10%, ¼ watt carbon

Capacitors

C1 5µF elect. 25V
C2 0·1µF polyester
C3* See text
C4 5µF elect. 25V

Transistors

TR1 BC169C
TR2/TR3 2N2926 (G) (2 off)

Diodes

D1 DD000

Miscellaneous

JK1, JK2 Standard jack sockets (2 off)
S1 On/off toggle switch. Control knobs
Veroboard 3¾in × 2½in 0·15in matrix, B1-PP3 9V battery. Battery connectors

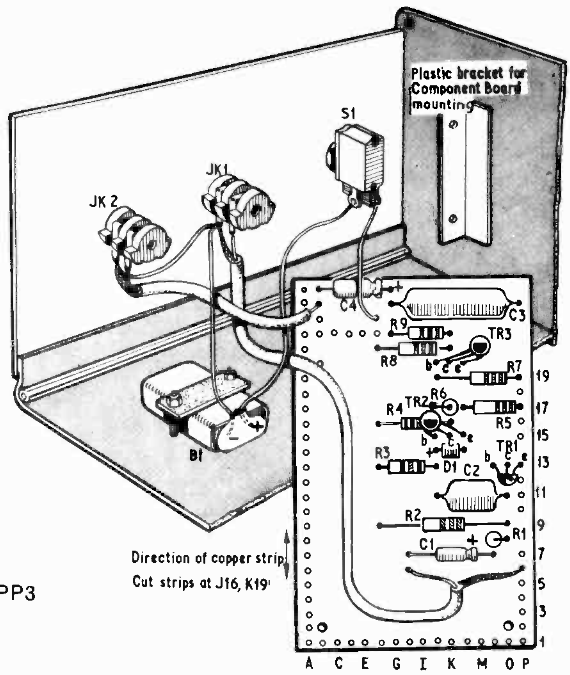


Fig. 2. Veroboard component assembly details and control panel interwiring

ELECTRONORAMA

In Search of the Quark

Two of these 75in flash tubes from the English Electric Valve Company are used at Leeds University to photograph the tracks of cosmic rays as they pass through a 100 cubic ft cloud chamber. From these photographs it is hoped to identify minute particles of matter called "quarks".

Atomic Pacemaker

Surgical care is needed in the assembly of electronic modules for a new heart pacemaker at the Raytheon Company. Powered by nuclear energy, the new pacemaker will have a life expectancy of ten years as compared with the two years of the present type powered by mercury batteries.

Fluoridation Control

A new type of meter relay from Sifam is to be used to control fluoridation by the South Derbyshire Water Board. The meter monitors the water flow and has two extra pointers which can be preset so that if the flow drops below the lower setting, fluoridation is stopped. When it again reaches the upper setting, fluoridation is resumed.

Computer Helps Conservation

Digital Equipment Computers are being used by the Natural Environment Research Council in their fight to conserve British wildlife.

Installed at the Marlewood Research Station in Lancashire, the computer is used to process data, particularly in connection with research into soil chemistry, Dutch Elm Disease, and a nationwide survey of woodland.

NEWS BRIEFS

Electro-Optics International '72

Although this year's exhibition at Brighton brought no startling new breakthroughs, it did highlight the rapid developments going on in this relatively new field.

Present in profusion were GaAsP light emitting diodes (LEDs) reduced in size from the clumsy packaging of only a few years ago to their present size, no larger than a transistor.

LEDs are now finding applications particularly in the field of communications. ITT showed how LEDs could be combined with low-loss fibre-optic cable to provide an efficient information transmission system even in noisy environments such as an aeroplane.

LEDs also appeared in a wide variety of alpha-numeric displays. ITT, Monsanto, Motorola and Ferranti all had their latest devices on show.

Liquid crystals are also being developed for alpha-numeric displays and in the next few months they should emerge as strong competition to the LED displays.

Vacuum tubes are still holding their own in area of low-level light detection. Also on show were thermal imaging devices which give a T.V. picture of the temperature distribution of the objects they are viewing. Useful both for medical diagnosis and night security.

Lasers also abounded in applications too numerous to mention. Solartron showed a novel use for them in the form of their Simfire system. The laser is used to simulate a gun providing accurate and safe determination of a marksmen's skill.

It was clear from the show that there can no longer be any clear dividing line between the two areas of optics and electronics, so readers should be prepared to find more light creeping into their future projects.

Exhibition Dates

I.E.A. (Instruments Electronics and Automation) will be held at Olympia, London, May 8 to 12.

International Audio Festival and Fair will be held in the Grand Hall, Olympia, London, October 23 to 28.

Fly Fishing

A new RCA low-light level TV camera that can detect from an aircraft the dim glow of sea plankton being disturbed by fish is being used for night-time ocean surveys.

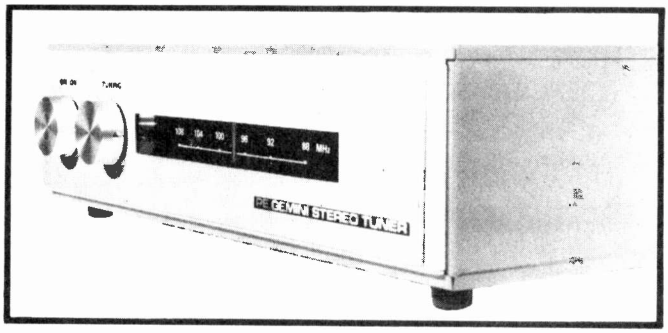
The camera, which employs an imaging tube similar to the one used in *Apollo* moon cameras, is being flown at altitudes up to 6,000 feet by the U.S. National Marine Fisheries Service in a new approach to the detection and assesment of ocean fish.

Besides detecting fish from the plankton glow, the camera can record the outline of the school. By analysing the size and shape of the outline, scientists hope to be able to determine the species of the school.

The new method of detecting fish is expected to provide scientists with a means of tracking and analysing the distribution and abundance of many types of marine resources. If tests are successful, a commercial version of this camera could one day be used by the fishing industry. One aircraft equipped with such a device might guide a large fleet of boats to the most productive fishing grounds.

P.E. GEMINI STEREO TUNER

PART TWO

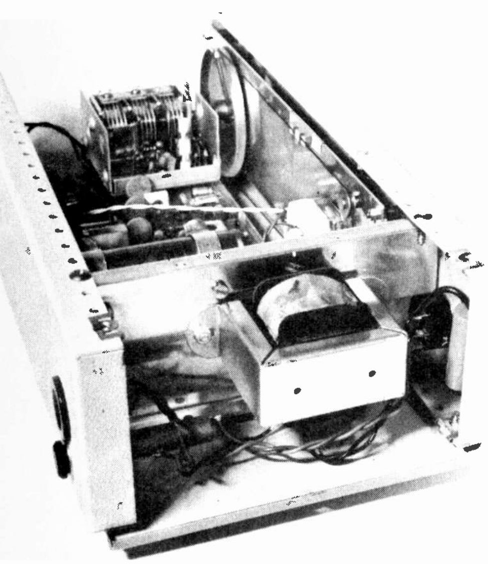


BY D.S. GIBBS & I.M. SHAW

LAST month complete circuit details were given with components list. This month the mechanical assembly of the case and tuning drive is given.

METALWORK

The Gemini Tuner is housed in a Contil Mod-2 case, size G; the front and rear grey panels should be cut and drilled as shown in Figs. 13a and 13b. Two extra panels, a dummy front panel and an inner front panel, are required and these should be cut from 18 s.w.g. aluminium as shown. Note that the slot in the dummy front panel is $\frac{1}{4}$ inch narrower and $\frac{1}{2}$ inch shorter than the slot in the case itself to facilitate the mounting of the Perspex tuning scale.



This is glued to the back of the dummy front panel and protrudes through the hole in the case. When the holes have been cut the edges of the panel should be smoothed off and it can then either be rubbed with wire wool (using soap and water) to give a "brushed" finish or sand blasted to give a "satin" finish.

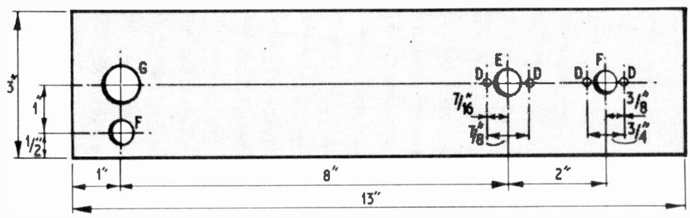
The aluminium inner front panel (Fig. 14) supports the tuning drive, the tuning meter and the stereo indicator lamp. The rectangular hole with the two fixing holes on either side are specifically for the type of tuning meter used in the prototype (Type MH-25B) and modifications will be necessary if a different tuning meter is used. The same applies to the $\frac{3}{16}$ inch hole for the stereo indicator lamp. The prototype used a Thorn 6V 60mA miniature pilot lamp, but any similar lamp can be used if the mounting hole is changed to suit. A 12V 40mA lamp can be used if R32 is omitted. The finished panel should be cleaned and can then be sprayed black with matt black car aerosol paint, or alternatively, brush painted with blackboard paint. Don't forget to cover up the meter fixing screws with a dab of paint. The tuning meter is mounted with two countersink 8B.A. screws. A piece of 2 inch wide matt black ahesive tape can be used instead of paint, if desired.

Two small brackets are required to hold the scale lamps in position and these should be cut from 18 s.w.g. aluminium as shown in Fig. 15.

The tuner head spindle should be cut down to $1\frac{1}{16}$ inches taking great care not to allow the filings to get into the tuner head assembly. The tuning drum should be positioned on the shaft so that the slot travels through the arc shown in Fig. 16. The fixing screws on the drum should be facing the tuner head case.

TUNING SCALE AND LABELLING

The scale is cut from a piece of $\frac{1}{16}$ inch clear Perspex and is labelled on the front with white Letraset or on the inside with "reverse lettering" Letraset, to contrast with the black background. The calibration is shown in Fig. 17. After lettering the scale should be protected by applying two *light* coats of Letracote



DRILL SIZES

C $\frac{3}{8}$in dia.
D No. 34 drill
E $\frac{5}{8}$in dia.
F $\frac{1}{2}$in dia.
G $\frac{3}{4}$in. dia.

Fig. 13a. Rear grey panel looking at inside

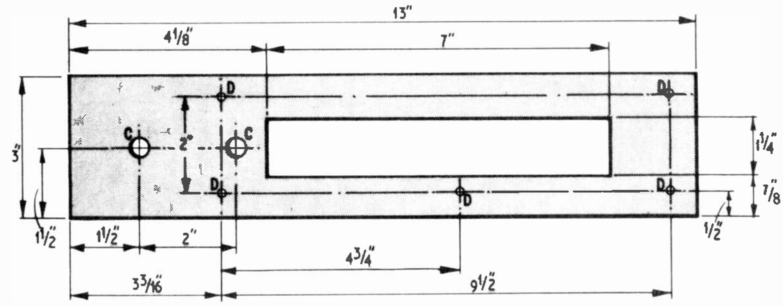


Fig. 13b. Front grey panel looking at inside

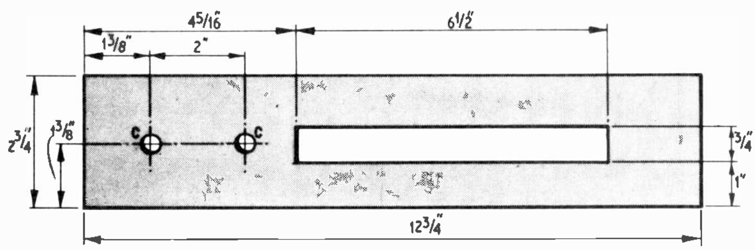


Fig. 13c. Front aluminium escutcheon plate

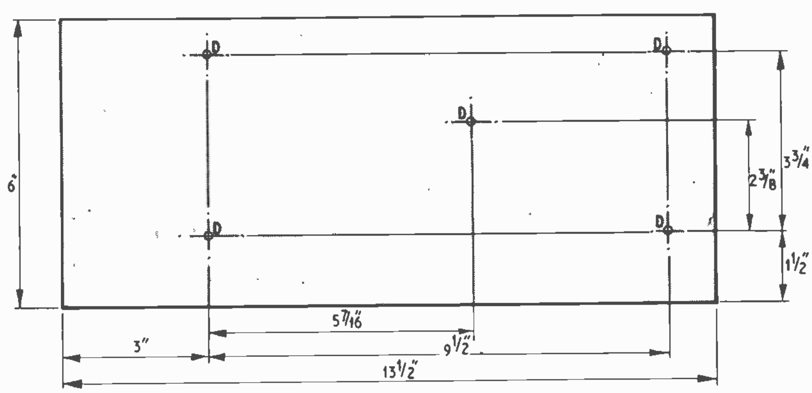


Fig. 13d. Blue base-plate looking at inside

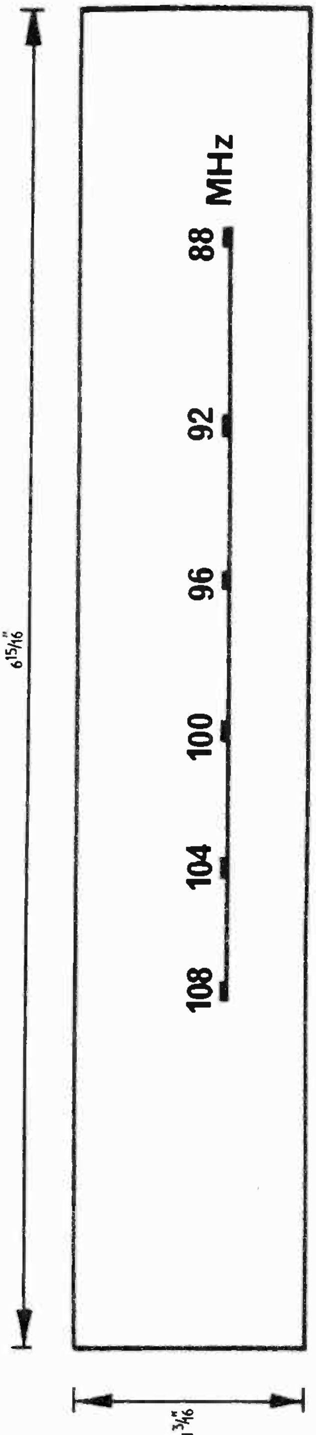


Fig. 17. Full size drawing of the tuning scale made from Perspex

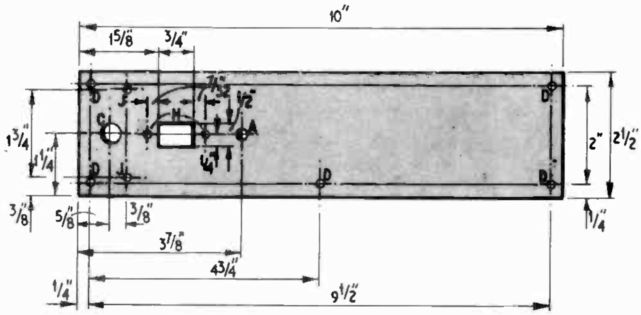


Fig. 14. Tuning drive assembly is mounted on this aluminium plate (front view)

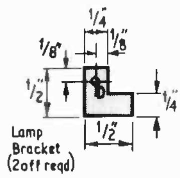


Fig. 15. Two of these aluminium brackets are required to mount the dial lamps

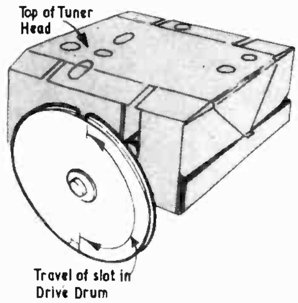


Fig. 16. Position of drum on tuner head

DRILL SIZES

A $\frac{3}{16}$in dia.
B No. 27 drill
C $\frac{3}{8}$in dia.
D No. 34 drill
H No. 44 drill
J $\frac{1}{8}$in dia.

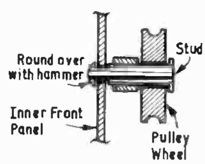


Fig. 18. Section through the pulley assembly riveted to holes J in the plate in Fig. 14

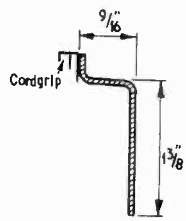


Fig. 19. The cursor is bent and trimmed to length as shown here

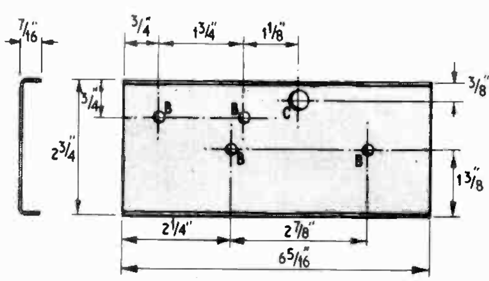
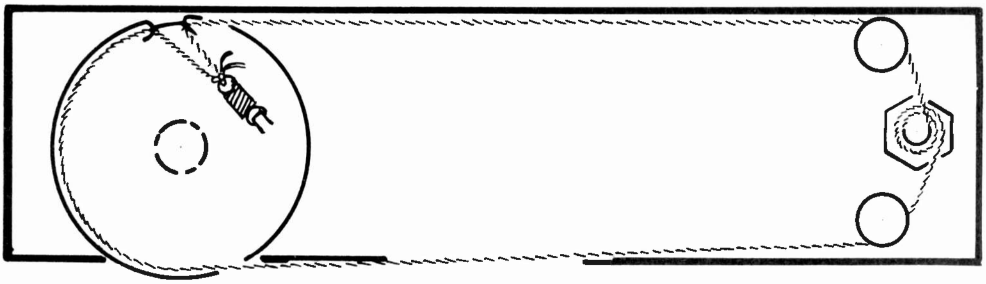


Fig. 20. This screening plate (available with the case) is drilled as shown here



The finished tuning drive assembly

gloss spray. Do not use heavy coats or household varnish as this will cause unpleasant discolouration of the scale.

