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MARCH 1971

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<th>Description</th>
<th>Price</th>
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<tr>
<td>30m</td>
<td>222ft, L.P. acetate</td>
<td>£2.75</td>
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<td>5000 ft. L.P. acetate</td>
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**SPECIFICATION**

- Waveband coverage: Medium 535kc/s to 1,605kc/s; Long 150kc/s to 300kc/s.
- Sensitivity: 35mV/m max.
- Selectivity: (at 30kc/s) 0.65 dB per octave.
- Max. Power source: 1.4V Mercury battery.
- Mallory type RM625 or equivalent. Mallory battery is not rechargeable.

**BATTERY CHARGER**

**COMPACT POCKET CHARGER**

This minute radio will play anywhere—any time, beach, garden, park, home office, school, etc. The super sensitive 6 transistor circuit is fully tunable over both long and medium wavebands, with built-in ferroxcube aerial to provide excellent reception. The Orion operates from one small battery, either mercury or nickel cadmium, for long life and economic running costs. The output is via a crystal type personal earphone, giving extreme clarity, which prevents disturbing other people when used in public parks, open spaces, etc. The small size of the Orion allows it to be carried easily in the pocket or handbag, and it is also supplied with an attractive presentation case. Complete with earpiece, battery and carrying case.

**COMPLETE WITH EARPIECE**

**RECHARGEABLE BATTERY**

**POCKET CARRYING CASE**

*“Spares rechargeable battery 18p extra—post FREE with radio.”

**EXCLUSIVE PACKAGE**

**MODEL TM-I**

- **BATTERY CHARGER**
  - **COMPACT POCKET CHARGER**
    - **COMPACT POCKET CHARGER**
      - **RECHARGEABLE BATTERY**
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**SONY TFM 8030L**

**BARGAIN SCOOP**

**PORTABLE BATTERY MAINS RADIO**

This is a really top performance, top quality solid state receiver packed with SONY know-how and backed by the outstanding reliability for which SONY are renowned. Now this outstanding set is available from Lasky's at over 27% below the manufacturer's list price making it without a doubt the No. ONE SCOOP of 1971! Just look at these outstanding features. Covers MW, LW and FM (VHF).

- 11 transistor circuit for high sensitivity and stability.
- Powerful output to 3in PM Dynamic speaker with fine clear tone quality.
- AFC for drift free VHF reception.
- Pushbutton wavechange selectors and tone control.
- Choice of three power sources - 9V battery, household mains or car battery with suitable adaptors.
- Dial lights up on turn on.
- External jacks for earphone, tape recording, external power input and car aerial.
- Ultra modern styling and superb finish with padded leatherette covered cabinet for superior sound damping with chrome trim, strong carrying handle.

The SONY TFM 8030L will enliven your leisure hours anywhere, anytime with exciting sound, news, sports, music, etc.

**Specifications:**
- Tuning: 512 lines
- Frequency: FM 87-108 MHz, LW150-235kHz, MW300-1,605 kHz.
- Circuit: 11 transistors, 7 diodes and 2 thermistors.
- Aerial: Directional telescopic for FM, internal ferrite bar for LW/MW.
- Power Output: 1.85W Dynamic (1m).
- Input sensitivities: Radio up to 3mV, Magnetic Pick-up 3mV: correct to R.I.A.A. curve 1/6dB 20 to 20,000Hz. Ceramic Pick-up up to 3mV: Auxiliary, up to 3mV. Outputs: 10V 1/2dB Signal to noise: better than 70dB. Frequency response: 30 to 300,000Hz ± 1dB. Distortion: 0.22%. Signal to noise: better than 70dB. Input sensitivity: 250mV into 100K ohms.
- Front select: Power supplies.
- Bazar: Ultra simple mechanism and high quality manufacture guarantee reliable operation and long life.

**MADE ESPECIALLY FOR LASKY'S BY FAMOUS MAKERS**

**BARGAIN SCOOP**

**OTHER FEATURES**

- **Mains Operation**
- **12-Hour Alarm**
- **Auto-Sleep**
- **Switch**
- **R migliori, Minutes and Seconds Read-Off**
- **Forward and Backward Time Adjustment**
- **Silent Operation**
- **Synchronous Motor**

**COMPATIBLE WITH NOOKS**

**LASKY'S SPECIAL OFFER PRICE £21.50**

**OPTIONAL EXTRAS**

- SONY AC-90AC adapter £1.25 = 3.5 in total.
- SONY AC-120 stabilised car battery card £6.

**MANUFACTURER'S LIST PRICE £29.75**

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<tr>
<th>Power Source</th>
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<td>9V power pack battery (Ever Ready PP9 or equiv.), AC mains with adaptor.</td>
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<td>Car battery and suitable adaptors.</td>
<td>3.95</td>
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**POST 13p**

**PROJECT 60**

**DIGITAL CLOCK**

- **Size:** 44 x 3f x 11in.
- **Two colour buff/green finish.**
- **Complete with test leads and multimeter with mirror scale and built-in thermal protection.**
- **Extremely high standards of accuracy and long life.**

**LASKY'S SPECIAL OFFER PRICE £27.30**

**POWER SOURCE:**
- 9V power pack battery (Ever Ready PP9 or equiv.).
- AC mains with adaptor.
- Car battery and suitable adaptors.

**MANUFACTURER'S LIST PRICE £29.75**

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<th>Voltage</th>
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<td>30V unstabilised</td>
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<td>35V stabilised</td>
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**OUT NOW**

LASKY'S NEW 1971 AUDIO-TRONICS CATALOGUE

Send your name and address and 13p for post and inclusion on our regular mailing list.
We make computers.
We also train computer engineers.

Could we train you?

We’re the Education Division of one of the world’s largest Computer manufacturers (and who’s better qualified to teach Computer Engineering than a Computer manufacturer?)

Already, we’ve set up 39 Centres throughout the world to train Computer personnel. Now, the 40th has opened in London, with complete courses for Computer Engineers.

The curriculum includes Basic Electronics, Computer Circuitry, Development in Computer Design with the emphasis on practical work on the world’s most advanced computers.

The first courses start in September and last approximately 6 months. We are now interviewing possible students for these courses.

If you are interested in the challenge of being responsible for the maintenance of a computer installation or if you feel you’d like a move into today’s fastest growing space-age industry we’d like to hear from you. We’ll give you all the details, assess your abilities and give you an honest answer about future prospects.

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If there’s a phone handy, ring us now at 01-637 2171 between 9 am and 9 pm (Mon-Fri) and ask for Mr. Parkes

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YOURS FREE FOR 7 DAYS

The ‘New Picture-Book’ way of learning

BASIC ELECTRICITY (5 VOLS.)
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You’ll find it easy to learn with this outstandingly successful NEW PICTORIAL METHOD—the essential facts are explained in the simplest language, one at a time, and each is illustrated by an accurate, cartoon-type drawing. The books are based on the latest research into simplified learning techniques. This has proved that the PICTORIAL APPROACH to learning is the quickest and soundest way of gaining mastery over these subjects.

TO TRY IT, IS TO PROVE IT

To The SLEW BOOK CO., 60 HAYES HILL, HAYES, BROMLEY, KENT BR2 7HP
Please send me WITHOUT OBLIGATION TO PURCHASE, one of the above sets on 7 DAYS FREE TRIAL, I will either return set, carriage paid, in good condition within 7 days or send the following amounts. BASIC ELECTRICITY £4.50. Cash Price on Down Payment of £1 followed by 4 fortnightly payments of £1 each (Total £6). BASIC ELECTRONICS £5.40. Cash Price or Down Payment of £1 followed by 5 fortnightly payments of £1 each (Total £6). This offer applies to UNITED KINGDOM ONLY. Overseas customers cash with order, prices as above.

Tick Set required (Only one set allowed on free trial)
BASIC ELECTRICITY
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Prices include Postage and Packing.

Signature

(If under 18 signature required of parent or guardian)
NAME
BLOCK LETTERS
FULL POSTAL ADDRESS

A TECH-PRESS PUBLICATION

POST NOW FOR THIS OFFER!!

Practical Electronics March 1971
HORSTMANN "TIME & SET" SWITCH
(A 10 Amp Switch) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control kettles, cookers, etc., and fans. Regular price probably around £5. Special offer price £1.50. Post and ins. free.

I HOUR MINUTE TIMER
Made by famous Smiths company, these have a large clear dial, size 4½ in. dia., which can be set in minutes up to 1 hour. After period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch, £1.15.

THE FULL-PHI STEREO
The amplifier sensation of the year! You will be amazed at the fullness of reproduction and the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 8 watts transistor, ¥135. For use with normal pick-up transformers. From the main drive shaft, very powerful and useful motor size approx. 3½ in., diameter 6 in., long. Price £9 plus 20p post and ins.

FREY in Practical Woodworking, out now!
Large-Scale Blueprint for the Wood Nymph dayboat

FREE in Practical Woodworking, out now Large-Scale Blueprint for the Wood Nymph dayboat

SPARTAN Portable RADIO
Long and medium wave, 7 transistor, size 6in. x 4in. x 1½in., with larger than usual speaker giving very good tone. Switchable aerial and telescopic aerial, separate output terminals. A real bargain complete with leather case, carry strap, earcup and case. £1 for 1 post and ins.

MULTI-SPEED MOTOR
Replacement in many well known food mixers. Six speeds are available, 500, 800, and 1,100 p.m. from either or both of the nylon sockets (where the beams of the food mixers normally go) and 8,000, 12,000 and 15,000 r.p.m. (ideal low-speed speeds) from the main drive shaft. Very powerful and useful motor size approx. 3½ in., diameter £1.50, price £6.95 plus 20p post and ins.

MAINS OPERATED CONTACTOR
250/450 V AC cycle shunt with laminated core so very silent in operation. Closes 4 circuits each rated at 18A. Extremely well made by a German electrical company. Overall size 2½ x 9½ x 2½ in. £1 each.

DOUBLE ENDED MAINS MOTOR
On feet with holes for screw-down fixing. To drive models, oven, blower heater, etc., load 2 pence each, plus 18p post and insurance. 6 or more post free.

FREE 120mF TUNING CONDENSER
Proven design, ideal for straight or reflex circuits. 18p each, £1.80 doz.

OSTRIMM Portable FAN HEATER
Three position switching to suit changes in the weather. Switch on for full heat (24 kW), switch down for half heat (12KW). When central heating is on, switch central control above. A logical addition for a central thermostat, acts as auto control and safety cut-out. Complete kit £17.50. Post and ins. 3½p.

SLIP AND COVER
Suitable for most auto changers, lead base with tinted perspex cover, £4.25 plus 35p postage. Special set for Balfour autochanger £4.50 plus 35p postage.

THYRISTOR LIGHT DIMMERS
Wide immersion of lighting up to 600 w. from full brilliance to cut. Amassable and wired ready to install.

AUTO-ELECTRIC CAR AERIAL
with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and wired ready dashboard switch. £5.50 plus 35p post and ins.

COMPUTER TAPE
2,000 ft of the best magnetic tape money can buy. Made by E.H. E. 7½ in. wide, semi -breakable and on a 10in. metal computer spool. Users have claimed successful results with video as well as sound recordings £1.35 plus 35p post. Canister to hold spool £0.35.

where postage is not stated then orders over £2 are post free. Below £2 add 11p. P.R.E. with enquiries please.

SPARKLE Portable IMMERSION BOILER
200/240V. Boils full cup in about 3 minutes. £2.50. Special snip price £2.35. Post and ins. 35p. 

PLINTH AND COVER
Suitable for most auto changers, lead base with tinted perspex cover, £4.25 plus 35p postage. Special set for Balfour autochanger £4.50 plus 35p postage.

2140 FAN HEATER
3 position switching to suit changes in the weather. Switch on for full heat (24 kW), switch down for half heat (12KW). When central heating is on, switch central control above. A logical addition for a central thermostat, acts as auto control and safety cut-out. Complete kit £17.50. Post and ins. 3½p.

12 volt Car Battery Trickle Charger. Made in Japan, this is a small unit. Regular use will keep your car battery in good trim throughout the winter. Single price £1.25 plus 35p post and insurance.

QUICK CUPPA
Mini Immersion Heater, 200w. £9.95. Bolts fully complete for two minutes. Tie any socket or lamp holder. Have included: teak, tea, baby's food, etc. £1.50, post and ins. 12v. car model also available £1.

THYRISTOR LIGHT DIMMERS
Wide immersion of lighting up to 600 w. from full brilliance to cut. Amassable and wired ready to install.

AUTO-ELECTRIC CAR AERIAL
with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and wired ready dashboard switch. £5.50 plus 35p post and ins.

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Where postage is not stated then orders over £2 are post free. Below £2 add 11p. P.R.E. with enquiries please.

4-STATION INTERCOM
£6.75
Solve your communications problems with this 4 -station Tranzistor Intercom system (1 master and 2 subs), in de-lux plastic cabinets for desk or wall mounting. Calibrated ranges from Master to Slave. Sub to Master. Ideally suitable for Business, Surgery, School, Hospital, Office and Home. £3.95 each. P. & P. 40p extra.

MAINST RPHEER

INTERCOM/BABY ALARM
£3.15
Mains or 4 -Station Intercom for two -way instant communication. Ideal for Baby Alarm and Door Phone systems. Complete with all necessary connecting wire. Battery £29. P. & P. 25p.

INTERCOM/TELEPHONE AMPLIFIER
£2.98

ELECTRONICS (CROYDON) LTD
Dept PE, 266 London Road, Croydon CR0 2TH
Also 102/3 Tamworth Road, Croydon

Vary the strength of your lighting with a DIMMASWITCH

FREY in Practical Woodworking, out now Large-Scale Blueprint for the Wood Nymph dayboat

The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The ivory mounting plate of the DIMMASWITCH matches modern electric fittings. The bright chrome control knob activates an on-off switch and controls 40-600 watts of all light except fluorescentes at mains voltage from 200-250 V, 50 Hz. The DIMMASWITCH has built-in radio interference suppression. Price £3. £4 plus 16½d post and packing. Kit Form: £2. £4. £4 plus 1½d post and packing Please send C.W.O. 10p.

DIXTER & COMPANY
1 ULVER HOUSE, 19, KING STREET, CHESTER CH1 2AH. Tel: 0244-25883
As supplied to H.M. Government Departments, Hospitals, Local Authorities, etc.
ELECTRIC CLOCK WITH 15 AMP SWITCH

Made by Smith's, these units are as follows:

- 900 mfd. 6V, $7p each 94 doz.
- 500 mfd. 10V, $8p each 95 doz.
- 250 mfd. 16V, $10p each 97 doz.

SWITCHES

- Glass encased, switches operated by plastic case: 30p each. 3 heat model 40p.
- Into a square solenoid.

PRICING:

- Price 10p each, 90p dozen.
- For each two kits ordered: 29p for each.

INTEGRATED CIRCUIT BARRIER


- 31 for $29.99 doz.

PRICE UP each.

MAGNET 

- Gold welded contacts. We can now offer magnet-welded contacts.

GLASS ENCASSED Switches

- Operated by plastic case: 30p each. 3 HEAT Model 40p.

DISTRIBUTION PANELS

- Complete with fitted 15 amp plug, plus 23p P. St 1.
- 10p each or 11.05 doz.

HIGH CAPACITY ELECTROLYTICS

- 100 mfd. 25V, 6p each 121 doz.
- 250 mfd. 25V, 10p each 102 doz.
- 500 mfd. 25V, 15p each 96 doz.
- 1000 mfd. 25V, 20p each 92 doz.
- 2000 mfd. 25V, 30p each 84 doz.

PRICE UP each.

Magnetic Switches

- With fitted 15 amp plug, plus 23p P. St 1.

1-PIECE SOCKET SET

- Complete with wall case or on/off switch. An ideal gift for the enthusiast. 90p plus 1p post and insurance. Most useful sizes from 2 in to 1 in.

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 35 circuits of micro switches, each of 10 amp operated by the trips thru 12 circuits may be changed per revolution. Drive motor is mains operated 3 rev per min. This type is suitable for all types of machinery control, building control, Disposing and Vending machines, Display cabinets, etc., and is available from Sloan Motors and Equipment Co. Ltd for 250 each.

MINIATURE WAFFER SWITCHES

- 3-way - 3 pole, 4-way - 4 pole, 2-way - 2 pole.
- 60 each, 55p dozen.

Micro Switch

- 900 mfd. 6V, $7p each 94 doz.
- 500 mfd. 10V, $8p each 95 doz.
- 250 mfd. 16V, $10p each 97 doz.

DISTRIBUTION PANELS

- Complete with fitted 15 amp plug, plus 23p P. St 1.
- 10p each or 11.05 doz.

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 35 circuits of micro switches, each of 10 amp operated by the trips thru 12 circuits may be changed per revolution. Drive motor is mains operated 3 rev per min. This type is suitable for all types of machinery control, building control, Disposing and Vending machines, Display cabinets, etc., and is available from Sloan Motors and Equipment Co. Ltd for 250 each.

MINIATURE WAFFER SWITCHES

- 3-way - 3 pole, 4-way - 4 pole, 2-way - 2 pole.
- 60 each, 55p dozen.

Micro Switch

- 900 mfd. 6V, $7p each 94 doz.
- 500 mfd. 10V, $8p each 95 doz.
- 250 mfd. 16V, $10p each 97 doz.

