

PRACTICAL

# ELECTRONICS

DECEMBER 1971

20p



LOGICAL  
RADIO  
CONTROL

**SPECIAL SUPPLEMENT:** Digital and Linear Integrated Circuits... Survey of Available Types

# ADCOLA Soldering Instruments add to your efficiency

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### ADCOLA L.646

for Factory Bench Line Assembly

A precision instrument—supplied with standard 3/16" (4.75 mm) diameter, detachable copper chisel-face bit\*.  
Standard temp. 360°C at 23 watts.  
Special temps. from 250°C—410°C.

PRICE  
£1.85

\*Additional Stock Bits  
(illustrated) available

#### COPPER

B 38  $\frac{1}{8}$ " — 3.2 mm CHISEL FACE

B 14  $\frac{3}{16}$ " — 2.4 mm CHISEL FACE

B 24  $\frac{1}{4}$ " — 4.75 mm SCREWDRIVER FACE

B 12  $\frac{1}{8}$ " — 4.75 mm EYELET BIT

B 58  $\frac{1}{2}$ " — 6.34 mm CHISEL FACE

#### LONG LIFE

B 42 LL  $\frac{1}{8}$ " — 4.75 mm CHISEL FACE

B 38 LL  $\frac{1}{8}$ " — 3.2 mm CHISEL FACE

B 14 LL  $\frac{3}{16}$ " — 2.4 mm CHISEL FACE

B 44 LL  $\frac{1}{4}$ " — 4.75 mm SCREWDRIVER FACE



Don't take chances. We don't. All our ADCOLA Soldering Instruments are of impeccable quality. You can depend on ADCOLA day after day. That's why they're so popular. You get consistent good service . . . reliability . . . from our famous thermally controlled ADCOLA Element and the tough steel construction of this ideal production tool.

\* Write for price list and catalogue



**ADCOLA PRODUCTS LTD.,**  
(Dept. L.), ADCOLA HOUSE, GAUDEN RD., LONDON, S.W.4  
Telephone: 01-622 0291/3 • Telegrams: Soljoint London Telex • Telex: Adcola London 21851

# SAFELOC

## of robust construction

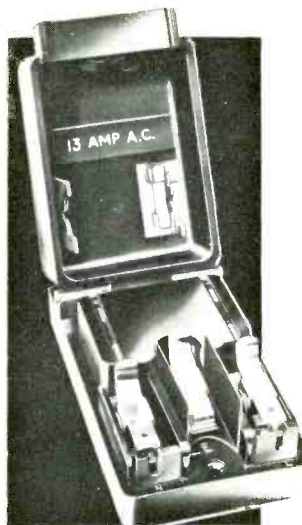
Safe, quick and secure it connects 2-core and 3-core bare-ended flexible leads to the mains (A.C. only).

The concept was pioneered by Rendar, and introduced to the market 13 years ago.

Safebloc saves time. No need to fit a plug for tests. No danger, as no current can pass with the lid open.

Invaluable for testing and demonstrations in industry and shops, the work bench and the home.

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PRICE £2.60 + 10p P.&P. EACH

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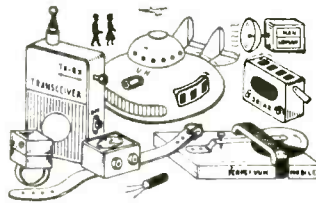
# RENDAR®

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## PRINTED CIRCUIT KIT

BUILD 50 INTERESTING PROJECTS on a PRINTED CIRCUIT CHASSIS with PARTS and TRANSISTORS from your SPARES BOX

CONTENTS: (1) 2 Copper Laminate Boards 4 1/4" x 2 1/2". (2) 1 Board for Matchbox Radio. (3) 1 Board for Wristwatch Radio, etc. (4) Resist. (5) Resist Solvent. (6) Etchant. (7) Cleanser/Degreaser. (8) 16-page Booklet *Printed Circuits for Amateurs*. (9) 2 Miniature Radio Dials SW/MW/LW. Also free with each kit: (10) Essential Design Data, Circuits, Chassis Plans, etc. for 50 TRANSISTORISED PROJECTS. A very comprehensive selection of circuits to suit everyone's requirements and constructional ability. Many recently developed very efficient designs published for the first time, including 10 new circuits.



EXPERIMENTER'S  
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**60p**

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SURFACE MAIL 15p

AIR MAIL 60p

Australia, New Zealand,  
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(1) Crystal Set with biased Detector. (2) Crystal Set with voltage-quadrupler detector. (3) Crystal Set with Dynamo Loudspeaker. (4) Crystal Tuner with Audio Amplifier. (5) Carrier Power Conversion Receiver. (6) Split-Load Neutralised Double Reflex. (7) Matchbox or Photocell Radio. (8) "TRI-FLEXON" Triple Reflex with self-adjusting regeneration (Patent Pending). (9) Solar Battery Loudspeaker Radio. The smallest 3 designs yet offered to the Home Constructor anywhere in the World. 3 Subminiature Radio Receivers based on the "Triflexon" circuit. Let us know if you know of a smaller design published anywhere. (10) Postage Stamp Radio. Size only 1.62in x 0.95in x 0.55in. (11) Wristwatch Radio 1.15in x 0.80in x 0.55in. (12) Ring Radio 0.70in x 0.70in x 0.55in. (13) Bacteria-powered Radio. Runs on sugar or bread. (14) Radio Control Tone Receiver. (15) Transistor P.P. Amplifier. (16) Intercom. (17) 1-valve Amplifier. (18) Reliable Burglar Alarm. (19) Light-Seeking Animal, Guided Missile. (20) Perpetual Motion Machine. (21) Metal Detector. (22) Transistor Tester. (23) Human Body Radiation Detector. (24) Man/Woman Discriminator. (25) Signal Injector. (26) Pocket Transceiver (Licence required). (27) Constant Volume Intercom. (28) Remote Control of Models by Induction. (29) Inductive-Loop Transmitter. (30) Pocket Triple Reflex Radio. (31) Wristwatch Transmitter/Wireless Microphone. (32) Rain Alarm. (33) Ultrasonic Switch/Alarm. (34) Stereo Pre-amplifier. (35) Quality Stereo Push-Pull Amplifier. (36) Light-Beam Telephone "Photophone". (37) Light-Beam Transmitter. (38) Silent TV Sound Adaptor. (39) Ultrasonic Transmitter. (40) Thyristor Drill Speed Controller. Plus 10 Photoelectric Circuits, Simple Alarms, Long Range Alarms, Projector Modulators, etc.

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Send a S.A.E. for full details and a brief description of all kits and Projects.

# LASKY'S SCOOP

## HI-FI BARGAIN OF THE CENTURY save up to 35% on LEAK recommended list prices!

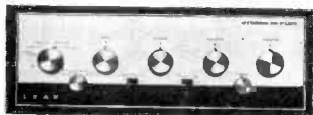
As the United Kingdom's leading High-Fidelity Retailers, we are proud to offer you the "Scoop of the Century", Leak Hi-Fi Amplifiers, tuners, turntables and speakers at fantastic prices. Each piece of equipment is brand new and covered by Leak's full guarantee. Leak have been the U.K.'s leading Manufacturer since the birth of High-Fidelity—their quality has always been used as a yardstick for true High-Fidelity.



**Leak Stereo 70 amplifier** (cased only) Power output (both channels linewave driven): 35 watts r.m.s. each channel into 8 ohm loudspeakers. Total harmonic distortion: 0.1% for all power levels up to 25 watts r.m.s. each channel at 1KHz into 8 ohm loudspeakers. Crosstalk: Between left and right channels 50dB up to 1KHz and 30dB at 10KHz. Dimensions: 13in (W) x 4½in (H) x 9½in (D) LIST PRICE £75.00 **LASKY'S PRICE £55.00** carriage and packing £1.00.



**Leak Stereofetic FM tuner**—Frequency range: 87-108MHz. Frequency response: ±1dB 40Hz to 15KHz. Frequency drift: Less than 25KHz without A.F.C. Sensitivity: 2½ microvolts for 3dB signal/noise. Output impedance: 200 ohms. Distortion: Less than 0.5% for full deviation, i.e., less than ¼% for average modulation. Signal/Noise: 60dB A.M. suppression: 50dB. Dimensions (cased) 12in (W) x 4½in (H) x 9½in (D) (chassis) 11½in (W) x 4½in (H) x 7½in (D). **CASED LIST PRICE £69.80 LASKY'S PRICE £45.00.** **CHASSIS LIST PRICE £64.03 LASKY'S PRICE £39.50** carriage and packing £1.00 on chassis or cased model.

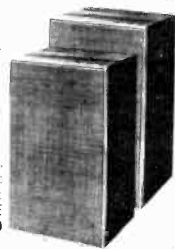


**Leak Stereo 30 Plus amplifier** (cased only) Power outputs (both channels sinewave driven) 15 watts r.m.s. each channel into 8 ohms loudspeakers. Music power outputs 20 watts r.m.s. each channel into 8 ohm loudspeakers. Total harmonic distortion 0.1% for all power levels up to 10 watts r.m.s. each channel at 1KHz into 8 ohm loudspeakers. Crosstalk: Between left and right channels 50dB up to 1KHz and 30dB at 10KHz. Dimensions: 13in (W) x 4½in (H) x 9½in (D). LIST PRICE £62.50 **LASKY'S PRICE £45.00** carriage and packing £1.00.



**Leak Truspeed Transcription Turntable Mk. III**  
A low speed (250 r.p.m.) synchronous 12-pole hysteresis motor (100 130V, or 200 250V, 15mW), gives constant turntable speed independent of mains voltage fluctuations. Speeds: 33½ r.p.m. and 45 r.p.m. Wow: Less than 0.15%. Flutter: Less than 0.02%. Frequency ranges: 20Hz-20KHz. Stereo separation: Better than 25dB at 1KHz. Dimensions: 12½in x 15½in x 7½in inc. cover. Complete with arm, tone arm, base and tinted perspex cover and Shure M75/6 cartridge. Made to sell for £69.50 **LASKY'S PRICE £47.50 C. & P. £1.50.**

**Leak 200 speaker system**—A Stainless Steel woven mesh grille cloth for maximum acoustic transparency and an attractive teak cabinet finished off with aluminium trim all round housing a 3 speaker system worthy of LEAK's name. Impedance 8 ohms, nominal. Frequency response: 60Hz to 18KHz. Power handling capacity 18 watts r.m.s. Resonance of bass unit (free air): 45Hz. Finish: Teak. Dimensions: 15½in x 10in x 8½in LIST PRICE £49.90 **LASKY'S PRICE £31.50 (pair) C. & P. £2.00.**



## fantastic LEAK packages

### Package 1

Stereo 30 Plus (cased) .....	£62.50
Stereofetic (chassis) .....	£64.03
Total Rec. Retail Price .....	£126.53

**LASKY'S PRICE £84 C. & P. £1.50**

### Package 2

Stereo 70 (cased) .....	£75.00
Stereofetic (chassis) .....	£64.03
Total Rec. Retail Price .....	£139.03

**LASKY'S PRICE £94 C. & P. £1.50**

### Package A

LEAK ST30 Plus (cased) .....	£62.50
LEAK 200 Spks (pr) .....	£49.90
LEAK Truspeed T/T system .....	£69.50
Total Rec. Retail Price .....	£181.90