The dummy front panel should be carefully cleaned and given one coat of Letracote spray before applying the lettering. This gives the panel a smooth surface which the lettering can adhere to better than the bare aluminium. After applying the lettering the panel should be given two further light coats of spray to protect it.

(Letraset and Letracote spray are available from most shops specialising in artist's and drawing materials, and also from some stationers.)

DIAL DRIVE ASSEMBLY

The Perspex scale can now be glued to the rear of the dummy front panel with "Clear Bostik". Take great care not to allow the adhesive to show on the front face and place the scale so that it can pass through the hole in the case.

The scale lamps (l.e.s. with nylon holders) can now be fitted to the inside top of the front panel, using the existing perforated holes to fix the two brackets at each end of the slot. The two lamps are then wired in series, using a length of very thin ((7/·0076) twin twisted wire, ready for connection to the printed circuit board later.

The two pulleys for the drive cord should be fixed to the inner front panel as shown in Fig. 18 (note: do this before painting the panel) and then the tuning meter, cord drive spindle, and stereo indicator lamp should be fitted to the finished panel. This panel is mounted on five $\frac{1}{4}$ inch spacers to the rear of the front panel of the case, using 6 B.A. countersink screws. Make sure that the heads of the screws are properly recessed, otherwise they will interfere with the fitting of the dummy front panel. The dummy front panel can then be glued into position on the front of the case, taking great care to align the holes correctly. Use clear Bostik, Evostik, or double sided adhesive tape.

The mains transformer and capacitor C39 can now be mounted on the small internal chassis supplied with the case, and the sockets, fuse holder, and switch mounted on the rear and front panels of the case, as shown in the photographs. The box can then be assembled except for the two sides and the top.

POINTER

The Jackson type SL6 pointer is supplied straight, and to avoid parallax error it must be carefully cut and bent as shown in Fig. 19. After bending, fit it on to the inner front panel and make sure that it can slide along the top edge freely. Any fouling can be rectified at this stage by bending to suit. The pointer should be as close to the front panel as possible without touching. This pointer is supplied with a white finish, but it can be made to stand out very brightly by giving it a coat of "Fire Orange" fluorescent paint.

CHASSIS PLATE

The chassis plate shown in Fig. 20 is supplied with the case and needs drilling. This plate is used to screen the a.c. power section from the rest of the tuner.

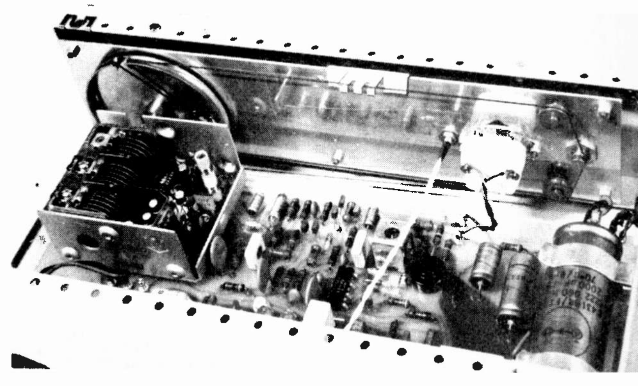
MORE ABOUT COMPONENTS

The slide pointer dial drive assembly is made up from components made by Jackson Bros. They are as follows:

Pointer type SL6, No. 4580
Drum $2\frac{3}{4}$in dia., No. 3955
Pulley assembly $\frac{1}{2}$in dia. (2 off), Nos. 4534, 4879, 4880
Cord drive spindle, Type H, No. 5081
Spring for drum, No. 4587
Nylon cord

The Tuner Head is a pre-aligned unit which should never be altered or tampered with; it can be obtained from A.M.C. Electronics Ltd. The coil L2 and Vernitron transfilters are generally available through component suppliers including Home Radio. Neosid coil formers are also generally available through component specialists who advertise in this magazine.

We regret that due to space restrictions the full details of the component assembly and printed circuit board is held over to next month.



SMALL POWER TRANSFORMERS

How to design and construct

By P. Duncan

A SMALL power transformer is constructed by winding a coil of insulated copper wire and assembling a treated iron laminated core into it.

The coil can be wound without the aid of a winding machine if certain simplified hand methods are adopted. Assembling the core is no trouble. Wire, core laminations, and other constructional material can be obtained either from clean discarded transformers or new from stockists.

It is feasible, therefore, for the electronics constructor to wind and assemble his own transformers, if the basic principles are grasped.

Before any winding is attempted, however, it is necessary to determine the number of turns, the gauge of wire, and the size of core. A method will be described in this article that reduces the electrical design of transformers to a few calculations.

It is also feasible, therefore, for the constructor to originate his own transformer designs. And when he does theoretical work in addition to doing the winding, he has the deep satisfaction of completely creating at least one component in his equipment.

THE BOBBIN

The easiest coil winding method employs a flanged bobbin. Bobbins may be made from any stiff insulating material such as cardboard or s.r.b.p. The thickness of this material should not exceed $\frac{1}{16}$in. Six pieces of the material are cut, two large pieces for the cheeks, and four smaller pieces for the former. An assembled bobbin is shown in Fig. 1. Polystyrene cement or impact adhesive may be used to hold the bobbin together, but must not be allowed to come into contact with the enamel insulation on the copper wire.

Dimensions for the various bobbin pieces are given in Table 1. A slot should be cut, or a line of holes drilled, in each cheek before assembly to

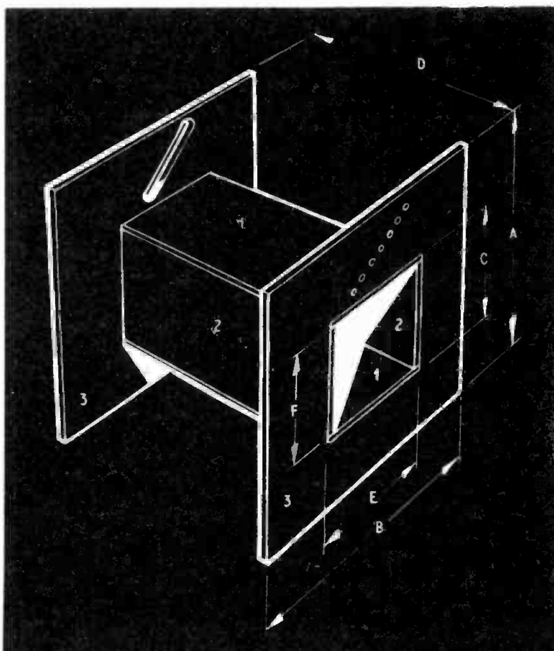


Table 1. DIMENSIONS OF BOBBIN PARTS (inches)

Lamination	A	B	C	D	E	F
$\frac{3}{4}$	Stack +1·250	1·47	Stack +0·187	1·094	0·906	Stack +0·062
$\frac{7}{8}$	Stack +1·500	1·72	Stack +0·187	1·281	1·031	Stack +0·062
1	Stack +1·625	1·97	Stack +0·187	1·469	1·156	Stack +0·062
$1\frac{1}{4}$	Stack +2·000	2·47	Stack +0·187	1·844	1·406	Stack +0·062
$1\frac{1}{2}$	Stack +2·375	2·97	Stack +0·187	2·219	1·656	Stack +0·062
$1\frac{3}{4}$	Stack +2·750	3·47	Stack +0·187	2·594	1·906	Stack +0·062

Fig. 1. The bobbin is made up from pieces cut from $\frac{1}{16}$in s.r.b.p. sheet or thick cardboard and glued together. Slots or holes in the cheeks (3) are to allow lead-out wires to be passed out

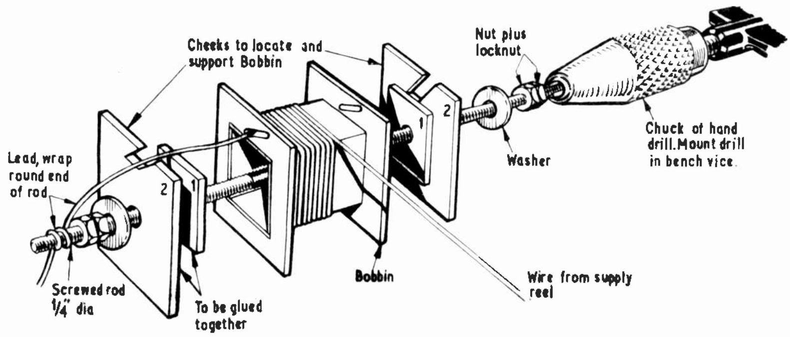


Fig. 2. A winding jig is made up so that Parts 1 fit inside the bobbin and the Parts 2 prevent the cheeks bulging. Studding and nuts clamp the two ends onto the bobbin; both pairs of Parts 1 and 2 are glued together. Tightness is very important, without damaging the bobbin, to prevent the bobbin assembly slipping. Spigotted washers or key-ways would help

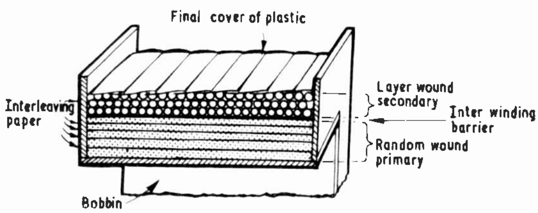


Fig. 3. Cross-section view of a transformer winding

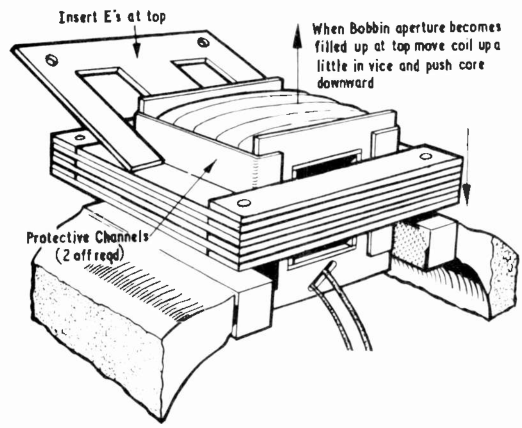


Fig. 5. Method of inserting laminations alternately. The insulating coating should face the same way throughout

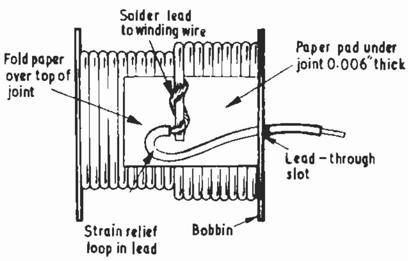


Fig. 4. Method of terminating the winding wire with very thin flexible p.v.c. covered wire. Remove about ¼in of enamel from winding with very fine emery paper. Do not allow paper pad, lead wire, or soldered joint to slide from top end of winding down the side of the winding where it would take up vital space and prevent the E's from fitting over the sides of the completed coil

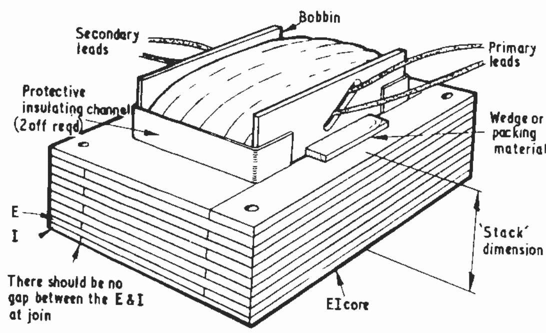


Fig. 6. The finished winding and lamination assembly

allow the connecting leads (or taps) to be brought out from the windings. If a cardboard bobbin lacks rigidity it may be strengthened by brushing with varnish and allowing to dry. Any sharp corners on the former should be rounded with a fine file to avoid damage to wire insulation.

WINDING DEVICE

The bobbin may be wound with the help of a hand drill supported in a bench vice. The bobbin is held in the chuck by a piece of studding or a long bolt. The set up is shown in Fig. 2. The supporting cheeks shown in Fig. 2 are cut from plywood. Part 1 of each cheek should just fit inside the bobbin; part 2 of each supporting cheek is cut as large as the bobbin cheek but must have a notch adjacent to the lead-out slot. Parts 1 and 2 are glued together.

Keeping count of the number of turns during winding is simplified if only the revolutions of the drill handle are noted. The count must then be multiplied by the gear ratio of the drill to find the number of turns on the bobbin.

The number of turns need not be exact. Even professional manufacturers with automatic machines only work to a turns accuracy of $\pm 2\frac{1}{2}$ per cent. That is, a winding that should have 1,500 turns is considered satisfactory if it actually contains anything from 1,463 to 1,537 turns.

Table 2. SIZES OF ENAMELLED WIRES AND INTERLEAVING PAPER THICKNESS

1 Area sq in	2 Dia. over Enamel	3 Layer Height	4 Paper Thickness	5 S.W.G.
0·000015205	0·0056	0·0066	0·001	41
0·000018096	0·0061	0·0071	0·001	40
0·00002124	0·0066	0·0076	0·001	39
0·00002827	0·0074	0·0084	0·001	38
0·00003632	0·0084	0·0094	0·001	37
0·00004536	0·0093	0·0103	0·001	36
0·00005542	0·0102	0·0122	0·002	35
0·00006648	0·0111	0·0131	0·002	34
0·00007854	0·0120	0·0140	0·002	33
0·00009161	0·0129	0·0149	0·002	32
0·00010568	0·0137	0·0157	0·002	31
0·00012076	0·0146	0·0166	0·002	30
0·00014527	0·0159	0·0179	0·002	29
0·00017203	0·0171	0·0191	0·002	28
0·0002324	0·0190	0·0210	0·002	27
0·0002545	0·0207	0·0227	0·002	26
0·0003142	0·0228	0·0258	0·003	25
0·0003801	0·0249	0·0279	0·003	24
0·0004524	0·0270	0·0300	0·003	23
0·0006158	0·0312	0·0342	0·003	22
0·0008042	0·0353	0·0383	0·003	21
0·0010179	0·0396	0·0426	0·003	20
0·0012566	0·0437	0·0467	0·003	19
0·0018096	0·0519	0·0549	0·003	18
0·002463	0·0602	0·0632	0·003	17
0·003217	0·0683	0·0713	0·003	16

Notes for use with Table 2.

All dimensions are in inches.

Column 1 gives the bare copper area for each wire gauge.

Column 2 gives the overall diameter including the enamel covering.

Column 3 gives the combined layer height of one layer of the wire plus one layer of the suggested interleaving paper from Column 4.

Column 4 suggests the thickness of interleaving paper for use with the respective wire gauge.

THE WINDING

The wire should be close wound on to the bobbin in flat even layers, each layer being filled out until the end turn of wire touches and is supported by the bobbin flange. After each layer of wire, a turn of paper the full width of the bobbin and 0·001 to 0·003in thick is inserted. "Bank" grade typing paper is suitable. The paper should also touch the bobbin flanges at each side, and it should go round the coil $1\frac{1}{4}$ times so that the overlap may be glued. A coil may therefore be built up from alternate layers of wire and paper. Pile winding and crossed turns of thick wire should be avoided if possible to prevent the risk of shorted turns. The secondary winding shown in Fig. 3 illustrates this method.

The method of winding, however, depends on the gauge of wire. It is easy to wind 20 s.w.g. wire with every turn lying neatly alongside its neighbour, but it is not as easy to achieve this with a fine wire such as 30 s.w.g.

RANDOM WINDING

Fine wires may be random wound (Fig. 3). In random winding the wire is filled into the bobbin in much the same way that thread is filled into a sewing machine shuttle, except that it is essential not to allow hills and valleys to form on the surface of the winding, otherwise all the turns will not fit into the bobbin.

From insulation requirements a random winding must be divided into sections. There is a maximum number of turns that can be included in each section. Table 3, column 10, gives the maximum number of turns for each core size.

A section in a random winding is created by inserting a turn of the same thin interleaving paper (0·001 to 0·003in) that is used in layer winding. The interleaving paper thickness suggested for use with the various wire gauges in Table 2, column 4, should therefore be used whether the coil is to be layer or random wound. All thin wire windings start and finish with very thin flexible wire connections that are well insulated. Do not use self-adhesive clear tape for insulation or the enamel is likely to be corroded by the adhesive. Tapped windings should also be connected to terminating wire and insulated. Finely soldered joints are always recommended, the enamel being removed with fine emery paper.