DISTRIBUTION PANELS

- Complete with fitted 15 amp plug, plus 23p P. St 1.
- 10p each or 11.05 doz.
**BI-PAK—LOW COST I.C.'s**

BI-PAK Semiconductors now offer you the largest and most popular range of I.C.'s available at these EXCLUSIVE LOW PRICES. TTI Digital-T/J series fully-codated, broad range. Dual in-line plastic 14 and 16 pin packages.

**BI-PAK**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Similar Type(s) to—Description</th>
<th>Price and qty.</th>
<th>1-24</th>
<th>25-99</th>
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<td>BP7831N</td>
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Data is available for the above series of Integrated Circuits in booklet form; price 15p.

**LINEAR I.C.'s**

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<tr>
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<td>BP 201C-DB201C</td>
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<td>BP 401C-DB401C</td>
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<tr>
<td>BP 401C-DB401C</td>
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**TTL INTEGRATED CIRCUITS**

Manufacturers: "Fall outs"—out of spec. devices including functional units and part functional but not all (< 80% out of spec. from the manufacturer's very tight specification. Ideal for learning about I.C.'s and experimental work.

**PAK No.**

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<tr>
<th>Order No.</th>
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**DUAL-IN-LINE LOW PROFILE SOCKETS**

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**RTL FAIRCHILD (U.S.A.) I.C.'s**

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**RTL DIGITAL I.C.'s**

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**RESISTORS**

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<tr>
<td>191</td>
<td>4712-2M (10%):</td>
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<tr>
<td>5%</td>
<td>4712-1M (1%):</td>
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<td>0.1%</td>
<td>4712-0.01M (0.01%):</td>
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**ZENER DIODES**

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**VERBOARD**

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**PLUGS AND SOCKETS**

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<tr>
<td>Standard in socket</td>
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<td>Stereo in insulatet</td>
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<td>Stereo in socket</td>
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**SHUCK DIM PANELS**

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<td>0.09p</td>
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**BRUSHED ALUMINIUM PANELS**

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**YATES ELECTRONICS**

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<tr>
<td>1.00</td>
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</table>

C.W.O. please. Post and packing, please add 7p to orders under £2.

Data sheets are available for most of the components listed, and will be sent free on request.

**839 WILSTOW DRIVE, EMMA, HERTS.**

Practical Electronics March 1971
**PREMIER STEREO SYSTEM “ONE”**


---

**MIDLAND AM/FM STEREO TUNER AMPLIFIERS**

Two new all solid state receivers from Midland at economical prices. Beautifully styled in simulated cabinets.

**MODEL 19-520**

- 5 watts per channel with inputs for pick-up, tape and tuner also tape output complete and supplied ready to plug in and play.

**MODEL 19-542**

- 2025 T/C auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish cabinet.

---

**50 WATT PUBLIC ADDRESS AMPLIFIER MODEL PA-5000**

A top quality amplifier giving 50 watts rms power output (80w peak). Incorporates 8 transistors and 4 silicon diodes (silicon output transistors). Inputs for 2 microphone each with individual volume controls, plus phone jack input. Master volume control, bass and treble controls. Well presented front panel for ease of operation, on/off power switch and pilot light. Output impedance 4/8/16 ohms Mike 1 and 2 sensitivity 2mV (50Ω). Frequency response 20-20,000Hz. Fused output and thermal overload protection. A.C. Main 220-250V. 26-0/Hz. Size 13in x 9in x 31/2in.

**NEW MATCHING F.M. TUNER (22.05.77)**

For only £142.09

---

**MONO STETHOSCOPE SET**

- Low Imp. 52p
- P.A. 10p

**STEREO STETHOSCOPE SET**

- Low Imp. 82p
- P.A. 10p

---

**VERITAS V-149 MIXER**

Battery operated 4-channel audio mixer providing four separate inputs. Size 5 x 2 x 3in. suitale for crystal microphione, low impedance microphone, low impedance transformer. microphione with transformer, radio, tape, etc. Max input 0.5V, max. output 2.5V, gain 60dB. Standard jack plug socket inputs, phonoplug output. Attractive teak wood finish case.

**POCKET SIZE MULTI-TESTER**

With wide amplitude, well presented front panel for ease of operation, on/off power switch and pilot light. Output impedance 4/8/16 ohms Mike 1 and 2 sensitivity 2mV. Frequency response 20-20,000Hz. Fused output and thermal overload protection. A.C. Main 220-250V. 26-0/Hz. Size 12in x 5in x 3in.

---

**PREMIER STEREO SYSTEM “TWO”**

As system “ONE” above but with Garrard RP5.

**PREMIER PRICE**

£47 Carr. £7.50
20 PROJECT SOLAR ELECTRONIC KIT Mod. R.128
This ultra modern Project Kit is shaped for the space age. Carried inside a transparent domed cabinet the R.128 comes complete with a self-contained solar cell to power any of 20 projects ranging from a one transistor radio to a stereo set complete with key and tone controls.

PRICE £4.50

2 OCTAVE ELECTRONIC ORGAN KIT Mod. R.129
Complete with a music book containing 10 easy to play songs the 11.129 solid state organ covers 2 full octaves.

PRICE £4.50

10 PROJECT INTEGRATED CIRCUIT KIT Model R.127

PRICE £5.00

2 TRANSISTOR SOLAR RADIO KIT Model R.126
Like all Roc Electronic Kits the R.126 uses reliable no-solder connections to produce a complete 2 transistor radio in under 2 hours. As well as battery operation the kit is supplied complete with a solar cell to provide power from the sun or any strong light source.

PRICE £2.50

CRYSTAL RADIO KIT Model R.125
This toy to build Radio is based on the same circuit developed by Marconi for the very first radio transmission but uses a modern ferrite aerial for maximum efficiency. A perfect introduction to Radio Theory.

PRICE £1.50

16 WATT STEREO AMPLIFIER Model R.138
As well as separate bass and tone controls the R.138 features switched main and remote speaker outputs so that the same stereo installations can be used to drive independent stereo speaker systems. Fitted in a well finished walnut cabinet the classical twinline styling of the R.124 will grace any home.

PRICE £16.50

5 WATT 8 TRACK CARTRIDGE STEREO AMPLIFIER Model R.133
Just like in one of the many 8 track cartridge tapes available for a continuous programme of your favourite music. A manual programme override switch enables you to switch from one track to the next at the push of a button at the same time a numbered indicator lights up to show which track is playing. Beautifully finished in a solid walnut cabinet the R.133 is mechanically engineered to provide long and reliable service.

PRICE £36.00

STEREO HEADPHONES Model R.328
Built up to a standard not down to a price, the R.329 stereo headphones represent a break through in value for money.

PRICE £2.40

PROFESSIONAL SOLID STATE FOUR BAND COMMUNICATION RECEIVER Model R.135
This is the communication receiver that you have long been waiting for. Fully transistorised and continuous coverage from 55KHz to 30MHz in four bands including illuminated electronic headphones for 10-10 metres. Also incorporates an internal speaker, automatic noise limiter, 500kHz AM/CW switch, AVC Switch, 8 Meter, Receive and standby switch, AF control/unit, STEREO AF gain, band selector, amber trimmer and RF gain.

PRICE £45.00

10 WATT TRANSISTOR STEREO AMPLIFIER Model R.137
With separate tone and volume controls on each channel and inputs for both phone and tuner, the 10 WATT STEREO AMPLIFIER is the ideal start to an excellent budget system. Frequency response 70-20,000Hz, Output impedance 8-16 ohms. Attractively styled with brushed aluminum front panel.

PRICE £9.50

10 WATT BUDGET STEREO AMPLIFIER Model R.136
Ideal as a second stereo system or for the newcomer to Hi-Fi who wishes to upgrade existing equipment the R.136 sounds every bit as good as it looks. As well as inputs for crystal or ceramic cartridge the R.135 has a Stereo Tuner input which accepts the matching R.134 only available from ROC.

PRICE £13.00

AM/FM MPX STEREO TUNER Model R.134
Perfect Matching Unit to the R.135 Amplifier. The R.134 Stereo Tuner is designed to give years of reliable performance. The Tuning Band covers AM & FM with a separate stereo beacon to indicate when stereo broadcasts are being received.

PRICE £21.00

STEREO FM AM MPX TUNER AMPLIFIER Model R.124
Another Roc Exclusive offering too value for money performance the R.124 is a Stereo Tuner/Amplifier with facilities only usually found in much more expensive units. Features like separate bass and treble controls, automatic frequency control switch and stereo headphones socket give the R.124 a price to specification ratio second to none.

PRICE £29.95

H.P. Terms available for personal customers on purchases over £25.

RETURN OF POST MAIL ORDER SERVICE Dept. PE
Orders under £10 please add 25p post and packing. Orders over £10 sent post free.

ROC ELECTRONICS LIMITED
193 EDGWARE ROAD LONDON W2 1ET
TELEPHONE: 01-723 6211
Shop open 9-6 Monday-Saturday (Than. 1 p.m.)
BUT, SERIOUSLY

Do some of us on occasion take this business a trifle too seriously? We feel this could be true, for now and again someone is heard to imply that so and so design is a flippant use of electronics.

Getting straight down to grass roots, let us consider any classic circuit arrangement; in fact suppose we take a well known building block such as the multivibrator, as a general illustration. This circuit has a habit of cropping up in the most unlikely guises, as we all know. It may appear in an item of test gear such as a c.r.o. trace doubler or a voltage to frequency converter, in a car lamp flasher, in the tone generator section of an organ, in a digital calculator, or in a “toss the coin” game, to name but a few. This ubiquity helps to demonstrate the point that an electronic circuit as such has no innate purpose apart from the purely electronic function it has been expressly designed to perform; and this alone is not enough. Outside purely academic circles, the circuit requires some gainful employment to justify its existence. Providing it is within the circuit’s capabilities, the precise nature of the task it may be given is, in an electronic sense, irrelevant. It may be useful or it may be frivolous. There is no list of prescribed duties that circuits must restrict themselves to! They work for us as we decree.

Electronics is a very “human” technology, simply because it is easily adaptable to most of our whims and needs. And it plays, quite rightly, a major part in our amusement and entertainment, no less than in the “serious” activities of life.

To be fair we must not forget that to some individuals the study of electronic circuitry can be an end in itself. Academic minds so inclined can derive plenty of intellectual pleasure from the analysis of circuit behaviour without too much worrying about specific applications. But to most of us electronics surely means more than conducting a minute anatomical examination of a pretty trace on the c.r.t., or indulging in a prolonged immersion in mathematics, however good all this may be for the mind. When it comes to the crunch, electronics is a tool and the most proper and sensible thing is to apply it however and wherever we can, to serve us at both work and play.

If there are theoreticians who still shudder at some frivolous application of the technology, there is a homely example for them to ponder. Let them consider the television receiver—that embodiment of many elegant electronic techniques, a mass produced complex of circuitry that has been designed principally for our entertainment. Just dare suggest that this cathode ray companion and comforter for millions be redesignated something like a “communications monitor” and provide nothing but news and elevating cultural programmes, and the whole nation would go on strike!

F.E.B.
Many drivers are not regular users of parking lamps and tend to use side lights when parking in a strange situation. Because they would not use an automatic parking light very often, they do not consider it a worthwhile investment. The added facility of a lighting up reminder that this circuit offers will thus make the parking lamp worthwhile. The circuit is very simple and provides the following facilities:

(a) An automatic parking lamp that turns itself on and off at dusk and dawn.
(b) A warning system when the car is used with no lights in poor light or after lighting up time.
(c) A warning indication, while driving, as lighting up time approaches.
(d) Automatic cancellation of either system when the sidelights are switched on.
(e) No additional control switching when on route.

The complete unit can be attached to the car dashboard or to the windscreen where it is in view of the driver. Only three wires need to be connected to the car wiring which is not altered in any way. Both positive and negative earth 12 volt circuits are given, and for cars already fitted with an automatic parking light, only part of the circuit need be built.

The unit utilizes a standard parking lamp so if such a lamp is already used it can now be automated.

CIRCUIT
The fundamental circuit adapted for both positive and negative earth systems is shown in Figs. 1a and 1b; this illustrates the operation of the system using normal ignition and side light switching. With switch S1 in the "normal" position the circuit is operative when the ignition is on and the sidelights off. The circuit is then in the lighting up reminder state and LP2 will signal the approach of lighting up time when en route, or when about to move off without lights when they are required.

With S1 in the "park" position, the sidelights switched off and a parking lamp (LP1) plugged into SK1 and SK2, the circuit will function as an automatic parking light, the ignition switch and LP2 being out of circuit.

LIGHT DEPENDENT RESISTOR
As daylight decreases, the l.d.r. (light dependent resistor—X1) resistance increases and since this forms a potential divider with R1 at the base of TR1, when the determined light level is reached, a switching function is triggered between transistors TR1 and TR2 so that TR2 conducts and consequently illuminates LP2 to show up the expression "no lights". The switching function is preferred to an emitter follower because there is no heat build-up across transistor TR2 while the input signal is developing. The life of the transistor is therefore prolonged. Resistor R3 is made up of two 22 ohm resistors in parallel.

The same circuit operation is carried out for both the parking lamp and internal warning system and the ignition/battery supplies are selected in conjunction with the appropriate lamp by the operation of the double pole changeover switch S1.

SYSTEM CANCELLATION
Both systems are cancelled when the normal side-light switching operation is carried out following the internal warning, or where sidelights are required when parked. The circuit is completed via the filaments of the sidelights, rear light and number plate light; with the sidelight switch off, the small current required for the system flows through the paralleled filaments of the sidelights and associated lamps. When, however, these lamps are switched on, the circuit is shorted out and the no lights warning or the parking lamp, cease to operate.

If the car is garaged or parked within the law, the switch remains in the normal position and both systems are isolated. A check is readily available for both systems when light is shielded from X1. It is to be noted that LP2 will hunt if the l.d.r. picks up reflected light from the hand or any other adjacent surface capable of reflecting light on to the sensor.

OPERATIONAL LIGHT RANGE
The operational range of the system is good and operational levels of light may be selected by the insertion of light filters under the cover of the l.d.r. These may be in the form of ordinary thin paper and are far more economical than the inclusion of a variable resistance in the circuit.

With the engine running when en route, the internal lamp may flicker as the critical light period approaches. This is due to voltage variation of the car's supply (the charging system) but since the flicker is an added attraction factor, the necessity for voltage stabilisation is considered unnecessary and not in the interests of economy.
A LIGHTING-UP REMINDER AND AUTOMATIC PARKING LIGHT . . . BY G. W. JONES

COMPONENTS . . .

Resistors
- R1 22kΩ
- R2 12kΩ
- R3 11Ω (2 × 22Ω in parallel)
- All 1/4W, ± 10% carbon

Transistors
- TR1, TR2 2N3704 (2 off)

Miscellaneous
- X1 ORP12 light dependent resistor
- LP1 12V, 2-2W external parking light
- LP2 12V 2-2W bulb and holder
- SK1, 2 Banana plugs and sockets (2 off)
- S1 d.p.d.t. toggle switch
- Veroboard 2in × 2in × 0-2in matrix (Electrovalue)
- Case—see text
- Three core cable for connection to car wiring
- 6B.A. fixings

Fig. 1. Complete circuit diagram of the lighting-up reminder plus automatic parking light. (a) Design for negative earth system; (b) design for positive earth system. Tinted area represents car wiring.
CONSTRUCTION

The prototype unit was housed in a small tobacco tin, the lid of which was reinforced with aluminium. Holes can be cut in the lid and aluminium plate for X1 mounting, SK1 and SK2, SI and the "no lights" indication. The legend "no lights" may be printed on tracing paper and inserted, between two protective celluloid layers, under the aluminium panel which is attached to the lid by three 6B.A. screws.

The mounting for XI and LP2 holder were obtained from a single indication lamp dismantled for the purpose. SK1 and SK2 can be banana sockets or any special socket to suit the parking light. The three core lead that connects the circuit to the car wiring can be taken out through a grommet hole in the side of the case.

Components in the prototype were mounted on a piece of 0.2 inch matrix Veroboard, fixed inside the tin by two 6B.A. screws and spacers (see Fig. 2). The inside of the tin should be protected by insulation tape so that no connection is made between the circuit and earth on the car. It is, of course, possible to use any form of construction, since the layout of components is not critical—the unit could be built into the dashboard of many cars and LP2 could be housed in a warning light mounting chosen to correspond with the other panel warning lamps.

REMEMBRANCE ONLY

If it is required to provide a lighting up reminder only—without the facility of an automatic parking light—then SI, SK1 and SK2, and the connection to S2 (sidelights switch) on the car battery side may be omitted (see Fig. 3).

When the complete system is operated in the lighting up reminder mode, LP1 can be unplugged from SK1 and SK2 and hence the no lights warning may be cancelled by operation of SI (change to "park") position as well as by switching on the sidelights.
SOVIET ACHIEVEMENTS IN SPACE

After a period of apparent inactivity, the Soviet Union has in the past two years or so made some significant advances that have been spread over the whole area of space activities. The Russians have for a long time favoured the use of space platforms and automatic probes. They have covered the human element involved by longer periods under space conditions, and experimented with the transfer of astronauts from one vehicle to another.

The local earth-moon activities have formed a part of their programme but they have paid a good deal of attention to the special techniques required to explore the other planets. Already they have had two attempts to land robot craft on Venus and now a third attempt has been made.

The unfortunate loss of Lunik 15 at the time of the Apollo 11 mission was a particular disappointment, but served to indicate the difficulties that attend attempts to maintain communication, with vehicles that are at a low level in areas where there are mountains involved.