**LASKY'S PRICE £120 post £2.00**

### Package B

LEAK ST70 (cased) .....	£75.00
LEAK 200 Spks (pr) .....	£49.90
LEAK Truspeed T/T system .....	£69.50
Total Rec. Retail Price .....	£194.40

**LASKY'S PRICE £130 C. & P. £2.00**

### Package C

LEAK ST30 Plus (cased) .....	£62.50
LEAK Stereofetic (cased) .....	£69.80
LEAK 200 spks (pr) .....	£49.90
LEAK Truspeed, T/T system .....	£69.50
Total Rec. Retail Price .....	£251.70

**LASKY'S PRICE £160 C. & P. £3.00**

### Package D

LEAK ST70 (cased) .....	£75.00
LEAK Stereofetic (cased) .....	£69.80
LEAK 200 Spks (pr) .....	£49.90
LEAK Truspeed T/T system .....	£69.50
Total Rec. Retail Price .....	£264.20

**LASKY'S PRICE £170 C. & P. £3.00**

### Package E

LEAK ST30 Plus (cased) .....	£62.50
Wharfedale Denton Spks. (pr) .....	£39.90
BSR McDonald MP60 .....	£15.20
Lasky's base and cover .....	£4.75
AD76K magnetic cartridge .....	£4.35
Total Rec. Retail Price .....	£126.70

**LASKY'S PRICE £92 C. & P. £2.00**

### Package F

LEAK ST70 (cased) .....	£75.00
Wharfedale Triton Spks (pr) .....	£59.90
Garrard AP76 .....	£27.85
Garrard base and cover .....	£9.75
Shure M44/E magnetic cart .....	£11.63
Rec. Retail Price .....	£184.73

**LASKY'S PRICE £129 C. & P. £3.00**

### Package G

LEAK ST30 Plus (cased) .....	£62.50
Lasky's Criterion Mk. X Spks. .....	£25.00
BSR McDonald MP60 .....	£15.20
Lasky's base and cover .....	£4.75
AD76K magnetic cartridge .....	£4.35
Rec. Retail Price .....	£111.80

**LASKY'S PRICE £85 C. & P. £2.00**

### Package H

LEAK ST70 (cased) .....	£75.00
LEAK Stereofetic (cased) .....	£69.80
LEAK Truspeed T/T system .....	£69.50
LEAK 600 spks (pr) .....	£99.00
Rec. Retail Price .....	£313.30

**LASKY'S PRICE £225 C. & P. £4.00**

These are only a few of our package bargains incorporating LEAK equipment, many more can be arranged. If none of the packages here suit you please send us details of your requirements and we will be pleased to quote.

# SUPER SONY SCOOP!



**DIGITAL  
CLOCK RADIO 8FC-59WA** **SAVE  
£12.19**

Sony's elegantly designed digital alarm clock radio. The digital clock shows you the time minute by minute with matchless accuracy, and once set the Digimatic will wake you up at the same time every morning without having to be re-set. The radio section features Sony's unique sleep button, you fall gently to sleep lulled by the sweet tone of the radio, which switches itself off at a pre-determined time. Available in either black or white. Frequency range: 530-1,605KHz (AM); 87-108MHz (FM). Uses 8 transistors and 8 semi-conductors, built-in ferrite aerial and 3 $\frac{1}{2}$ in loudspeaker. Power requirements: 230V a.c. 50Hz. Dimensions: 12 $\frac{1}{2}$ in 3 $\frac{1}{2}$ in 5 $\frac{1}{2}$ in.

**LIST PRICE LASKY'S  
£28.94 PRICE £16.75** Post 25p

# OUT NOW! '72 AUDIO-TRONICS

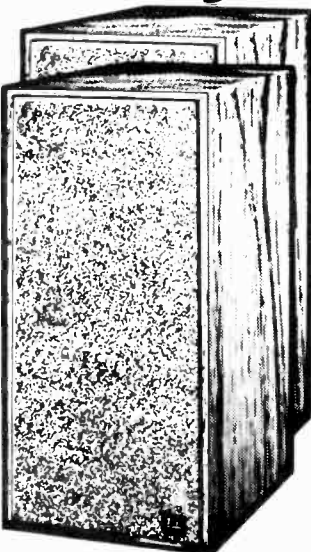


The great new 1972 edition of Lasky's famous Audio-Tronics Catalogue is now available — **FREE** on request. The 44 newspaper size pages—many in full colour—are packed with 1,000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast. Electronics hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio accessories and don't miss **LASKY'S AUDIO-TRONICS CREDIT CARD SCHEME** offering holders one month's interest free credit up to £50 and the fantastic £1,000 plus colour TV competition. Send your name and address and 15p for post and inclusion on our regular mailing list.

# NEW From Lasky's

## CRITERION Mk. X

Because of the increasing demand for inexpensive, high quality bookshelf speakers, we have seen fit to introduce the Criterion Mk. X bookshelf system. The speaker is a sealed infinite baffle type enclosure using 8in woofer, a 5in mid. range and 2 $\frac{1}{2}$ in tweeter. The compact cabinet is finished in oiled walnut and black woven speaker grille cloth. Frequency response: 40Hz—20KHz. Power handling capacity: Max. 20 watts. Impedance: 8 ohms. The Criterion is fitted with two types of speaker lead connections — screw terminal and phono. Size: 18 $\frac{1}{2}$ in (H) — 9 $\frac{1}{2}$ in (W) — 9 $\frac{1}{2}$ in (D). Operational horizontally or vertically.



**LASKY'S  
AMAZING  
PRICE** **£25** C & P 50p  
£13.50 each

# a sound future

Lasky's Radio for over 38 years Great Britain's Leading Radio, High Fidelity, Tape Recorder and Electronics Specialists have vacancies in their West End and City Branches for both male and female Sales Assistants. We are seeking intelligent young men and women sales personnel to join our expanding organisation (already the largest in Europe) on a career basis with the finest prospects for early promotion and financial advancement. Working with our energetic sales teams in any of our six West End and City branches will bring you into contact with people from every walk of life including Pop Stars, film and television personalities, royalty and above all enthusiasts in every field of Audio, Hi-Fi and Electronics-people who expect you to share their enthusiasm and interest.

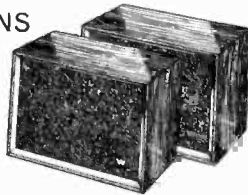
Knowledge of Hi-Fi and electronics is not essential although it will help—all that we require as the basic qualities needed for a successful application are willingness to learn and a common-sense approach to the business of selling. Salary ranges from £850 to £1,850 plus, three weeks' holiday after one year, and Incentive Bonus Schemes are added benefits of working in our progressive organisation. Holiday arrangements will be honoured. If you are interested in a career in Audio and Hi-Fi write at once to: **Kenneth Lasky, Lasky's Radio Limited, 3-15 Cavell Street, London E1 2BN.**

*Interviews will be arranged to suit your convenience.*

## SUPER SPEAKER BARGAINS

### WHARFEDALE DENTONS

A compact system sold in matched pairs for a perfectly balanced stereo system. Each Denton contains an 8in bass unit with 3in pressure unit, coupled by a Wharfedale crossover network. Rated input: 15 watts maximum. Frequency response: 65-17,000Hz. Impedance: 4/8 ohms. Cabinet 9 1/2in x 14in x 8 1/2in. Available in oiled teak finish and are small enough to blend in with most surroundings.



Post 50p

LIST PRICE £39.90 **LASKY'S PRICE £29.00**

### WHARFEDALE TRITONS

A new and exciting addition to the Wharfedale range, this three-speaker system will satisfy the most ardent Hi-Fi enthusiast. Shelf or floor standing—hand finished in oiled teak. Frequency response: 55-22,000Hz. C.A.B. Dome pressure unit. Bass unit 8in. Mid-range unit 5in. Treble unit 2in. Impedance: 8 ohms. Size: 21 1/2in x 9 1/2in x 9in.



Post 50p

LIST PRICE £59.90 **LASKY'S PRICE £39.00**

## EXCLUSIVE TM-1

### MODEL TM-1 MINI-TESTER

The first of Lasky's new-look top value meters, the TM-1 is a really tiny pocket multimeter providing "big" meter accuracy and performance. Precision movement calibrated to 3in of full scale. Click stop range selection switch. Beautifully designed and made impact resistant black case with white and metallic red/green figuring. Ohms zero adjustment.

#### Size Only

- 3 1/2in x 2 1/2in x 1 1/2in
- DC/V: 0-10-50-250-1,000 at 1k OPV
- AC/V: 0-10-50-250-1,000 at 1k OPV
- DC CURRENT: 0-1mA, 100mA

- Resistance: 0-150k
- Decibels: -10dB to 22dB
- Complete with test leads, battery and instructions



LIST PRICE £1.95 **LASKY'S PRICE £1.95** POST 13p

## TM-5 5K ohms/V POCKET MULTIMETER

Another new look pocket multimeter from Lasky's providing top quality and value. The "slimline" impact resistant case, size 4 1/2in x 2 1/2in x 1 1/2in, fitted with extra large 2 1/2in square meter. Readability is superior on all low ranges; making this an excellent instrument for servicing transistorised equipment. Recessed click stop selection switch. Ohms zero adjustment. Buff finish with crystal clear meter cover.

- DC/V: 3-15-150-300-1,200 at 5k OPV
- AC/V: 6-30-300-600 at 2.5k/OPV
- DC Current 0-300µA, 0-300mA
- Resistance: 0-10k/ohms, 0-1M/ohm
- Decibels: -10dB to +16dB
- Complete with test leads, battery and instructions.

LIST PRICE £2.95 **LASKY'S PRICE £2.95** POST 13p

## LASKY'S NEW "LOW NOISE" CASSETTES FROM THE U.S.A.

Model	Singles	5	10	20
C.60	32p	£1.52	£2.96	£5.60
C.90	50p	£2.37	£4.62	£8.75
C.120	69p	£3.28	£6.38	£10.85

Post Each 5p. 5-20p. 10-25p. 20-50p.

## TRIO KA.2002 PACKAGE DEAL TOP VALUE

- TRIO KA.2002 ..... £39.50
- Pair Wharfedale Dentons .. £39.90
- BSR MP60 ..... £15.20
- LASKY BASE & COVER ..... £4.75
- AD76K CARTRIDGE ..... £4.35

Total list price **£103.70**

## PACKAGE PRICE £79.50

Carriage in U.K. £2.00

ADD £9 if Wharfedale TRITONS are preferred to Dentons

## TMK MODEL 200 METER KIT

TMK offer the unique opportunity of building a really first-class precision multimeter at a worthwhile saving in cost. The cabinets are supplied with the meter scale and movement mounted in position. The highest quality components and 1% tolerance resistors are used throughout. Supplied complete with full construction circuit and operating instructions.

#### Specification

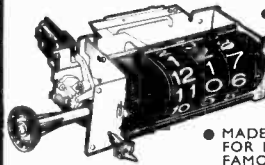
20,000 P.O.V. Multimeter. Features 24 measurement ranges with mirror scale accuracy. DC/V and current: 2%. A.C./V: 3%. Resistance 3%. Special 0-6V DC range for transistor circuit measurements.