LEADS

Transformer windings must be connected to the source of power and to the load circuit. This is best accomplished by flexible leads whether a terminating tag strip is used or not. Leads should provide a good electrical connection and should also be strong enough to withstand handling.

Winding wires of 25 s.w.g. and thicker are strong enough, yet flexible enough in themselves to form lead-out connections. Such a lead may, therefore, be made by extending the winding wire out through the slot in the cheek of the bobbin. This extension may then be covered with sleeving for extra protection. The sleeving should be passed back through the slot so that it becomes anchored within the winding.

If the winding wire is 26 s.w.g. or thinner, then an insulated flexible lead should be soldered on to the first and last turns of the winding. The method of connection to the last turn is shown in Fig. 4. At the start of a winding, the lead is connected to the first turn of the winding wire in the same way, except that the pad of 0·006in paper is placed over the joint. The soldered joint should have no sharp points or edges that would puncture the paper pad.

TAPS

If taps are required on a winding, the winding wire need not be cut. The wire should be scraped clean of enamel with fine emery paper for a short distance and a flexible lead soldered on. The insulating pad of paper must now be folded round the soldered joint so that it insulates the joint from the other turns in the winding both above and below.

It is not essential for a stranded flexible lead wire to have a total copper area equal to the copper area of the winding wire to which it is connected. As a general rule, a popular lead wire such as 7/36 (7/0076), that is, a lead built up from seven strands of 36 s.w.g. tinned copper wire, may be used with all thin winding wires.

THE HEIGHT CHECK

Design Table 3 gives, for each core size (assuming a 1/16in former), the wire gauge and the number of turns for a 250 volt primary winding. This primary leaves a certain space in the bobbin into which the secondary must fit. Normally, if the bobbin is not overloaded, the secondary will indeed fit.

Unfortunately, for certain combinations of secondary volts and amperes, the secondary will not fit. The build up of winding height for the secondary should therefore be checked before a transformer is wound.

The method of checking the secondary build up is explained in Step 5 of the practical example that follows later.

Table 3. TRANSFORMER DESIGN TABLE, 50Hz

1 VA	2 Lam Size	3 Lam Stack	4 Primary Wire	5 Primary Turns	6 Turns per Volt Sec	7 Sq In Per Amp	8 Bobbin Width	9 Bobbin Height	10 Random Turns	11 Weight lbs
10·0	0·75	0·75	42	2720	13·2	0·000313	0·969	0·105	545	0·19
13·3	0·75	1·0	40	2045	9·65	0·000313	0·969	0·105	410	0·21
16·6	0·75	1·25	39	1635	7·55	0·000313	0·969	0·105	328	0·23
20·0	0·75	1·5	38	1362	6·20	0·000313	0·969	0·105	273	0·25
25·0	0·875	1·0	37	1750	8·22	0·000313	1·156	0·125	351	0·36
31·3	0·875	1·25	36	1400	6·46	0·000313	1·156	0·125	281	0·40
36·5	0·875	1·5	36	1167	5·30	0·000321	1·156	0·125	234	0·43
41·6	0·875	1·75	35	1000	4·50	0·000329	1·156	0·125	200	0·46
41·9	1·0	1·0	35	1532	7·20	0·000325	1·344	0·150	307	0·50
49·3	1·0	1·25	34	1225	5·60	0·000337	1·344	0·150	245	0·54
56·5	1·0	1·5	33	1020	4·60	0·000353	1·344	0·150	204	0·59
63·2	1·0	1·75	32	875	3·88	0·000367	1·344	0·150	175	0·63
70·0	1·0	2·0	30	765	3·36	0·000380	1·344	0·150	153	0·67
85	1·25	1·25	29	1025	4·47	0·000432	1·719	0·195	205	1·00
98	1·25	1·5	28	854	3·68	0·000439	1·719	0·195	171	1·07
112	1·25	1·75	28	734	3·13	0·000451	1·719	0·195	147	1·15
124	1·25	2·0	27	638	2·71	0·000463	1·719	0·195	128	1·22
135	1·25	2·25	26	568	2·41	0·000478	1·719	0·195	114	1·28
147	1·25	2·5	25	512	2·15	0·000492	1·719	0·195	103	1·36
160	1·5	1·5	25	740	3·14	0·000518	2·094	0·242	148	1·90
182	1·5	1·75	24	634	2·68	0·000532	2·094	0·242	127	2·10
202	1·5	2·0	23	555	2·35	0·000543	2·094	0·242	111	2·20
223	1·5	2·25	23	493	2·06	0·000558	2·094	0·242	99	2·30
241	1·5	2·5	22	444	1·95	0·000573	2·094	0·242	89	2·40
276	1·5	3·0	22	370	1·53	0·000602	2·094	0·242	74	2·50
285	1·75	1·75	22	544	2·29	0·000608	2·469	0·289	109	3·30
316	1·75	2·0	21	476	1·99	0·000627	2·469	0·289	96	3·45
344	1·75	2·25	21	420	1·75	0·000648	2·469	0·289	84	3·62
374	1·75	2·5	21	382	1·58	0·000663	2·469	0·289	77	3·80
420	1·75	3·0	19	318	1·31	0·000702	2·469	0·289	64	4·10

Notes for use with Table 3

All dimensions are in inches.

Column 1 is the maximum volt-amp rating for the core given in Columns 2 and 3.

Column 2 gives the size of the centre tongue of the required lamination. This is dimension "A" in the lamination table, Table 4.

Column 3 gives the stack of laminations required. The stack is shown in Fig. 6.

Columns 4 and 5 give the wire gauge (s.w.g.) and turns for a 250V 50Hz primary.

Column 6 gives the turns per volt for the secondary. The secondary voltage should not be greater than 500V.

Column 7 gives the wire area in square inches per ampere for use with any secondary.

Columns 8 and 9 give the space that is available in the bobbin for the secondary winding after the given primary has been wound.

Column 10 gives the maximum number of turns that may be wound in a random section without the insertion of interleaving paper.

Column 11 gives the total weight of wire required for the transformer. The weight of wire required for either a primary or a secondary winding will be one half of this figure.

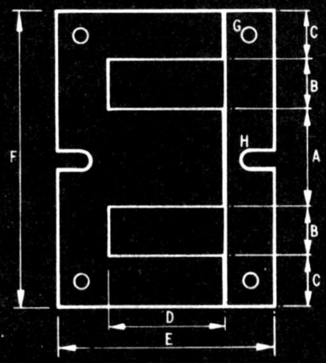


Table 4. DIMENSIONS OF STANDARD EI LAMINATIONS (inches)

A	B	C	D	E	F
0·75	0·375	0·375	1·125	1·875	2·25
0·875	0·437	0·437	1·312	2·187	2·625
1·00	0·5	0·5	1·5	2·5	3·00
1·25	0·625	0·625	1·875	3·125	3·75
1·5	0·75	0·75	2·25	3·75	4·5
1·75	0·875	0·875	2·625	4·375	5·25

Note: Holes G and notches H are provided for mounting purposes.

In calculating the build up, the layer height from Column 3, Table 2, should be used whether the secondary is to be layer or random wound. A layer wound secondary of, say, ten layers of 25 s.w.g. would have a total winding height of 10 × 0·0258 = 0·258in. If the same winding were to be random wound then the same height calculation should be made.

Although the layer of paper that normally follows every layer of wire is omitted in a random winding, it is found that the build up of a random winding is approximately equal to the build up of a layer winding. A random winding has less paper in it, but it becomes untidy as the winding progresses and therefore uses space inefficiently compared to a neat layer winding.

In the case of a high current secondary it is permissible to wind with two or three wires in parallel, but when the height is checked it must be remembered that the winding consists of side by side turns of a multiple wire.

CORE ASSEMBLY

The core laminations are insulated one from the other to prevent the circulation of eddy currents that could overheat the core and damage the transformer.

The most common arrangement for transformer laminations is the pairing of "E" and "I" pieces. Table 4 lists the dimensions of typical EI laminations. For use on 50Hz supplies the lamination thickness should be in the range 0·010 to 0·025in.

Laminations are usually referred to by the width of their centre tongue which passes through the bobbin. In Table 4, a 1in lamination is the lamination with dimension "A" equal to 1in.

When the winding is complete the core laminations are stacked into the bobbin by first inserting the E lamination then the I lamination alternately (Fig. 5). The insulated surface on all laminations must face the same way. The bobbin is filled with E's and I's until it is full, the last piece being a firm fit otherwise excessive hum will result when the transformer is energised. If necessary, the correct degree of tightness can be obtained by tapping a thin card wedge, or some other non-metallic packing material, in at the top of the stack as shown in Fig. 6.

It is necessary to hold the two outside I's in place with the mounting brackets or clamps.

With the E's and I's all in place, the core should be finally squared up by tapping on a flat surface with a small block of wood.

OVERSIZE COILS

It may be found that after a coil is wound the E laminations will not fit into the bobbin because the windings have built up until they bulge beyond the edge of the bobbin cheeks.

An oversize coil is either caused by there being too much wire and paper in the bobbin or it is caused by insufficient tension having been applied to the wire during winding. If the present design method is followed, an oversize coil due to excessive wire and paper should not occur.

Insufficient winding tension merely results in the coil being loose and spongy, and such a coil can be used if the winding is gently compressed before the insertion of the laminations. The vice method is shown in Fig. 5, but is not to be recommended unless extreme care is exercised to prevent the laminations chafing the winding. The best solution really is to strip and rewind the bobbin.

INSULATION

Enamelled winding wire should be used. The enamel, however, is usually only about 0·0005in thick. Where two wires touch, therefore, the total thickness of insulation between them is 0·001in (or one thou). The maximum working stress that can be placed on the insulation in a home constructed transformer is about 50 volts per 0·001in. Hence the reason for splitting a random winding into sections. The sections ensure that not more than 50 volts will ever occur between adjacent wires.

A barrier of insulation 0·010in thick should be wound on top of the primary winding before the secondary is started. It is usual to build up this barrier from three turns of 0·003in paper (e.g. thickness of bond typing paper). Fig. 3 shows the location of the insulation barrier between a primary and a secondary winding.

The outer surface of the secondary winding may be protected by covering with one or two layers of insulating paper tape or, better still, cambric. The tape should be pulled tight so that it holds the windings firm within the bobbin.

There is a possibility of the sharp corners on the legs of the E laminations to cut into the surface of the coil during assembly of the core. It is advisable, therefore, to fit stiff paper channels, 0·010 thick, on each side of the completed coil before inserting the E's. The channels can be seen in Fig. 6. There is no need to put adhesive on the channels; the first E will hold them in place.

Small quantities of electrical insulating paper are difficult to obtain and the enthusiast must improvise. Thin brown wrapping paper, clean writing paper, typewriter paper, office file covers, all are possible alternatives. A matt finish paper is better than a gloss paper because the wire beds into it better.

A dry unprotected transformer will give years of service in a domestic indoor location. But if a transformer is for use in portable equipment, or a damp location, then protection against the ingress of moisture is necessary. Such protection can be obtained by dipping the completed transformer in wax, or by brushing it with varnish. Before dipping or brushing, the transformer should be dried out by warming for two hours in a moderate oven set to 212°F.

There is the possibility, particularly with mains and audio power transformers, for buzzing to occur. This is usually the wire or laminations vibrating in sympathy with the a.c. supply. The best cure is wax dipping using beeswax or paraffin wax.

SPECIFICATION

Before a transformer can be designed the following electrical parameters must be known: (a) the volt-amp rating (VA); (b) the primary voltage; (c) the secondary voltage; (d) the secondary current; (e) the voltage of any taps that are required on either the primary or secondary.

For most small power transformer applications the VA rating of the transformer is equal to the rating of the load in watts.

DESIGN

By making use of Table 3, the design is reduced to the following six steps.

1. A core with a VA rating equal to or greater than the VA rating of the proposed transformer is chosen via column 1.
2. The wire size and the number of turns for the primary are copied from columns 4 and 5.
3. The number of secondary turns is determined by multiplying the secondary voltage by the turns per volt figure from column 6.
4. The area of wire required for the secondary is found by multiplying the secondary current by the current density from column 7. The first wire gauge with an area in excess of this calculated area is then chosen from column 1, Table 4.
5. A height check is made to ensure that all the secondary turns of the chosen wire gauge will fit into the bobbin. Columns 8 and 9, Table 3, give the winding width and height that remains for the secondary winding.
6. If taps are to be included in the windings, the location of each tap is determined and space should be allowed for the extra bulk at terminations.

The complete design procedure is illustrated by the flow diagram in Fig. 7.

EXAMPLE

A transformer was required to power a piece of equipment that was rated at 115 volts, 50/60Hz, 70 watts from 250V 50Hz mains supply. The following specification was required:

Rating: 70VA.

Primary: 250 volts, 50Hz, with taps at 210 volts and 230 volts.

Secondary: 115V, 0·61A, with a tap at 110 volts.

(Note: 0·61 amps = 70VA/115 volts)

The design went as follows.

Step 1. From columns 1, 2 and 3 of Table 3, the first core capable of delivering 70VA is built up from a 1in lamination with a stack of 2in.

Step 2. From columns 4 and 5, the primary wire size is 30 s.w.g. and the primary turns are 765.

Step 3. In column 6, the secondary turns per volt is 3·36. Therefore, for 115 volts, the number of secondary turns is 3·36 × 115 = 386.

Step 4. The required wire area for the secondary is found by multiplying 0·61A by the current density in column 7. The wire area is therefore 0·61 × 0·000380 = 0·000232 square inches. And from Table 2, a wire gauge of 27 s.w.g. is required to meet this area.

Step 5. From column 8 of Table 3, the available winding width between the cheeks of the bobbin is 1·344in (see dimension "A" Fig. 8). From column 2, Table 2, the overall diameter of 27 s.w.g. is 0·019in. Therefore 1·344/0·019 ≃ 70, is the number of turns that may be wound in each layer of the secondary.

If 70 turns go on each layer, and if the total secondary turns are 386, then 386/70 = 5·5 layers

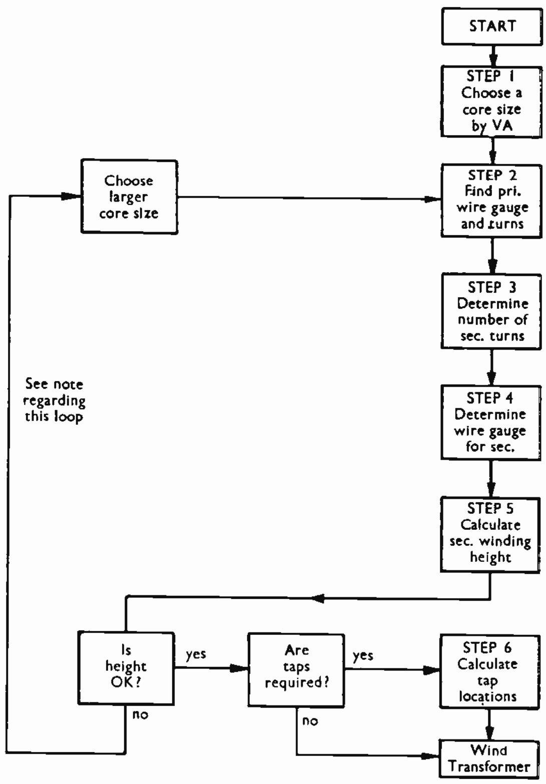


Fig. 7. Flow diagram of design procedure using Table 3. If the winding height calculated for the secondary in Step 5 exceeds the available height given in column 9, Table 3, then the next larger core size should be chosen and the design procedure repeated by looping back to Step 2

are required to accommodate the secondary winding. But since 0·5 of a layer occupies the same build up in height as a whole layer, then the number of secondary layers must be considered as six.

From column 3, Table 2, the height of each layer of 27 gauge is 0·021in, therefore 6 × 0·021 = 0·126in will be the total build-up in height for the secondary winding. From column 9, Table 3, the height available for the secondary winding is 0·150in (see dimension "B" Fig. 8). There should therefore be plenty of room for the secondary on top of the primary.