COLLECTING MOON SAMPLES

However the loss of control of Lunik 15 was more than compensated by the successful mission of Lunik 16. This vehicle departed from the earth for the moon with the main task of collecting, automatically, samples of lunar soil, putting them into containers, and returning them to earth.

The vehicle consisted of a descent platform carrying the return vehicle, which carried the drilling mechanism and control. Altogether something in excess of 100 grammes of lunar material was recovered.

The point of operation was in the Sea of Fertility, 56° 18' W and 0° 41' S, which is some 900km from the site of the Apollo 11 landing. The material was friable surface substance of fine grain, for the first 15cm of the sample. The next section from 15cm to 33cm was of variable granular material with some larger inclusions of the order of 3mm in diameter. The last section from 33cm to 35cm was of large grain with some fragments of bedrock.

In appearance the material is a very dark grey almost black powdery substance. The mean specific gravity of the material was of the order of 1.2 and the variation in particle size ranged from 70µm at the surface to 120µm at the lowest depth. The composition appears to be basaltic with some feldspar and some metallic iron and vitreous particles. Some isotopes of short life were found and altogether about 70 chemical elements were present.

A comparison with the specimens brought back by Apollo 12 shows very close agreement in the percentage of the various elements.

SOYUS 9

Andrian Nikolayev, who captained Soyus 9, has made some interesting comments on the 18-day flight. Month long flights are feasible but anything longer would require different techniques. There would be need for more efficient and extensive conditioning and also new medical procedures.

The post flight effects of this mission were very much more marked than those encountered with the shorter flights. Walking was found to be difficult over a period of days and there was frequent stumbling. They found it difficult to climb stairs, sometimes hard to stand upright.

A notable feature was the wasting of the lower limbs by as much as 4cm round the hips and 2cm round the shins. This appears to result from the loss of muscle tissue in the legs which are normally used to support the body at 1g. There was a loss of body weight of 5kg for the new astronaut Sebastianov and a little less for Nikolayev. However, they both recovered their normal weight in three weeks.

LUNOKHOD

The mobile moon vehicle Lunokhod was an exciting event and represented a new era in space technology. Although an instrument unit, previously landed by the United States, had been made to hop, Lunokhod 1 is the first vehicle to be landed on the moon and become mobile under guidance from the earth direct. When the difficulties are properly realised, a task of this kind becomes a major point in history.

Because it is the first time that such a successful operation has been mounted, a whole new vista in the exploration of the moon becomes available. Provided that communications between the base station and the unit can be maintained, many new areas of the moon can be explored in detail.

At the moment this is feasible only in open areas because in hilly or mountainous regions loss of communication could be disastrous. This points to the likelihood that control from a space platform would be the ultimate aim. A very great advantage is that a mobile system remotely controlled would enable special regions to be explored which might be impossible for manned units.

MANNED FLIGHTS

It is significant that the Soviet space scientists do not regard the robot as the principal method. This is borne out by the fact that the internal environment of Lunokhod 1 is similar to a life support system having a temperature between 16 and 18 degrees centigrade and a pressure of between 730 and 780mm Hg.

The present instrumentation could be built into a manned cabin without modification. From this it could well be surmised that a manned landing is still part of Soviet plans. Also there is a distinct suggestion that the Russians are looking further afield to Mars for automated surface units.

LUNAR EXPERIMENTS

Although not much appeared in the initial stages about the type of experiments being undertaken, the following were included in the mission.

(a) Determination of the composition of the surface of the moon using a spectroscopy.

(b) Measurement of extra-galactic x-radiation using an x-ray telescope to make long exposure studies of weak sources. These cannot be done effectively (where distant sources are concerned) with rockets and satellites.

(c) Assessing the mechanical properties of the lunar soil by impressing a special stamp.

(d) The study of cosmic radiation from the sun.

(e) Experiments which involve the radiation from the moon itself.

(f) The very important cooperative effort of France and the Soviet Union in a laser experiment to determine accurately the earth-moon distance.

A special system of telemetric sensors is in use to measure the stresses acting on the chassis of the vehicle and a great deal of television recording is being made of the tracks that are made on the lunar surface.

Practical Electronics March 1971
For demonstration purposes, it is convenient to be able to produce any of these 16 functions without having to construct separate gates. The multi-function logic circuit makes it possible to establish any required function simply by selecting the appropriate combination with four switches.

FUNCTIONS OF BINARY VARIABLES

In the logic diagram of Fig. 1, each of the four switches S3, S4, S5, and S6 puts a 0 or 1 condition on its respective gate input, according to Table 1. This lists the function logic output corresponding to each of the 16 functions.

The switch settings are, in fact, those that would appear in a truth table of the desired function.

The A, B inputs are connected to decode each of the four possible input conditions and so select the appropriate gate as follows:

<table>
<thead>
<tr>
<th>Input state</th>
<th>A.B</th>
<th>A.B</th>
<th>A.B</th>
<th>A.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate selected</td>
<td>G1</td>
<td>G2</td>
<td>G3</td>
<td>G4</td>
</tr>
</tbody>
</table>

The G5 gate output will therefore assume a 0 or 1 condition depending both on the position of the function setting switches and on the particular combination of the A, B inputs.

A 1 condition will light the lamp via the lamp driver but a 0 condition will not.

CIRCUIT

The multi-function logic circuit makes use of two integrated circuits. These i.c.s are three and four input NAND gates; the SN7410N and SN7420N respectively.

**MULTI-FUNCTION LOGIC CIRCUIT**

By P. A. Davis, A.M.Inst.E.
In the circuit diagram (Fig. 2), all the switched gate inputs are taken to the positive rail by way of resistors. This ensures that each input is held at logic 1 when its switch is opened.

The unused input at gate G4 is connected to a used input rather than left floating.

Fig. 3 shows the i.c. gate configuration used.

Table 1. FUNCTIONS OF TWO BINARY VARIABLES

<table>
<thead>
<tr>
<th>Function number</th>
<th>Function setting switches S3 S4 S5 S6</th>
<th>Logic function produced</th>
<th>Function name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 0 0 1</td>
<td>A . B</td>
<td>AND</td>
</tr>
<tr>
<td>2</td>
<td>0 0 1 0</td>
<td>A . B</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0 0 1 1</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0 1 0 0</td>
<td>A . B</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>0 1 0 1</td>
<td>A</td>
<td>Exclusive OR</td>
</tr>
<tr>
<td>6</td>
<td>0 1 0 0</td>
<td>A . B + A . B</td>
<td>OR</td>
</tr>
<tr>
<td>7</td>
<td>1 0 0 0</td>
<td>A + B = A + B</td>
<td>NOR</td>
</tr>
<tr>
<td>8</td>
<td>1 0 0 1</td>
<td>A . B</td>
<td>Logical Equivalence</td>
</tr>
<tr>
<td>9</td>
<td>1 0 0 0</td>
<td>A . B</td>
<td>NOT A</td>
</tr>
<tr>
<td>10</td>
<td>1 0 0 1</td>
<td>A</td>
<td>NOT B</td>
</tr>
<tr>
<td>11</td>
<td>1 0 1 0</td>
<td>A + B</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1 0 1 1</td>
<td>A + B</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>0 1 0 1</td>
<td>A + B</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1 1 1 0</td>
<td>A + B = A . B</td>
<td>NAND</td>
</tr>
<tr>
<td>15</td>
<td>1 1 1 1</td>
<td>A + B = A . B</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>0 0 0 0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3. Circuit diagram of the 3-input NAND gate employed in the SN7410N. For the SN7420N gates, an additional input, shown dashed, is used.
CONSTRUCTION
Apart from the chassis mounted switches and lamp, all of the components are mounted on a single piece of Veroboard as given in Fig. 4. To accommodate the dual-in-line i.c. packages, Veroboard of 0·1in matrix is used.

Wiring of the switches to the board is shown in Fig. 5. Positioning of these will depend very much on the preference of the user; whether a large or small display is required.

COMPONENTS . . .

<table>
<thead>
<tr>
<th>Resistors</th>
<th>R1–R8 22kΩ (8 off)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R9 1kΩ</td>
</tr>
<tr>
<td></td>
<td>All 10%, 1⁄4 watt carbon</td>
</tr>
<tr>
<td>Transistor</td>
<td>TR1 2N706A</td>
</tr>
<tr>
<td>Integrated Circuits</td>
<td>IC1 SN7410N</td>
</tr>
<tr>
<td></td>
<td>IC2 SN7420N</td>
</tr>
<tr>
<td>Switches</td>
<td>S1–S2 Single pole changeover (2 off)</td>
</tr>
<tr>
<td></td>
<td>S3–S6 Single pole on/off (4 off)</td>
</tr>
<tr>
<td>Lamp</td>
<td>LPI Miniature indicator 6V 0·06A (Electroniques)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>0·1in matrix Veroboard 2½in × 2½in, Vero pins (14 off), Aluminium chassis 8in × 6in × 1½in</td>
</tr>
</tbody>
</table>

OPERATION
To operate the completed unit, first select the required function from Table I. This function is then set using the switches S3, S4, S5, and S6.

Each input combination of A,B is then operated on by this function, and the result, a 1 or 0, will appear at the output of gate G5. If the output is 1 the lamp will light.

Say, for example, the OR function is required. Table I gives the function switch setting as 0111 (Function 7).

With these switches set accordingly, the switches S1 and S2 are set to A,B. It will be found that the lamp lights, hence, we can conclude that provided that A or B (or both) is present at the input, the lamp lights.

Apart from the convenience of the unit for demonstrating logic functions, it can be useful as part of a training programme — particularly if the function governing the input-output relationship has to be deduced from the unit's behaviour.
MARKET PLACE

Items mentioned in this feature are usually available from 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.

WIPER DELAY

There are many windscreen wiper control units on the market and, as our readers will have noted, the problem with many circuits is that they are unable to accommodate the various wiring configurations and wiper motor types in use on all modern cars.

Wiperdwell, a unit manufactured by Automents Ltd., is one unit that can be used with all types of self-parking wiper motors and can easily be fitted by the average motorist in a very short time. The unit allows the selection, by a single control, of the most suitable wiping frequency for slight rain, fog and snow—a principle that works extremely well.

The unit can be fitted using a drill and screwdriver, comprehensive connection instructions are supplied and physical connection is made by way of "piggib back" connectors thus avoiding altering existing wiring and obviating soldering.

The Wiperdwell unit will not affect the normal operation of the wipers, can give up to 20 seconds between sweep delay, costs £4.75 and is supplied with a six month guarantee.

MINIATURE SWITCHES

Sub-miniature toggle switches with a rating of 6A at 125V or 3A at 250V a.c. suitable for most of our constructional projects are now being marketed by WEL Components Ltd.

The switches have a breakdown voltage of 1,000V a.c. with insulation resistance of more than 100 megohms at 500V d.c. The switch contact resistance is typically less than 5 milliohms at 1A 2-4V d.c.

The switches are moulded in phenolic melamine with solder tag connections and are available in two types—Type TS106D is a single-pole double throw and costs approximately 37½p (7s 6d) each. Type TS206N is a double-pole double throw and costs approximately 47½p (9s 6d).

Addresses of nearest stockists can be obtained from WEL Components Ltd., 5 Loverock Road, Reading, Berkshire.

Another range of sub-miniature toggle and pushbutton switches suitable for many P.E. projects are those manufactured by Birch-Stolec Ltd.

The switches include toggle, lever lock, rocker and momentary push-button types with one, two, three or four poles.

Contact ratings are: coin silver contacts, 5A resistive load at 115V a.c., or 2A at 250V a.c.; brass contacts with gold over nickel plate, 0.4V/A maximum at 20V maximum (a.c. or d.c.); coin silver contacts with gold over nickel plate, 5A resistive load at 115V a.c. or 28V d.c., or 2A at 250V a.c., and 0.4V/A maximum (a.c. or d.c.).

Available with short or long toggles with nine different colour caps, the switches can also be supplied for printed circuit board or angled mounting.

Full details of these switches and addresses of nearest stockists can be obtained from Birch-Stolec Ltd., Ponswood Industrial Estate, Wim- mill Road, Hastings, Sussex.

Also, we have been informed that Gothic Electronic Components, Beacon House, Hampton Street, Birmingham 19, have been appointed stockists and distributors of the complete range of standard and miniature thumbwheel switches from Birch-Stolec.

REED RELAY

Two new miniature encapsulated reed relays supplied with either one normally open reed switch or one changeover contact are the most recent products from Osmor Ltd.

Ideal for printed circuit board mounting, the type ERA has maximum d.c. contact ratings of 10W (a.c. or d.c.). Contact ratings are: 100VA maximum d.c. or 200V d.c. and type ERC is rated at 4W 28V 0.1A d.c.

The relays are available for 6V, 12V and 24V operation, and are colour coded for easy identification. The

Wiperdwell windscreen wiper control from Automents

coil is wound on a glass-filled nylon bobbin, and a magnetic screen is fitted as standard.

The complete relay is encapsulated in glass-filled nylon and measures only 22mm (4in) x 10-5mm (0.24in) diameter.

Price of the relays vary according to type and quantity; full details can be obtained from Osmor Ltd., 540 Purley Way, Croydon, Surrey, CR9 4DY, or at 53 London Road, Leicester, LE2 0PD.

TAPE HEAD CLEANING

Suitable for all compact casette type tape recorders and car player units, Multicore Solders have recently introduced a new tape head cleaning cassette tape.

It comprises a cassette tape container in which high quality cleaning tape is incorporated to clean tape heads, capstan and pinch wheel. Used in the same manner as a tape cassette by placing in the machine and operating in the play-back position, the whole operation takes approximately one minute.

Supplied in a plastic container the Bib Size 31 cassette tape head cleaner retails at 53p (10s. 7d.) and is available from most hi fi shops.
In this, the final part of the P.E. Gemini dual purpose stereo amplifier, we give final construction details of the pre-amplifier, a fault finding chart and hints on using the completed amplifier.

**Drilling**

The pre-amplifier is housed in a Contil Mod-2 case size G and the dummy front panel (aluminium 12\(\frac{\text{in}}{\text{in}}\times 2\frac{\text{in}}{\text{in}}\times 18\text{ s.w.g.}) was actually cut from the unused main amplifier chassis. Full drilling dimensions for the box and panels are given in Figs. 36, 37, and 38.

Miniature toggle switches were used in the prototype for S1, S2, and S5 and the holes for these and the pilot light LPI must be drilled to suit whatever components the constructor has available. The best arrangement is to drill the front panel and the dummy front panel whilst they are clamped together to ensure that any slight errors do not prevent the components from fitting through the holes. All the holes must be de-burred with a file or a large drill.

**Front Panel**

To obtain a presentable finished article the dummy front panel can be rubbed with wire wool, using household soap and water, in one direction along the length of the panel. This process should be continued until all the scratches have been removed. A very good "brushed aluminium" finish can be obtained in this way; a satin finish can be obtained if the panel is coarse sand blasted by some local workshop or garage. Care must be taken not to introduce any fingerprints or grease before the panel is sprayed with Letracote gloss.

**Labelling**

The front and rear panels can now be labelled using the same method as for the main amplifier cabinet, i.e. one light coat of Letracote gloss, apply the letters and then a further two coats of Letracote. As can be seen in the photographs, the prototype controls have numbers of relative magnitude arranged around them. The indication dots for these numbers can be marked first lightly in pencil with the help of the template, Fig. 39. The template is transferred to a thin piece of celluloid by drilling small holes in the required places. The celluloid template can then be placed over the dummy front panel and the dots marked in lightly in pencil. This method ensures that the dots exactly line up with the 30 degree switch positions and that the dots round the other controls are all at the same angles and radii.

**Assembly**

The front panel components are now mounted, not forgetting the dummy front panel which is held on by the control spindle nuts. Care must be taken not to mark the dummy front panel whilst tightening the various nuts and screws. The rear panel components, C52 (using a suitable capacitor clamp) and the assembled printed circuit board should be mounted on the appropriate parts of the case.

**Wiring**

The wiring should be executed with the case dismantled, i.e. opened out like an exploded diagram, to make the connections to the front and rear panels easier. Any systematic way of wiring the interconnections can be adopted but it is recommended that many...
Fig. 36. Drilling details of the base of the pre-amplifier case. The small chassis supplied with the case is used to mount CS2 and has one hole drilled in it ½ inch down and 3½in across the panel. This hole can be seen as the earthing point in Fig. 42—top right hand diagram.

Fig. 37. Front panel drilling details. The dummy front panel should be clamped to this for drilling.

Fig. 38. Rear panel drilling details.

Fig. 39. Template for marking out indicator dots on the dummy front panel.

Fig. 40. Wiring of components mounted on the rear panel.