ONLY

LIST PRICE £4.60 **LASKY'S PRICE £4.60** POST 13p

## DIGITAL CLOCK SCOOP



- SHOCK AND VIBRATION PROOF
- 12-HOUR ALARM
- AUTO "SLEEP" SWITCH
- HOURS, MINUTES AND SECONDS READ-OFF
- FORWARD AND BACKWARD TIME ADJUSTMENT
- SILENT OPERATION SYNCHRONOUS MOTOR
- MADE ESPECIALLY FOR LASKY'S BY FAMOUS MAKER
- MAINS OPERATION

- BUILT-IN ALARM BUZZER

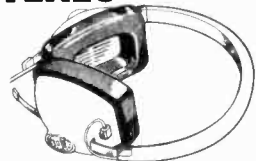
EXCLUSIVELY FROM LASKY'S in chassis form for you to mount in any housing. The clock measures 4 1/2W x 1 1/2H x 3 1/2D (overall from front of drum to back of switch). SPEC.: 210/240V AC, 50Hz operation; switch rating 250V, 3A. Complete with instructions.

HUNDREDS OF APPLICATIONS. COMPLETE WITH KNOBS

LIST PRICE £6.50 **LASKY'S PRICE £6.50** POST 18p

SPECIAL QUOTATIONS FOR QUANTITIES

## TRIO HS.1 HS.2. STEREO HEADPHONE BARGAINS



Models HS.1 and HS.2. Both these sets by TRIO offer really superb stereo reproduction in a lightweight, fully adjustable headset designed for optimum comfort. Listening fatigue is unknown with TRIO headphones. Brief spec. both models: Input imp. 8 nominal (matching 4 to 8); max. input 0.5W; frequency response 20-19k Hz; output sensitivity at 1mW input: HS.1 118dB, HS.2 111dB; weight 0.66lb. Identical in appearance—both models are finished in ivory with contrasting foam-filled ear pads and head band.

HS.1. List Price £8.40.

HS.2. List Price £6.75.

Lasky's Price **£5.00**

Lasky's Price **£4.00** Post 18p

## Lasky's Radio Limited

#### Branches

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THE ULTIMATE IN COMMUNICATIONS RECEIVERS

# WORLD MASTER 8 WAVE BANDS

+ WORLD MAP & TIME ZONE DIAL



**Brings instant World Wide Reception at the touch of a button.**

The five continents to your armchair. What can we say about this superb radio—it gets everything! 2 short waves to cover the world! America—India—Africa—You name it—it gets it!

**MARINE BAND** (1.6-4mcs)  
**Medium Wave** 535-1605kcs.  
**Long Wave** 150-350kcs.  
**FM-VHF** 88-108mcs for B.B.C., Local Radio Stations.  
**AIRCRAFT** 108-135mcs. The complete aircraft band, hear the pilots talking to control. Police and Public Service Bands. 135-175mcs. Hundreds of shipping, "Private", RT calls, ambulances, taxis, gas boards, Radio Hams, etc. etc.  
 Battery/or Mains with A.F.C., tone control, volume control, internal and external aerials. Finished in black leatherette and stainless steel.  
**TRULY A COMPLETE COMMUNICATIONS RECEIVER**

CASH PRICE **£35.50**

+ 50p p. & p. or sent for £7.50 dep. + 50p p. & p. & 6 monthly payments of £5.60 (Total £41.10)

## PORTABLE COMMUNICATIONS RECEIVER

ONE OF THE WORLD'S MOST EXCITING RADIOS  
 - NO LESS THAN THREE V.H.F. BANDS

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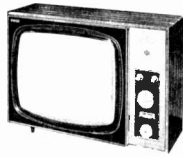
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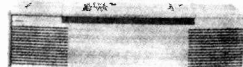
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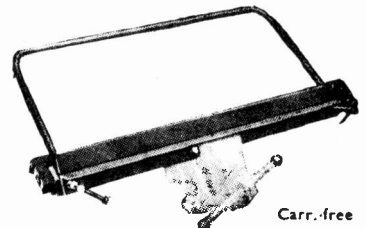
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2N1307	20p	2N3859A	30p	ACY19	25p	BDY18	21-75	BSY79	45p	NKT20329	471p
2N1308	30p	2N3860	30p	ACY21	25p	BDY19	21-82	BSY82	571p	NKT20339	371p
2N1309	30p	2N3866	21-50	ACY21	25p	BDY20	21-121	BSY90	571p	NKT80111	721p
2N1507	171p	2N3877	40p	ACY22	20p	BDY38	971p	BSY95A	121p	NKT80112	971p
2N1613	25p	2N3877A	40p	ACY28	20p	BDY60	21-25	C111	75p	NKT80113	121p
2N1621	35p	2N3900	371p	ACY40	20p	BDY61	21-25	C424	271p	NKT80211	121p
2N1632	20p	2N3900A	40p	ACY41	25p	BDY62	21	C425	55p	NKT80212	921p
2N1637	30p	2N3901	971p	ACY44	40p	BF117	471p	C426	40p	NKT80213	921p
2N1638	271p	2N3903	35p	AD140	521p	BF115	371p	C428	371p	NKT80214	921p
2N1671B	81p	2N3904	35p	AD149	571p	BF167	18p	C744	30p	NKT80215	921p
2N1711	25p	2N3905	371p	AD150	621p	BF173	18p	D18T1	621p	NKT80216	921p
2N1889	321p	2N3906	371p	AD161	371p	BF177	30p	D18P1	371p	OC20	75p
2N1893	371p	2N4058	171p	AD162	371p	BF178	30p	D18P2	371p	OC22	50p
2N2147	821p	2N4059	10p	AF106	421p	BF179	30p	D18P3	371p	OC23	60p
2N2148	821p	2N4060	121p	AF114	421p	BF180	35p	D40N1	75p	OC24	60p
2N2160	571p	2N4061	121p	AF115	25p	BF181	35p	GET102	30p	OC25	50p
2N2193	40p	2N4062	121p	AF116	25p	BF184	25p	GET113	20p	OC28	271p
2N2193A	421p	2N4244	471p	AF117	25p	BF185	421p	GET114	20p	OC29	621p
2N2184	80p	2N4285	171p	AF118	621p	BF194	171p	GET118	30p	OC36	50p
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2N2218	25p	2N4287	171p	AF120	221p	BF196	421p	GET120	521p	OC41	221p
2N2220	25p	2N4289	171p	AF123	20p	BF197	421p	GET123	121p	OC42	25p
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2N2287	21-07p	2N4292	121p	AF139	371p	BF224	14p	GET187	20p	OC45	121p
2N2287	20p	2N4303	471p	AF178	421p	BF225	19p	GET189	221p	OC46	15p
2N2289	171p	2N4307	521p	AF179	781p	BF227	23p	GET189	221p	OC70	15p
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2N2483	271p	2N5172	121p	AF239	421p	BF259	25p	GET189	221p	OC74	321p
2N2484	321p	2N5174	521p	AF279	471p	BF260	25p	MJ400	21-07	OC75	221p
2N2539	20p	2N5175	521p	AF280	521p	BF261	25p	MJ420	21-07	OC76	221p
2N2640	221p	2N5176	521p	AF281	221p	BF262	471p	MJ421	21-07	OC77	221p
2N2613	35p	2N5232A	40p	AFY26	25p	BFX13	221p	MJ430	21-07	OC78	221p
2N2614	30p	2N5245	45p	AFY27	271p	BFX29	30p	MJ440	971p	OC81D	221p
2N2646	521p	2N5246	421p	AFY28	271p	BFX30	30p	MJ480	971p	OC82	25p
2N2696	321p	2N5249	671p	AFY29	271p	BFX43	371p	MJ481	21-25	OC84	35p
2N2711	25p	2N5256	23-25	AFY36	25p	BFX44	371p	MJ490	21-371	OC140	321p
2N2712	20p	2N5265	27-28	AFY50	25p	BFX68	671p	MJ491	21-371	OC170	30p
2N2713	271p	2N5267	22-25	AFY51	321p	BFX82	25p	MJ530	22-171	OC171	30p
2N2714	30p	2N5305	371p	AFY60	321p	BFX85	25p	MJ530	22-171	OC200	40p
2N2865	621p	2N5306	40p	AFY64	321p	BFX86	25p	MJ530	22-171	OC201	60p
2N2901	30p	2N5307	371p	AFY86	321p	BFX87	271p	MJ530	22-171	OC202	60p
2N2904A	321p	2N5308	371p	ABZ21	421p	BFX88	25p	MJ530	22-171	OC203	421p
2N2905	371p	2N5309	621p	AU103	21-25	BFX89	621p	MJ530	22-171	OC204	421p
2N2905A	45p	2N5310	421p	BC107	10p	BFY9A	70p	MJE521	75p	OC205	421p
2N2906	25p	2N5354	271p	BC108	10p	BFY10	321p	MJE521	75p	OC206	90p
2N2906A	271p	2N5355	271p	BC109	10p	BFY11	221p	MJE521	75p	OC207	75p
2N2907	30p	2N5356	321p	BC110	10p	BFY12	221p	MJE521	75p	OC208	75p
2N2923	15p	2N5385	471p	BC111	15p	BFY18	221p	MJE521	75p	OC209	75p
2N2924	15p	2N5386	321p	BC115	15p	BFY19	221p	MJE521	75p	OC210	75p
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2N2926	15p	2N5457	371p	BC118	10p	BFY21	221p	MJE521	75p	OC212	75p
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.. Yellow	121p	2N802	22	BC122	20p	BFY25	45p	MJE521	75p	OC214	75p
.. Orange	121p	2N810	60p	BC125	20p	BFY26	20p	MJE521	75p	OC215	75p
2N3011	30p	2N8103	25p	BC126	20p	BFY29	50p	MJE521	75p	OC216	75p
2N3014	321p	2N8104	25p	BC140	371p	BFY30	50p	MJE521	75p	OC217	75p
2N3053	30p	2N8101	25p	BC147	10p	BFY43	621p	MJE521	75p	OC218	75p
2N3054	45p	2N8502	35p	BC148	10p	BFY44	621p	MJE521	75p	OC219	75p
2N3055	62p	2N8503	271p	BC149	10p	BFY50	23p	MJE521	75p	OC220	75p
2N3133	30p	2N3128	70p	BC152	171p	BFY51	20p	MJE521	75p	OC221	75p
2N3134	30p	2N3139	21-271	BC157	20p	BFY52	23p	MJE521	75p	OC222	75p
2N3135	25p	2N3140	771p	BC158	171p	BFY53	171p	MJE521	75p	OC223	75p
2N3136	20p	2N3141	75p	BC159	12p	BFY54	571p	MJE521	75p	OC224	75p
2N3380	25p	2N3142	671p	BC160	621p	BFY76	421p	MJE521	75p	OC225	75p
2N3391	20p	2N3143	671p	BC167	11p	BFY77	571p	MJE521	75p	OC226	75p
2N3391A	30p	2N3152	871p	BC168B	10p	BFY90	671p	MJE521	75p	OC227	75p
2N3392	171p	R.C.A.:	—	BC169C	11p	BPX25	21-85	MJE521	75p	OC228	75p
2N3393	15p	40050	55p	BC170	12						

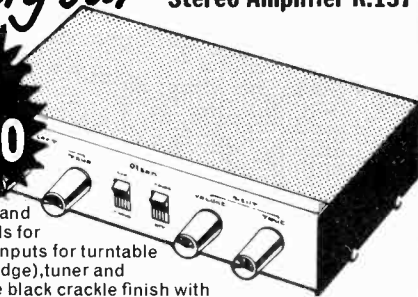
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**ROC price**  
**£10.50**

Separate tone and volume controls for each channel, inputs for turntable (ceramic cartridge), tuner and tape. Attractive black crackle finish with brushed aluminium front. Frequency response: 70-20,000 Hz  $\pm$  3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 80mV; tuner/aux 80mV.