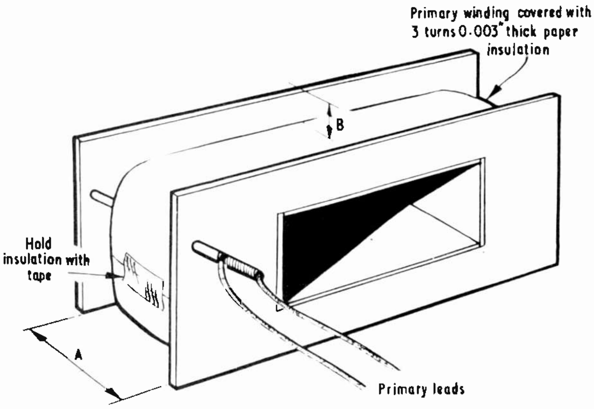
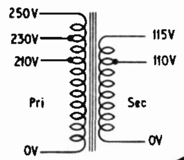


Fig. 8. Designing for optimum bobbin size. Dimension "A" is the available winding width between the flanges of the bobbin for both the primary and the secondary windings. The value of "A" for each core size can be found in column 8, Table 3. Dimension "B" is the winding height remaining for the secondary after the primary has been wound. The value of "B" for each core size can be found in column 9, Table 3



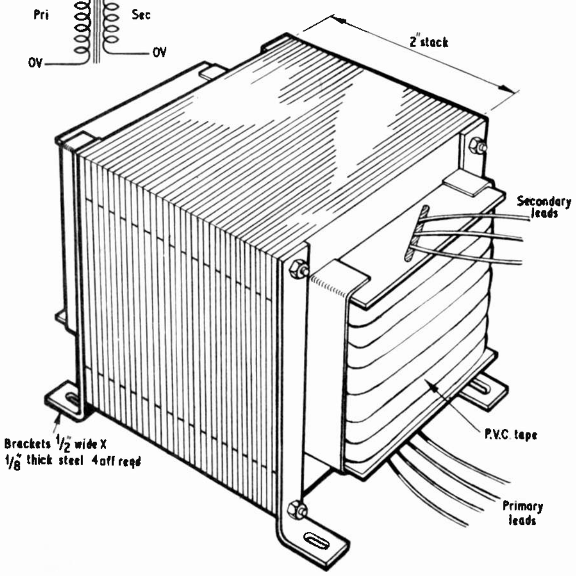


Fig. 9. Finished transformer with mounting clamps

Step 6. The location of a tap is determined by dividing the total number of turns in a winding by the full winding voltage and then multiplying the result by the voltage at which the tap is required.

In this design, the 230 volt primary tap must be made at (765/250) × 230 = 704 turns. The primary 210 volt tap must be made at (765/250) × 210 = 643 turns. And the secondary tap must be made at (386/115) × 110 = 369 turns for 110 volts.

The final design was therefore:
Core: 1in lamination with a 2in stack.
Primary: 765 turns of 30 s.w.g. wire tapped at 704 and 643 turns.
Secondary: 386 turns of 27 s.w.g wire tapped at 369 turns.

CONSTRUCTION

The bobbin was made from $\frac{1}{16}$in cardboard. The primary was random wound in five sections, which required the insertion of a turn of interleaving paper every 153 turns (or every 41st turn of the drill handle since the gear ratio of the hand drill used in the winding was 3·73:1).

Interleaving paper was cut from sheets of new typewriter paper that was 0·0025in thick. P.V.C. insulated lead wire, 7/36, was used for all taps and also at the start and finish of both primary and secondary.

On completion of the primary winding the height remaining for the secondary measured 0·125in. That is, dimension "B" Fig. 8, measured 0·125in. Column 9, Table 3, states that there should be 0·150in remaining for the secondary after the primary has been wound. The primary winding was therefore oversize and occupying more space than it should.

To reduce the excessive coil build up, the secondary was wound as tightly as possible in three random sections. The turns of interleaving paper being inserted at the 128th and at the 256th turn of wire.

On completion of the secondary winding the finished coil was oversize and the E laminations would not go in. The laminating method shown in Fig. 5, however, enabled the insertion of the E's and the core was successfully assembled.

The 0·001in channels that protect the windings during the laminating operation were made from an office folder.

Four lengths of ½in steel strap are cut and shaped into mounting brackets. The brackets can be seen in Fig. 9, which shows the final appearance of the completed transformer. Before testing, wire up the primary winding to the 250V a.c. supply via a 3A fuse. Use a reliable meter for checking a.c. voltage tappings.

TESTING

On test, with 250 volts applied to the whole primary winding, the primary taps measured 232 and 211 volts. The open circuit secondary voltage measured 125 volts, with the tap at 119·5 volts.

After allowing two hours running to warm up, the secondary full load voltage measured 116 volts.

In the author's opinion the most exacting part of the construction is the making of the bobbin. The winding, which at first may be thought the major problem, proved easy, and only required about half an hour for each winding. ★

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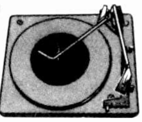

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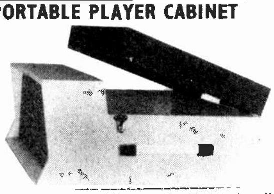

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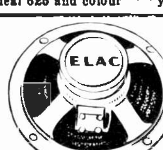

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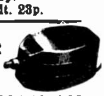

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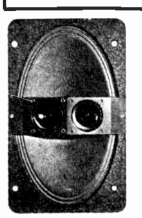

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LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft

GOODMANS 6½in. HI-FI WOOFER

8 ohm, 10 watt. Large ceramic magnet. Special Cambric cone surround. Frequency response 30–12,000 cps. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watt. 3 ohm or 15 ohm models. **£1·90** Post 10p

SPEAKER COVERING MATERIALS. Samples Large S.A.E. Horn Tweeters 2-16Kc/s, 10W 8 ohm or 15 ohm £1·50. De Luxe Horn Tweeters 2-18 Kc/s, 15W, 15 ohm £3. TWO-WAY 3,000 c.p.s. CROSSOVERS 3 or 8 or 15 ohm 95p. SPECIAL OFFER: 80 ohm. 2¾in. 2½in. 35 ohm, 2in.; 3 in. 25 ohm, 2½in. dia.; 3in. dia.; 6 × 4in; 8 × 5in. 15 ohm, 3½in. dia.; 6 × 4in; 7 × 4in; 3 ohm, 2½in, 3in, 5in, 5 × 3in. **£1** EACH TYPE. LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in. £1·25; 6½in. £1·50; 8 × 5in. £1·60; 8 × 2½in. 90p; 8in. £1·75; 10 × 6in. £1·90. ELAC 10in. 10w. Twin Cone. De Luxe Ceramic 8 ohm £4. RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. dia. 4 watt; 10in. dia. 5 watt; 12 in. dia. 6 watt, 3 or 8 or 15 ohm models £2 each. Post 15p. VALVE OUTPUT TRANS. 25p. MIKE TRANS. 50:1 25p. 5 WATT MULTI RATIO, 3, 8 and 15 ohms 80p.

BAKER 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

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

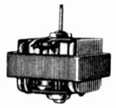
BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **£4·50**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **£3·50** Stereo version of above £4·50.

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9 volt. Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4 inch **£12·50**
BARGAIN FM TUNER as above. Chassis only, less cabinet. **£8·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **£3·50**

COAXIAL PLUG 6p, PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES. SURFACE OR FLUSH 25p. BALANCED TWIN FEEDERS 5p yd. 80 ohms or 300 ohms. JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 5p. Phono Socket 5p. JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 14p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.



E.M.I. TAPE MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3½ × 2½ × 2½in. (illustrated). Post 15p. **£1·25**

BALFOUR GRAM. MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 50mA. Spindle ⅛ × 3/20. Size. 2½ × 2½ × 1¼in. Post 15p **85p**

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INDUSTRY NOTEBOOK

By Nexus

ELECTRO-OPTICS

Early in 1971 Milton S. Kiver launched his first Electro-Optics exhibition and conference in the UK. It was a smash-hit. Everything was good about it. The venue at Brighton was popular, the technical conference was above suspicion with many world authorities speaking and listening, the turn-out of trade exhibitors was first-class, the attendance figures for such a specialised show were little short of fantastic.

This year we had a repeat performance and although the number of exhibitors was down the attendance seemed as good as ever. Laser Instrumentation Ltd wittily supplied a match with their hand-out literature with the invitation "Strike a match and read this!"—an allusion, of course, to the aftermath of the miners' strike which was still causing problems although Kiver had seen to it that plenty of emergency power was available to keep the large number of live demonstrations ticking over.

What makes Kiver's shows so popular is the quality of the technical sessions. This year, as last, he won the co-operation of the SIRA Institute who acted as a technical filter for the 50 or so technical papers presented.

At a time of general misery and rising prices it was good to see Integrated Photomatrix Ltd announcing big price reductions at the show. IPL had only just celebrated their third birthday and what a lusty infant the company is. Peter Noble, managing director, told me that greatly increased production had enabled him to cut prices of some IPL light activated switches by almost half in 100+ quantities. But the highlight of IPL exhibits was a line scan camera incorporating up to 256 optical devices.

Low light TV systems were abundantly on view with exhibitors keen to show that their own systems were most sensitive. The big rush to sell these systems commercially came only after de-classification of some military equipment last year. Apart from obvious applications like prison security, low light TV could penetrate into completely new fields.

Sad note at the closing of Electro-Optics '72 was that there will be no exhibition next year. In future it will take place every two years, the reason given by the organisers being that the rate of development of new technology is no longer such that an annual event is justified.

NEW HOME FOR "PHYSOC"

So we have seen the last of the Physics Exhibitions at Alexandra Palace, N. London. Next year it will be teaming up with the Laboratory Equipment Exhibition (Labex) at Earls Court. I welcome the change to a more central location and it will now be possible to take in two exhibitions in a single day—at least for those who are content with a quick spin-round.

A big disappointment this year was the failure of the Scandinavian countries to mount their own display. An invitation was extended but was declined, I understand, at comparatively short notice.

UNHAPPY IRISH

Ireland's electronics industry has been expanding nicely. In the past five years some high technology companies, mainly US-based, have become established and started making an increasing contribution to the country's exports as well as providing the foundation for training the first generation of home-grown Irish electronics engineers.

The Irish Government has been offering good incentive schemes for investment of foreign capital and a ten-year tax-holiday for all profits from exports. Everything was going fine—until the troubles.

I recently visited nine electronics plants in Ireland ranging in size from tiny Gow-Mac employing only ten people up to the 1,000-strong Ecco Ltd which is a wholly owned subsidiary of US General Electric turning out 200 million diodes, transistors and rectifiers a year.

Irish industrialists are worried—and they have good reason. Wage-inflation has been high, eroding many of the advantages of operating in what used to be a comparatively low-cost labour area. Tourism, on which so much of the country's economic prosperity depends, will be very hard hit this year. And few industrialists are likely to be tempted to make any new investment until a greater level of stability has been achieved.

It is hard to see how any real growth in Irish electronics can be sustained this year although most manufacturers are putting a brave face on things and trying not to talk themselves into a depression. Most, too, would like to see an end to bitterness and a long period of tranquility in which Irish electronics can build its strength and play a leading role in bringing the country forward into our technological age.

BUILT-IN SERVICES

Two cheers for the Post Office for announcing that every house in the new town of Milton Keynes is to have piped-in services. We should have adopted such systems on the widest scale years ago. But better late than never.

Each house will have not only its own telephone pair but also a high-performance coaxial cable for piping in radio and TV services and, eventually, for piping out the data from your own computer terminal, your viewphone, even your North Sea gas meter readings.

Both v.h.f. and u.h.f. will be used on the system, the v.h.f. for trunk circuits and u.h.f. over local lines. Everything will be underground so there will be no need for forests of TV aerials and last-minute overhead telephone cables. The Post Office has already had some experience in other new towns but Milton Keynes is the biggest and the forecast is that over 2,000 houses will be wired in to the system in the next twelve months.

CHIPS HAVE EVERYTHING

Those single chip large scale integrated circuits (LSI) have certainly got going commercially in a big way. And they must be real cheap, too. Latest rock-bottom price I have heard of for an electronic desk calculator using a single Texas Instruments LSI and an eight digit readout is about £36 in the Japanese supermarkets.

The desk calculator market is one the Japanese have now sewn up so tightly that no-one else has a chance. Which product line is next on their list?

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

ELECTRONIC CALCULATOR

The time when housewives will soon be doing their shopping with the aid of an electronic pocket calculator is fast approaching; only price seems the deterrent.

The latest calculator to be marketed by **West Hyde Developments** under the trade name of Tobicom, measures only 7in × 9½in × 3½in and costs only £99.

Weighing only 3½lb, the calculator adds, subtracts, multiplies and divides. Also, the arithmetic can be mixed, i.e. $2 + 6 - 3 \times 5 - 6 \div 2 + 4{\cdot}5 = 14$. The decimal place can be set with 0 to 7 digits to the right and the machine automatically clears after the equals sign is pressed. Zero suppression is included to make easier reading.

Built around six MOS LSI (Large Scale integration) chips the calculator will give up to a 16-digit answer for up to an 8-digit entry. It will multiply a negative number by a positive number. As each entry is displayed it can be checked and cleared if incorrectly entered. Only the last entry is acted on.

The keys are in three colours and arranged in three groups for ease of operation. For repetitive multiplication or division a constant factor key is depressed.

GAS DETECTOR

For some unexplained reason the reported number of accidents that have been attributed to gas leaks has been increasing over the last nine months.

For companies who rely on gas for producing their respective products the Gasmarker from **Crowcon (Instruments) Ltd.** would seem a reasonable investment. Perhaps, even private individuals may consider the investment a worth while one, since the unit is portable.

The Gasmarker sells for approximately £25 and operates on the thermal conductivity principle and gas detection is through a sintered bronze diffusion head. It can be supplied calibrated for "town" or natural gas (methane). Operation is by a single pushbutton, percentage gas by volume being indicated on a large-scale moving-coil meter.

A particular feature is the special meter scale, the lower end of which has been expanded so that 0–25 per cent concentrations occupy approximately half the scale width and 25–100 per cent the remainder. This is of special significance in locating a leak, because it allows accurate comparative measurements of very low gas concentrations in the early stages of a search; the higher end of the scale then being used to trace the leak to its source.

Additional information on the Gasmarker is available from Crowcon (Instruments) Ltd., The Common, Stokenchurch, Bucks.

AUDIO KITS

Just as someone had to be first to break the "sound barrier", it would seem that **Radio and TV Components (Acton) Ltd.** have broken the "price barrier" for home entertainment and the motorist. With the introduction of their Unisound system and the Tourist PB car radio they have certainly struck a blow for the reader.

At £25 the Unisound 505 must surely be the best value for money in the audio field, especially as their kit comes complete with turntable, stereo ceramic cartridge and a pair of EMI dual-cone eliptical loudspeakers. Also included in the kit is a simulated teak plinth, with a tinted cover, to house the amplifier and changer, plus two matching loudspeaker enclosures.

Based on the well known Mullard Unilex modules, the output stages have been modified and improved by the addition of integrated circuits which provide an output power of 5 watts per channel, ample for living rooms.

The pre-amplifier module has separate bass, treble controls and two separate volume controls.

The complete kit can be easily assembled, with a screwdriver, in approximately 40 minutes and R & TV claim that any novice or housewife who can wire up a three-pin plug can successfully assemble a Unisound 505 kit.

Once again the joy of sitting and listening to reproduction of good music has been achieved without prohibitive cost.

The new Tourist PB car radio kit is claimed to be the first in the UK to feature an integrated circuit combined with push-button station selection.

The radio covers both the medium and long wavebands and the five push-buttons can be tuned in the conventional manner or set to pre-selected stations. Four of the push-buttons operate on the medium waveband and the fifth selects stations on the long waves.

Permeability tuning and the inclusion of longwave coils ensure excellent tracking, sensitivity and selectivity on both wavebands. R.F. sensitivity at 1MHz is claimed better than 15μV.

The power output of the car radio is 2·5W into an 8 ohm loudspeaker.

Retailing at only £7 the kit contains full step-by-step instructions and the company claims that anyone who can solder should be able to complete the kit in an evening.

Both the Unisound system and the Tourist PB car radio are backed by an excellent after sales service. For approximately £2 R & TV will undertake to "trouble shoot" any returned unit provided that a genuine attempt has been made to construct a unit following their instructions.

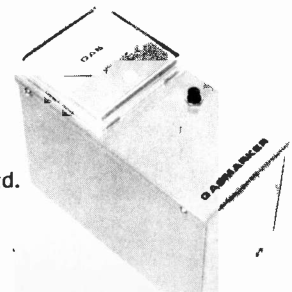
HEATSINKS

A new range of heatsinks which, it is claimed, will improve the performance and life of transistors is announced by **J. W. Sales.**

Further details and information can be obtained from J. W. Sales, 6 Russet Road, Cox Green, Maidenhead.

Tobicom calculator marketed by West Hyde Developments

Completed car radio and Unisound 505 kit from Radio & TV Components Ltd.



Gasmarker detector from Crowcon Ltd.