DRILL SIZES for all metalwork
A — ½ in
B — No. 27
C — ⅛ in
D — No. 34
E — ⅜ in
F — ⅜ in
G — ⅜ in

Typical group

VR4/VR104
VR5/VR304
VR6/VR305
VR7

SK15
SK12
SK7
SK8
SK9
SK5

To suit S1
To suit S2

VR4 EARTH VR104

SK2
SK3
SK4

S3
S4
S5

VR4/VR104

S6

Case

N.B. only connection between case and Negative Rail

39 44 40
46 47 41 42

VR6/VR305

96 97 98

R32

R132

100

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different colours are used for identification purposes. The components which are wired to the tone controls, C45, C46, C47, C145, C146, C147, must have sleeved wire ends and as short leads as practicable. The same applies to the four resistors in the area around S1, and SK5. The only internal screened cables necessary are the ones from the input sockets to S3, with the actual screens being connected to a stout tinned copper wire joining the “Out” positions of the selector switch. The sole connection between the case and the negative rail must be at SK5 as indicated, or complications may arise due to an earth loop being formed which could result in an incurable hum. The earth from the mains input cable is connected to a solder tag which is on the same bolt as C52 capacitor clip, but on the other side of the screening plate. This screen is fitted on final assembly in convenient holes between the mains switch and balance control such that it touches neither. As with the main amplifier the paint may have to be removed from around the screw holes to ensure that all the different sections of the box make electrical connection with each other. Finally, the feet can be fitted to the base of the case. Figs. 40, 41 and 42 give the wiring up details.

**INTER UNIT CONNECTIONS**

The cable which supplies power to the pre-amplifiers and audio to the main amplifier must be made a suitable length to suit the particular installation. Any multi-core (at least three core) screened cable can be used since the output impedance of the pre-amplifier is quite low. We have not given any pin connection numbers for this cable because we have noticed that in some cases the numbers on plugs and sockets do not always correspond with each other. All that is required is that the channels do not inadvertently get reversed and that the earth and supply rails have a continuous path from the main amplifier. This cable must be in place before power is applied to the main amplifier or the charging current taken by C6 and C106, if this plug is inserted after the power has been applied, may damage the driver and output transistors.

**FAULT FINDING**

This is a complex amplifier and it is possible that the constructor will have some problems to iron out before it works perfectly. Most faults will be due to: wires left unconnected or connected to the wrong place, components inserted at the wrong place on the printed circuit board, transistors or diodes inserted the wrong way round (easily done with the Ferranti devices), or surplus solder bridging the gap between two printed circuit tracks.
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catalogue.

Please send me the following irons
Quantity Model Bit Size Volts Price

NAME
ADDRESS

I enclose cheque/P.O./cash value

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MINIATURE
SOLDERING IRONS

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and voltages immediately available from stock.

Practical Electronics  March 1971
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**3P TAP FOR FREE CATALOGUE**
Faulty components are rare, especially if one uses new components of good quality, and if it is found that one of the transistors or diodes is defective after testing the amplifier, make sure that it was not destroyed by a wiring error before replacing it. To avoid expensive accidents great care should be taken to check all the wiring thoroughly before connecting the amplifier to the mains—it will be too late afterwards.

Given time and patience, most faults can be tracked down with a multimeter. An instrument of at least 20,000 ohms per volt is recommended. An oscilloscope and an audio oscillator can save a lot of time and trouble, particularly with faults such as distortion and oscillation. And if it is required to test the amplifier through its full specification, a wave analyser and a squarewave generator will also be required.

To assist in getting the amplifier to work correctly, a table giving the normal voltages at various points in the circuit, is given on page 212, together with a list of fault symptoms and their most likely causes. This will help to track down most faults with the minimum of trouble, but we can not claim to have thought of everything.
CONNECTING UP

The amplifier is working perfectly, a record deck or f.m. tuner is connected to it; on switching on there is a loud hum on both channels. This happens to nearly every audio enthusiast sooner or later and the usual cause is an earth loop. This arises when both the amplifier and the piece of equipment to which it is connected are earthed separately to the mains. A small a.c. voltage is induced into the earth leads of both units and when they are connected together a 50Hz current flows in the outer braid of the coax cable between them, causing an objectionable hum. The cure is simply to disconnect one of the earths, preferably the amplifier, and so break the loop. The record player deck or f.m. tuner, etc. will then be earthed via the mains plug and socket.

Another source of hum arises if the earth connection between the amplifier and the ancillary equipment gets broken whilst still leaving the signal lead (coax inner) connected. This causes a really colossal hum, often accompanied by a chorus of radio stations.

The prototype amplifier did not show any sign of radio breakthrough but if it is to be operated near a transmitter and breakthrough is experienced, connect a capacitor of 100 to 1,000pF directly between each input and earth, alternatively a ferrite bead may be placed on each of the input leads (directly at the input sockets in both cases). Radio breakthrough can also be a symptom of h.f. oscillation in the circuit.

Supposing the amplifier is working perfectly, but there is only an output from one channel. The first thing to do is to check the wiring of the input plug, especially if using a ready made lead. The P.E. Gemini is wired as Fig. 43a which is the DIN standard for amplifiers but many of the ready made leads, intended for tape recorders, etc. are wired as Fig. 43b.

Low impedance signal sources, such as a tape recorder, f.m. tuner or low impedance dynamic microphone, can be connected up with ordinary twin screened (stereo) cable, but low capacitance screened cable should be used for high impedance sources, particularly magnetic pickups. The popular stereo cable has a capacitance of 1000pF or more per foot, and only 4 to 5 feet is required to produce a resonance at 10kHz with a normal 500mH magnetic pickup. Twin lighting flex is quite suitable for connecting up the loudspeakers.

---

### PE GEMINI CHECK CHART

#### POWER SUPPLY

<table>
<thead>
<tr>
<th>Normal Voltages (no load)</th>
<th>Across secondary</th>
<th>45-55V (50Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across C3</td>
<td>50-75V</td>
<td></td>
</tr>
<tr>
<td>Across output terminals</td>
<td>55V</td>
<td></td>
</tr>
<tr>
<td>Across D1 and C2</td>
<td>10V</td>
<td></td>
</tr>
<tr>
<td>Between 0V rail and TR1 base</td>
<td>9.3V</td>
<td></td>
</tr>
<tr>
<td>Across R4</td>
<td>0.7V</td>
<td></td>
</tr>
<tr>
<td>Across R5</td>
<td>1.4V</td>
<td></td>
</tr>
</tbody>
</table>

#### Fault symptoms and possible causes

**Output voltage zero**

1. Fuse blown. Check for cause before replacing.
2. Bad contact in mains plug and socket.
3. Cl short circuit, or short circuit present across output.
4. R6 omitted or open circuit.
5. D2, D3, D4, or D5 open circuit.

**Output voltage low**

1. D1 or C2 wrong way round.
2. TR1, TR2 or TR3 open circuit or wrongly connected.
3. R1 or R2 wrong value.
4. Wrong transformer taps connected.

**Output voltage high**

1. D1 omitted or open circuit.
2. TR1, TR2 or TR3 short circuit or wrongly connected.
3. R1, R2, or R6 wrong value.
4. Across R25 and R26 0.7V

#### MAIN AMPLIFIER

<table>
<thead>
<tr>
<th>Normal Voltages</th>
<th>Across C25 and C30</th>
<th>28.5V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across R10 and R15</td>
<td>18V</td>
<td></td>
</tr>
<tr>
<td>Across R20 and R25</td>
<td>9V</td>
<td></td>
</tr>
<tr>
<td>Across R30 and R35</td>
<td>4V</td>
<td></td>
</tr>
</tbody>
</table>

**Fault symptoms and possible causes**

**Voltage at output terminal high**

1. TR10 or TR12 short circuit or wrongly connected.
2. TR4, TR5, TR6, TR11 or TR13 open/c.
3. R9, R10 wrong value or R10 open/c.

**Voltage at output terminal low**

1. TR4, TR5, TR6, TR11 or TR13 open/c.
2. TR10 or TR12 open circuit.
3. R9, R10 wrong value or R9 open circuit.
4. C6, C7 open/c.

#### PREAMPLIFIER

<table>
<thead>
<tr>
<th>Normal Voltages</th>
<th>Across CI6 and C21</th>
<th>37.5V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across R21 and R25</td>
<td>25V</td>
<td></td>
</tr>
<tr>
<td>Across R26 and R30</td>
<td>14V</td>
<td></td>
</tr>
<tr>
<td>Across R31 and R35</td>
<td>7V</td>
<td></td>
</tr>
</tbody>
</table>

**Fault symptoms and possible causes**

**No output for all inputs**

1. No h.t., check wiring and C52.
2. TR18, 19, 20, or 21 open/c or o/c.
3. Wiring error after S3.

**Weak distorted output for all inputs**

1. H.T. voltage excessively low.
2. TR18, TR19, TR20, or TR21 inserted wrong way round.
3. C32, C46, or C50 leaky or short circuit.
4. Incorrect resistor value.

**No output or weak distorted output on disc**

1. TR14, TR15, C7, or C9 open/c.
2. C17, C18, or C23 leaky.
3. Incorrect resistor value.

**No output or weak distorted output on Mic**

1. TR16, TR17 or C7, or C9 open/c.
2. C25, C27, or C29 leaky.
3. Incorrect resistor value.

---

Add 100 for right-hand channel component numbers  

\[ o/c = \text{open circuit} \quad s/c = \text{short circuit} \]
### BARGAINS IN NEW SEMICONDUCTORS

Many items at new reduced prices. All power types supplied with free mounting kits.

<table>
<thead>
<tr>
<th>Code</th>
<th>Power</th>
<th>Tolerance</th>
<th>Range</th>
<th>Values</th>
<th>1 to 9</th>
<th>10 to 99</th>
<th>100 up</th>
</tr>
</thead>
<tbody>
<tr>
<td>GN06</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E12</td>
<td>7p</td>
<td>6p</td>
<td>6p</td>
</tr>
<tr>
<td>GN07</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E14</td>
<td>1p</td>
<td>0.8p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN08</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN09</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN10</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN11</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN12</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN13</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN14</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>GN15</td>
<td>20p</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
<tr>
<td>WW</td>
<td>2N290A/2</td>
<td>±5%</td>
<td>0.1-2.2MΩ</td>
<td>E24</td>
<td>1.8p</td>
<td>1p</td>
<td>0.7p</td>
</tr>
</tbody>
</table>

RESISTORS


VALUES: E12 denotes series 12, 13, 16, 18, 21, 27, 33, 39, 47, 68, 82 and their deciles. E24 denotes series 12, plus 11, 12, 16, 18, 20, 22, 24, 25, 32, 62, 71, 72, 79, 91 and their deciles.

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**HEADPHONE OUTPUT**

The headphone output from the main amplifier is connected directly to the loudspeaker outputs and in most cases it will be necessary for the constructor to add an attenuator to reduce the volume to a comfortable level. Because of the wide variation in headphone impedances (4 to 600 ohms) and sensitivity between different types, the constructor will have to determine the correct values experimentally; Fig. 44 shows the circuit used, the values given being suitable for AKG K50 headphones of 400 ohms impedance. Resistor R1 should not be greater than the impedance of the earpiece and (R1 + R2) should not be less than 15 ohms, and preferably greater than 100 ohms if the attenuator is permanently wired to the amplifier. Some headphones have a built in attenuator and these can be connected directly to the headphone output socket.

**CASES**

The Contil Mod 2 cases, used for both units, were chosen because they are relatively cheap, easily obtainable, and have an attractive if somewhat functional appearance. There is no reason why the constructor should not design his own case to match other equipment, provided that the case is well screened and the layout given is closely adhered to.

The preamplifier may be mounted in a console by increasing the size of the front panel so that it covers the hole required, as shown in Fig. 45. The front panel can be secured by screws from the front or clamps behind the panel.

**ACKNOWLEDGEMENTS**

The authors wish to thank Ferranti Ltd. for permission to publish this article and also L. Morral, R. J. Grundy and M. A. Rambaut for help given at various stages of the construction of the P.E. Gemini Amplifier.

*Note: In Fig. 14 the arrow from tag 24 should go to F52 not F51. Main amplifier components list—R12 and R112 should be 1.2kΩ not 1kΩ.*
As mentioned in the first part of this article, "Contil" Mod-2 case type "C" is used to house the Digi-Clock, and this makes construction much simpler than if a "one-off" case design were to be employed.

The front and back panels of these cases are formed from p.v.c. covered aluminium, which makes the necessary hole cutting quite easy. The only tools absolutely necessary are a hand drill and a good file, but a clean and neat finish can be more easily achieved with a nibbling tool such as the "Monodex" sheet metal cutter.

**Construction on Chassis**

The chassis supplied with the case is also made of aluminium and is used as a base-plate for all the main components, including the three circuit boards which are spaced from it only by three 6BA nuts. The chassis is earthed and acts as a low impedance "ground plane" for the logic circuitry, thus increasing the noise immunity of the system.

The series pass transistor TR2 employed by the 5V regulator uses the chassis as a heat sink; it is vital that this transistor is isolated from the aluminium by an insulating mica washer of the type normally supplied with this type of device.

Drilling dimensions for the chassis and front and back panels are given in the diagrams, and it is important to remember that some of the chassis holes are required to match other holes drilled by the constructor in the circuit boards and the display panel bracket. It is preferable to match these chassis holes to the latter, rather than drill all the holes straight from the diagrams.

The mounting bracket for the "Nixie" tubes is made from ¼ in s.r.b.p. sheet, and as can be seen from the diagram, the tubes are inserted directly into holes drilled in this bracket, no bases being employed.

With the dimensions given, the tubes are a tight fit in their mountings, and no extra fixative was used in the prototype. A dab of contact adhesive could be used if necessary, and still allow the tubes to be removed should this ever be desirable. Valve bases type B12A are available for the GN5A although the numeral spacing would have to be altered if these are used, since the tubes would not be so close together.

The decimal point indicator is mounted in a ¼ in coil former or some other suitable tube, cut to the dimensions shown, and fastened to the display panel with contact adhesive. When being installed, the neon is simply pushed through from the rear of the bracket, its insulated leads providing all the tension necessary to retain it in the tube.
Fig. 17. Chassis drilling details assuming components used are as specified in the components list. Modifications may be necessary for variations of component type. Clearance above chassis 2\(\frac{1}{2}\)in

Fig. 18. Display panel drilling for "Nixie" tubes
Fig. 19. Back panel drilling details for components specified

Fig. 20. Front panel drilling details for components specified

Table I: CONNECTIONS TO MAIN CLOCK BOARD "A"

(a) Plain side terminations

<table>
<thead>
<tr>
<th>IC Number</th>
<th>Hole Number</th>
<th>Board &quot;A&quot; Outlet</th>
<th>Wire Colour</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6E</td>
<td>2</td>
<td>black</td>
<td>T2, 6-3V</td>
</tr>
<tr>
<td>2</td>
<td>2E</td>
<td>3</td>
<td>red</td>
<td>S1c wiper</td>
</tr>
<tr>
<td>3</td>
<td>6A</td>
<td>4</td>
<td>orange</td>
<td>S1b wiper</td>
</tr>
<tr>
<td>4</td>
<td>4F</td>
<td>5</td>
<td>red</td>
<td>Board B5</td>
</tr>
<tr>
<td>5</td>
<td>3C</td>
<td>6</td>
<td>orange</td>
<td>Board B4</td>
</tr>
<tr>
<td>6</td>
<td>3B</td>
<td>7</td>
<td>pink</td>
<td>Board B3</td>
</tr>
<tr>
<td>7</td>
<td>2H</td>
<td>8</td>
<td>violet</td>
<td>Board B1</td>
</tr>
<tr>
<td>8</td>
<td>3E</td>
<td>9</td>
<td>green</td>
<td>Board B9</td>
</tr>
<tr>
<td>9</td>
<td>2F</td>
<td>10</td>
<td>blue</td>
<td>Board B13</td>
</tr>
<tr>
<td>ALL + Veo rail</td>
<td>12</td>
<td></td>
<td>red</td>
<td>Board B12</td>
</tr>
<tr>
<td>12</td>
<td>3B</td>
<td>13</td>
<td>brown</td>
<td>Board B10</td>
</tr>
<tr>
<td>13</td>
<td>3G</td>
<td>14</td>
<td>yellow</td>
<td>Board B2</td>
</tr>
<tr>
<td>14</td>
<td>7H</td>
<td>15</td>
<td>(optional hours x 10)</td>
<td>zero line to V1 pin 10</td>
</tr>
</tbody>
</table>

(b) Copper side terminations

<table>
<thead>
<tr>
<th>IC Number</th>
<th>Hole Number</th>
<th>Board &quot;A&quot; Outlet</th>
<th>Wire Colour</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6H</td>
<td>25</td>
<td>pink</td>
<td>V4 pin 10</td>
</tr>
<tr>
<td>2</td>
<td>6G</td>
<td>26</td>
<td>green</td>
<td>V4 pin 1</td>
</tr>
<tr>
<td>3</td>
<td>2A</td>
<td>27</td>
<td>red</td>
<td>V4 pin 2</td>
</tr>
<tr>
<td>4</td>
<td>6A</td>
<td>28</td>
<td>brown</td>
<td>V4 pin 3</td>
</tr>
<tr>
<td>5</td>
<td>6E</td>
<td>29</td>
<td>black</td>
<td>V4 pin 4</td>
</tr>
<tr>
<td>6</td>
<td>6F</td>
<td>30</td>
<td>white</td>
<td>V4 pin 5</td>
</tr>
<tr>
<td>7</td>
<td>6C</td>
<td>31</td>
<td>yellow</td>
<td>V4 pin 6</td>
</tr>
<tr>
<td>8</td>
<td>6B</td>
<td>32</td>
<td>orange</td>
<td>V4 pin 7</td>
</tr>
<tr>
<td>9</td>
<td>2H</td>
<td>33</td>
<td>grey</td>
<td>V4 pin 8</td>
</tr>
<tr>
<td>10</td>
<td>2G</td>
<td>34</td>
<td>violet</td>
<td>V4 pin 9</td>
</tr>
<tr>
<td>11</td>
<td>6H</td>
<td>35</td>
<td>orange</td>
<td>V2 pin 1</td>
</tr>
<tr>
<td>12</td>
<td>7G</td>
<td>36</td>
<td>green</td>
<td>V2 pin 2</td>
</tr>
<tr>
<td>13</td>
<td>2A</td>
<td>37</td>
<td>grey</td>
<td>V2 pin 3</td>
</tr>
<tr>
<td>14</td>
<td>7A</td>
<td>38</td>
<td>brown</td>
<td>V2 pin 4</td>
</tr>
<tr>
<td>15</td>
<td>7E</td>
<td>39</td>
<td>pink</td>
<td>V2 pin 5</td>
</tr>
<tr>
<td>16</td>
<td>7F</td>
<td>40</td>
<td>yellow</td>
<td>V2 pin 6</td>
</tr>
<tr>
<td>17</td>
<td>7C</td>
<td>41</td>
<td>red</td>
<td>V2 pin 7</td>
</tr>
<tr>
<td>18</td>
<td>7B</td>
<td>42</td>
<td>black</td>
<td>V2 pin 8</td>
</tr>
<tr>
<td>19</td>
<td>2H</td>
<td>43</td>
<td>white</td>
<td>V2 pin 9</td>
</tr>
<tr>
<td>20</td>
<td>2G</td>
<td>44</td>
<td>violet</td>
<td>V2 pin 10</td>
</tr>
</tbody>
</table>
Table 2: CONNECTIONS TO ALARM BOARD “B”
Copper side terminations only