Normal retail price: **£14.70**

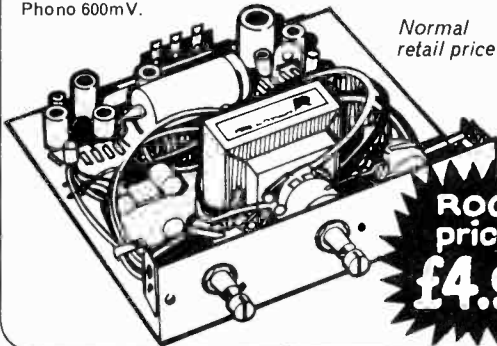


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**5-Watt Transistor Stereo Amplifier Chassis R.123**

Completely self-contained, fully transistorised, mains-powered (240V AC) amplifier, needing only cabinet and knobs. Ideal for adapting mono players to stereo. Frequency response: 40-17,000 Hz  $\pm$  3dB. Output: 2.5 watts per channel @ 8 ohms. Input: Phono 600mV.

Normal retail price: **£7.30**



**ROC price**  
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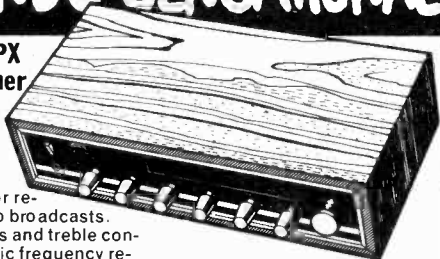
# SOUNDS SENSATIONAL

**AM/FM/MPX Stereo Tuner Amplifier R.124**

A top quality amplifier with facility for receiving stereo broadcasts. Separate bass and treble controls, automatic frequency response, stereo headphone socket, output power: 8 watts. FM frequency range 88-108 MHz; AM frequency range 535-1605 KHz. Inputs for turntable (ceramic cartridge) and tape. Frequency response: 50-10,000 Hz  $\pm$  3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 200mV, tape 100mV. FM: Sensitivity 20 $\mu$ V, stereo separation 26dB, image rejection 55dB. AM: Sensitivity 300 $\mu$ V.

Normal retail price: **£42.00**

**ROC price: £29.95**



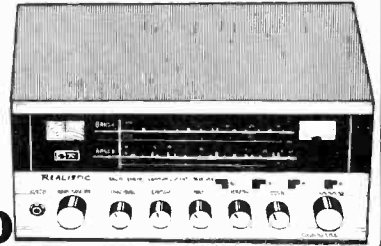
# World wide reception

**Professional Solid-state, Four-band Communications Receiver R.135**

Fully transistorised with continuous coverage from 555K Hz to 30 MHz in four bands (with illuminated bandspread for 160-10 metres). Incorporates internal speaker, automatic noise limiter, SSB/AM/CW switch, AVC switch, S Meter, Receive and Standby switch, external socket for headphone or speaker, bandspread control, BFO control, on/off/AF gain, band selector, antenna trimmer and RF gain. Runs off 240 v AC, batteries or any 12 v DC negative ground source. Frequency ranges (in MHz): Band A, 535-1.6; B, 1.55-4.5; C, 4.5-13; D, 13-30. Sensitivity: 0.5 $\mu$ V @ 30mHz. Bandsread: 10-160 metres.

Normal retail price: **£65.00**

**ROC price:**  
**£45.00**

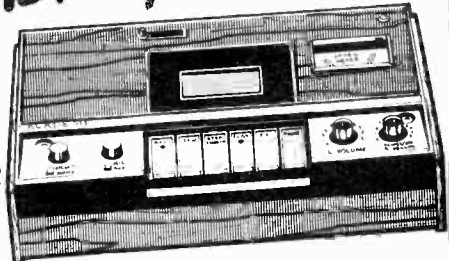


# AMAZING OFFER!

**Stereo Cassette Tape Unit R.142**

Complete stereo record and playback unit with line and microphone inputs. Fitted with tape counter, separate pause control, recording level metres for each channel, pop-up cassette ejection. Supplied complete with two pencil microphones. Wow & flutter better than 0.3%, frequency response 100-10,000 Hz. Tape speed: 1 1/2 IPS, 4.75 CMS. Rewind time: Better than 60 sec (C.60 cassette).  
Normal retail price: **£65.00**

**ROC price**  
**£49.50**

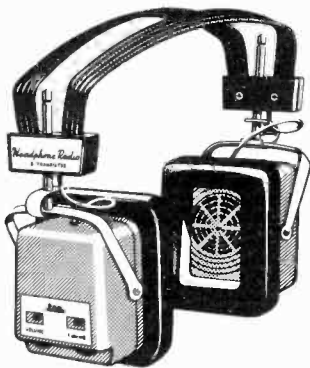


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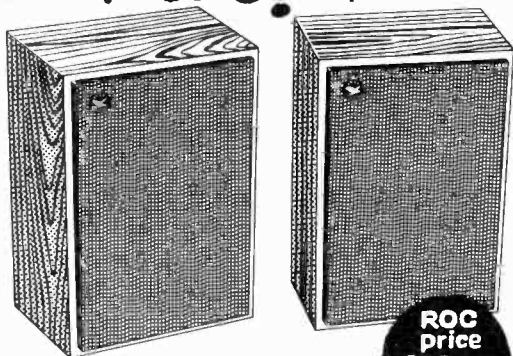


**Headphone Radio R.143**  
For completely private listening without the distortion of the ordinary earphone adaptor. Battery operated; PP3. Fully transistorised. Frequency range: 535-1600 K Hz, Medium Wave Band. Maximum output: 300mW.

**ROC price**  
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Normal retail price: £9.40

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Heavily lagged teak finish cabinets each with large dual cone base unit and separate tweeter. Power handling: 10 watts peak; frequency range: 40-18,000 Hz, impedance: 8 ohms. Size: 14 x 8½ x 6½.

Normal retail price: £19.60

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only  
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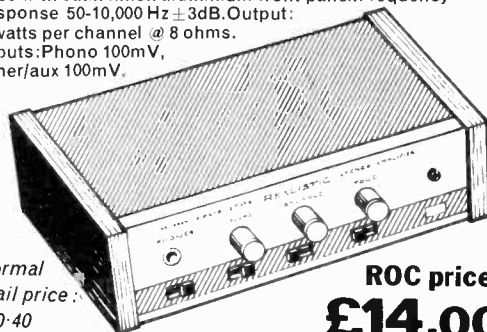


**Stereo Headphones R.328**

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**10-watt Transistor Stereo Amplifier R.136**  
Ganged volume, balance and tone controls. Inputs for turntable (ceramic cartridge), tuner (see R.134) or tape. Oiled walnut case with satin finish aluminium front panel. Frequency response 50-10,000 Hz ± 3dB. Output: 5 watts per channel @ 8 ohms. Inputs: Phono 100mV, tuner/aux 100mV.



Normal retail price: £20.40

**ROC price: £14.00**

## The Perfect match!



**AM/FM/MPX Stereo Tuner R.134**

Matching unit to the R.136 amplifier. Covers AM and FM tuning bands with automatic stereo signal light. FM frequency range: 88-108MHz; AM frequency range: 535-1605kHz. FM: Sensitivity 5µV, stereo separation 25dB@1kHz, image rejection 50dB. AM: Sensitivity 250µV.

Normal retail price: £28.60

**ROC price**  
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BSY27	0-13	OC26	0-25
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OC44	0-13	AUY10	1-25
OC75	0-13	25034	0-25
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OA47 Gold Bonded Diodes, Marked & tested	3	3	2
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Data sheet supplied with device.

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3823E Field effect Transistors. This is the 2N3823 in Plastic Case, 500+ 13p each; 1,000+ 10p each.

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AC127	12p	BSY56	30p	OC82	12p	2N3702	15p
AC128	12p	BSX21	25p	ORP12	48p	2N3703	14p
AD140	40p	BY124	71p	IN4001	71p	2N3704	171p
AF115	20p	BYZ10	20p	IN4002	10p	2N3705	15p
AF117	20p	BYZ13	20p	IN4003	11p	2N3706	12p
BC107	10p	OA85	7p	IN4004	12p	2N3707	181p
BC108	10p	OA91	5p	IN4005	13p	2N3708	10p
BC109	10p	OA202	7p	IN4006	13p	2N3709	11p
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160V: 0-01μF, 0-015μF, 0-022μF, 0-033μF, 0-047μF, 0-068μF, 3p, 0-1μF 3 1/2p, 0-15μF 4 1/2p, 0-22μF, 5p, 0-33μF, 6p, 0-47μF, 7 1/2p, 0-68μF, 11p, 1-0μF, 13p.

## MULLARD POLYESTER CAPACITORS C280 SERIES

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## MYLAR FILM CAPACITORS 100V

0-001μF, 0-002μF, 0-005μF, 0-01μF, 0-02μF, 2 1/2p, 0-04μF, 0-05μF, 0-068μF, 0-1μF, 3 1/2p.

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2 1/2 x 3 1/2	22p	16p
2 1/2 x 5	24p	24p
3 1/2 x 3 1/2	24p	24p
3 1/2 x 5	27p	27p
17 x 2 1/2	75p	57 1/2p
17 x 3 1/2	100p	78p
17 x 5 (plain)	—	82p
17 x 3 1/2 (plain)	—	60p
17 x 2 1/2 (plain)	—	42p
2 1/2 x 5 (plain)	—	12p
2 1/2 x 3 1/2 (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

## JACK PLUGS AND SOCKETS

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

## D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin  
Plug 12p. Socket 8p.

## BATTERY ELIMINATOR

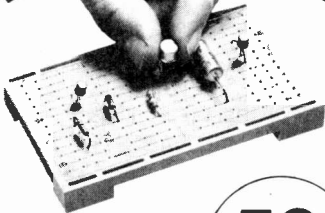
Same size as PP9 battery. £1.50

9V mains power supply.



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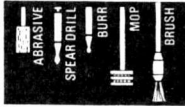
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NOW IT'S HERE AT LAST, after experimenting for four and a half months with a multitude of different circuits and carrying out actual field tests with prototypes, our design team have come up with this real winner. This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. **FINDS GOLD, SILVER, LOST COINS, JEWELLERY, KEYS, WAR SOUVENIRS, ARCHAEOLOGICAL PIECES, METALLIC ORE, NUGGETS, ETC., ETC.** Outdoors or indoors. *Extremely sensitive, will signal presence of certain objects buried several feet below ground!* No knowledge of radio or electronics required. Can be built with ease in one short evening by anybody from nine years of age upwards, with the wonderfully clear, easy to follow, step-by-step, fully illustrated instructions—it really is easy as ABC. Transistorised—no valves. Uses standard PP3 battery. No soldering necessary. Size of detector head: 13 1/2" x 10" x 2 1/2". Great demand expected at this remarkably low price—ORDER WHILE PRESENT STOCKS LAST.



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Includes detector head case, nuts, screws, wire, simple instructions, etc., etc. ONLY £2-37 (47/6) + 27p (5/6) p. & p. (Sectional handle as illustrated 75p (15/-) extra). Parts available separately. Made up looks worth £15!