Great new OFFER from DIOTRAN

TRANSISTORS

BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p
AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p
AC176	23p	ASY26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p
AC177	20p	ASY27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p
AC187	30p	ASY28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p
AC188	30p	ASY29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p
ACY17	25p	ASY50	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p
ACY18	20p	ASY51	25p	BC175	22p	BF160	30p	BSY38	15p	OC71	9p	2G382	15p
ACY19	22p	ASY52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p
ACY20	20p	ASY54	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G414	30p
ACY21	20p	ASY55	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p
ACY22	19p	ASY56	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388	30p
ACY27	18p	ASY57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p
ACY28	19p	ASY58	25p	BC182	10p	BF173	22p	BU105	£3·90	OC81	15p	2N404	22p
ACY29	30p	ASY58	25p	BC182L	10p	BF176	35p	C111E	60p	OC81D	15p	2N404A	30p
ACY30	25p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p
ACY31	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p
ACY34	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p
ACY35	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p
ACY36	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p
ACY40	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p
ACY41	18p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p
ACY44	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	25p	2N717	42p
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p
AD161/		BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p
162(MP)	63p	BC134	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p
ADT140	50p	BC135	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p
ADZ11	£2	BC136	30p	BC318	12p	BF257	35p	C762	17p	P397	45p	2N743	17p
ADZ12	£2·10	BC137	35p	BC319	12p	BF270	25p	C764	60p	OCP71	43p	2N744	17p
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	EC401	15p	ORP12	43p	2N914	17p

2N918	30p	2N2714	25p	2N3704	15p
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2N930	25p	2N2904A	30p	2N3706	12p
2N1131	20p	2N2905	25p	2N3707	13p
2N1132	22p	2N2905A	30p	2N3708	8p
2N1302	17p	2N2906	25p	2N3709	8p
2N1303	17p	2N2906A	27p	2N3710	10p
2N1304	20p	2N2907	25p	2N3711	10p
2N1305	20p	2N2907A	30p	2N3819	40p
2N1306	22p	2N2923	13p	2N3820	£1
2N1307	22p	2N2924	13p	2N3903	25p
2N1308	27p	2N2925	13p	2N3904	27p
2N1309	27p	2N2926		2N3905	25p
2N1613	17p	(G)	12p	2N3906	27p
2N1711	20p	2N2926(Y)	11p	2N4058	15p
2N1889	35p	2N2926		2N4059	10p
2N1890	45p	(O)	10p	2N4060	12p
2N1893	37p	2N3010	80p	2N4061	12p
2N2160	60p	2N3011	20p	2N4062	12p
2N2147	75p	2N3053	20p	2N5172	12p
2N2148	60p	2N3054	50p	2N5459	43p
2N2192	30p	2N3055	63p	2S034	75p
2N2193	30p	2N3391	17p	2S301	50p
2N2194	27p	2N3391A	20p	2S302A	45p
2N2217	20p	2N3392	17p	2S302	45p
2N2218	25p	2N3393	15p	2S303	60p
2N2219	27p	2N3394	15p	2S304	£1·10
2N2220	22p	2N3395	20p	2S305	£1
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2N2222	27p	2N3403	22p	2S307	£1·10
2N2368	17p	2N3404	32p	2S321	60p
2N2369	15p	2N3405	45p	2S322	50p
2N2369A	15p	2N3414	20p	2S322A	45p
2N2411	50p	2N3415	20p	2S323	60p
2N2412	50p	2N3417	37p	2S324	£1·20
2N2646	55p	2N3525	74p	2S325	£1·20
2N2711	22p	2N3702	12p	2S326	£1·20
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BY100	15p	BYZ17	35p	OA95	7p
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BY105	15p	BYZ19	25p	OA202	7p
BY114	12p	OA5	17p	SO10	4p
BY126	15p	OA10	22p	SO19	4p
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Clearance of manufacturers' seconds, selected in types and guaranteed no open or short circuit units. Ideal cheap transistors for radio enthusiasts, manufacturers, schools and colleges.

TYPE STN18. Silicon Planar Transistors npn TO-18 Metal Can. Types similar to: 2N706, 2N2220, BSY27-95A, BSX44-76-77.
Price: 500 £9; 1,000 £15

TYPE STP18. Silicon Planar Transistors pnp TO-18 Metal Can. Types similar to: BCY70-72, 2N2906-7, 2N2411 and BC186-7. Also used as complementary to the above npn type device type STN18.
Price: 500 £9; 1,000 £15

TYPE STN5. Silicon Planar Transistors npn TO-5 Metal Can. Types similar to: BFY50-51-52 and 2N2192-92.
Price: 500 £9·50; 1,000 £16

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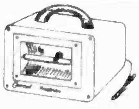

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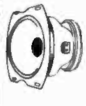

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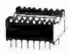

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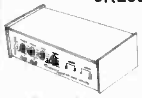

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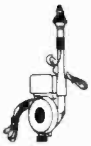

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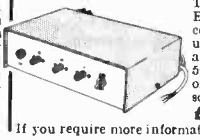

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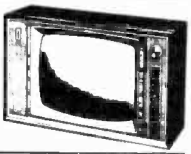

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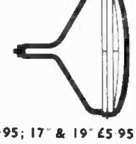

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6K7G	·12	B729	·62	ECL86	·35	PC88	·47	PY83	·28	AC107	·17
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INGENUITY UNLIMITED

**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.**

IC DICE

READERS may be interested in a modification I have made to J. D. Croft's, "IC Digital Dice" published in the December 1971 edition of P.E.

I had also been thinking along the same lines but decided against using an SN7492 ÷ 12 counter. The output "000" of the counter greatly increases the amount of decoding circuitry required.

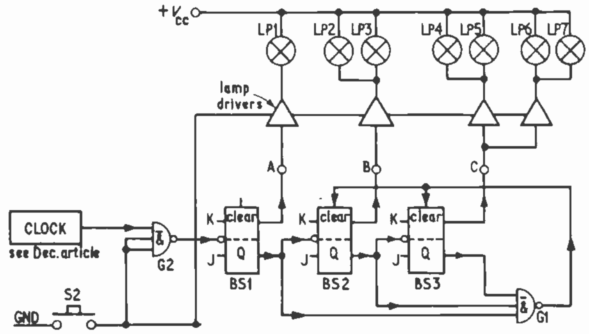
The circuit design shown in Fig. 1 uses only four packages and requires no decoder. The counter was built from two dual JK flip-flops (SN7473). The gate G1 is used to set the counter back to the "001" state after a final count of "110".

It can be seen from the truth table that if the lamps are connected directly to the counter outputs A, B, C and if the lamps are arranged as in Fig. 2, a suitable display will result. If the lamp drivers shown in the December article are used it may be necessary to use two to drive the four lamps LP4-LP7. Alternatively, a higher power transistor could be used.

The major disadvantage of the circuit is the failure to use all packages completely: there remains a flip-flop and a 3-input NAND gate unused. The flip-flop might be incorporated as a "Head or Tails" device, or could be used to indicate a "+" or "−" sign on the display to give a forwards or backwards move. It could also be used to control a bulb lighting the legend "Add Six" thus extending the dice throw to twelve. The latter will not, however, indicate doubles, for which purpose the unit must be duplicated.

No doubt readers will be able to think of other ingenious uses for the "left-overs".

A. J. Jacobs,
Beaconsfield,
Bucks.



COUNT	DISPLAY STATE			COUNTER OUTPUT		
	LP1	LP2	LP4	C	B	A
1	1	0	0	0	0	1
2	0	1	0	0	1	0
3	1	1	0	0	1	1
4	0	0	1	1	0	0
5	1	0	1	1	0	1
6	0	1	1	1	1	0

Fig. 1. Circuit diagram for the modified i.c. digital dice. The truth table is shown on the right

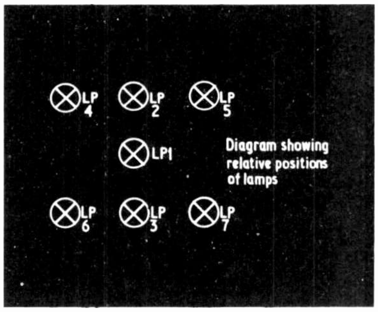


Fig. 2. Suggested layout for the indicator lamps

PATENTS REVIEW...

ELECTRICAL DAMP COURSE

A CERTAIN degree of mystery surrounds the electrode methods for providing a damp-proof course in buildings prone to rising damp. A new British patent originating from Rumania (BP 1 248 441) clears up some of this mystery.

In this field there are so-called "active" methods and "passive" methods.

In the passive methods, electrodes are fixed in the damp zone of the wall and then connected in groups to grounding electrodes. Usually, pairs of electrodes made of different metals are coupled together and then connected in groups to the grounding electrodes, the more electro-negative metal being in the lowest row. No external source of current is provided.

In a known active method a continuous current is provided in the circuit, the wall electrodes being connected to the positive pole and the grounding electrodes to the negative pole.

Humidity is removed through the electro-osmotic migration from the capillaries of the building into the soil where the grounding electrodes are placed. The disadvantages are that corrosion of the electrodes will take place over the years and that little moisture is removed directly by the air.

The Rumanian proposal is that in the active method the positive, as well as the negative, electrodes should be fixed in a horizontal row in the wall without any grounding electrodes. The positive electrodes are made of solid metallic bars and the negative electrodes are perforated metallic tubes. The interior of each tubular electrode is hollow and open to the air. The positive and negative electrodes are connected alternately as two separate circuits at a distance from the ground level equal to 0·86 of the distance between the electrodes.

By the use of tubular negative electrodes, humidity from the walls can escape direct into the air. To avoid corrosion the electrodes are formed of depolarising compositions appropriate to the nature of the wires associated with them.

The theory becomes a little clearer by reference to Fig. 1. Solid metallic positive electrodes and perforated metallic tube negative electrodes are fixed alternately in the building wall. No

BP 1 248 441

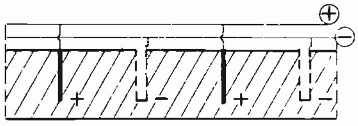


Fig. 1

grounding electrodes are provided and the water migrates directly into the air with the assistance of the electro-osmotic current which drains it to the negative tubular electrodes. Experiments have shown that optimum drying is obtained when the quoted circumstance is met; namely when the height of the electrodes above ground level is equal to 0·86 of the distance between the electrodes.

The patent gives calculations to substantiate this and suggests suitable depolarising compositions for the electrodes. For instance for copper electrodes the depolarising mixture is 50 per cent clay powder, 20 per cent copper sulphate powder and 30 per cent Portland cement.

Readers interested in more of these and other details should refer to the patent specification.

LOUDSPEAKER DESIGN

THE diaphragm of a loudspeaker, outlined in a new patent (BP 1 250 640) by the Japanese firm of Nippon Gakki Seizo Kabushiki Kaisha, resembles a cross between an ordinance survey map and a ceiling tile.

It is known to use foamed plastics, such as polystyrene, as a loudspeaker diaphragm, but the usual principle of suspending a symmetrical cone or circular sheet of the polystyrene at its periphery has been shown to produce a non-linear frequency response and attempts have been made to improve on it by using an asymmetrical diaphragm. One shape tried, for example, is similar to a grand piano, with a near conical area in the central region.

Kaisha now suggest that problems arise with asymmetrical diaphragms because strong resonances may be produced due to the relatively large flat portion which is formed between the asymmetric periphery and the outer lines of the conical portion. The flat portion gives reduced flexural rigidity and this in turn gives rise to excessive peaks and dips in the frequency response curve, especially in the middle and low frequency ranges.

The suggested answer is an asymmetrical diaphragm with an initially truly conical trumpet shaped central driven portion smoothly merging into an outer asymmetrical flat portion of uniform width all around the periphery of the diaphragm. The resultant diaphragm thus looks rather like a contour model of an asymmetric hill with a circular peak and a flat base surround region of uniform width. See Fig. 2. This uniform surround and absence of large flat lands apparently improves linearity quite dramatically.

BP 1 250 640

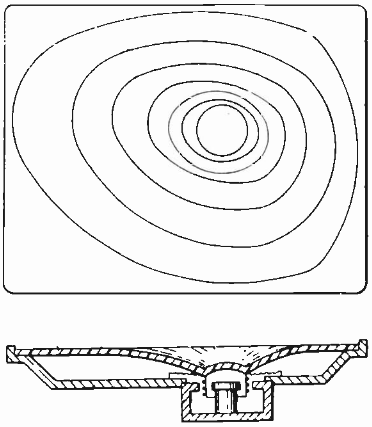


Fig. 2

TIMELY REMINDER

Now seems a timely point to remind readers of the points made in the introductory *Patents Review* published in the November 1971 issue—e.g. copies of all specifications are available at 25p each from the British Patent Office in Southampton Buildings, Chancery Lane, London, E.C.4. (Back numbers of Practical Electronics are also available there for reference.)

Readers should always, of course, bear in mind the points made in the November issue on the legal aspect of the protection which a granted patent offers its owner against infringers.

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ACY20	20p
ACY21	20p
ACY22	10p
ACY39	55p
ACY40	20p
ACY41	15p
ACY44	25p
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AD149	50p
AD161	35p
AD162	35p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF124	25p
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AF185	50p
AF186	40p
AF239	40p
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ASY28	25p
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BA100	15p
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BA110	25p
BA115	7p
BAX13	5p
BAX16	7p
BAY31	7p
BAY38	15p
BC107	10p
BC108	10p
BC109	10p
BC109C	12p
BC113	10p
BC114	20p
BC115	20p
BC116	20p
BC116A	25p
BC117	20p
BC118	20p
BC119	30p
BC134	20p
BC135	15p
BC136	20p
BC137	20p
BC138	20p
BC147	12p
BC148	10p
BC149	12p
BC153	20p
BC154	20p
BC167	15p
BC169	12p
BC169C	15p
BC177	20p
BC178	20p
BC179	20p
BC182L	10p
BC183L	10p
BC184L	12p
BC212L	12p
BC213L	12p
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BF196	15p
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BFX29	25p
BFX30	25p
BFX84	25p
BFX85	30p
BFX86	25p
BFX87	25p
BFX88	20p
BFY18	25p
BFY50	20p
BFY51	20p
BFY52	20p
BFY53	15p
BFY90	65p
BSX20	15p
BSX21	20p
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BY100	15p
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BYZ12	30p
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GET103	25p
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GET115	50p
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OC44	15p
OC45	12p
OC70	12p
OC71	12p
OC72	20p
OC75	25p
OC76	25p
OC77	40p
OC81	20p
OC81D	20p
OC81Z	40p
OC83	25p
OC84	25p
OC139	25p
OC140	40p
OC141	60p
OC170	25p
OC171	30p
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ZTX502	20p
ZTX503	17p
ZTX504	40p
ZTX531	26p
1N914	7p
1N916	10p
1N4148	7p
1S44	7p
1S921	7p
1S922	8p
2G301	25p
2G302	25p
2G303	35p
2N404	20p
2N696	15p
2N697	15p
2N698	30p
2N706	10p
2N706A	12p
2N708	15p
2N930	20p
2N987	40p
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2N1132	25p
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2N1304	22p
2N1305	22p
2N1306	25p
2N1307	25p
2N1308	25p
2N1309	25p
2N1613	20p
2N2147	75p
2N2160	60p
2N2217	25p
2N2218	25p
2N2218A	25p
2N2219	20p
2N2219A	25p
2N2220	25p
2N2221	20p
2N2221A	25p
2N2222	20p
2N2222A	25p
2N2369	15p
2N2369A	15p
2N2646	40p
2N2904	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906	20p
2N2906A	25p
2N2907	23p
2N2907A	25p
2N2925	15p
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7470	Single J-K flip flop (gated inputs)	30p	27p	25p	22p	20p
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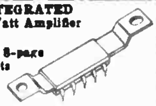

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SC40B	200	6 amps	£1·05
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SC45B	200	10 amps	£1·15
SC45D	400	10 amps	£1·25
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1N4003	200	8p	7p	6p	5p	4½p
1N4004	400	8p	7p	6p	5p	4½p
1N4005	600	10p	9p	8p	7p	6p
1N4006	800	12p	10p	9p	8p	7p
1N4007	1000	15p	12p	10p	9p	8p

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4002	400	2a	75p	1006	100	6a	70p
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Light guide

Sir—I have read with interest the article by Mr M. K. Titman on *Fibre Optics* published in your February edition. My Company is actively engaged in the field of fibre optics on behalf of JENAer Glaswerk Schott & Gen., of Mainz, Western Germany, who are one of the major suppliers and manufacturers of fibre optics and are world renowned for the range of high quality optical glasses.

I would like to draw the author's attention to some minor inaccuracies in the paragraph headed "Present Limitations". Schott produce a vast range of fibres, some of which will cater for infra-red transmission and, more especially, for ultra-violet light transmission. In both cases, these fibres are not currently available from any other European source and, indeed, the ultra-violet light transmitting fibre optic is unique to Schott and is not available from any other manufacturer.

With regard to the author's comments on long distance communications, I would like to take this opportunity of informing you that Schott are actively engaged both with the Post Office Research and various other commercial telecommunication companies here in the United Kingdom on the use of fibre optic light guides for long distance communication systems.

Existing fibres are used in aircraft communication links, because these light guides are not subject to noise and other electronic interference and this makes them ideal as signal transmission mediums within the aircraft.

The whole point I wish to make on this subject is really that the distance of 6 to 10 feet mentioned by Mr Titman in his article, would generally seem to indicate that this is the maximum length over which adequate signals can be transmitted, whereas signal lengths of 30 metres are quite normal.

One final item I would like to mention is the suggested use of fibre optics for the monitoring of vehicle lights. I wholeheartedly agree with him on this subject and believe that this positive signal indication is highly desirable for vehicles. I personally have had a vehicle equipped and it has been running on the road for approximately two years now and I derive a great deal of satisfaction from being able to check from the driver's position that my lights are operating. The beauty of the fibre optic system is that it is fail-safe and will monitor all light conditions.