<table>
<thead>
<tr>
<th>IC Number</th>
<th>Hole Number</th>
<th>Board “B” Outlet</th>
<th>Wire Colour</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>7D</td>
<td>1</td>
<td>violet</td>
<td>LS1</td>
</tr>
<tr>
<td>15</td>
<td>3H</td>
<td>2</td>
<td>yellow</td>
<td>Board A14</td>
</tr>
<tr>
<td>15</td>
<td>3F</td>
<td>3</td>
<td>pink</td>
<td>Board A7</td>
</tr>
<tr>
<td>15</td>
<td>3A</td>
<td>4</td>
<td>orange</td>
<td>Board A6</td>
</tr>
<tr>
<td>15</td>
<td>7B</td>
<td>5</td>
<td>red</td>
<td>Board A5</td>
</tr>
<tr>
<td>15</td>
<td>3E</td>
<td>6</td>
<td>black</td>
<td>S2a/4</td>
</tr>
<tr>
<td>15</td>
<td>3B</td>
<td>7</td>
<td>violet</td>
<td>S2a/2</td>
</tr>
<tr>
<td>15</td>
<td>6C</td>
<td>8</td>
<td>brown</td>
<td>S2a/1</td>
</tr>
<tr>
<td>16</td>
<td>2H</td>
<td>9</td>
<td>green</td>
<td>Board A9</td>
</tr>
<tr>
<td>16</td>
<td>3F</td>
<td>10</td>
<td>brown</td>
<td>Board A13</td>
</tr>
<tr>
<td>ALL</td>
<td>ALL</td>
<td>11</td>
<td>black</td>
<td>chassis</td>
</tr>
<tr>
<td>ALL</td>
<td>+Vcc rail</td>
<td>12</td>
<td>red</td>
<td>Board A12 (5V)</td>
</tr>
<tr>
<td>16</td>
<td>2A</td>
<td>13</td>
<td>blue</td>
<td>Board A10</td>
</tr>
<tr>
<td>16</td>
<td>6B</td>
<td>14</td>
<td>violet</td>
<td>Board A8</td>
</tr>
<tr>
<td>16</td>
<td>6H</td>
<td>15</td>
<td>orange</td>
<td>S2b/8</td>
</tr>
<tr>
<td>16</td>
<td>3E</td>
<td>16</td>
<td>grey</td>
<td>S2b/4</td>
</tr>
<tr>
<td>16</td>
<td>3B</td>
<td>17</td>
<td>red</td>
<td>S2b/2</td>
</tr>
<tr>
<td>16</td>
<td>6C</td>
<td>18</td>
<td>blue</td>
<td>S2b/1</td>
</tr>
<tr>
<td>18</td>
<td>6D</td>
<td>19</td>
<td>orange</td>
<td>S3 (OFF)</td>
</tr>
<tr>
<td>(collector of TR1)</td>
<td>20</td>
<td></td>
<td>red</td>
<td>TR2 collector, (10V).</td>
</tr>
<tr>
<td>Resistor</td>
<td>R21, 22</td>
<td>21</td>
<td>yellow</td>
<td>TR2 emitter</td>
</tr>
<tr>
<td>(TR1</td>
<td>4B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>emitter)</td>
<td>3F</td>
<td>22</td>
<td>green</td>
<td>TR2 base</td>
</tr>
</tbody>
</table>

PRINTED BOARDS “A” AND “B”

The circuit boards carrying the i.c.s are mounted on the chassis by means of 6BA bolts passing through each corner. Remember that the printed sides of these boards are adjacent to the chassis in the final assembly, and it will be necessary to make breaks in some cases in the printed tracks near the corner holes to prevent shorts to the chassis via the spacer nuts. Any breaks made for this purpose must be reconnected with wire links on the wiring side of the board.

Note that in Fig. 13 last month C8 should be connected to the link wire to C7 and pin 4 of IC19.

Using lin long bolts at the board corners allows their use as “legs” to support the chassis during wiring up, damage to the delicate boards being avoided. The transformers perform a similar task on the other side of the chassis.

WIRING UP

Once all the major components have been mounted on the chassis and the circuit boards have been tested for accuracy of fit, wiring up of the power supplies can be carried out. There is no need to attach the back panel wiring permanently at this stage, although it should be hooked in temporarily while the power supplies are tested, before proceeding further.

When the power supplies are operating satisfactorily, the interboard wiring can be started, remembering that the 5V regulator board has two wires leaving it which do not pass through the edge connector. All connections are given in Tables 1 and 2 for the boards.
carrying the i.c.s. It is most important that only very fine p.v.c. covered flexible wire be used for this stage of the wiring, no other type of wire is suitable, as will become obvious as you proceed to wire up the Main Clock Board “A” edge connector with its 42 connections.

On completion of the interboard wiring the front and rear panels and their associated components can be attached to the chassis and the wiring finished off. The alarm speaker should be glued carefully to the rear panel with contact adhesive, making sure that it does not foul the smoothing capacitor or bridge rectifier wiring. The orange tinted Perspex filter is also fixed to the outside of the “Nixie” window front-panel cut-out with contact adhesive, and of course it is important that this operation be carried out with care to ensure a neat appearance.

The front and rear panels are finished off with “Letra-set” dry print transfer lettering. The lettering should be sprayed with clear lacquer fixative to avoid damage during handling.

TESTING

There are no controls on the Digi-Clock which have to be set-up before operation, except the voltage control on the 5V regulator which should be set-up when the regulator wiring is completed, before its connection to the $V_{cc}$ lines to the i.c. boards. This control setting should be rechecked with the clock operating normally, to ensure that the 5V line is as accurate as possible.

If on switching on for the first time, all appears healthy, the set-time switch may be used to set the display to the correct time.

With the switch set to the “fast” position, the minutes counter will be counting 600 times faster than normal, making it a simple job to set the display to within about 15 minutes of the correct time. The slow position is then used to facilitate the final setting, a minute being clocked up every second. As soon as the display is correct the switch is returned to the “normal” position, and the clock continues normally.

If all is still well, the alarm circuit can now be checked. With the alarm “reset” switch in the “off” position, any valid time may be entered on the thumbwheel switches, after which the “alarm reset” switch is returned to the “set” state. When the “hours” and “tens of minutes” display counts to the same time as the alarm setting, the alarm should sound, and may be silenced by returning the “reset” switch to the “off” position. This check can be carried out with the clock running at a fast speed, making it a quick job to test all the alarm settings.

FAULT LOCATION

If problems are encountered during any of these tests, a constructor who has become familiar with the logic of the Digi-Clock should find it a fairly simple matter to trouble-shoot with the aid of a logic probe such as that shown in Fig. 22 or even a multimeter set to the low voltage range.

![Fig. 22. Simple test circuit or logic probe](image-url)
The important thing to remember if a fault is present in the logic circuitry, is that ten minutes working out what could be the problem with a pencil and paper, is worth hours of aimless probing and measuring. Logic faults, providing they have symptoms observable through the display, are not hard to find because they always follow some form of sequence, which, when analysed, usually yields the answer, without any testing in the usual sense.

One of the easiest faults to occur is the incorrect sequence of time indication, possibly with more than one digit showing on one tube. In this case, check that there are no short circuits or solder runs between adjacent outlets on the Main Clock Board “A”. If erroneous alarm triggering should occur, check for a similar fault on the Alarm Board “B”. Also make sure that the copper strips are cut correctly as shown at “X” in the first photograph (last month).

Check for solder runs between adjacent strips of copper; where these should not occur remove the solder. The wiring diagrams in Figs. 5 and 13 show the only places where these may occur intentionally.

The wiring tables and diagrams give colours to the wires as they were in the prototype. There is no reason why these should not be changed, but they are given to help the constructor to follow the wiring through if a fault is apparent.

TENS OF HOURS DISPLAY

Readers may have noticed that in the block diagram given in part one of this project, the tens of hours “Nixie” has two connections to its cathodes, one being a dotted line to the “0” numeral. This connection was shown in this way because it is a matter of personal taste whether the “0” needs to be used at all, a more conventional readout being given by allowing this tube to be completely blank during the hours of one to nine o’clock.

The decoder is, of course, able to accommodate either method, and the wiring diagram given in part one includes an edge connector contact for the “0” at outlet 15 of Board “A” so that it can be wired up if desired. This would be connected to pin 10 of VI.

MODIFICATIONS

Apart from the alarm expansion scheme discussed in Part 2, many other improvements can be incorporated in the Digi-Clock if required. The operation of the clock counters could be altered to conform to the 24 hour system, counting could be extended to include an a.m./p.m. flip-flop, or even a calendar, provided the extra components required could be accommodated.

A slave display, or even several slave displays, could be driven by the basic circuit. In this case the outputs of the clock counters should be buffered by TTL gates or inverters and fed to lines which terminate in further buffers at the slave end.

Fairly long lines could be driven by this method because of the slow speed operation and the relative unimportance of noise at this end of the system. The slave units would consist of a few buffer gates as mentioned and four SN7441AN decoders to drive the “Nixies”. A simple power supply would also be needed.

Finally, for anyone who finds the fairly high outlay on the Digi-Clock components unjustifiable, the master-slaves system might tip the balance, because this type of system would become more economic as more slaves were added.

SOUND CONTROLLED LIGHT DISPLAY

Following its recent success at the Audio & Music Fair, Practical Electronics now presents the full do-it-yourself details of this fascinating addition to the sound scene. Part one of this series appears in the April issue.

P.E. Aurora is a controlled colour light display system which can be fed from any audio amplifier to provide the appropriate mood setting in the home or discotheque. It will respond to serious music or pop and can be arranged to give random displays from a digital sequencer.

Also:

* BOAT SPEED INDICATOR
* DOOR YODELLER

APRIL ISSUE ON SALE MARCH 19
THE crystal receiver has for a long time been for many their first introduction to table top electronics. It isn't difficult to seek out the reason for its appeal, for this first-time project can be an unending source of entertainment pleasure for a modest outlay.

For the T-Dec form of plug-in construction that has been maintained throughout this series, the choice of receiver circuit was based on the requirements of good stability, that is no "howls" or unwelcome oscillations, and excellent volume with little aerial and no earth in areas of good signal strength.

REFLEX ACTION

Radio signals are characteristically of high frequency. For the medium wave band which this receiver will tune to, this covers the range from 500 to 1,500kHz (200 to 600 metres).

Since many transmitters are sending out signals in this band, the receiver must be able to select the one required. In the block diagram of the receiver Fig. 1, the tuned circuit enables such selection to be made.

Since the currents generated in the aerial system are extremely weak, it is necessary to amplify them before they reach the diode detector.

The detector has the job of removing the desired audio signal from the high frequency signal which has, in effect, carried it pick-a-back from the transmitter.

The title of the circuit, "reflex", derives from what now follows. Audio output from the detector is reflected back through the r.f. amplifier so that this stage plays a dual role in boosting first the r.f. and then the extracted a.f. signals.

The output is taken through a further amplifying stage and then to the headphones.

RECEIVER CIRCUIT

The complete receiver circuit diagram is given in Fig. 2. Here the tuned circuit consists of T1 primary and TCI. An aerial coupling capacitor C1 is included to improve selectivity; however, it must be borne in mind that with this simple type of single tuned circuit receiver, station separation is not ideal since it follows that the more tuned circuits used, the sharper is the tuning of that receiver.

The coils of the aerial transformer are wound on a ferrite slab which has the capacity to concentrate r.f. energy in its length and so improve signal strength. In areas where signals are very strong, it may be possible to dispense with a wire aerial and earth provided the slab aerial is orientated for maximum signal.

CHOKES

The selected r.f. signal voltage is passed to the base of TR1 by transformer action. Biasing of this amplifier is achieved by R1, R2 and R4.

The low level signal appears amplified at the collector but at this juncture it is faced with two routes to follow. The choke L1 offers a high impedance path to radio frequency signal current whilst C3 does not. Signal voltages developed across L2 are applied to the detector D1, the desired audio programme material is then "unloaded" from the r.f. carrier and passed back to the input of TR1, via C6.

The audio signal is amplified and passed directly to the load resistor R3 since at low frequencies the resistance of the choke L1 is small. The capacitor C5 passes this a.f. signal to a second amplifier stage, TR2, which provides the power for the headset.

SETTING UP

Providing the component layout of Fig. 3 is adhered to, no reception problems should be encountered. Whilst this receiver will give a good account of itself even with a short length of wire connected to C1, a good aerial will increase the sensitivity enormously in areas of difficult reception.

To demonstrate the effectiveness of a fair sized aerial, try connecting the co-axial outer of the television aerial to C1, after first removing it from the set. Crocodile clips can be used for this. Bedtime listeners will find the bedsprings a convenient aerial, here once again, a crocodile clip will prove a suitable connector.

In general, at medium wavelengths, the receiving aerial takes the form of a vertical wire length, a common variant includes a horizontal top section of a few metres, but this sort of receptor would only be justified with the most elementary of crystal receivers.

SPANNING THE BAND

To cover the medium waveband, it may be necessary to adjust the aerial coils on the ferrite slab. This merely involves moving the coil former until, say, Radios 1 to 4 can be tuned using TC1.
COMPONENTS...

Resistors
RI 20kΩ
R2 3-9kΩ
R3 6-8kΩ
R4 4-7kΩ
R5 27kΩ
R6 10kΩ
R7 3-3kΩ
All ± 10%, 1/4 watt carbon

Capacitors
C1 100pF
C2 0-01µF
C3 0-001µF
C4 25µF elect. 6V
C5 10µF elect. 15V
C6 8µF elect. 15V
C7 0-01µF
C8 25µF elect. 6V

Transistors
TR1 OC44
TR2 AC126

Diodes
D1 1GP10 or OA81 (germanium)

Aerial Transformer
T1 F33 Ferrite slab aerial (G. W. Smith & Co. (Radio) Ltd)

Inductors
L1, L2 1.5mH r.f. chokes (2 off)

Tuning Capacitor
TC1 208pF variable

Miscellaneous
X1 High impedance headphones
or earpiece,
BY1 9 volt battery
T-Dec, wire links

Fig. 2. Circuit diagram showing T-Dec connections. Thick lines indicate wire links

Fig. 3. Component layout on T-Dec. Small Terry clips connected back-to-back are used for aerial retention
Racing Car Data Display

Miniature, battery powered transmitters, fitted to the sides of racing cars, are being used for the first time in America, to increase spectator interest. They give instant, continued information on the position of every car on the track.

Underground sensors at the track—Ontario Motor Speedway, California—enable the transmitters accurately to “fix” the car’s position at all stages of a race. The transmitters feed this information direct to a computer which evaluates it, prints out the race order, and relays the race data direct to visual displays on three 60 foot pylons.

The radio transmitters used in this revolutionary scoring system rely upon the power provided by four 1.5V Mallory alkaline batteries (left).

The innovation has proved so popular with spectators that the track organisers now plan to install an additional and even more sophisticated display—a mammoth animated sign which gives times, laps, car numbers and other digital information.

Unfortunately electronics does not always keep everybody happy. Used on the race track it has information and entertainment value and probably upsets or inconveniences nobody, however a slightly different application—still relating to cars—and many motorists get hot under the collar and start writing letters to magazines and the police about unfair and unashamed trickery. The application is of course the radar speed meter and no doubt many readers will be interested to know that an improved version has recently been announced by Shorrock Developments Ltd., part of the Hawker Siddeley Group Ltd. (see below).

New Sh(orr)ock for Fast Drivers

The Shorrock microwave radar meter has two advantages over equipment at present used by the police: firstly, it is about two-thirds cheaper; and, secondly, it is much less obtrusive.

The Shorrock equipment is contained in a standard document case, weighing 20 lb (9 kg) complete. For use, the radar head is left at the roadside and a cable is run to the document case which can be used from a car parked in a side turning or other comfortable site. Power is provided by two 9V dry batteries and calibration can be carried out using the tuning fork provided.