## BUILD 5 RADIO AND ELECTRONIC PROJECTS



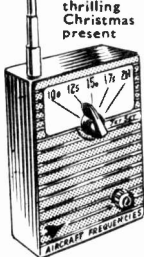
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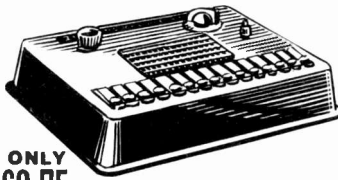
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## REAL WORKING ELECTRONIC ORGAN



ONLY £2-75 (55/-)

ANYONE FROM NINE YEARS UPWARDS can build it easily in one short evening following the fully illustrated, step-by-step, simply worded instructions. BIG DEMAND ANTICIPATED FOR THIS UNIQUE INSTRUMENT at our low, low building price. ONLY £2-75 (55/-) + 23p (4/6) p. & p. for all parts, including case, loudspeaker, transistors, condensers, resistors, knobs, transformer, volume control, wire, nuts, screws, simple (but full) instructions, etc., etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting Christmas gift for someone.

Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds, etc. Eight months were spent in creating and testing this superb, revolutionary electronic organ. Fully transistorised—no valves. Proper self-contained loudspeaker. *Pipes separate keys upon two full octaves—play the "Yellow Rose of Texas" and play "Silent Night" play "Auld Lang Syne", play lots and lots of similar tunes on this real working electronic organ. Although it's no theatre organ it's certainly no tiny thing, it measures 13 1/2" x 10" x 2 1/2". You have the thrill and excitement of building it together with the pleasure of playing a real, live, throbbing electronic organ. *Make it anywhere—play it anywhere. NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED—NONE WHATSOEVER.* No soldering necessary, it really is as simple as ABC to make.*

## GET A GOOD NIGHT'S SLEEP—EVERY NIGHT! INGENIOUS ELECTRONIC SLEEP INDUCER

Ideal Xmas Gift

only £2-75 (55/-)



CAN'T SLEEP AT NIGHTS? DO YOU WAKE UP IN THE NIGHT AND CAN'T GET OFF TO SLEEP AGAIN? WOULD YOU LIKE TO BE GENTLY SOOTHED OFF TO SATISFYING SLEEP EVERY NIGHT? Then build this ingenious electronic sleep inducer. *It even stops by itself so you don't have to worry about it being on all night!* The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sounds gradually become less and less—until they eventually cease altogether, the effect it has on people is amazingly very similar to hypnosis. A control is provided for adjusting the length of times, etc., all transistor, can be built by anyone over 12 years of age in about two hours. No knowledge of electronics or radio needed. Extremely simple, easy-to-follow, step-by-step, fully illustrated instructions included. No soldering necessary. Works off standard batteries—extremely economical. Size only 3" x 4 1/2" x 1 1/2"—fits in anywhere. All parts including case, loudspeaker, condenser, nuts, wire, screws, etc., etc. THERE WILL BE A GREAT DEMAND FOR THIS UNIQUE NEW DESIGN—SEND NOW £2-75 + 25p (5/- + 5/-) p. & p. (parts available separately).



Ideal Xmas Gift

ONLY £2-25 (43/-)

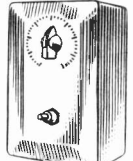
## SHORTWAVE TRANSISTOR RADIO Can be built in one evening

At last! After trying countless circuits searching for easy build, work first-time short waver. Giving advanced world-wide performance, we chose this "Sky Roma". Anyone from 9 years up can follow the step-by-step, easy-as-ABC, fully illustrated instructions. (We built ten prototypes and every one worked first time), no soldering necessary. 75 stations logged on rod aerial in 30 mins.—Russia, Africa, USA, Switzerland, etc. Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Transistorised (no valves). Size only 3" x 4 1/2" x 1 1/2". As tremendous demand anticipated price held to only £2-25 (43/-) + 17p (3/6) p. & p. for all parts incl. cabinet, screws, instructions, etc. (Parts available separately).

## SOOTHE YOUR NERVES, RELAX WITH THIS AMAZING RELAXATRON

Ideal Xmas Gift

only £2-25 (45/-)



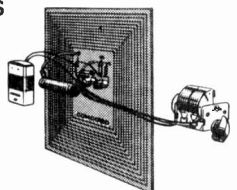
CUTS OUT NOISE POLLUTION—SOOTHS YOUR NERVES! Don't underestimate the uses of this fantastic new design—the RELAXATRON is basically a pink noise generator based on avalanche operated transistors. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. For instance, many people find a rainstorm mysteriously relaxing, a large part of this feeling of well-being can be directly traced to the sound of falling raindrops—a well-known type of pink noise. A group of Dentists have experimented on patients with this pink noise—NO ANAESTHETICS WERE USED! The noise ostensibly created a most definite reaction in these patients' nervous systems with the results that their pain systems were blocked. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then Relaxatron. Once used you will never want to be without it—use the amazing pink noise generator whenever you feel uneasy, can't relax or wish to concentrate. TAKE IT ANYWHERE, pocket sized. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones, Components, Nuts, Screws, Wire, etc., etc. no soldering. Send only £2-25 + 25p (48/- + 5/-) p. & p. (Parts available separately.)

## FIND BURIED TREASURE WITH THIS READY BUILT & TESTED

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2 x Duo Type III speakers	£32+£3	P.&P.
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Size approx. 17in x 10½in x 6½in. Drive unit 13in x 8in with parasitic tweeter. Max. power 10W, 3 ohms. Simulated Teak cabinet. **£14 pair + £2 P. & P.**  
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14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0.1%. P.U.1 (for ceramic cartridges) 150mV into 3 Meg. P.U.2 (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within  $\pm$ 1dB R.I.A.A. Radio 150mV into 220K. (Sensitivities given at full power.) Tape out facilities; headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to -17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to -12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) R101—P.U.1. and radio—65dB. P.U.2—58dB. R100 same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than -35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13½ x 9in x 3½in.

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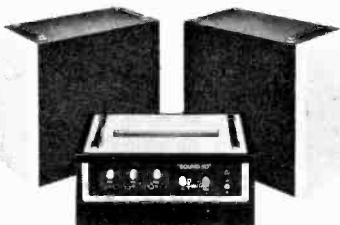
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1. Crystal Mic. or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 and 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.). All 250mV sensitivity.

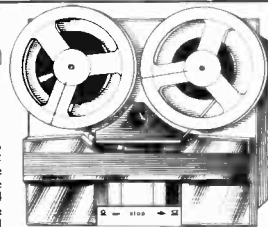
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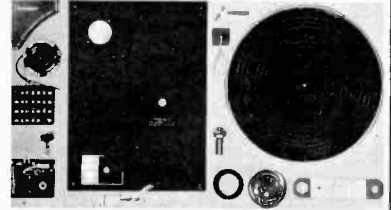
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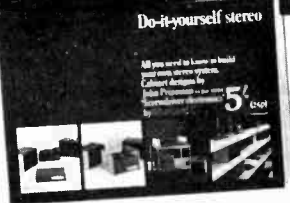
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**CN.240/2** Miniature soldering iron 15 watt 240 volts, fitted with nickel plated 3/32" bit and packed in transparent display box. Also available for 220 volts. Price **£1.70**

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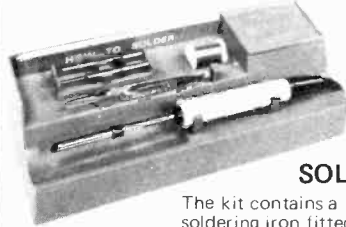
**CCN.240** New model 15 watt 240 volts miniature soldering iron with ceramic shaft to ensure perfect insulation (4,000 v A.C.). Will solder live transistors in perfect safety: fitted with 3/32" iron coated bit. Spare bits 1/8" 3/16" and 1/4" available. Can also be supplied for 220 volts. Price **£1.80**

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### SK.1 SOLDERING KIT

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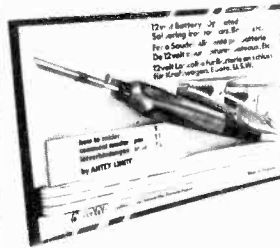
Price **£2.75**



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Price **£2.40**



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PIV	1A	3A	7A	10A	16A	30A
	TO-5	TO-66	TO-66	TO-48	TO-48	TO-48
50	0-23	0-25	0-47	0-50	0-53	1-15
100	0-25	0-33	0-53	0-58	0-63	1-40
200	0-35	0-37	0-57	0-61	0-75	1-80
400	0-43	0-47	0-57	0-75	0-83	1-75
600	0-53	0-57	0-77	0-97	1-25	
800	0-63	0-70	0-90	1-20	1-50	4-00

**SIL. RECTS. TESTED**

PIV	300mA	750mA	1A	1.5A	3A	10A	30A
50	0-04	0-05	0-05	0-07	0-14	0-21	0-47
100	0-04	0-05	0-05	0-13	0-16	0-23	0-75
200	0-05	0-06	0-06	0-14	0-20	0-24	1-00
400	0-06	0-13	0-07	0-20	0-27	0-37	1-25
600	0-07	0-16	0-10	0-23	0-34	0-45	1-85
800	0-10	0-17	0-13	0-25	0-37	0-55	2-00
1000	0-11	0-25	0-15	0-30	0-46	0-63	2-50
1200		0-33		0-33	0-57	0-75	

**TRIACS**

VBO	2A	6A	10A
	TO-1	TO-66	TO-88
100	0-50	0-63	1-00
200	0-70	0-90	1-25
400	0-90	1-00	1-60

**LUCAS SILICON RECTIFIERS**  
35 amp, 400 P.I.V. Stud type. £1-10 each.

**DIACS**  
FOR USE WITH TRIACS  
BR100 . . . . . 37p each

**2A POTTED BRIDGE RECTIFIERS 200V 50p**

**UNIUNION**  
UT46. Evt. 2N2046, Evt. T1843, BEN3000 27p each, 25-99 25p 100 UP 20p.

**NPN SILICON PLANAR**  
BC107/8/9, 10p each; 50-99, 8p; 100 up, 8p each; 1,000 up, 7p each. Fully tested and coded TO-18 case.

**FREE**  
One 50p Pak of your own choice free with orders valued £4 or over.

AF239 PNP GERM. SIEMENS VHF TRANSISTORS. RF MIXER & OSC. UP TO 900 MHZ. USE AS REPLACEMENT FOR AF139-AF186 & 100's OF OTHER USES IN VHF. OUR SPECIAL LOW PRICE—1-24 37p each, 25-99 34p each 100 + 30p each.

**FET'S**

2N 3819 . . . . . 35p  
2N 3820 . . . . . 83p  
MPF105 . . . . . 40p

**CADMIUM CELLS**  
ORP12 43p  
ORP60, ORP61 40p each

**PHOTO TRANS.**  
OCP71 Type, 43p

**SIL. G.P. DIODES** £p  
300mV 30 . . . . . 0-20  
40PIV (Min.) 100 . . . . . 1-50  
Sub-Min. 500 . . . . . 5-00  
Full Tested 1,000 . . . . . 9-00  
Ideal for Organ Builders.