I sincerely hope that you find my comments of interest and I hope that they help to clarify one or two inaccuracies in the article mentioned.

A. Hardy,
Fibre Optics Division,
H. V. Skan Ltd.,
Solihull,
Warks.

Long distance optical communication is indeed an exciting prospect for the future since the bandwidth using light is very wide. Indeed this system is the only practical arrangement for the introduction of domestic videophones.

At present fibre optics are not as acceptable as line of sight or mirrored circular waveguide systems, but development will reduce this gap. Bell Laboratories and ITT/STC in the U.S.A. are also actively working in this field using laser projectors with solid state photomultiplier detectors.

Present practical limitations on distance are governed primarily by the complexity of the projector/detector system and the 6 to 10ft I quoted assumed the simplest arrangement. As Mr Hardy points out, longer runs are feasible but care must be taken over projector/detector stability and sensitivity, or a modulated light system adopted.

I welcome the development of fibres for use in the infra-red and ultra-violet spectrum and also the low loss guides, and look forward to the widespread use of fibre optic guides in the future.—M.K.T.

Dogmatic

Sir,—With reference to the letter of Mr (or is it Mrs?) W. G. Jones (Abysmal Writing), published last month, I would like to make the following comments, partly in defence of a periodical to which I have subscribed since its inception, and partly as a protest against the dogmatic criticism of a person entrusted with the education of tomorrow's technocrats.

To a person of such self claimed ability, the task of understanding and relating in his own words the underlying principles of *Logical Radio Control* should not have required such tremendous powers of concentration.

A dice is essentially a passive device and in itself "generates" nothing.

Hands do not "see".

When the counter is stopped the "numbers" cannot be in a random condition. Also, a previous statement made it clear that the count was cyclic from 1 to 6, and therefore not random. The randomness is achieved only as a function of probability with respect to time.

It is worth noting that within industry all explanations accompanying new circuitry are not crystal clear and textbook fashion. It is therefore almost a pre-requisite that persons operating with the presented information must be capable of salvaging the salient features and reconstructing these into realistic representation of the phenomena in question.

As an educator of sixth form students, Mr Jones might well be better employed in preparing his charges for such eventualities, instead of composing uninteresting letters. If, however, he is bent on writing low-level semi-technical jottings, perhaps he would be good enough to iron out his own ambiguities and fantasy phrases before attacking professionals.

J. P. T. Travers,
Poole,
Dorset.

Good vet needed

Sir,—I have just read Mr W. G. Jones' letter regarding the standard of writing in PRACTICAL ELECTRONICS. His general comments are, in my opinion, quite correct even though I would say the standard is slightly higher than the abysmal standard he gave it. The digital dice explanation of Mr Jones was definitely far easier to understand, but even then there was no reason given as to why it was necessary to run the digital dice at *forty-six thousand times* per second when the limit of visual observation is *fifteen times* per second even with the bulbs illuminated, which they are not in the digital dice.

May I therefore suggest that a standard instructional technique is employed as advocated by the D.E.S. in which each subject or project is divided into "Must Knows", "Should Knows" and "Could

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Knows" and these are presented in a logical sequence. Obviously the circuit, components employed and method of construction are all "Must Knows" in order that the project can be completed but the internal functions of an integrated circuit are only a "Could Know" which could be omitted if, for example, space was short.

One further point on a similar path is that I am of the opinion that projects that are intended for use on a vehicle should be vetted by some good auto electricians.

Similarly, with ignition systems the authors appear to be quite unaware that the present h.t. lead is a bit of carbon string not copper wire and a capacitor discharge unit will give you an awful lot of trouble if you use the standard type h.t. lead.

May I suggest that future projects aimed specifically at car owners could be a Zenon tube timing light, an exhaust gas analyser, a dwell meter and how to connect a standard oscilloscope to a car along with the interpretation of the pattern. I know all these are commercially available but at £1,200 per set.

I trust that you will accept these comments as being constructive and if only part are incorporated in your excellent magazine I am sure you will find an ever increasing interest and increase in readership.

H. D. Briggs,
Telford, Salop.

Baby alarm

Sir,—I have just read with interest the article "Child Care" in the Gerry Brown column *On The Fringe*, January 1972 issue, and would like to say that it is about time a device was available on the market to help prevent the abduction of babies from their prams. To this end my company has marketed a product which electronically senses a baby's weight, and sounds an alarm bell should the baby be removed from its pram. The complete unit does not need to be permanently attached to the pram in question, but remains free to be used in a carry-cot or push-chair.

I would, however, disagree that one needs to sense pram movement, since statistics have shown that only a small percentage of baby abductions actually involve the taking of the pram, and to manufacture a device that senses brake position is difficult, in so much that every pram manufacturer seems to have his own idea on braking.

One method that can be used is to have a small magnet attached to one of the spokes of one wheel that operates a reed switch during the first revolution of the wheel. This pulse triggers a self-latching switch, preferably an electronic one, because of the current drain involved in relays, and the alarm is sounded.

B. Naylor,
Bournemouth,
Hants.

Mind travelling

Sir—I read with great interest Gerry Brown's piece on "Brainwave Reinforcement" in the March issue of P.E. Perhaps you could pass on to him the message that the arrangement he shows does not actually work, for the following reasons. Alpha rhythms (of 8–12Hz, which are present in *all* normal persons) are generated when the eyes are closed and the subject is resting with mind blank and no distractions. The rhythms disappear on falling asleep. Any attempt to visualise mental pictures or watch a flashing light, even with the eyes closed, will tend to break up the Alpha rhythm.

The system in vogue in America operates by sound, that is to say the subject listens to gentle white noise or a low audio tone which is modulated by his own Alpha waves. The trick is not to listen too intently, but let the sound lull one into a state akin to that commonly experienced just prior to falling asleep. With a certain amount of practice it is possible to attain a high Alpha output and thus enforce complete relaxation. In effect the gadget tells you when you are relaxed and when you are not.

A possibility I have not investigated with Gerry's set-up is that the equipment actually handles Beta waves from the front of the head (18–25Hz) which result from minute motor movements of the eye during normal vision. It could be that the flashing light then interacts with eye movements and causes some kind of "way out" effect.

If Gerry wants an unusual experience though, he should try feeding the output from an audio oscillator to electrodes on his head. The oscillator *must*, of course, be battery powered otherwise he might find he is undergoing unwanted shock therapy! A mere 2–4V r.m.s. at 5–20Hz is sufficient to cause pronounced visual strobing in broad daylight and a wealth of coloured patterns when the eyes are closed.

D. Bollen,
Cornwall.

Poor bunnies!

Sir—With reference to Mr D. Nunn's enquiry as to an electronic ferret tracker: no doubt such a device would be entirely feasible. However, I would suggest that if Mr Nunn is so intent on hunting poor little bunnies with his nasty little ferrets, he reads a book on electronics and designs one himself.

May it take him a long while.

G. J. Rounce,
Grays,
Essex.

Collared

Sir—Reading the March *Readout* as promised, I noticed Mr D. Nunn's letter on ferret tracking. The Heath Co. Model GD-48 metal locator would be an excellent device for him. He could detect a piece of iron attached to the collar with good reliability from my experience.

Brice Ward,
Kidsgrove,
Stoke-on-Trent.

Scorpio shake-up

Sir—May I suggest that any readers who are building the P.E. Scorpio car ignition might find it advisable to tie down capacitors C6 and C7 to the board as the leads could possibly fracture under the low frequency conditions in a car.

G. Boyd,
Basingstoke,
Hants.

Lost components

Sir—Some time ago, the question of availability of components was commented on by dealers and constructors in your magazine.

Since that time, several well-known firms have closed down, merged with others, or reduced their range of products. I have to hand, two larger component suppliers' catalogues and various other smaller ones, yet not one of them lists items which were once easily obtainable.

The "Electroniques" (now defunct) 10μH to 10mH range or r.f. chokes and the Painton encapsulated chokes; the temperature compensating ceramic capacitors in the NPO (zero change), N and P types (i.e. the popular N750) were once available for frequency stabilisation of r.f. oscillators against temperature drift. Where have these items gone?

Perhaps a dealer who can supply these items would contact us.

M. J. Shepherd, BRS 25625,
72 Westerland Avenue,
Canvey Island, Essex.

Build yourself a TRANSISTOR RADIO

NEW! ROAMER 10 WITH VHF INCLUDING AIRCRAFT

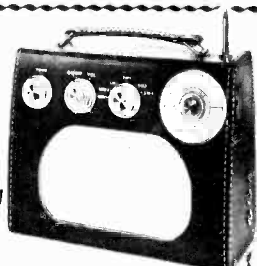
10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS AND AIRCRAFT BAND.

Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated telescopic aerial, for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. Switched earpiece socket complete with earpiece. 10 transistors plus 3 diodes. 8" × 2½" speaker. Air spaced ganged tuning condenser with VHF section. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in.

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

TOTAL BUILDING COSTS **£8·50** P.P. & INS. 50p (OVERSEAS P. & P. £1)

ROAMER EIGHT Mk. I

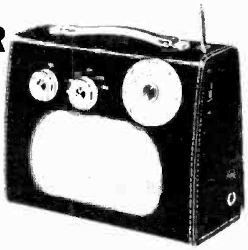


NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. Switched earpiece socket complete with earpiece. 8 transistors plus 3 diodes. 8" × 2½" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£6·98** P. P. & INS. 41p (OVERSEAS P. & P. £1)

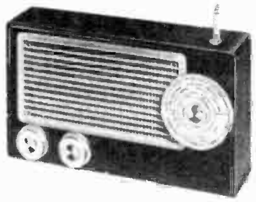
ROAMER SEVEN Mk. IV



7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. 8" × 2½" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening, 30p extra.

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

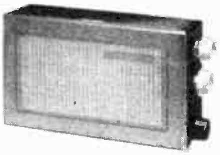
ROAMER SIX



6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5¼in × 2¾in approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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

POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5¼in × 1¼in × 3½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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

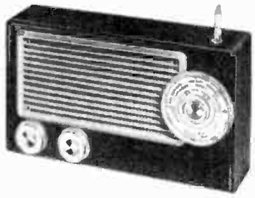
TRANSONA FIVE

5 TRANSISTORS AND 2 DIODES

3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6¼in × 4½in × 1½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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

TRANS EIGHT



8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5¼in × 2¾in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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

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TRANSONA FIVE	☐	ROAMER SIX	☐
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	£p	£p	£p	£p	£p	£p
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100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
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200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	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
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·33	0·57	0·75	—

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100	0·50	0·63	1·00
200	0·70	0·90	1·25
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OCP71 Type. **43p**

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300mW	30 ..	0·50
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T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
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All 50p each pak

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U3	75 Germanium gold bonded diodes sim. OA5, OA47	0·50
U4	40 Germanium transistors like OC81, AC128	0·50
U5	60 200mA sub-min. Sil. diodes	0·50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0·50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0·50
U8	50 Sil. planar diodes 250mA, OA/200/202	0·50
U9	20 Mixed volts 1 watt Zener diodes	0·50
U11	25 PNP silicon planar transistors TO-5 sim. 2N1132	0·50
U13	30 PNP-NPN sil. transistors OC200 & 28104	0·50
U14	150 Mixed silicon and germanium diodes	0·50
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U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0·50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0·50
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U19	25 Silicon NPN transistors like BC108	0·50
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U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0·50
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U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0·50
U32	25 Zener diodes 400mW D07 case mixed volts, 3–18	0·50
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U35	25 Sil. planar trans. PNP TO-18 2N2906	0·50
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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
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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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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36, NKT 401-403-404-405-406-430-451-452-453, T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B, 2G220–222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

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2N3055
115 WATT SIL POWER NPN
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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
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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
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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
Q51	7 BSY95A NPN trans. 300MHZ	0·50
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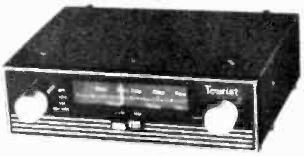

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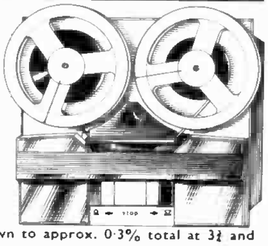

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Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	11	7·0 × 6·0 × 6·5	1·61	30
100	60	3	8	8·9 × 8·0 × 7·7	2·39	36
61	100	5	12	10·2 × 8·9 × 8·3	2·62	52
30	200	9	8	12·0 × 10·3 × 10·0	4·39	52
62	250	12	4	9·5 × 12·7 × 11·4	5·80	67
55	350	15	0	14·0 × 10·8 × 12·4	7·77	82
63	500	27	0	17·1 × 11·4 × 15·9	11·20	*
92	1000	40	0	17·8 × 17·1 × 21·6	20·63	*
128	2000	63	0	24·1 × 21·6 × 15·2	34·10	*

AUTO SERIES (NOT ISOLATED)

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20		11	7·3 × 4·3 × 4·4	0-115-210-240	0·85	22
64	75	1	14	7·0 × 6·4 × 6·0	0-115-210-240	1·66	30
4	150	3	0	8·9 × 6·4 × 7·6	0-115-200-220-240	2·00	36
66	300	6	0	10·2 × 10·2 × 9·5	,, ,,	3·89	52
67	500	12	8	14·0 × 10·2 × 11·4	,, ,,	5·78	67
84	1000	16	0	11·4 × 14·0 × 14·0	,, ,,	10·49	82
93	1500	28	9	13·5 × 14·9 × 16·5	,, ,,	15·20	*
95	2000	40	0	17·8 × 16·5 × 21·6	,, ,,	19·84	*
73	3000	45	8	17·4 × 18·1 × 21·3	,, ,,	26·99	*

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PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		12	7·6 × 5·7 × 4·4	0-12V at 0·25A × 2	0·85	22
213	1·0	0·5	1	0	8·3 × 5·1 × 5·1	0-12V at 0·5A × 2	1·01	22
71	2	1	1	0	7·0 × 6·4 × 5·7	0-12V at 1A × 2	1·33	22
18	4	2	2	4	8·3 × 7·0 × 7·0	0-12V at 2A × 2	1·86	36
70	6	3	3	12	10·2 × 7·6 × 8·6	0-12V at 3A × 2	2·24	42
108	8	4	5	4	10·0 × 8·3 × 8·2	0-12V at 4A × 2	2·48	52
72	10	5	6	3	7·9 × 10·8 × 10·2	0-12V at 5A × 2	2·94	52
17	16	8	7	8	12·1 × 9·5 × 10·2	0-12V at 8A × 2	4·54	52
115	20	10	11	13	12·1 × 11·4 × 10·2	0-12V at 10A × 2	5·78	67
187	30	15	16	12	13·3 × 12·1 × 12·1	0-12V at 15A × 2	10·67	82
226	60	30	34	0	17·0 × 14·5 × 12·5	0-12V at 30A × 2	19·61	*

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	8·3 × 3·7 × 4·9	0-12-15-20-24-30V	1·01	22
79	1·0	2	0	7·0 × 6·4 × 6·0	,, ,,	1·35	36
3	2·0	3	2	8·9 × 7·0 × 7·6	,, ,,	2·01	36
20	3·0	4	6	10·2 × 8·9 × 8·6	,, ,,	2·48	42
21	4·0	6	0	10·2 × 10·0 × 8·6	,, ,,	2·94	52
51	5·0	6	8	12·1 × 10·0 × 8·6	,, ,,	3·66	52
117	6·0	7	8	12·1 × 10·0 × 10·2	,, ,,	4·36	52
88	8·0	10	0	14·0 × 11·7 × 10·0	,, ,,	5·64	67
89	10·0	12	2	14·0 × 10·2 × 11·4	,, ,,	7·14	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	11	7·0 × 7·0 × 5·7	0-19-25-33-40-50V	1·33	30
103	1·0	2	10	8·3 × 7·3 × 7·0	,, ,,	1·94	36
104	2·0	5	0	10·2 × 8·9 × 8·6	,, ,,	2·69	42
105	3·0	6	0	10·2 × 10·2 × 8·3	,, ,,	3·65	52
106	4·0	9	4	12·1 × 11·4 × 10·2	,, ,,	4·83	52
107	6·0	12	4	12·1 × 11·1 × 13·3	,, ,,	7·14	67
118	8·0	18	9	13·3 × 13·3 × 12·1	,, ,,	9·32	97
119	10·0	19	12	16·5 × 11·4 × 15·9	,, ,,	11·68	97

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	8·3 × 9·5 × 6·7	0-24-30-40-48-60V	1·35	36
126	1·0	3	0	8·9 × 7·6 × 7·6	,, ,,	1·88	36
127	2·0	5	6	10·2 × 8·9 × 8·6	,, ,,	2·94	42
125	3·0	8	8	11·9 × 9·5 × 10·0	,, ,,	4·48	52
123	4·0	10	6	11·4 × 9·5 × 11·4	,, ,,	5·78	67
120	6·0	16	12	13·3 × 12·1 × 12·1	,, ,,	8·37	82
122	10·0	23	2	16·5 × 12·7 × 16·5	,, ,,	13·85	*