More than 40 county authorities are using Shorrock speed indication equipment and police forces are showing interest in it.
Quietened noise on Musicassettes

DECCA 8-track stereo Musicassettes are now in full production at the Company's own factory at Bridgnorth and made exclusively from master tapes utilising the Dolby "A" noise reduction system which produces a significantly improved signal to noise ratio. It is claimed that these Musicassettes offer the best quality of sound now available on this format and that this single factor will be one of the most significant selling points.

The tape duplicating equipment consists of two mother reproducers (also known as "master machines"), two loop bins and 13 slave recorders. One mother reproducer and loop bin is seen in the foreground of the photograph.

Computerised Telephone Trouble Shooter

AN aptly-named Argus computer system to watch over the reliability of the telephone service has been ordered by the Post Office from Ferranti Ltd. The Argus 500 configuration is to be installed in Leicester about the end of 1971 for trials that could lead country-wide to the faster detection of faults, further improvements of service for customers, and cost savings.

Acting as a round-the-clock trouble shooter, the £180,000 on-line computer system will monitor performance, draw instant attention to faults and impending breakdowns and alert maintenance engineers, enabling them to start repair work much sooner. Repairs will often be completed without the customers being aware that a fault has ever developed.

The computer will help network development staff to provide additional plant where it is needed by tracing the pattern of calls and identifying the most commonly used routes, and by keeping a constant check on the volume of calls being made. It will also analyse signals from the equipment-testing devices already used to provide engineers with information on fault-prone equipment. The computer's analysis of these tests of individual pieces of exchange will show where overhaul is needed and provide an additional safeguard against breakdown.

Infra-red Thermometer Finds Faults in Wiring

A new infra-red thermometer—the LR120 Rayner—has recently been announced by A. Levermore and Co. Ltd. The LR120, shown above, has many industrial uses but the prime applications are in the electricity generating and distribution industry for locating faults in overhead cable connectors, transformers, splices, etc. which show themselves by small temperature rises.

To cope with these difficult operating conditions, the Rayner, which is battery operated and completely portable, has been designed to measure temperatures between 0 and 100 degrees Centigrade above ambient, giving a resolution of better than 2 degrees. The ratio of distance to object size is 120:1, e.g. a 2 inch diameter area can be accurately measured at 20 feet distant.

Right—a typical Argus 500 configuration, this is a similar system to that to be installed at West Wigston Exchange, Leicester.
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 merit.

**FUSE FAILURE INDICATOR**

A simple way of giving an indication of when a mains fuse has blown is to connect a neon and its series resistance in parallel with the fuse as in Fig. 1. When the fuse is intact the resistor and neon are shorted, but when the fuse has blown they are effectively connected across the mains via the load resistance and the neon will strike.

A neat way of using a neon to indicate in a positive manner if the fuse is intact or not, is to have the neon lit steadily under normal conditions and for it to flash at a desired rate, should the fuse blow. The circuit evolved is a simple modification to an RC relaxation oscillator in which a capacitor is charged via a resistor (see Fig. 2a) until it reaches the striking voltage of the neon. At this point the neon strikes, discharging the capacitor to a level at which the neon extinguishes. The circuit then commences to recharge and the cycle repeats, Fig. 2b.

Referring to Fig. 3, with the fuse intact, on positive half cycles current is fed to the neon and capacitor via D1, D2, R1, and R2, whose resultant resistance is such that good, even illumination of the neon takes place. Should the fuse blow, however, diode D2 is connected via the load to the neutral side of the supply and is therefore reverse biased. Current is then limited by the larger resistance R1 to give a long time constant. The capacitor takes longer to reach the striking voltage of the neon with the result that the neon flashes repeatedly drawing the attention of the operator to it. One advantage of this circuit is that the neon will flash irrespective of the load resistance, whether it is open or short circuit.

The flash rate can be adjusted by altering the value of either C1 or R1, but if R1 is altered then corresponding alterations will have to be made to R2.

One point to notice is that as C1 is charged to the striking voltage of the neon, the diodes should have a peak inverse voltage rating greater than peak mains plus this striking voltage.

S. J. Forrest, Witney, Oxford.

---

**Fig. 1.** Simple fuse failure circuit diagram

**Fig. 2a.** Circuit diagram for a flashing neon indicator

**Fig. 2b.** Graph showing the effect of the capacitor on the voltage across the neon

**Fig. 3.** Final circuit diagram for the flashing neon version of the fuse failure indicator
ENCLOSE a circuit for a linear scale ohmmeter which may be of interest to your readers.

The circuit diagram Fig. 1a consists of a constant current generator TR1 and TR2, and a high input impedance meter driver TR4. A constant current is sent through the unknown resistor $R_x$ and the voltage across it measured. Transistor TR3 compensates for the $V_{be}$ drop across TR4. The current is set by varying potentiometer VR1, which can be replaced by several resistors to give switched ranges, Fig. 1b.

On setting up, a one per cent resistor of value equal to the desired f.s.d. is used as $R_x$ and VR1 is adjusted to give full scale deflection. The meter will then read any value resistor in that range as a linear proportion of full-scale.

For very high ranges, the single emitter follower should be replaced by a two-stage circuit as shown in Fig. 2. In theory there is no limit to the range, but in practice, components limit the maximum range.

The advantages of this circuit over conventional linear ohmmeters is that a cheap meter can be used, and the unit is accurate over a wide range of temperatures.

Ian R. Hornby, Timperley, Cheshire.

---

**Fig. 1a. Circuit diagram of the linear scale ohmmeter**

**Fig. 1b. Adding a switched range**

**Fig. 2. Two-stage version for very high ranges**

---

The "P.E. Aurora Lighting Display" will be included among the exhibits making up the Electric Theatre. This is an exhibition of artistic works which make specific use of electrics, electronics and mechanics to create effects with light and sound.

The Electric Theatre will be held at the Institute of Contemporary Arts, Nash House, The Mall, London, S.W.1., from March 18 to April 18 inclusive, 11 a.m. to 10.30 p.m. daily. Admission (at the door) 25p, students and members ICA 15p.
ALL monolithic i.c.s start off as discs of silicon, an inch or so in diameter, on which may be built several thousand simple gates. We have already seen that by connecting together gates only, it is possible to build many different types of flip-flop, and by connecting together flip-flops it is possible to build counters and shift registers.

It is only a short step from this line of reasoning, that counters and shift registers could be built at the i.c. processing stage, by joining together a large number of gates to produce the logic required. This is, in fact, how MSI devices are built.

BASIC MSI CONCEPT

A chip of silicon cut from the disc and containing around 30 gates, has a layer of metal deposited as an interconnection pattern, perhaps to form a four stage binary counter. The finished chip is mounted on a lead frame and packaged in the usual way as there are no space problems to worry about.

A dual-in-line pack is vast compared with the silicon chip it contains, whether it forms a flip-flop or a counter. The limitation to this process comes only with the restricted number of lead-outs the standard package can accommodate, not the size of the chip it can contain.

Fortunately the lead-out problem is not as severe as one might imagine, because most of the interconnections required to produce a complex function device are performed internally. Only the essential inputs and outputs are required to see the light of day.

What does this process do to help the designer or experimenter? The most obvious effect is the reduction in cost, a decade counter built using separate gate and flip-flop packages could cost in the region of £3 10s (£3.50), whereas the same function can be obtained from the MSI range for about £2. The number of packages in this example is reduced by a factor of three, another very important saving.

Using MSI, it is possible to think in terms of counters as building blocks instead of just flip-flops. The design of this larger block has already been carried out by the manufacturer, so a system is much easier to design, or it may be more complex for the same design effort.

All these things add up to an impressive list of advantages, which can be put to good use by the amateur constructor.

BUILDING BLOCKS

TTL complex functions are contained in the usual 14- and 16-pin dual-in-line packages, and their equivalent in the flat-pack range; there is no external difference apart from the way the pins protrude. The inputs and outputs are completely compatible with the rest of the family, and usually employ the same type of circuitry.

However, the gates used inside the package are sometimes different in construction, because internal gates may not need the fan-out capability of others which have to drive external circuits. It is not intended here to go too deeply into the internal workings of MSI devices; earlier articles have already described the individual circuits in the TTL range.

We need only treat them as the useful building blocks that they are.

MSI COUNTERS

Several different counters are available in the 74 series, each of which may be used for many different jobs and connected in several different configurations. Let us have a look at a typical example, the 7490 decade counter, which is shown in Fig. 9.1.

This counter, like the others in the series, is a ripple type, made up of four master/slave flip-flops; three of them are JK types and one a set/reset. It consists of two separate sections, a divide-by-five stage and a divide-by-two stage, which may be externally interconnected to give two different count modes, depending on the application.
The asynchronous flip-flop inputs are connected to two internal NAND gates which, when enabled, allow the counter to be reset either to zero (0000) or nine (1001).

If the count input is connected to the divide-by-two input, and the output of flip-flop A is connected to the divide-by-five input, the counter will count in the binary coded decimal code, as shown in the truth table in Fig. 9.1a. In this mode the counter behaves as a normal four-stage binary counter until it reaches the count of nine; the next clock pulse sets the counter to the all zeros state.

This type of counter is employed when the outputs have to be decoded to drive indicator tubes, for instance in a frequency counter, or integrating digital voltmeter. The secondary count mode is obtained by connecting the count input to the divide-by-five input, and the output of flip-flop D to the divide-by-two input, in effect causing the output of the divide-by-five counter to be divided by two, the opposite of the first count mode.

The truth table for this type of count is also shown in Fig. 9.1b, and it can be seen that the divide-by-ten output is taken from flip-flop A as a symmetrical waveform, up for five counts and down for five counts. This kind of count code is generally called the 1245 code, and is useful where these counters are used just as frequency dividers, but to drive neon number indicating tubes such as “Nixies”.

These counters may be used to divide by numbers less than ten by using the reset gates to detect the desired final count plus one, and reset the counter to 0000, or even nine, at this time. Any division by less than ten is possible, and an application is shown in Fig. 9.2, where a 7490 is used as a divide-by-six counter.

The other two counters in the series are similar to the 7490, but have a divide-by-six and divide-by-eight section respectively, instead of the divide-by-five of the 7490. They also do not have the facility of nine reset, only the zero reset is included.

**MSI DECIMAL DECODERS**

Very often, the output of a decade counter is required to be decoded to the “one-of-ten” decimal equivalent of the binary count, in order that it may be displayed on some form of indicator. It is not surprising then, to find that the 74 MSI range contains several circuits which are capable of achieving this.

As an example let us look at the 7441 decoder/driver package. The 7441 takes a four-line binary coded decimal input word, and by means of gates and inverters, decodes this information into its decimal form, giving ten separate outputs. The outputs in this case are not designed to drive other logic gates, but to drive neon number indicating tubes such as “Nixies”.

Fig. 9.1. The SN7490 decade counter with truth tables for (a) binary coded decimal (b.c.d.) count mode and (b) symmetrical-10 mode

Fig. 9.2. The SN7490 used as a -6 counter with truth table
This type of indicating tube uses ten separate cathodes, each in the shape of a decimal character, and a common anode. The anode is connected, through a limiting resistor, to an h.t. supply of the order of 200 volts. When a particular cathode is grounded the number it represents is illuminated by the ionisation of the neon gas surrounding it.

Fortunately, it is not necessary to use transistors which will stand 200 volts on their collectors to drive these tubes, because reducing the voltage across them by only (say) 50 volts is sufficient to extinguish them, as this reduces the total voltage to below the "striking" potential.

In fact, the output transistors of the 7441 will withstand at least 55 volts, and to ensure that this rating is not exceeded a Zener diode is connected from collector to ground. The basic idea of the output circuits used with these i.c.s is shown in Fig. 9.3.

To drive the ten output stages the four line binary word at the input to the 7441 has to be decoded by appropriate gating, and to carry out this decoding correctly, complementary information is necessary, i.e. A and NOT A, B and NOT B, etc. The generation of the inverted form of the input word is carried out internally, which makes things much easier, as only the true information needs to be supplied.

There is no doubt that this i.c. represents excellent value for money when compared with any of the possible discrete approaches. Even if i.c.s were employed to perform the gating, the price of ten high breakdown transistors would be more than a single 7441, which is a fraction of the size.

Fig. 9.3b shows the 7441 being used to decode the output of a 7490 decade counter, which has reached a count of two. This could represent one stage of a frequency counter.

The 74 MSI range offers three separate types of full-adder. The one which is, perhaps, most interesting is the 7483, so let us have a closer look at this one as an example.

The 7483 has four complete full-adders crammed into one 16-pin dual-in-line package. Because it is intended for use in parallel addition computers, the carry line is internally connected between the four adders, making it possible to add two four-bit numbers together in less than 50 ns.

There are A and B inputs to each adder, with a single carry input to the first stage, and a single carry out from the fourth stage; four separate sum outputs are provided.

The logic of the 7483 is shown in Fig. 9.4; it is left to the interested reader to work out the truth table of the entire system, which will be in line with that given with the discrete-gate version in the section on gates.

Many other types of decoding may be performed with the large range of circuits available in the 74 series. Some have the standard TTL output stage, others will drive incandescent lamps. Some will even drive seven segment display systems, and in these, more than 35 separate gates are employed.

**MSI ADDERS**

Adder circuitry, as we have already seen, is fairly complex, and now that computers are growing faster and faster, the use of parallel arithmetic is increasing, bringing with it a demand for large numbers of separate "full-adder" blocks.
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A total of 90 transistors, including multi-emitter versions, are incorporated in this one package with 10 diodes and 70 resistors.

Counters of a most useful type can be built using this package in conjunction with a shift register. Counting is, after all, just the repeated addition of one to the contents of a store. Counting down requires the subtraction of one; both operations are made simple with these adders.

If the carry input is grounded, and two changing words applied to the A and B inputs, the four sum outputs will only go to a 1 when the two input words are exactly opposite, or complementary. By feeding the sum outputs to a 4-input NAND gate, a four bit non-equivalence gate emerges using only one and a half packages, a useful device indeed which can be better appreciated by looking at Fig. 9.5.

The other adders in the series are the 7480 single-bit and the 7482 double-bit devices, both of which have greater versatility than the 7483 due to the extra pins available on the package.

**MSI SHIFT REGISTERS**

Several types of shift register are available in this series, and between them they cover almost all the likely applications. All the shift registers use RS master/slave flip-flops, but because the clock input to these devices is buffered, and therefore inverted, they shift data on the positive edge of the input clock.

As all these registers have different applications and we have already gone over basic principles in the TTL flip-flop section last month. It is only necessary here to have a brief look at them all. The block diagrams and package layouts are shown in Fig. 9.6.
**7491 Eight-bit Register**

The 7491 is an eight-bit serial register, and information must be both inserted and withdrawn serially, as no individual inputs or outputs are available from the separate flip-flops. As with the other registers the clock input is buffered and therefore represents only one load. Data input gating is provided allowing “input enable” logic to be performed.

**7494 Four-bit Register**

This register is organised as a dual source parallel to serial converter, data being entered by means of the asynchronous inputs. Two preset enable inputs allow the data to be entered from either of the two sources, through four AND-OR-INVERT gates. The common clock and clear lines are buffered, and a serial input is provided.

**7495 Four-bit Register**

The 7495 is a versatile register which has both parallel inputs and outputs provided. Parallel entry is synchronous, and is entered through AND-OR-INVERT gates which are controlled by the mode control input. When the mode control input is low, the register will shift data serially, from left to right.

Separate clock inputs are available for the two operational modes, and these are again controlled by the mode control input. By using external gates it is possible to make this register shift in both directions, i.e. right to left or left to right.

**7496 Five-bit Register**

The 7496 is similar to the 7494 except that asynchronous data can be entered from only one source, but parallel outputs from each flip-flop are available. A preset enable input is provided. As all inputs and outputs are available from each stage parallel/serial, parallel/parallel, serial/parallel and serial/serial operation may be employed.

**VERSATILITY**

As can be seen, these shift registers leave little to be desired in the way of versatility, and of course by cascading several of them it is possible to build a register of any length which may be required. Apart from their use as storage devices it is also possible to build counters of various kinds, including the Unitary and Johnson types.

We have, in this brief introduction, only scratched the surface of the series 74 MSI, but the examples examined should set many an inventive mind buzzing, and there is really no reason why simple computers should not be designed by amateur constructors, using these devices, almost all of which are now available from advertisers in this magazine.

**Next month: Metal Oxide Silicon ICs (MOS)**

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*Fig. 9.6. Package diagrams of 74 Series shift registers*
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TRIACS

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TRIAC is the name used to identify the triode a.c. semiconductor bidirectional switch. It is basically two reverse blocking triode thyristors or silicon controlled rectifiers connected in inverse parallel, but with a common control electrode (gate). As the triac is a development of the thyristor, it is logical to describe this first and then compare with the triac to show the advantages and disadvantages of both devices.

REVERSE BLOCKING THYRISTOR

The thyristor is a four-layer semiconductor device which has two stable states, one being the conducting state and the other the non-conducting state. The characteristics are shown in Fig. 1.

In the forward blocking region, i.e. when the anode is positive with respect to the cathode, an increase in the voltage across the device has little or no effect on the leakage current until the forward breakover voltage is reached. Increasing the voltage past this point causes the current through the device to increase rapidly, and the voltage across it to fall to about a volt.

The device is now in the conducting state and will remain in this state providing the anode current is above a certain minimum value known as the holding current. If the current through the device falls below the holding current, the device again reverts to the non-conducting state.