**D13D1 Silicon Unilateral switch 50p each.**  
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

**BRAND NEW TEXAS GERM. TRANSISTORS**  
Coded and Guaranteed  
Pak No. . . . . QVVT  
T1 8 2G371A OC71  
T2 8 2G374 OC75  
T3 8 2G374A OC81D  
T4 8 2G381A OC81  
T5 8 2G382T OC82  
T6 8 2G344A OC44  
T7 8 2G345A OC45  
T8 8 2G378 OC78  
T9 8 2G399A 2N1302  
T10 8 2G417 AF117  
All 50p each pak

**2N2060 NPN SIL. DUAL TRANS. CODE D1899 TEXAS.** Our price 25p each.

**120 VOB NIXIE DRIVER TRANSISTOR.** Sim. BEN1 & C407, 2N1669 FULLY TESTED AND CODED ND120. 1-24 17p each. TO-5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Evt. ZEN300 5p each. Any Qty.

**EX-EQUIPMENT MULLARD**  
AF117 transistors. Large can 4 leads type. Leads cut short but still usable, real value at 15 for 50p.

**KING OF THE PAKS Unequalled Value and Quality**

**SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS**

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	Price
U1	120 Glass sub-min. general purpose germanium diodes	0-50
U2	60 Mixed germanium transistors AF/RF	0-60
U3	75 Germanium gold bonded diodes sim. OA5, OA47	0-50
U4	40 Germanium transistors like OC81, AC128	0-50
U5	60 200mA sub-min. Sil. diodes	0-50
U6	30 Silicon planar transistors NPN sim. 8BY95A, 2N706	0-50
U7	16 Sil. rectifiers Top-Hat 750mA up to 1,000V	0-50
U8	50 Sil. planar diodes 250mA, OA/200/202	0-50
U9	20 Mixed volts 1 watt Zener diodes	0-50
U11	30 PNP silicon planar transistors TO-5 sim. 2N1132	0-50
U13	30 PNP-NPN sil. transistors OC200 & 2S104	0-50
U14	150 Mixed silicon and germanium diodes	0-50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0-60
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0-50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0-50
U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0-50
U19	25 Silicon NPN transistors like BC108	0-50
U20	12 1.5-Amp silicon rectifiers Top-Hat up to 1,000 PIV	0-50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0-50
U23	30 Madt's like MAT series PNP transistors	0-50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0-50
U25	25 300Mc/s NPN silicon transistors 2N708, BSY27	0-50
U26	30 Fast switching silicon diodes like IN914 micro-min	0-50
U28	Experimenters' assortment of integrated circuits, untested. Gates, flip-flops, registers, etc., 8 assorted pieces	1-00
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CR81/25-600	1-00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0-50
U32	25 Zener diodes 400mV D07 case mixed volts, 3-18	0-50
U33	15 Plastic case 1 amp silicon rectifiers IN4000 series	0-50
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	0-50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0-60
U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0-50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2B322	0-50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0-50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0-50
U40	10 Dual trans. 6 lead TO-5 2N2060	0-50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0-50
U42	10 VHF germ. PNP trans. TO-1 NKT667 AF117	0-50

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

**NEW QUALITY TESTED PAKS**

Pak Description	Price
Q1 20 Red spot trans. PNP AF	0-80
Q2 16 White spot R.F. trans. PNP	0-50
Q3 4 OC77 type trans.	0-50
Q4 6 Matched trans. OC44/45/81/81D	0-50
Q5 4 OC75 transistors	0-50
Q6 4 OC72 transistors	0-50
Q7 4 AC128 trans. PNP high gain	0-50
Q8 4 AC126 trans. PNP	0-50
Q9 7 OC81 type trans.	0-50
Q10 7 OC71 type trans.	0-50
Q11 2 AC127/128 comp. pairs PNP/NPN	0-50
Q12 4 AF118 type trans.	0-50
Q13 3 AF117 type trans.	0-50
Q14 3 OC171 H.F. type trans.	0-50
Q15 3 2N2925 sil. epoxy trans.	0-50
Q16 2 GE7880 low noise germ. trans.	0-50
Q17 3 NPN 1 ST141 & 2 ST140	0-50
Q18 4 Madt's 2 MAT 100 & 2 MAT 120	0-50
Q19 3 Madt's 2 MAT 101 & 1 MAT 121	0-50
Q20 4 OC44 germ. trans. A.F.	0-50
Q21 3 AC127 NPN germ. trans.	0-50
Q22 20 NKT trans. A.F. R.F. cooled	0-50
Q23 10 OA202 sil. diodes sub-min.	0-50
Q24 8 OA81 diodes	0-50
Q25 8 IN914 sil. diodes 75PIV 75mA	0-50
Q26 8 OA95 germ. diodes sub-min. IN69	0-50
Q27 2 10A 600PIV sil. rect. 1843H	0-50
Q28 2 Sil. power rect. BYZ13	0-50
Q29 4 Sil. trans. 2 x 2N696, 1 x 2N697, 1 x 2N698	0-50
Q30 7 Sil. switch trans. 2N708 NPN	0-50
Q31 6 Sil. switch trans. 2N708 NPN	0-50
Q32 3 PNP sil. trans. 2 x 2N1131, 1 x 2N1132	0-50
Q33 3 Sil. NPN trans. 2N1711	0-50
Q34 7 Sil. NPN trans. 2N3369, 500MHZ.	0-60
Q35 3 Sil. PNP TO-5 2 x 2N2904 & 1 x 2905	0-50
Q36 7 2N3646 TO-18 plastic 300MHZ NPN	0-50
Q37 3 2N3053 NPN sil. trans.	0-50
Q38 7 PNP trans. 4 x 2N3703, 3 x 2N3702	0-50
Q39 7 NPN trans. 4 x 2N3704, 3 x 2N3705	0-50
Q40 7 NPN amp. 4 x 2N3707, 3 x 2N3708	0-50
Q41 3 Plastic NPN TO-18 2N3904	0-50
Q42 6 NPN trans. 2N5172	0-50
Q43 7 BC107 NPN trans.	0-50
Q44 7 NPN trans. 4 x BC108, 3 x BC109	0-50
Q45 3 BC113 NPN TO-18 trans.	0-50
Q46 3 BC113 NPN TO-5 trans.	0-50
Q47 6 NPN high gain 3 x BC107, 3 x BC108	0-50
Q48 4 BCY70 NPN trans. TO-18	0-50
Q49 4 NPN trans. 2 x BFY51, 2 x BFY52	0-50
Q50 7 8BY28 NPN switch TO-18	0-50
Q51 7 8BY95A NPN trans. 300MHZ.	0-50
Q52 8 BY100 type sil. rect.	1-00
Q53 25 Sil. & germ. trans. mixed all marked new	1-50

**PRINTED CIRCUITS—EX-COMPUTER**

Packed with semiconductors and components, 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards, 50p. Plus 10p P. & P. 100 Boards £3. P. & P. 30p.

**GENERAL PURPOSE GERM. PNP POWER TRANSISTORS**  
Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACEMENTS FOR: OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-431-452-453. T13027-3028, 2N2504, 2N4564-4574-4584, 2N511 A & B. 2G220-222, FFC.

**SPECIFICATION**  
V<sub>CEO</sub> 80V V<sub>CE0</sub> 50V IC 10A PT. 30 WATTS Hie 30-170.  
Hie 20-100. FTI MHZ

PRICE	1-24	25-99	100 up
	43p each	40p each	36p each

**GENERAL PURPOSE SILICON NPN POWER TRANSISTORS**  
Coded GP300. BRAND NEW TO-3 CASE. POSS. REPLACEMENT FOR:—2N3055, BDY26, B1Y11.

**SPECIFICATION**  
V<sub>CEO</sub> 100V, V<sub>CE0</sub> 60V, IC 15AMP/8, PT. 115 WATTS. Hie 20-100. FTI MHZ

PRICE	1-24	25-99	100 up
	55p each	50p each	47p each

**GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8, BSY27/28/95A.** All usable devices no open or short circuits. ALSO AVAILABLE IN PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

	£p	100	For	1-75	
20	For	0-50		500	
50	For	1-00		1000	
				For	13-00

**JUMBO COMPONENT PAKS**

**MIXED ELECTRONIC COMPONENTS**

Especially good value (no rubbish)

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 310s in weight. Price incl. P. & P

**£1-50 only**

Plus our satisfaction or money back guarantee.

**NEW EDITION 1971 TRANSISTOR EQUIVALENTS BOOK.** A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each.

**GERM. POWER TRANS.**

Type	Price each	Type	Price each
OC20	50p	OC29	40p
OC22	30p	OC35	33p
OC23	35p	OC36	40p
OC25	25p	AD140	40p
OC26	25p	AD142	40p
OC28	40p	AD149	43p

**OUR STOCKS** of individual devices are now too numerous to mention in this Advertisement. Send S.A.E. for our listing of over 1,000 Semiconductors. All available Ex-Block at very competitive prices.

**SILICON PHOTO TRANSISTOR.** TO-18 Lens end. NPN Sim. to BP x 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	45p	40p	35p

**RTL MICROLOGIC CIRCUITS**

	Price each
Epoxy TO-5 case	1-24 25-99 100 up
uL900 Buffer	35p 32p 27p
uL914 Dual 2 1/p gate	35p 33p 27p
uL923 J-K flip-flop	50p 47p 45p

Data and Circuits Booklet for I.C.'s

**Dual-in-Line Low Profile Sockets**  
14 and 16 Lead Sockets for use with Dual-in-Line Integrated Circuits

Order No.	1-24	25-99	100 up
T80 14 pin type	30p	27p	25p
T80 16 pin type	35p	32p	30p

# -the lowest prices!

## 74 series T.T.L. I.C.'s DOWN AGAIN IN PRICE

Check our 74 Series List before you buy any I.C.'s. Our prices are the lowest possible. All devices ex-stock. Full spec. guaranteed.