LEAD ACID BATTERY CHARGER TYPES

Ref. No.	Amps.	Weight lb	oz	Size cm.		P & P £	p
45	1·5	1	9	7·0 × 6·0 × 6·0		1·34	30
5	4·0	3	11	10·2 × 7·0 × 8·3	Please note, these	2·03	42
86	6·0	5	12	10·2 × 8·9 × 8·3	units do not in-	3·07	52
146	8·0	6	4	8·9 × 10·2 × 10·2	clude rectifiers	3·49	52
50	12·5	11	14	13·3 × 10·8 × 12·1		5·20	67

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1N23	0·20	AC127	0·25	BF181	0·35	GJ5M	0·25	OC44	0·17
1N85	0·88	AC128	0·20	BF184	0·20	GJ7M	0·37	OC44M	0·17
1N253	0·50	AC187	0·25	BF185	0·20	HG1005	0·50	OC45	0·12
1N256	0·50	AC188	0·25	BF194	0·17	HS100A	0·20	OC45M	0·18
1N645	0·25	ACY17	0·30	BF195	0·15	MAT100	0·25	OC46	0·27
1N725A	0·20	ACY18	0·25	BF196	0·15	MAT101	0·30	OC57	0·60
1N914	0·07	ACY19	0·25	BF197	0·15	MAT120	0·25	OC58	0·60
1N4007	0·20	ACY20	0·20	BF861	0·28	MAT121	0·30	OC59	0·65
1S021	0·20	ACY21	0·20	BF898	0·28	MJE520	0·87	OC66	0·50
1S113	0·15	ACY22	0·10	BFX12	0·20	MJE2955	1·37	OC70	0·12
1S130	0·13	ACY27	0·25	BFX13	0·25	MJE3055	0·87	OC71	0·12
1S131	0·18	ACY28	0·17	BFX29	0·25	NKT128	0·35	OC72	0·20
1S202	0·23	ACY39	0·50	BFX30	0·25	NKT129	0·30	OC73	0·30
2G240	1·97	ACY40	0·15	BFX35	0·98	NKT211	0·25	OC74	0·30
2G301	0·20	ACY41	0·15	BFX63	0·50	NKT213	0·25	OC75	0·25
2G302	0·22	ACY44	0·25	BFX84	0·25	NKT214	0·15	OC76	0·25
2G306	0·30	AD140	0·50	BFX85	0·30	NKT216	0·37	OC77	0·40
2G371	0·22	AD149	0·50	BFX86	0·25	NKT217	0·35	OC78	0·20
2G381	0·25	AD161	0·37	BFX87	0·25	NKT218	1·13	OC79	0·22
2G414	0·30	AD162	0·37	BFX88	0·20	NKT219	0·33	OC81	0·20
2G417	0·22	AF106	0·30	BFY10	1·00	NKT222	0·20	OC81D	0·20
2N214	0·43	AF114	0·25	BFY11	1·25	NKT224	0·22	OC81M	0·20
2N247	0·25	AF115	0·25	BFY17	0·25	NKT251	0·24	OC81DM	0·18
2N250	0·50	AF116	0·25	BYF18	0·25	NKT271	0·25	OC81Z	0·40
2N404	0·20	AF117	0·25	BFY19	0·25	NKT272	0·25	OC82	0·25
2N697	0·15	AF118	0·62	BFY24	0·45	NKT273	0·15	OC82D	0·20
2N698	0·40	AF119	0·20	BFY44	1·00	NKT274	0·20	OC83	0·25
2N706	0·10	AF124	0·25	BFY50	0·22	NKT275	0·25	OC84	0·25
2N706A	0·12	AF125	0·20	BFY51	0·20	NKT277	0·20	OC114	0·38
2N708	0·15	AF126	0·17	BFY52	0·22	NKT278	0·25	OC122	0·60
2N709	0·63	AF127	0·17	BFY53	0·17	NKT301	0·40	OC123	0·65
2N711	0·37	AF139	0·30	BFY64	0·42	NKT304	0·75	OC139	0·25
2N987	0·53	AF178	0·55	BFY90	0·65	NKT403	0·75	OC140	0·35
2N1090	0·30	AF179	0·65	BSX27	0·50	NKT404	0·55	OC141	0·60
2N1091	0·33	AF180	0·52	BSX60	0·93	NKT678	0·30	OC169	0·20
2N1131	0·25	AF181	0·42	BSX76	0·15	NKT713	0·25	OC170	0·25
2N1132	0·25	AF186	0·40	BSY26	0·18	NKT773	0·25	OC171	0·30
2N1302	0·18	AFY19	1·13	BSY27	0·17	NKT777	0·38	OC200	0·40
2N1303	0·18	AFZ11	0·60	BSY51	0·50	O78B	0·38	OC201	0·70
2N1304	0·22	AFZ12	1·00	BSY95A	0·12	OA5	0·20	OC202	0·80
2N1305	0·22	ASY26	0·25	BSY95	0·12	OA6	0·12	OC203	0·40
2N1306	0·25	ASY27	0·32	BT102/500R		OA47	0·10	OC204	0·40
2N1307	0·25	ASY28	0·25		0·75	OA70	0·10	OC205	0·75
2N1308	0·25	ASY29	0·30	BTY42	0·92	OA71	0·10	OC206	0·90
2N1309	0·25	ASY36	0·25	BTY79/100R		OA73	0·10	OC207	0·90
2N1420	0·93	ASY50	0·17		0·75	OA74	0·10	OC460	0·20
2N1507	0·28	ASY51	0·40	BTY79/400R		OA79	0·10	OC470	0·30
2N1526	0·38	ASY53	0·20		1·25	OA81	0·08	OCP71	0·97
2N1909	2·25	ASY55	0·20	BY100	0·15	OA85	0·12	ORP12	0·50
2N2147	0·75	ASY62	0·25	BY126	0·15	OA86	0·15	ORP60	0·40
2N2148	0·60	ASY86	0·33	BY127	0·17	OA90	0·08	ORP61	0·42
2N2160	0·60	ASZ21	0·42			OA91	0·07	S19T	0·30
2N2218	0·20	ASZ23	0·75	BY182	0·85	OA95	0·07	SAC40	0·25
2N2219	0·20	AUY10	0·93	BY213	0·25	OA200	0·07	SFT308	0·38
2N2287	1·03	AU101	1·50	BYZ10	0·35	OA202	0·10	ST722	0·38
2N2297	0·20	BC107	0·10	BYZ11	0·32	OA210	0·25	ST7231	0·63
2N2369A	0·15	BC108	0·10	BYZ12	0·30	OA211	0·30	SX68	0·20
2N2444	1·99	BC109	0·10			OAZ200	0·55	SX631	0·30
2N2613	0·28	BC113	0·15	BYZ13	0·25	OAZ201	0·50	SX635	0·40
2N2646	0·45	BC115	0·20	BYZ15	1·00	OAZ202	0·42	SX640	0·50
2N2712	0·25	BC116	0·25	BYZ16	0·62	OAZ203	0·42	SX641	0·55
2N2784	0·50	BC116A	0·30	BYZ88C3V3		OAZ204	0·30	SX642	0·60
2N2846	0·75	BC118	0·25		0·15	OAZ205	0·42	SX644	0·75
2N2848	0·42	BC121	0·20	C111	0·65	OAZ206	0·42	SX645	0·75
2N2904	0·20	BC122	0·20	CRS1/05	0·25	OAZ207	0·47	V15/30P	0·50
2N2904A	0·25	BC125	0·68	CRS1/40	0·47	OAZ208	0·32	V30/201P	0·75
2N2906	0·20	BC126	0·65	CS4B	2·50	OAZ209	0·32	V60/201	0·50
2N2907	0·23	BC140	0·55	CS10B	3·13	OAZ210	0·32	V60/201P	0·75
2N2924	0·23	BC147	0·15	DD000	0·15	OAZ211	0·32	XA101	0·10
2N2925	0·15	BC148	0·13	DD003	0·15	OAZ222	0·45	XA102	0·18
2N2926	0·10	BC149	0·15	DD006	0·18	OAZ223	0·45	XA151	0·15
2N3054	0·50	BC157	0·15	DD007	0·40	OAZ224	0·45	XA152	0·15
2N3055	0·75	BC158	0·12	DD008	0·38	OAZ241	0·22	XA161	0·25
2N3702	0·10	BC160	0·63	GD3	0·33	OAZ242	0·23		
2N3705	0·10	BC169	0·13	GD4	0·05	OAZ244	0·22	XA162	0·25
2N3706	0·23			GD5	0·33	OAZ246	0·23	XB101	0·43
2N3707	0·12	BCY31	0·35	GD8	0·25	OAZ290	0·38	XB102	0·10
2N3709	0·10	BCY32	0·55	GD12	0·05	OC16	0·50	XB103	0·25
2N3710	0·10	BCY33	0·25	GET102	0·30	OC16T	0·38	XB113	0·12
2N3711	0·10	BCY34	0·30	GET103	0·22	OC19	0·37	XB121	0·43
2N3819	0·35	BCY38	0·40	GET113	0·20	OC20	0·85		
2N3820	0·60	BCY39	1·00	GET114	0·15	OC22	0·50	ZR24	0·63
2N3823	0·75	BCY40	0·50	GET115	0·45	OC23	0·60	ZS170	0·10
2N5027	0·53	BCY42	0·25	GET116	0·50	OC24	0·60	ZS271	0·18
2N5088	0·33	BCY70	0·15	GET120	0·25	OC25	0·37	ZT21	0·25
2S005	1·00	BCY71	0·20	GET872	0·30				
2S178	0·40	BCZ10	0·35	GET875	0·25	OC26	0·25	ZT43	0·25
2S301	0·50	BCZ11	0·50	GET880	0·37	OC28	0·60	ZTX107	0·15
2S304	0·75	BD121	0·65	GET881	0·25	OC29	0·60	ZTX108	0·12
2S501	0·37	BD123	0·80	GET882	0·25	OC30	0·40	ZTX300	0·12
2S703	0·62	BD124	0·75	GET885	0·25	OC35	0·50	ZTX304	0·25
AA129	0·20	BDY11	1·62	GEX44	0·08				
AAZ12	0·30	BF115	0·25	GEX45/1	0·10	OC36	0·60	ZTX500	0·16
AAZ13	0·12	BF117	0·50	GEX941	0·15	OC41	0·25	ZTX503	0·17
AC107	0·37	BF167	0·25	GJ3M	0·25	OC42	0·30	ZTX531	0·25

SEMI-CONDUCTOR SET FOR P. E. GEMINI AMPLIFIER £13·95

SEND S.A.E. FOR LIST OF 8,000 TYPES VALVES, TUBES AND TRANSISTORS

Open daily to callers : Mon.-Sat. 9 a.m.-5 p.m.
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Terms C.W.O. only | Tel. 01-769 0199/1649

MULTI-SPEED MOTOR

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000; 12,000 and 15,500 r.p.m. shaft is ¼in dia. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor, size approx. 2in dia. × 5in long. Price 88p plus 23p postage and insurance.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1 each or £11 per dozen. Specify 5, 10 or 15 amp—*simply fit in place of switch.*

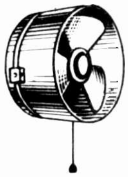
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 83p, plus 20p postage.

MICRO SWITCH

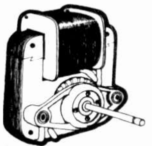
5A changeover contacts, 9p each. £1 doz. 15 amp Model 10p each or £1·05 doz.

EXTRACTOR FAN



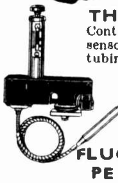
Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5¼" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2 plus 36p post and ins.

MAINS MOTOR



Precision made — as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 50p. Postage 15p for first one, then 5p for each one ordered.

THERMOSTAT



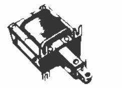
Continuously variable 30-90°C. Has sensor bulb connected by 33in of flexible tubing. On operation a 15A 250V switch is opened and in addition a plunger moves through approx. ¼in. This could be used to open valve on ventilator, etc. £1·50 plus 23p post and insurance.

FLUORESCENT INVERTER
PE GEMINI AMPLIFIER
WIDE BAND SIGNAL INJECTOR
FUZZ BOX
ULTRA-SONIC TRANSMITTER RECEIVER

as featured this and last month
Send S.A.E. for parts list

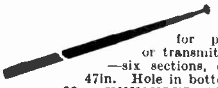
We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

MAINS OPERATED SOLENOIDS



Model 772—small but powerful 1in pull—approx. size 1½in × 1¼in × 1¼in 60p. **Model 400/1**—⅝in pull. Size 2⅛in × 2in × 1⅞in 75p. **Model TT10** 1¼in pull. Size 3in × 2½in × 2½in £1·80 plus 20p post and insurance.

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated —six sections, extends from 7½ to 47in. Hole in bottom for 6B.A. screw, 38p. KNUCKLED MODEL FOR F.M. 50p.

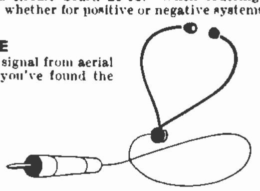
3 STAGE PERMEABILITY TUNER

This Tuner is a precision instrument made by the famous "Cyldon" Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available as an extra if required) with a frequency coverage 1,620kHz–525kHz and intended to operate with an I.F. value of 470kHz. Extremely compact (size only 2⅞ × 2 × ⅝in thick) with reduction gear for fine tuning. Snip price this month 68p, with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post free.

CAPACITOR DISCHARGE CAR IGNITION

This system has proved to be amazingly efficient. We offer a Kit of Parts as PW circuit. £5·95 plus 20p postage. **De-luxe model** with prepared circuit board £6·95. When ordering please state whether for positive or negative systems.

RADIO STETHOSCOPE

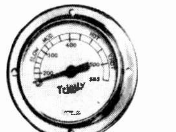


Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra—post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

STANDARD WAFER SWITCHES

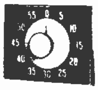
Standard size 1½ wafer—silver-plated 5-amp contact, standard ¼" spindle 2 in long—with locking washer and nut.

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



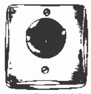
Dial Thermometer. Reading from 200–525F used on Tricity and other cookers. This has a flange and can be mounted through a 1⅜in hole or alternatively it can just be rested on the object whose temperature it is required to measure. Size 2in × ⅝in overall dia. Depth ⅞in below and ⅜in above mounting panel. Price 80p each or 10 for £7·20.

THIS MONTH'S SNIP



1 HOUR MINUTE TIMER. Made by Smiths complete with control knob and calibrated dial. This month's special bargain at **50p**. Useful in the kitchen, office and dark-room, etc.

THYRISTOR LIGHT DIMMER



For any lamp up to 1kW. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £1·99 plus 20p post and insurance.

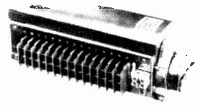
MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up. 9V battery operated. Size 2in long × 1½in wide 1in high.
SPECIAL SNIP PRICE **60p** each. 10 for **£5**.

POCKET CIRCUIT TESTER

Test continuity for any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). **30p** or 2 for **50p**. Post paid.

HONEYWELL PROGRAMMER

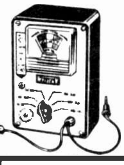


This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 r.p.m. Some of the many uses of this timer are Machinery control, Boiler firing. Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price £5·75 plus 25p post and insurance. Don't miss this terrific bargain.

INTEGRATED CIRCUIT BARGAIN

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

BATTERY CONDITION TESTER



Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3¾" × 6¼" × 2" with leads and prods. Price £1·75 plus 20p postage.

Thermostat with Probe. Made by the famous Ranco Thermostat Co. Covers the range from approx. 0°–200°C variable by a control spindle, handles currents up to 16A. Length of capillary and sensor tube approx. 3ft 6in. These are ideal for ovens and as a general purpose thermostat. Price 50p each or 10 for £4·50.

Small Tuning Condenser as fitted to many imported Japanese and Hong Kong radios. Two gang about 200μF per gang. Size approx. 1in by 1in with a ⅛in dia. spindle with dust cover. 25p each or 10 for £2·25.

Heat Sink. Small type as used with OC81, etc. Price 5p each or 10 for 45p.

High Voltage Condenser. 0·265 mfd 1500V RMS which means that these have a d.c. rating of over 4,000V. 75p each or 10 for £6·75.

125W Starter. For 8ft fluorescent tubes. Mazda 1⅛in canister 4 pin base. Price 20p each or 10 for £1·80.

IF Transformers. 465 K.C. double tuned and made for transistor circuits. 35p per set of 3. 10 sets for £3·15.

Spectacle Frames (No lenses). With built-in hearing aids. The amplifier and battery being housed in the arms. Although these are complete hearing aids we are selling them purely for the sub miniature components they contain. We give no guarantee that they are in working order also these may be secondhand. Price £2·50 each.

Foot Switch. Twin levers each of which operates a 10A QMB change over switch. Price 90p each.

9V Gram Unit. On unit plate with 33–45 change lever, complete with turntable price £2·25 each, plus 20p post and insurance.