If the voltage across the thyristor is increased in the reverse direction, only a small current flows until the voltage reaches the reverse avalanche region where the anode current increases very rapidly and may destroy the device.

Looking again at Fig. 1, we can see that as the gate current is increased, the breakover voltage is reduced. If the gate current is high enough, the device will act like a rectifier.

Normally the thyristor is used in applications where the voltage across the device is well below the forward breakover voltage and is triggered into the conducting region by increasing the gate current. This method requires only small gate currents to switch large anode currents and is therefore the most useful method of turning the device on.

Once the thyristor goes into the conducting state, the gate has no control, and the device continues to conduct, therefore the gate current may be removed as soon as the device is turned on. This typically takes 20μs, and so a fast pulse can be used for triggering.

TRIAC

The characteristics of the triac are shown in Fig. 2. From the characteristics it can be seen that the triac operates like the thyristor, but can breakover into the conducting state for either polarity of applied voltage. The triac, like the thyristor, can be triggered into the conducting state by a gate signal, but unlike the thyristor it can be triggered by a positive or negative gate signal. Thus the triac has four possible modes of operation within first and third quadrants of current/voltage characteristic.
I(\(-\)) MT2 positive and gate signal negative with respect to MT1
I(\(+\)) MT2 positive and gate signal positive with respect to MT1
III(\(-\)) MT2 negative and gate signal negative with respect to MT1
III(\(+\)) MT2 negative and gate signal positive with respect to MT1

MT1 and MT2 are “main terminals 1 and 2” and used in place of cathode and anode, because the device conducts in either direction. With no gate signal, the triac blocks in both directions so long as the voltage across it remains below the breakover voltage. If the voltage does exceed the breakover voltage, the triac turns on, and providing the current through it is limited to a safe value, then the device is unharmed, unlike the thyristor which may be damaged by an excessive reverse voltage. Once in the conducting state, the triac will remain so until the current through the device is reduced to less than the holding current, and only then will the device turn off.

If the voltage applied to a triac is reversed in a very short time, then the triac, instead of turning off as the thyristor would do, merely turns on in the opposite direction. In order to ensure that the triac turns off reliably, it is necessary to reduce the current through it to below the holding current for a period of time before reapplying a voltage. This limits the frequency of operation of the triac to somewhere over the 60Hz mark, but as the main use for the triac is in 50Hz and 60Hz control circuits, this is not a serious limitation.

TRIGGERING

The triac may be triggered into conduction by either d.c., a.c. or pulsed signals applied to the gate. If d.c. is used, the voltage must exceed about 3V, but the power in the gate circuit must be limited.

An example of d.c. triggering is shown in Fig. 3. This type of circuit is useful for switching large currents using a low current switch.

A.C. triggering is perhaps the most useful method to use for a.c. mains power control, because the gate signal is synchronised from the controlled supply. An example of a.c. triggering is shown in Fig. 4.

TRIGGER DIODE

A.C. triggering may also be achieved by using a bidirectional trigger diode (diac), the characteristics of which are shown in Fig. 5.

From these characteristics it can be seen that the device has similar properties to that of the triac, but because the negative resistance portion of the characteristic extends over the whole operating range the device does not latch into the conducting state. A typical breakover voltage for the trigger diode is ±30V.

An example of a circuit using a trigger diode and triac is given in Fig. 6. More will be said about this type of circuit later.
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UNIJUNCTION TRANSISTOR TRIGGERING

The third type of triggering mentioned is pulse triggering and this is sometimes achieved by using a unijunction transistor. The basic u.j.t. relaxation oscillator used for triggering purposes is shown in Fig. 7.

There are many other methods of triggering thyristors and triacs such as pulse transformers and neon lamps, but the last few examples illustrate the main methods of triggering.

The most common applications for the triac is in motor speed control, heater control, or light dimming.

By using the triac instead of the thyristor, a considerable saving in components may be made.

This coupled with the fact that the triac is less expensive than using two thyristors makes the triac very attractive indeed.

PHASE CONTROL

In the majority of domestic controllers, such as lamp dimmers, phase control is used to vary the brightness. In phase control, current from an a.c. supply is connected to the load for part of each cycle. The length of time during each cycle for which the current is connected to the load, determines the amount of power dissipated in the load. Therefore if the load is a lamp, then the brightness of the lamp may be varied.

Using a thyristor for phase control, as in Fig. 8, we can achieve half-wave control, i.e. only positive half-cycles are controlled, negative ones being blocked by the thyristor. If the thyristor is triggered at point A in Fig. 8, then the white portion of the waveform represents the power supplied to the load. Thus if the triggering point is moved to a point earlier in each half-cycle, then more power will be dissipated in the load, and vice versa.

FULL WAVE CONTROL

If we use two thyristors, as in Fig. 9, then we can achieve full-wave control, one switching the positive half-cycles and the other switching the negative half-cycles. Unfortunately this method requires insulated gate signals for the two thyristors, which is commonly achieved by using pulse transformers in the gate circuits.

Yet another way of achieving full-wave phase control using a thyristor is illustrated in Fig. 10. This circuit has the great advantage that it may be used for controlling a.c. or d.c. loads, but for purely a.c. control it is an expensive method as it requires four diodes with a high p.i.v., and a current rating equal to that of the load.

By far the most simple and reliable method of full-wave a.c. control is the circuit shown in Fig. 11. This circuit uses a triac as the controlling element and requires only a simple trigger circuit to make it function.

The simplest practical triac phase control circuit is shown in Fig. 12. This circuit is extremely economical as it uses only four components, the function of which are as follows. VR1 and C1 form a phase shift network, the amount of phase shift varying with the setting of VR1. When the voltage on C1 exceeds the breakover voltage of the diac, it conducts and C1 is partially discharged into the triac gate. The triac is triggered into conduction for the remainder of the half-cycle.

Unfortunately this simple circuit has a limited range of control the load current jumping from zero to some intermediate value as the control is advanced and only then may be controlled smoothly up to full power. This effect may be reduced by using a circuit with a double time constant as shown in Fig. 13, giving very smooth power control.
INTERFERENCE SUPPRESSION

In thyristor and triac control circuits, the load current rises from zero to maximum in a few microseconds. This sharply rising current causes radio frequency interference to be generated, which can cause great annoyance on the a.m. bands. Fig. 14 shows a very simple method of interference suppression.

A small inductor of a few microhenries is used to slow the rate of rise of current, but if used on its own, the interference can still be sufficient to be annoying. The addition of the shunt capacitor C1 further reduces the interference to negligible proportions for domestic applications.

TRIAC LAMP DIMMER

The circuit given in Fig. 13 can form the basis of a triac lamp dimmer which can be fitted behind a wall switch plate, giving continuously variable light control.

It is advisable to incorporate the suppression shown in Fig. 14 to reduce interference, starting with component values of 0.1μF for C1, and adjusting for the best results, with an r.f. choke rated at a minimum of 2A. This choke could be made by winding about 40 turns of thin single core p.v.c. connecting wire on a ferrite ring core or rod.

The triac should be rated at a minimum of 400V p.i.v. 3A for domestic lamp dimming. There are several available that would suit the purpose; the author used a General Electric type SC35D in conjunction with diac type ST2. Some readers may prefer to try a quadrac which incorporate a triac and diac in one encapsulation.

The triac is mounted on a small “L” shaped bracket which is mounted on to a small component board. No difficulty should be experienced in constructing the unit and providing care is taken, the unit is perfectly safe.

The potentiometer may be wired to give full brightness immediately the switch on the potentiometer goes on, and then dim the light as the control is advanced, or to give minimum brightness rising to maximum as the control is advanced. The triac should be rated to withstand initial surge of current which occurs due to the cold filament, when the lamp is first switched on.

CHECKING AND FITTING

When the circuit has been wired up, the circuit may be tested by wiring it in series with a mains bulb and connecting these across the mains as in Fig. 15. The control should give smooth flicker-free control of the lamp up to full brightness, and the lamp should be extinguished by the switch.

Before fitting the dimmer, it is wise to wrap a piece of heavy polythene around the circuit to ensure that nothing shorts to the metal switch box. It may be found that the switch box is too shallow for the body of the potentiometer. If this is the case then it will be necessary to obtain a deeper box from an electrical shop.

After fitting the unit, the mains should be reconnected and the unit tried out. If everything has been carefully insulated, then no trouble should be encountered.

This dimmer should only be used with incandescent filament lamps rated at 230–250 volts a.c. 50Hz. The lamp power should not exceed 500 watts. Fluorescent lights are not suitable.

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There I lay, exchanging platitudes with this bright young nurse, as 450 odd milligrams of my life-blood trickled into some remote bottle. Would-it, I wondered, be converted directly to plasma, or perhaps help save some drunken driver's neck the following week-end. As I, somewhat mechanically, continued with the conversation my mind entered a reverie of ideas about this rather wonderful stuff, but I would find it so hard to do without.

Blood is supposed to contain a fair quantity of iron, I mused. Could it be magnetic? It is difficult to remember ever having sufficient amounts of it to experiment with and, in any case, not being charged with the motive to become a second "Dracula", had never really given such matters another thought!

Nevertheless, it now occurred to me that if, indeed, blood was magnetic (or perhaps, more likely, magnetically susceptible), the possibilities could be quite awe-inspiring. For example, the earth's magnetic field might have some influence on the flow of blood around our systems, and what about the effect of stray fields from transformers and the like? The effect on the capillary action of the smaller blood vessels could be quite dramatic couldn't it? Surely, I told myself, things were getting out of all proportion.

Not to be deterred, I changed tack slightly away from the gory path, and began entertaining thoughts about the chances of inducing currents in the nervous system through similar agencies. "Do you think", I muttered into the, now one-sided, conversation, "that it would be a possibility to influence the brain with magnetic fields?" As you may imagine, the nurse knew little more about what I was talking about than I did, and she replied in a hushed whisper, as though to one demented, "You've nearly given your pint, I 'spect you'll feel better after your tea 'n biscuits". Putting an optimistic face on the situation and dropping back onto my pillow, I lapsed into day dreaming again. Electric currents can be induced in copper wires, so why shouldn't the same apply to the effects of magnetism on liquids.

Subtle influence

If such really is the case this could mean that, quite unbeknown to us, magnetic fields might have some kind of modulating influence upon certain parts of the body and, who knows, perhaps even modify our very thoughts in certain subtle ways!

No, this was too much to accept in one go; the loss of blood must obviously be having its effect I considered, so decided to re-examine the idea later and in the meantime put up with the good-natured ministrations of my N.B.T.S. attendant.

Two months later I was chatting with an old friend of mine, a librarian, about this rather crazy idea of mine and, would you believe . . ., he referred me to a paper written only a couple of years or so ago about the effect on reaction-time performance by magnetic fields! The paper concerned was pretty lengthy, so only the main import of its discussion will be given here.

Apparently, three individuals of the medical profession, and all from the Syracuse area of New York, have discovered quite a profound relationship between the difference in the time taken to react to the appearance of a light source with and without the influence of a fairly weak (5 to 11 gauss) magnetic field. Initially, the field, which was generated by a couple of 14-Sm diameter Helmholtz coils placed near the head, was non-oscillatory and showed no effect.

Later, instead of a d.c. current being used to drive the coils, a low frequency a.c. signal was employed. Immediately, there appeared to be a perceptible change in the rate of response and, indeed, this was confirmed over a number of trials. Every time the field was present a distinct increase in the reaction time occurred.

It is extremely difficult to know just what to make of their findings. One thing however I know: never will I go out again in a magnetic storm without first donning my lead-lined crash hat!

By any other name

Only a matter of months ago I was muttering about tomatoes showing electrical reactions to the application of heat to their skins! Well it seems they are not the only ones among the vegetable kingdom to "blow their cool" in this way! The latest addition to the "psychosensitive" list is the rose - one which on careful reflection I could have thought held first place; it's the rose.

This time it is the Russians who have un-earthed the effect. It seems that hundreds of experiments have recently been performed at the Moscow Agricultural Academy which reveal that in addition to the rose reacting to tactile (touch) stimuli, it also displays a form of crude memory. According to Pravda, the Communist newspaper, the researchers show that rose bushes exhibit electrical activity similar to nerve discharges observed in man!

All this has yet to be demonstrated to me; perhaps we shall be hearing a lot more of these findings in the not too distant future though.

So long

Wouldn't it be nice if we could gain access to the methods (whatever they may be) employed in man and other animals for generating time-constants? I mean if someone says "See you in an hour and a half", the chances are that, provided they said where, you will see them.

Yes, I agree, we would probably be using our watch, or maybe available clocks; who knows, we may even be relying upon the position of the sun in the sky. Assuming though that none of these methods were available, we would still feel fairly confident that the time period could be judged with a reasonable degree of accuracy. How?

Well, "hunger-pains" aside, no one is by any means certain. It could have an oscillatory principle I am told, and someone has even suggested a pulse coincidence basis.

Actually, in electronic practice, this latter idea works well for generating long time-constants; perhaps you would like to try it. Fig. 1 shows the general arrangement. An AND gate receives the outputs from two astable pulse generators, the frequencies of which are both very low and slightly different; the gate thus only returns an output when the input pulses are coincident.

With the frequencies given, only one pulse should appear at the output of the gate approximately every hour! This can be used to set a bistable or whatever application one may have in mind.

Only one problem exists with this kind of timer . . . one has to wait such a long time during the setting-up periods to establish that the correct frequencies exist!
IT is always interesting to note the developments in marine electronics during the past year at the London International Boat Show. Last year in our Boat Show report we noted that there were more firms displaying electronic gear and a greater range of instruments available; the same trend is repeated this year.

The advantages of solid state electronics in marine equipment were particularly evident from two new equipments, these are: the Acoustron 2-11, forward looking echo ranger and computer by Apollo Electronics Ltd., and a digital readout echo sounder by Marine Electronics Ltd. These instruments use integrated circuits to provide, compact design with clear, unmistakable readout, low power consumption and greater reliability than more conventional designs.

Acoustron 2-11 will no doubt interest almost every owner of power craft of a reasonable size. This computerised sonar uses two narrow transducer beams to probe under and ahead of the boat. The resultant echoes are used by computer circuitry to predict the possibility of grounding and to give visual and audible warning of impending danger. Warning time and depth warning can be selected as can the memory time to suit various coastlines and conditions.

LOW COST RADAR AND SONAR

Low cost is always an attraction when buying equipment, particularly if it is well constructed and has a good specification. This year has seen the first under £500 radar for small boats from Electronic Laboratories (Marine) Ltd.; the radar, called Seascan, is completely housed in two units—the scanner transceiver and the display unit. It has a working range from 25 yards to 16 nautical miles, which is covered in six switched ranges. If this radar is as popular as the Seafarer depth sounder from the same firm, and we think at the price (£450) it will be, both yachtsmen and Electronic Laboratories should be very pleased.

Space Age Electronics Ltd. are marketing what is claimed to be the world's most powerful small boat echo sounder for £35, using neon readout, and an auto pilot costing £99 that is claimed to be the world's cheapest pilot for small yachts and motor cruisers. This company is one to watch for future developments and they have said that they should be showing some interesting new instruments next year.

Marine Electronics are marketing a neon echo sounder for £39 with built-in depth warning; they also sell a meter type sounder and the digital readout unit mentioned earlier.

WIND SPEED INDICATOR

New developments in equipment from Brookes and Gatehouse consist of a simplified, lightweight wind direction and speed indicator—Hengist and Horsa model C—although primarily intended for the cruising yachtsman, these models will no doubt appeal to the racing man since they are lighter in weight, more simple to use and the masthead unit will give slightly less windage.

From chatting to various stand holders, it is apparent that most of the firms are engaged in development of various new equipments and some, such as Baron Instruments and Space Age Electronics, are hinting strongly of exciting new projects next year. The added competition from new firms that have launched marine electronic equipment within the last few years, has brought about a fast moving industry that is quality and price conscious and that will have to be up to date to survive.
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   - AMPERETERS
   - OSCILLATORS
   - SIGNAL TRACER
   - PHOTO ELECTRIC CIRCUIT
   - COMPUTER CIRCUIT
   - BASIC RADIO RECEIVER
   - ELECTRONIC SWITCH
   - SIMPLE TRANSMITTER
   - A.C. EXPERIMENTS
   - D.C. EXPERIMENTS
   - SIMPLE COUNTER
   - TIME DELAY CIRCUIT
   - SERVICING PROCEDURES

This new style course will enable anyone to really understand electronics by a modern, practical and visual method—no maths, and a minimum of theory—no previous knowledge required. It will also enable anyone to understand how to test, service and maintain all types of Electronic equipment, Radio and TV receivers, etc.