BI-PAK Order No.	Similar Types to:—Description	Price and qty. prices		
		1-24	25-99	100 up
BP00 = 7400	Quad 2-input NAND gate	0-15	0-14	0-12
BP01 = 7401	Quad 2-input pos. NAND gate (with open collector output)	0-15	0-14	0-12
BP02 = 7402	Quad 2-input pos. NOR gates	0-15	0-14	0-12
BP03 = 7403	Quad 2-input pos. NAND gates (with open collector output)	0-15	0-14	0-12
BP04 = 7404	Hex Inverters	0-15	0-14	0-12
BP05 = 7405	Hex Inverter (with open-collector output)	0-15	0-14	0-12
BP10 = 7410	Triple 3-input pos. NAND gates	0-15	0-14	0-12
BP13 = 7413	Dual 4-input Schmitt trigger	0-29	0-28	0-24
BP20 = 7420	Dual 4-input pos. NAND gates	0-15	0-14	0-12
BP30 = 7430	8-input pos. NAND gates	0-15	0-14	0-12
BP40 = 7440	Dual 4-input pos. NAND buffers	0-15	0-14	0-12
BP41 = 7441	BCD to decimal nixie driver	0-67	0-64	0-58
BP42 = 7442	BCD to decimal decoder (4-10 lines, 1 of 10)	0-67	0-64	0-58
BP46 = 7446	BCD-to-seven-segment decoder/driver	2-00	1-75	1-50
BP47 = 7447	BCD-seven-segment decoder/drivers (15V outputs)	0-97	0-94	0-88
BP48 = 7448	BCD-to-seven-segment decoder/driver	0-97	0-94	0-88
BP50 = 7450	Expandable dual 2-input and-or-invert	0-15	0-14	0-12
BP51 = 7451	Dual 2-wide 2-input and-or-invert gates	0-15	0-14	0-12
BP53 = 7453	Quad 2-input expandable and-or-invert	0-15	0-14	0-12
BP64 = 7464	4-wide 2-input and-or-invert gates	0-15	0-14	0-12
BP60 = 7460	Dual 4-input expander	0-15	0-14	0-12
BP70 = 7470	Single-phase J-K flip-flop	0-29	0-28	0-24
BP72 = 7472	Master slave J-K flip-flop	0-29	0-28	0-24
BP73 = 7473	Dual Master slave J-K flip-flop	0-37	0-35	0-32
BP74 = 7474	Dual D type flip-flop	0-37	0-35	0-32
BP75 = 7475	Quad latch	0-47	0-45	0-42
BP76 = 7476	Dual J-K with pre-set and clear	0-43	0-40	0-38
BP80 = 7480	Gated full adders	0-67	0-64	0-58
BP81 = 7481	16-bit read/write memory	0-97	0-94	0-88
BP82 = 7482	2-bit binary full adders	0-97	0-94	0-88
BP83 = 7483	Quad full adder	1-10	1-05	0-85
BP86 = 7486	Quad 2-input exclusive NOR gates	0-32	0-30	0-28
BP90 = 7490	BCD decade counter	0-87	0-84	0-58
BP91 = 7491	8-bit shift registers	0-87	0-84	0-78
BP92 = 7492	Divide-by-twelve counters	0-87	0-84	0-58
BP93 = 7493	4-bit binary counters	0-87	0-84	0-58
BP94 = 7494	Dual entry 4-bit shift register	0-77	0-74	0-68
BP95 = 7495	4-bit up-down shift register	0-77	0-74	0-68
BP96 = 7496	3-bit parallel in parallel out shift register	0-77	0-74	0-68
BP100 = 74100	8-bit bistable latches	1-75	1-65	1-55
BP104 = 74104	Single J-K flip-flop equivalent 9000 series	0-97	9-94	0-88
BP105 = 74105	Single J-K flip flop equivalent 9001 series	0-97	9-94	0-88
BP107 = 74107	Dual Master slave flip-flops	0-40	0-38	0-36
BP110 = 74110	Gates master-slave flip-flops	0-55	0-53	0-50
BP111 = 74111	Dual data lock-out flip-flop	1-25	1-15	1-00
BP118 = 74118	Hex set-reset latches	1-00	0-95	0-90
BP119 = 74119	Hex set-reset latches, 24-pin	1-35	1-25	1-10
BP121 = 74121	Monostable multivibrators	0-67	0-64	0-58
BP141 = 74141	BCD-to-decimal decoder/driver	0-67	0-64	0-58
BP145 = 74145	BCD-to-decimal decoder/driver O/C	1-60	1-40	1-30
BP150 = 74150	16-bit data selector	1-80	1-70	1-60
BP151 = 74151	8-bit data selectors (with strobe)	1-00	0-95	0-90
BP153 = 74153	Dual 4-line-to-1-line data	1-20	1-10	0-95
BP154 = 74154	4-to-16 line decoder	1-60	1-50	1-60
BP155 = 74155	Dual 2- to 4-line decoder	1-40	1-30	1-20
BP156 = 74156	Dual 2- to 4-line decoder O/C	1-40	1-30	1-20
BP160 = 74160	Sync. decade counter	1-80	1-70	1-60
BP161 = 74161	Sync. 4-bit binary counter	1-80	1-70	1-60
BP190 = 74190	Sync. up-down BCD counter	3-50	3-25	3-00
BP191 = 74191	Sync. binary up-down counter (single clock line)	3-50	3-25	3-00
BP192 = 74192	Sync. up-down decade counter	2-10	1-95	1-75
BP193 = 74193	Sync. binary up-down counter (two clock lines)	2-10	1-95	1-75
BP196 = 74196	Pre-settable 50MHz decade counter	1-80	1-70	1-60
BP197 = 74197	Pre-settable 50MHz binary counter	1-80	1-70	1-60
BP198 = 74198	8-bit parallel L-R shift register	5-60	5-00	4-00
BP199 = 74199	8-bit parallel access shift register	5-50	5-00	4-00

Devices may be mixed to qualify for quantity price. Larger quantities—prices on application (TTL 74 Series only). Data is available for the above series of I.C.'s in booklet form. Price 13p.

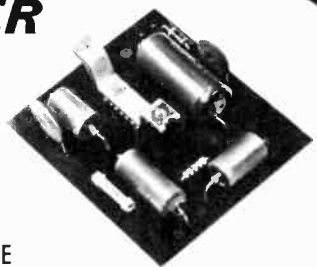
### TTL INTEGRATED CIRCUITS

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

PAK No.	PAK No.	PAK No.
UIC00 = 12 x 7400N 50p	UIC42 = 5 x 7450N 50p	UIC80 = 5 x 7480N 50p
UIC01 = 12 x 7401N 50p	UIC50 = 12 x 7450N 50p	UIC82 = 5 x 7482N 50p
UIC02 = 12 x 7402N 50p	UIC51 = 12 x 7451N 50p	UIC83 = 5 x 7483N 50p
UIC03 = 12 x 7403N 50p	UIC60 = 12 x 7460N 50p	UIC86 = 5 x 7486N 50p
UIC04 = 12 x 7404N 50p	UIC70 = 8 x 7470N 50p	UIC90 = 5 x 7490N 50p
UIC05 = 12 x 7405N 50p	UIC72 = 8 x 7472N 50p	UIC92 = 5 x 7492N 50p
UIC10 = 12 x 7410N 50p	UIC73 = 8 x 7473N 50p	UIC93 = 5 x 7493N 50p
UIC20 = 12 x 7420N 50p	UIC74 = 8 x 7474N 50p	UIC94 = 5 x 7494N 50p
UIC40 = 12 x 7440N 50p	UIC75 = 8 x 7475N 50p	UIC95 = 5 x 7495N 50p
UIC41 = 5 x 7441AN 50p	UIC76 = 8 x 7476N 50p	UIC96 = 5 x 7496N 50p
	UICX1 = 25 x 74x50	

Paks cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1. Every PAK carries out BI-PAK Satisfaction or money back GUARANTEE.

## ANOTHER BI-PAK FIRST!



THE NEW S.G.S.  
EA 1000 AUDIO  
AMPLIFIER MODULE

\*GUARANTEED NOT LESS THAN 3 WATTS RMS

Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TA/621 providing unlimited applications for the enthusiast in the construction of radios, record players, Audio and Stereo units. Also ideal for intercom systems, monitoring applications and phone answering machines. OTHER USES: portable applications where supply rails as low as 9V are of prime importance.

- Sensitivity 40 mV for 1 watt
- VOLTAGE GAIN 40dB but can be varied up to 73dB for some applications.
- Signal to Noise Ratio 86dB.
- Frequency response better than 50 KHz to 25 KHz for -3dB.
- Normal supply Voltage 9-24V.
- Suitable for 8-16 OHM Loads.
- Overall Size 2" x 3" x 1".
- Typical Total Harmonic distortion at 1 watt less than 1%.
- Supply voltage (Vs) = 24V 15ohm load.

Module Tested and Guaranteed

Quantity 1-9 10-25  
Price each £2.63 £2.28

Larger quantities quoted on request

Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

### ROCK BOTTOM PRICES—CAN'T BE BEATEN!

LOGIC Type No.	DTL 930 SERIES Function	Price 1-24	Price 25-99	Price 100 up
BP930	Expandable dual 4-input NAND	12p	11p	10p
BP932	Expandable dual 4-input NAND buffer	13p	12p	11p
BP933	Dual 4-input expander	13p	12p	11p
BP935	Expandable Hex Inverter	13p	12p	11p
BP936	Hex Inverter	13p	12p	11p
BP944	Dual 4-input NAND expandable buffer without pull-up	13p	12p	11p
BP945	Master-slave JK or RS	25p	24p	22p
BP946	Quad, 2-input NAND	12p	11p	10p
BP948	Master-slave JK or RS	25p	24p	22p
BP951	Monostable	65p	60p	55p
BP962	Triple 3-input NAND	12p	11p	10p
BP983	Dual Master-slave JK with separate clock	40p	38p	35p
BP994	Dual Master-slave JK with separate clock	40p	38p	35p
BP997	Dual Master-slave JK with Common Clock	40p	38p	35p
BP999	Dual Master-slave JK Common Clock	40p	38p	35p

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

### BRAND NEW LINEAR I.C.'s—FULL SPEC.

Type No.	Case	Leads	Description	Price 1-24	Price 25-99	Price 100 up
BF 201C—BL201C	TO-5	8	G.P. Amp	63p	58p	45p
BF 701C—BL701C	TO-5	8	OP Amp	63p	50p	45p
BF 702C—BL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BF 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	46p	40p
BF 709—72709	D.I.L.	14	High OP Amp	53p	46p	40p
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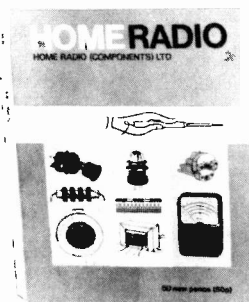


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## TODAY'S ICs AND TOMORROW'S

THE profusion of integrated circuit devices on the retail market offers great opportunities for equipment designing and building. Yet the formidable lists of type numbers must be daunting to many a reader as he peruses those advertisements featuring i.c.s. Clearly there is a requirement for a guide that identifies the more common types, indicates function and provides basic application data. This need we have attempted to meet in the Linear and Logic IC Survey which is the subject of this month's special supplement.

It will be appreciated that this Survey is not, and indeed could not be, exhaustive. Only those types of integrated circuit known currently to be available via retailers are included. This in fact makes the Survey all the more valuable, since no reader is likely to be sent on a wild goose chase after some rare device that cannot be obtained, unless one has special connections within the industry.

★ ★ ★

Having (hopefully) clarified the current i.c. situation to some extent and produced two separate lists, one for linear, the other for logic devices, we learn that this orderly and simple segregation into just two clearly defined categories may not always be possible in the years to come. By strange chance, just as our Survey was completed news was released of what is claimed to be a revolutionary development in i.c. design and manufacture by a British firm. The Collector Diffusion Isolation (CDI) method now perfected by Ferranti permits both digital and linear circuits to be formed on the same monolithic chip; it combines the linear high performance and digital high speed capability of the bipolar method with the high circuit density capability offered by the MOS technique.

The developers of CDI have suggested that this new bipolar process will cause a general widening of MSI and LSI applications particularly in areas involving analogue-digital techniques; they have mentioned, specifically, desk calculators, fuel injection systems, washing machine controls, and model control as examples where CDI will have great impact.

It is good to hear of a UK firm making an outstanding contribution to the development of new i.c. techniques. Just how important and significant the CDI method actually is, time will tell. But there are already two American contenders in the field. Both Fairchild and Raytheon have developed their own methods for increasing the component density on a single chip. Are we about to witness another price war? With mammoth production runs, technical considerations tend to play a minor role—the more economical process usually wins the day.

F.E.B.

## THIS MONTH

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### SPECIAL SUPPLEMENT

LINEAR AND LOGIC IC SURVEY

*Our January issue will be published on  
Friday, December 10.*

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# LOGICAL

By A.J. Dunn

*A proportional control system, using integrated circuits, suitable for use with most types of radio control transmitter or receiver.*

THE vast number of integrated circuits now on the market has lowered the cost to levels whereby they can be used for many applications. Although the circuitry for the system described would be possible with discrete components, the complexity would be such as to deter many from contemplating a sophisticated system, whereas with integrated circuits, the modules are simple and easy to build.