18 Way Plug and Socket. 15p per pair. 10 pairs for £1·35.

Programmers. 5 r.p.m. Made by Magnetic Devices, Ltd. The contacts may be set to trigger anywhere around the shaft, ideal for motivated lighting displays, sequential switching, etc. Drive motors are 200–240V 50Hz. Model A has 5 changeover contacts. Price £1·50. Model B has 11 changeover contacts. Price £3.

Black Heat Elements. Copper clad ¼in tubular construction replacements in Tricity and many other cookers also suitable if connected in series to heat airing cupboards and for other low temperature applications. The following types are available. 900W model, 14in long × 1⅛in wide. Made by Backer. Price 75p or 10 for £6·75. 2,200W model, W shaped, 14½in long × 9in wide. 85p each or 10 for £7·65.

Radiant Cooker Rings. As fitted to Tricity and many other popular cookers. We have two types. These are copper clad ¼in tubular construction. Both models having an external diameter of 6⅛in and the elements have been slightly flattened to increase radiation. Backer Type 7D1, 2,000W has a metal cover, size approx. 3in × 1⅛in × 1⅛in over the element connections. So in addition to being a replacement this could also quickly be made into a boiling ring as it only needs mounting on a simple iron frame. This element is rated 200–210V but it is perfectly safe on 240V and as these are usually simmerstat controlled the lower voltage rating is not all that important. Price 75p each or 10 for £6·75. Backer Model 7D1 MK.II again 2,000W rated but 230–240V, has no cover over element ends. Price 65p each or 10 for £5·85.

Tricity Cooker Elements. We have quite an assortment of these and will describe them in future issues—but if in the meantime you are needing these then please let us have a sketch, we may have the exact one in stock.

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp, 6p each, 10 for 54p, 100 for £5·10, 500 for £24.

Sub Miniature Slide Switch. DPDT 19mm (⅝in approx.) between fixing centres. 12p each or 10 for £1·08.

Thermal Trip. Bakelite encased called the "Klixon". Current passes through the heater coil and bi-metal strip clicks the circuit open should the current exceed 3A. Quite small and with tag and lead connections, ideal for protecting transformers or motors. Price 25p each or 10 for £2·25.

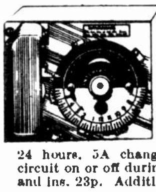
Mains Transformer. Primary 240V tapped 220V. Secondary 20V ½A. Price 60p each or 10 for £5·40.

Transformer. Primary 230–240V. Secondary 6·5–0–6·5V 1A. With fitted primary screen. 65p each or 10 for £5·85.

Small Croc. Clips. Suitable for instruments, etc. 5p each or 10 for 45p.

Bell Transformer. Normal mains input 4, 6, 8V output, normal bakelite case with protective connections. 75p each.

24-HOUR TIME SWITCH



Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours. 5A changeover contacts will switch circuit on or off during these periods. £2·50 post and ins. 23p. Additional time contacts 50p pair.

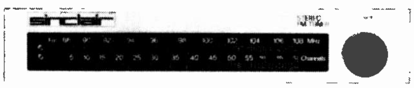
Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. P.E.) 7 Park Street, Croydon CRO 1YD
Callers to 102/3 Tamworth Road, Croydon.

Project 60 Stereo F.M. Tuner

Built and tested. Post free. **£25**

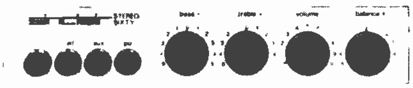


The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 7μV for lock-in over full deviation. **Squelch level:** 20μV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10 Hz – 15 KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC.
Indicators: Stereo on, tuning. **Size:** 93 x 40 x 207mm.

Stereo 60 Pre-amp/control unit

Built, tested and guaranteed. **£9.98**

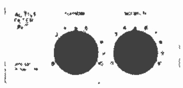


Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

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 10 KHz: BASS + 12 to —12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

A.F.U. High & Low Pass Filter Unit

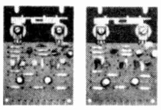
Built tested and guaranteed. **£5.98**



For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. **Size:** 66 x 40 x 90 mm.

Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. **Z.30 £4.48** **Z.50 £5.48**



The Z.30 and Z 50 are of advanced design using silicon epitaxial planar transistors to achieve 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 may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***

Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz ± 1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms (for 15w into 8Ω)
For speakers from 3 to 15 ohms impedance.
Size: 14 x 80 x 57 mm.

Power Supply Units

Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ 6 where a stabilised supply is essential.

PZ.5 *30 volts unstabilised* **£4.98**
PZ.6 *35 volts stabilised* **£7.98**
PZ.8 *45 volts stabilised*
(less mains transformer) **£7.98**
PZ.8 *mains transformer* **£5.98**

Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

sinclair

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

Please send ____________

Name ____________

Address ____________

I enclose cash/cheque/money order.

PE5

YATES ELECTRONICS
(FLITWICK) LTD.

ELSTOW STORAGE DEPOT, KEMPSTON HARDWICK, BEDFORD

C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.
Catalogue which contains data sheets for most of the components listed will be sent free on request. 5p stamp appreciated.
10% DISCOUNT TO ALL CALLERS ON SATURDAYS

RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction. ⅛W Mullard CR25 carbon film—very small body size 7·5 × 2·5mm. 4W Erie wire wound. ½W 2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1·0p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1·0p	0·8p
½	2%	10Ω–1MΩ	E12	3·5p	3p
⅛	10%	1Ω– 3·9Ω	E12	1·0p	0·8p
⅛	5%	4·7Ω–1MΩ	E12	1·0p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors **£2·40**. E24 pack 650 resistors **£4·70.**

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch **24p.**

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **6p** each.

SEMICONDUCTORS

AC107	15p	BC108	10p	BFY52	22p	OC71	12p	1N4006	12p
AC126	12p	BC109	10p	BY127	12p	OC72	12p	1N4007	12p
AC127	12p	BC147	13p	BZY10	20p	OC81	12p	2N2926R	9p
AC128	12p	BC148	13p	BZY13	20p	OC82	12p	2N2926O	9p
AC131	12p	BC149	13p	OA85	7p	OC82D	12p	2N2926Y	9p
AD140	50p	BC157	14p	OA90	5p	ORP12	50p	2N2926G	10p
AF114	20p	BC158	14p	OA91	5p	1N4001	6p	2N3055	60p
AF115	20p	BC159	14p	OA202	7p	1N4002	10p	2N3702	13p
AF116	20p	BC179	32p	OC26	45p	1N4003	10p	2N3703	11p
AF117	20p	BFY50	22p	OC44	12p	1N4004	10p	2N3707	13p
BC107	10p	BFY51	22p	OC45	12p	1N4005	12p	2N3711	10p

ZENER DIODES
400mW 5% 3·3V to 30V, **15p.**

LINEAR I.C.'s (D.I.L.)
709 **50p** 741, **50p**
710 **50p** 748, **50p**

DIL Socket 14 and 16 pin. **16p**

BRUSHED ALUMINIUM PANELS

12in × 6in=**25p**; 12in × 2½in = **10p**; 9in × 2in = **7p.**

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF **3½p.** 0·15μF **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p.** 1·5μF, **20p.** 2·2μF, **24p.**

MYLAR FILM CAPACITORS 100V

0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

CERAMIC DISC CAPACITORS

100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS—MULLARD C426 SERIES — **6p** each.

(μF/V) 10/2·5, 40/2·5, 80/2·5, 160/2·5, 320/2·5, 500/2·5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 6·4/6·4, 25/6·4, 50/6·4, 100/6·4, 200/6·4, 320/6·4, 4/10, 16/10, 32/10, 64/10, 125/10, 200/10, 2·5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 1·6/25, 6·4/25, 12·5/25, 25/25, 50/25, 80/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0·64/64, 2·5/64, 5/64, 10/64, 20/64, 32/64.

ELECTROLYTIC CAPACITORS—MULLARD C437

100/40, 160/25, 250/16, 400/10, 640/6·4, 800/4, 1000/2·5, **9p.** 100/64, 160/40, 250/25, 400/16, 640/10, 1000/6·4, 1250/4, 1600/2·5, **12p.** 160/64, 250/40, 400/25, 640/16, 1000/10, 1600/6·4, 2000/4, 2500/2·5, **15p.** 250/64, 400/40, 640/25, 1000/16, 1600/10, 2500/6·4, 3200/4, 4000/2·5, **18p.**

ELECTROLYTIC CAPACITORS Miniature P.C. mounting — **5p** each.

(μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

VEROBOARD

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 3¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	57½p
17 × 3¾	100p	78p
17 × 5 (plain)	—	82p
17 × 3¾ (plain)	—	60p
17 × 2½ (plain)	—	42p
2½ × 5 (plain)	—	12p
2½ × 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, **15p**/metre.
6 way screened cable **22p**/metre.

BATTERY ELIMINATOR — £1·50

9V mains power supply. Same size as PP9 battery.

Component Factors

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250 FOR £1
E24 Series 4·7Ω 10MΩ ¼W and ½W, 5% and 10% mixed. Your selection, but subject to a maximum of 20 different values, and no more than 50 of any one value. If any value is out of stock the nearest will be sent. Note: No quantity discount allowed.

Miniature Ceramic Lemco All 750V · 10%
3PF, 5PF, 10PF, 20PF, 25PF, 40PF, 75PF, 100PF, 120PF, 180PF, 220PF.
Price: **2½p** each or 10 for **20p** (same value).

Latest Transistor Equivalents Book, **40p**

CERAMIC

1PF	500V	2p
270PF	50V	2p
0·0047 Disc	30V	2p
0·01 Disc	30V	3p
0·01 Disc	350V	2p
0·022 Disc	30V	2p
0·047 Disc	30V	2p
0·1 Disc	100V	3p

Electrolytic Mullard C426 Range

4MFD	40V	4p
8MFD	40V	4p
10MFD	16V	4p
16MFD	40V	4p
25MFD	25V	4p
32MFD	10V	4p
40MFD	16V	6p
50MFD	6·4V	6p
100MFD	6·4V	4p
Large Electrolytic		6p
16MFD	350V	10p
220MFD	40V	10p
500MFD	50V	12p
1000MFD	12V	12p
2500MFD	6V	10p
2500MFD	12V	12p
1000MFD	50V	35p
1000MFD	25V	25p
100MFD	50V	10p

DIODES

100V 1A Bridge	50p
100V 20A Plastic Case Rectifier	50p
OA5	20p
OA47	5p
IN5054 (1kV)	10p
IN914	6p
OA202 equiv.	5p

TUNNEL DIODES

IN3717	£1
TD715	50p
TD716	40p
TD717	50p
TD719	50p

ZENER DIODES

3V3	BZY88C	10p
3V9	BZY88C	10p
4V3	BZY88C	10p
5V1	MZ5·1T5	10p
5V6	IN752A	15p
6V8	BZY96C	15p
7V5	BZY96C	15p
10V	KS42A	10p
13V	BZY94C	15p
20V	BZX22	12p
24V	BZY88C	12p
39V	IN5259	15p

S.G.S. EA1000 Amplifier Module with Manual, **£2·60.**

Large range of Tantalum, Polycarbonate and Polyester capacitors available.

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MC1027	£2
SN7400N	15p
SN7410N	15p
2N706	10p
BFY51	10p
2N3866	80p
2N3055	60p
BSX21	12p

Mains Transformer 32-0-32 at 150mA **50p**

Mains Transformer 150V at 20mA, 8V at 650mA **75p**

¾ Black Knob with Silver Disc ¼in hole **5p**

P.V.C. Wire 14/0076 100yd **50p** or **1p** per yd

Miniature RF chokes 0·22, 1, 1·5, 2·2, 12, 15, 22μH **8p** each

Red Panel Neon, **15p**

Neon lamp A230. 5 for **20p.** Strikes at 70V

TERMS: Cash with order. Post and packing free on orders above £5. For smaller orders please add 10p. DISCOUNT: orders above £10—10%, above £20—15%. All goods subject to a money refund guarantee if not satisfied. We have many components not advertised, and enquiries are welcome. Price list 5p. Data sheets 5p. Trade enquiries welcome.

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Large range of many sizes, types and manufactures

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B Standard change over	**40p each**

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2/EE 2 contacts	**44p**
2/EEE 3 contacts	**52p**
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Momentary Action

1 contact	**£1·00**
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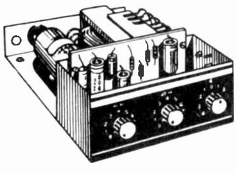
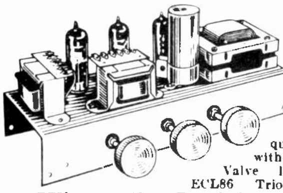
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. A.C. 200/250V.

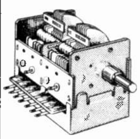
PRICE £10·50 P. & P. 25p.

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 300mV 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.

SPECIAL PURCHASE OF MANUFACTURER'S SURPLUS! All Transistor F.M. tuner head with twin A.M. Gang incorporated. Beautifully engineered with precision geared reduction drive. F.M. R.F. Transistor, oscillator/Mixer and first I.F. stage (10.7 Mc/s output) with optional AFC connection. Built on printed circuit panel and fully screened. Extremely stable over range 88-108 Mc/s. Brand new and pre-aligned. Size 2¼in H. × 1¾in W. × 2½in D. For 6V D.C. @ 2.8mA. A.M. Gang fitted with trimmers which can be connected to standard A.M. aerial and oscillator circuits if required. LIMITED NUMBER. Only **£2·25** post free. Connection details supplied.



BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2¼in × 3in approx. **25p** pair. P. & P. 5p.

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BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL 3½inW × 3inD. Price **£1·75**. P. & P. 30p.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9–0–9 at 500mA. **70p.** P. & P. 13p. Pri. 200/240V. Sec. 12–0–12 at 1 amp. **88p.** P. & P. 13p. Pri. 200/240V. Sec. 10–0–10 at 2 amp. **£1·38.** P. & P. 30p. Tapped Primary 200–220–240V. Sec. 21·5V at 500mA. **63p.** P. & P. 13p.

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LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. 3 d. 6 h. Ready built and tested. PRICE **£3·75**. P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE **£4·88**. P. & P. 50p.

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HI-FI LOUDSPEAKER SYSTEM

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CABINET AVAILABLE SEPARATELY **£4·50**. Carr. 60p.
Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. **£6·50**. Carr. 65p.

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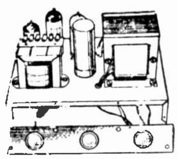
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12–30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ± 3dB 12–15,000Hz. Bass boost approx. to ± 12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size—12" wide × 8" deep × 2½" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, **£10·50** P. & P. 15p.
POWER PACK KIT, **£3** P. & P. 30p.
CABINET, **£3** P. & P 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£20·50**. Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMPLIFIER HA34 MK II

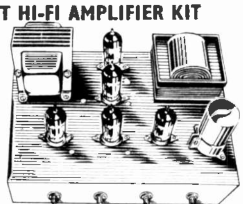


Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·75**. P. & P. 35p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£3·98**. P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer. FEW ONLY.
OUR ROCK BOTTOM BARGAIN PRICE £2·75 P. & P. 35p

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 13p (Free with parts). **All parts sold separately.** ONLY **£7·97**. P. & P. 55p. Also available ready built and tested complete with std. input sockets, **£9·97**. P. & P. 55p.

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A few minutes from South Wimbledon Tube Station

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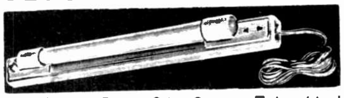

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(As featured by *Practical Wireless* May/June 1972)

DEVELOPED BY "TEXAS" ENGINEERS FOR PERFORMANCE, RELIABILITY AND POWER

FEATURES INCLUDE: Low profile with specially designed Gardners Transformer. 6 I.C.'s, 10 Transistors, 4 Diodes, 2 Zeners. Fibreglass P.C. panel. Multi protection. Stabilised supply. DIN input/output. Complete chassis work.
FUNCTIONS: Separate Treble/Bass/Volume/Balance controls. Input selector, Mag. pu, Radio, Tape in and out. Headphone socket. Scratch and rumble filters. Mono/Stereo switch.
SLIM DESIGN WITH SILVER TRIM—Chassis size overall 14½in 6in 2in max.
TOTAL COST TO BUILD **£28·50** post 45p. (Optional teak sleeve available July/August.)

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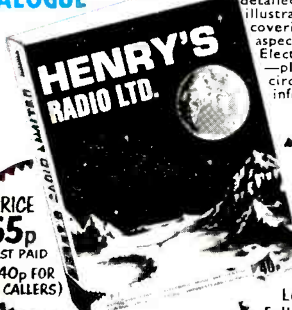

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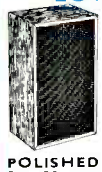

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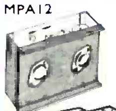
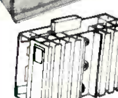
MPA12





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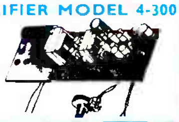
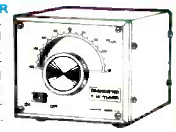


BUILD THIS VHF FM TUNER



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