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Practical Electronics March 1971
**G. F. MILWARD, Drayton Bassett, Tamworth, Staffs.**

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**ELECTRONIC COMPONENTS**

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**WIRE-ENDED TYPES**

**NOTE: IT IS ESSENTIAL THAT REFERENCE NUMBER IS QUOTED WHEN ORDERING THESE CAPACITOR**

<table>
<thead>
<tr>
<th>REF. No.</th>
<th>Value</th>
<th>Qty</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>G11/1</td>
<td>20/450V</td>
<td>10p</td>
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<td>36V</td>
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<td>G5/11</td>
<td>40/450V</td>
<td>2p</td>
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<td>1/6V</td>
<td>1p</td>
<td>500/5V</td>
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<tr>
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**CAN END TYPES**

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<thead>
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<th>Value</th>
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<tr>
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<td>6/6V</td>
</tr>
<tr>
<td>G3/10</td>
<td>40/100/350V</td>
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<td>6/6V</td>
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<td>H1/2</td>
<td>200/20V</td>
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**PRINTED CIRCUIT, CAN END TYPES**

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**PRINTED CIRCUIT TYPE, WIRE END**

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<td>G5/4</td>
<td>1/6V</td>
<td>1p</td>
<td>340/50V</td>
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<tr>
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<td>10/10V</td>
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**TAG END TYPES**

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<td>H10/4</td>
<td>2/20V</td>
<td>1p</td>
<td>10/10V</td>
</tr>
</tbody>
</table>

**SPECIAL 50p PACKS. ORDER 10 AND WE WILL INCLUDE AN EXTRA ONE FREE!!!**

**RESISTORS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
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<th>Unit Price</th>
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<td>1 to 3 watt</td>
<td>100</td>
<td>50p</td>
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<tr>
<td>5 to 7 watt</td>
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<tr>
<td>Multi-tapped</td>
<td>15</td>
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<td>50p</td>
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**PACKAGING & ENVELOPES**

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<td>Electrolytic condensers</td>
<td>Soldered 2-Watt</td>
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<tr>
<td>Multilayer polyester condensers 1000V</td>
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</tr>
<tr>
<td>Silver Mica 2-Watt</td>
<td>Lugs Controls</td>
</tr>
<tr>
<td>Large Selenium</td>
<td>3</td>
</tr>
<tr>
<td>Nuts &amp; Bolts</td>
<td>500 micro-amp level</td>
</tr>
<tr>
<td>Metal speaker grilles</td>
<td>5</td>
</tr>
<tr>
<td>Earphones, Magnetic</td>
<td>No 50 micro-amp level</td>
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<tr>
<td>Transistorised Signal</td>
<td>2</td>
</tr>
<tr>
<td>Verdansk tri bias</td>
<td>10</td>
</tr>
</tbody>
</table>

**MULLARD 'UNILEX' AMPLIFIERS**

In our opinion these units are the best value for money ever offered. A complete stereo unit consisting of Combo Amplifier, Two Mini. Amplifiers. Complete the selection for your home with no extra components to buy... yours for £15. (Normal retail price is £16.50.)

**TRANSPORTED RADIOS**

Once again we have a supply of these excellent radios which offer superb quality sound and excellent sensitivity. They are packed in a colourful presentation box complete with battery, earpiece and carrying case. Each one is guaranteed. You would expect to pay at least £5—but our price due to bulk purchase is only £1.88.

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**G. F. MILWARD, Drayton Bassett, Tamworth, Staffs.**

Postal (minimum) per order 10p.
Shipwreck

Sir—I recently finished making your game “Operation Seasearch” and I am writing to point out a defect in the circuit given for this game in your December 1970 edition. I feel that this should be pointed out to other readers who may be considering building the game. This defect will not usually cause difficulty but it may in certain circumstances as explained below.

This difficulty is as follows. With reference to the enclosed diagram, Fig. 1, it can be seen that if the “Raider” is at say, Ao, and the “Supply Ship” at Bo, current can pass to S5 when it is in position “A” or “B”. If S6 is in position “u”, current will be passed to S2a and thus to LPI when S9 is depressed. Thus S5 can be in position “B” and on depressing S9 LPI will glow showing that the raider has been detected, when in fact it hasn’t. This situation can occur in a number of positions.

D. W. Guest, St. Helens, Lancs.

Mr. Guest is quite right; this is a point that was omitted in the original article. The condition occurs when either searching ship is in line with the “Raider” along one axis and also in line with the “Supply Ship” along the other axis. Overcoming the condition can be done quite simply by inserting a second pole of each push button where indicated, this was not done in the prototype on the grounds of economy, as a second pole was needed in the later “Submarine Game”, and three pole push buttons come a bit expensive!

Actually, in the game situation the phenomenon is not so drastic as it might appear. Firstly, the chances of the right conditions arising in any one game move are approximately 70 to 1 against. (Suffice to say that in innumerable games, it has occurred only two or three times.) Secondly, since both players take turns to control the “Raider”, the chances against each player are exactly equal.

On the few occasions that the situation has arisen, we have attributed the discovery of the “Raider’s” position to an accidental sighting by long-range aircraft, which satisfied our sense of the propriety of things—it gave the searcher another “fix” on the “Raider’s” position just as he has in variations 3 and 6, page 989.—D.R.D.

Fuzz thump

Sir—Reference to the “Fuzz Circuit” included in Ingenuity Unlimited, December 1970 issue. Having constructed this circuit, I found as have probably many of your readers, that it needs quite a considerable clout, on even the lowest guitar string (open E) to set off the trigger circuit, once it is stable, and it has zero response to the top E and B strings at standard tuning.

Modifying the circuit by wiring resistor R1 (1 MΩ) directly between the base and collector of TR1 and changing the value of C5 to 10 µF 10V working should cure the above problems.

B. K. Cox, Wellingborough, Northants.

Economic damper

Sir—May I congratulate you on the series of articles currently running on using logic i.e’s; they are very useful to me. Also, the “Digital Clock” is a very useful design but, as is very often the case, the difficulty in obtaining parts (Nixie tubes in this case) at the right price, tends to put a damper on one’s enthusiasm.

After several enquiries and visits to shops I may be able to satisfy my requirements, given several more weeks. Of course, I know it is possible to get anything if your are prepared to pay top prices, but I begrudge doing this when I know that someone must be selling the equivalent article much cheaper.

Referring to Gerry Brown’s brake fluid level detector (On The Fringe, November 1970 issue), I had the same idea myself a few months ago but on trying it out I found that as soon as the fluid was shaken up a thin film of fluid adhered to the insulated cap, thus permanently shorting the probe, see Fig. 1 (below).

Did Mr. Brown have this trouble or was it just a theoretical circuit?

John Westmoreland, Bispham, Blackpool.
Sinclair Project 60 presents high fidelity in such a way that it meets every requirement of performance, design, quality and value and now that the remarkable phase lock loop stereo FM tuner is available, it becomes the most versatile of high fidelity systems. With Project 60, it is possible to start with a modest mono record reproducer and expand it to a sophisticated stereophonic radio and record reproducing system of fantastically good quality to hold its own with any other equipment, no matter how expensive. Project 60 is a unique high fidelity module system where compactness and ease of assembly are combined with circuitry that is far in advance of any other manufacturer in the world. Thus it is extraordinarily easy to assemble any combination of modules using nothing more complicated than the simplest of tools, and you certainly do not have to be experienced to build with complete confidence. The 48 page manual free with Project 60 equipment makes everything easy and you can house your assembly in an existing cabinet, motor plinth, free standing cabinet or virtually any arrangement you wish. Once you have completed your assembly you will have superlatively good equipment to give you years of service and enjoyment. You will have obtained superb value for money because Project 60 is the best selling modular system in Europe and can therefore be produced at extremely competitive prices and with excellent quality control.

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### System The Units to use together with Cost of Units

| A | Simple battery record player | Z.30 Crystal P.U., 12V battery volume control | £9.6 (£6.47) |
| B | Mains powered record player | Z.30, PZ.5 Crystal or ceramic P.U. volume control etc. | £9.9 (£9.45) |
| C | 20+20 W. R.M.S. stereo amplifier for most needs | 2 x Z.30s, Stereo 60, PZ.5 Crystal, ceramic or mag. P.U., most dynamic speakers, F.M. Tuner etc. | £23.18.0 (£23.90) |
| D | 20+20 W. R.M.S. stereo amplifier with high performance spks. | 2 x Z.30s, Stereo 60, PZ.6 High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc. | £26.18.0 (£26.90) |
| E | 40+40 W. R.M.S. deluxe stereo amplifier | 2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr As for D | £32.17.6 (£32.87£) |
| F | Outdoor P.A. system | Z.50 Mic., up to 4 P.A. speakers controls, etc. | £5.9.6 (£5.57£) |
| G | Indoor P.A. | Z.50, PZ.8, mains transformer Mic., guitar, speakers, etc., controls | £17.8.6 (£17.42£) |
| H | High pass and low pass filters | A.F.U. C, D or E | £5.19.6 (£5.97£) |
| J | Radio | Stereo F.M. Tuner C, D or E | £25.0.0 |
Sinclair Project 60

Z.30 & Z.50 power amplifiers

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 full output 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).
- Frequency response: 30 to 30,000 Hz ±1 dB.
- Distortion: 0.02% into 8 ohms.
- Signal to noise ratio: better than 70dB unweighted.
- Input sensitivity: 250mV into 100 Kohms. For speakers from 3 to 15 ohms impedance. Size: 3½ x 2 x ¾ in.
- Z.30
  - Built, tested and guaranteed with circuits and instructions manual.
  - Price: £9.19.6 (£5.47½).
- Z.50
  - Built, tested and guaranteed with circuits and instructions manual.
  - Price: £19.6 (£5.47½).

Power Supply Units

Designed specially for use with the Project 60 system of your choice. Illustration shows PZ.5 to left and PZ.6 where a stabilised supply is essential.
- PZ.6 30 volts unstabilised £4.19.6 (£2.97½).
- PZ.6 35 volts stabilised £7.19.6 (£5.47½).
- PZ.8-45 volts stabilised (less mains transformer) £5.19.6 (£5.47½).
- PZ.8 mains transformer £5.19.6 (£5.47½).

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 postage by surface mail. Air mail charged at cost.

Stereo 60 pre-amp/control unit

Designed for the 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; corrected R.A.A. curve ± 1dB 200 to 20,000 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 +15 to -15dB at 10kHz. BASS +15 to -15dB at 100Hz.
- Front panel: brushed aluminum with black knobs and controls.
- Size: 9 x 3 x 4 ins.

Built, tested and guaranteed.

£9.19.6 (£5.47½).

Active Filter Unit

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 stages of filtering are incorporated - rumble (high pass) and scratch (low pass). Supply voltage - 25-30 V.D.C. Operating voltage: 2 x 150mV R.M.S. A.F.C. range: ±200 kHz. Signal to noise ratio: >65dB. Total harmonic distortion: 0.02% at rated output.

Price: £5.19.6 (£5.47½).

Stereo FM Tuner

First in the world to use the phase lock loop principle.

Before production of this tuner, the phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal-to-noise ratio over other systems. Now, for the first time, the principle has been applied to an FM 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. Sensitivity is such that good reception becomes possible in difficult areas. Foreign stations can be tuned in suitable conditions and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereobroadcasts 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 any other high fidelity system.

SPECIFICATIONS:
- Number of transistors: 16 plus 20 in I.C.
- Tuning range: 87.5 to 108 MHz.
- Capture ratio: 1:50 dB.
- Sensitivity: 2µV for 30dB quieting; 7µV for full limiting.
- Squelch level: 20µV.
- A.F.C. range: ±200 kHz.
- Signal to noise ratio: >65dB.
- Audio frequency response: 10Hz - 15kHz (±3dB).
- Total harmonic distortion: 0.02% for 30% modulation.
- Stereo decoder operating level: 2µV.
- Pilot tone suppression: 30dB.
- Cross talk: 40dB.
- I.F. frequency: 10.7 MHz.
- Output voltage: ±2 x 150mV R.M.S.
- Aerial Impedance: 75 Ohms.
- Mains indicators: Mains on; Stereo on; tuning indicator.
- Operating voltage: 2 x 30 V.D.C.
- Size: 5 x 1 x 8.15 inches. 9.5 x 40 x 207 mm.
- Price: £25 built and tested. Post free.

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVE5 HUNTINGDONSHIRE PE17 4HJ

Please send

Name

Address

for which I enclose cash/cheque/money order.

Price: £25

Page 251
Sinclair IC10/Q16/Micromatic

IC10

The world's most advanced high fidelity amplifier
This is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick, having 5 watts RMS output (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, and is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins.

Circuit Description
The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. There is generous negative feedback round both sections and in the complete freedom from thermal runaway and a very low level of distortion.

The IC10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. It may also be used in other applications, including car radios, electronic organs, servo amplifiers etc.

Specifications:
Output: 10 watts peak. 5 watts RMS continuous.
Input impedance: 8 ohms.
Total harmonic distortion: Less than 0.5% at full output.
Load impedance: 15 ohms.
Power gain: 110 dB (100,000,000,000 times).
Supply voltage: 100,000,000,000 (100 volts).
Size: 1 x 0.4 x 0.2 in. plus heat sink and tags.
Sensitivity: 5 mV.

Price (with manual): £2.97.

Q16

High fidelity loudspeaker
The Q16 employs the well proven acoustic principles specially developed by Sinclair in which a special driver assembly is meticulously matched to the characteristics of the uniquely designed cabinet. In reviewing this exclusive Sinclair design, technical journals have justly compared the Q16 with much more expensive loudspeakers. Its shape enables the Q16 to be positioned and matched to its environment to much better effect than is the case with conventionally styled enclosures. Solid teak surround with a special all-over cellular foam front is used as much for appearance as its ability to pass all audio frequencies.

This elegantly designed shelf mounting speaker brings genuine high fidelity within reach of every music lover.

Specifications:
Construction: Special sealed seamless sound or pressure chamber with internal baffle.
Loading: up to 14 watts RMS.
Input impedance: 8 ohms.
Frequency response: From 60 to 16,000 Hz.
Power gain: 110 dB (100,000,000,000 times).
Case: Black plastic with anodised aluminium front panel around a ceramic magnet of 11,000 gauss, aluminium speech coil and a special cone suspension for excellent transient response.
Size: 36 x 33 x 13 mm (14/7 x 13/10 x 1/2 in.).
Weight: 28.4 gm (1 oz.).


Micromatic

Britain's smallest radio
Considerably smaller than an ordinary box of matches, this is a multi-stage AM receiver brilliantly designed to provide remarkable standards of selectivity, power and quality for its size. Powerful AGC counteracts fading from distant stations; bandwidth at higher frequencies makes reception of Radio 1 easy. The plug-in magnetic earpiece provided matches the Micromatic’s output to give wonderful standards of reproduction. Everything including the special ferrite rod aerial and batteries is contained within the minute and attractively designed case. Whether you build a Micromatic kit or buy this amazing receiver ready built and tested, you will find it as easy to take with you as your wrist watch, and dependable under the severest listening conditions.

Specifications:
Size: 36 x 33 x 13 mm (14/7 x 13/10 x 1/2 in.).
Weight: Including batteries, 28.4 gm (1 oz.).
Case: Black plastic with anodised aluminium front panel and spun aluminium dial.
Tuning: Medium wave band with bandwidth at higher frequencies, (550 to 1,600 Hz).
Earpiece: Magnetic type.
On/off switching: By inserting and withdrawing earpiece plug.

Price (with manual): £2.97.

Two Mallory Mercury batteries type RM675 required: From radio shops, chemists, etc.

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ
Please send
Name
Address

for which I enclose cash/cheque/money order.

Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (046 06) 4311

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The Classic

Simulated tea case

£9 50

Plus P. & P. 50p

**SPECIFICATION:**
- Sensitivities for 10 watt output: 
  - 1kHz to 3kHz: Tape Head: 3mV (at 3f)
  - 1kHz to 3kHz: Mag. P.U.: 3mV
  - 1kHz to 3kHz: Cer. P.U.: 80mV
  - 1kHz to 3kHz: Tuner: 100mV
- Aux: 100mV
- Tape/Rec. Output: Equalisation for each input is correct to within +2dB (R. I. A. A.) from 10Hz to 20kHz
- Tone Control Range: Bass: 13dB at 60Hz
- Treble: 16dB at 15kHz
- Total Distortion: (for 10 watts) -15dB
- Signal Noise: -60dB
- A. C. Mains 200-250V
- Size 12in long, 4in deep, 2in high. Built and tested.

The Viscount F.E.T. Mk. I

£14.25

High fidelity transistor stereo amplifier employing field effect transistors. With this feature and accompanying guaranteed specifications below, the Viscount F.E.T. vastly surpasses amplifiers costing far more.

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- Output per channel: -10W rms into 3 ohms
- Frequency bandwidth: 20Hz to 20kHz: -1dB = 1W
- Total distortion: Spec. on Mag. P.U.: 3mV @ 1kHz.
- Spec. on Cer. P.U.: 100mV
- Tuner: 100mV
- Overload Factor: Better than 26dB
- Signal to noise ratio: Better than 65dB
- Input sensitivities:
  - Cer. P.U. 100mV
  - Mag. P.U.: 3mV
  - Treble (with D.P.S. on/off): 12dB @ 1kHz
  - Tape recording output sockets on each channel
- Size 12in x 6in x 2in in simulated teak case. Built and tested.

**£15.75**

Post & packing 50p extra.

Speakers: (Mag. P.U.) 3mV @ 1kHz, input impedance 47kΩ. Fully equalised to within ±1dB R.I.A.A. Signal to noise ratio—65dB (vol. max.)

**THE RELIANT Mk. II SOLID STATE GENERAL PURPOSE AMPLIFIER**

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- Mains input: 220/250 volts
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Practical Electronics March 1971
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SPEAKERS: 8in. 10-12" incorporating Baker's 12" heavy duty 25 watt high flux, quality loudspeaker with cast frame. Cabinets attractively finished in two tone colour scheme-Black and grey.

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Amplifier £28-50 plus £1 P. & P.

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**258 Practical Electronics March 1971**

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Recipients

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Microcircuits

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Printed Circuits

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