This article deals with the coder and decoder sections only; a block diagram of a typical system is shown in Fig. 1a. These may be built and tested against each other (Fig. 1b) the interface or coupling units being simple stages allowing, for example, a transmitter with a  $-12\text{V}$  supply to be used with the coder which requires  $+5.2$  to  $5.7\text{V}$ .

The system is described for six channels although it can easily be varied for three to nine channels. It is not economic to have less than three channels; for more than nine channels some compromise is necessary with regard to proportionality and the time rate of control.

Printed circuit boards are necessary for this project and care should be taken to make these of a high standard since one interconnection short can cause complete malfunction and may be hard to trace; time taken wiring up is amply repaid.

Alternative forms of coder are described and it is not advisable to attempt construction without considering the corresponding decoder. Positive logic (output high = 1, low = 0) is used throughout.

## PULSE CONTROL TECHNIQUES

The control system involves the production of a train of (positive going) pulses, each pulse corresponding to a channel and being independently and proportionally variable in length from about  $0.5$  to  $4\text{ms}$ .

As shown in Fig. 2a, the pulses occur sequentially but their position relevant to the start of the train is determined by the length of the other pulses and the interval time between pulses  $-\frac{1}{3}\text{ms}$ .

The pulse train is repeated at intervals  $\tau_1$  of 25 to 50ms or 20 to 40 times a second. This is the rate at which the pulse lengths are measured and changes detected. Allowing five measurements (but preferably ten) for the detection of a small change and servo initiation, this gives a system response time of about  $\frac{1}{3}$  to  $\frac{1}{2}$  second.

Due to the inertia of the motor and load, the servo has a response time which must be added to the above; a model aircraft flying at 60 m.p.h. would move 22ft in  $\frac{1}{4}$  second before, say, the rudder servo started operating.

## PULSE LENGTH

The pulse train repetition time  $\tau_1$  for  $n$  channels is made up of  $(n - 1) \times \frac{1}{3}\text{ms}$  intervals,  $n$  pulses of maximum length  $\tau_3\text{ms}$  and a synchronising period  $\tau_2$  used in the decoder to determine the start of the pulse train. This synchronising period  $\tau_2$  must be  $1\frac{1}{2} \times \tau_3$  or preferably  $3 \times \tau_3$ .

A four-channel system with a maximum pulse length ( $\tau_3$ ) of say  $4\text{ms}$  would therefore give as a minimum  $(4 \times 4) + (3 \times \frac{1}{3}) + (1\frac{1}{2} \times 4) = 23$  milliseconds.

The sharp-edged pulses used in the coder and decoder are "softened" to approximately sine wave shape, before actual transmission and reception (as shown in Fig. 3), the pulse interval period being then approximately  $0.5\text{ms}$  wide corresponding to a 2kHz tone. This allows a factor of approximately two for the bandwidth performance of any existing receiver, it being equally convenient to use a tone modulator transmitter or to use the i.c.w. mode and to detect the 27MHz carrier only in the receiver.

The maximum pulse length ( $\tau_3$ ) is determined as a reasonable relationship with regard to the interval time, being restricted to contain  $\tau_1$  to less than 50ms. If a slower system response time can be tolerated, as in the case of a scale model boat, the maximum pulse length could be increased to 10ms or alternatively more channels could be used.





# RADIO CONTROL

Use integrated circuits to simplify control functions

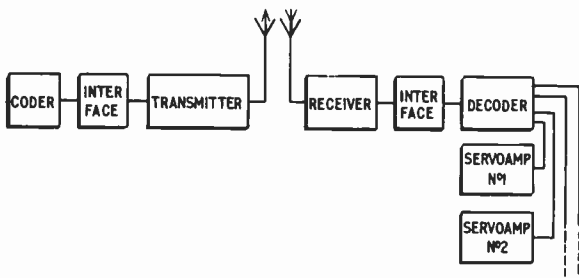


Fig. 1. Block diagram of a typical radio control installation

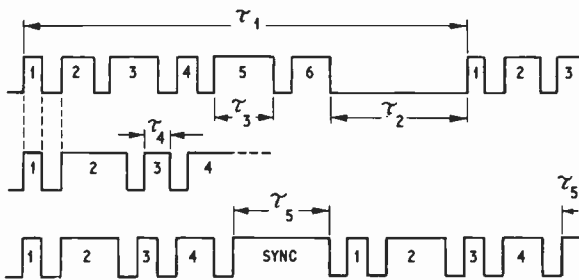


Fig. 2. Variable pulse lengths for proportional control

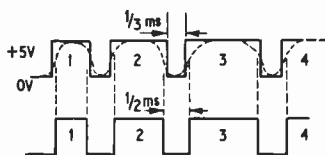


Fig. 3. The coder pulses are "softened" to almost sine wave shape for transmission to avoid troubles with short propagation times of square wave pulses

If only one channel, e.g. rudder, was required for maximum sensitivity, the corresponding maximum pulse length could be increased provided that the other channels in use were restricted operationally to prevent all the pulses being at maximum length, hence encroaching into the sync period  $\tau_5$ .

## CODER VARIANTS

Three variants of coder are described: coders 1 and 2A are similar in form providing alternative construction dependent upon the use of components that may be to hand. The cost of the timing capacitors becomes comparable with that of the "active" components. In these cases, the period  $\tau_1$  is fixed by using a multivibrator.

The coder 2B simply uses a longer positive-going pulse to provide the synchronising period shown as  $\tau_5$  in Fig. 2b; the channels are no longer being completely independent,  $\tau_1$  not being fixed. In this case the end of the synchronising pulse  $\tau_5$  is used to initiate the next pulse train.

The particular advantage is that, with some of the channel controls at minimum, a shorter system response time is possible. The disadvantage is that, operating any control, the corresponding pulse length is changed, in turn changing the total cycle time, and hence changing the measurement rate of the other pulses and their corresponding output.

Considering the case of a six-channel coder with all controls in the mid-position a pulse length of 2ms cycle time =  $(6 \times 2) + (6 \times \frac{1}{4}) + 6$  (synchro pulse) = 20ms. If one control is changed to maximum and its corresponding pulse length to 4ms, then the cycle time becomes 22ms.

The output signal derived from these pulses changes in the ratio  $\frac{2}{20} : \frac{4}{22}$  not 2 : 4 and the other channels outputs change by 20 : 22.

The greater the number of channels used, the less marked the loss of complete channel independence, and the greater the gain with respect to cycle and system response time.

**Table 1: MAKERS LOGIC I.C. TYPE NUMBERS**

Description	Logic type	Ferranti	Motorola	Mullard	SGS	Signetics	S.T.C.-I.T.T.
Quad 2-input NAND gate	TTL	ZN7400E	MC7400P	FJH131	6900259		
8-input NAND gate	DTL	ZN346E	MC846		6994659		MIC9495D
8-input NAND gate	TTL	ZN7430E	MC7430P	FJH101		N7430A	
Dual JK flip-flop	TTL	ZN7473E	MC7473P	FJJ121		N7473A	
Monostable	TTL	ZN7470E		FJJ101		N7470A	
Retriggerable Monostable	TTL				9601		
Monostable	DTL				T118		
Dual 4-input NAND gate with node	DTL	ZN330E	MC830P		6993059		MIC9305D

**DECODER**

The decoder consists of two parts, the sync separator using a retriggerable monostable, and a shift register formed from a chain of JK flip-flops.

The received positive-going pulses repeatedly trigger the special monostable which has a full back-off time of at least  $1\frac{1}{2} \times$  the maximum signal pulse length. It can change state therefore only during the sync period, this change of state being used to produce a special pulse which is applied to all the "clear" inputs of the JK flip-flops.

During the sync period the outputs of the flip-flops are set to "0", awaiting the train of signal pulses which are applied to all the "clock" inputs. One flip-flop is used to store a "1" which is successively moved down the chain (shift register) in steps coincident with the signal pulses.

The final individual output pulses from each flip-flop output is equal to the period of the signal pulse together with the following interval ( $\frac{1}{2}$ ms). Either one more flip-flop than the number of channels is used (to store a "1") or the last output is gated out as shown, the gating being associated with the decoder or one servo unit as desired.

**SUPPLY VOLTAGE**

For reliable operation the supply should be constant and between + 5.2 and + 5.7V. The most convenient way of obtaining this voltage for the coder is by the use of a good 6V battery in series with a 150mA diode. Precaution should be taken to prevent more than 6V being applied even momentarily, a Zener diode being used with the decoder.

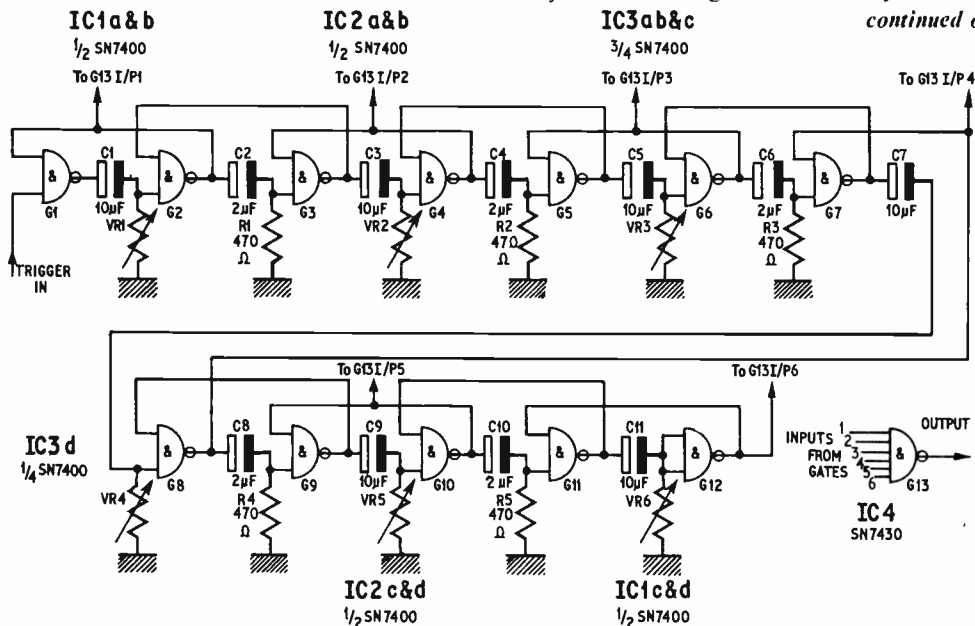
**CODER I**

The first coder is for six channels of positive going pulses. Four i.c.s only are used, one being an 8-input NAND gate (SN7430) to collate the outputs derived from an array of NAND gates (Fig. 4).

Pairs of these gates are used with a timing resistor and capacitor to give the signal pulse (for example, input 3 from G5 and G6 to G13) or the interval period ( $\frac{1}{3}$ ms) from G4 and G5.

The quad 2-input gate i.c. (SN7400) is used, therefore, to produce three timing periods and the series can be extended as desired. Eight channels would be a convenient limit unless G13 in IC7 is replaced by two or more gates followed by further grouping.

*continued on page 1003*



**Fig. 4.** The pulse lengths are determined and set by the potentiometers in the timing circuits. NAND gates are used to determine the timed sequence of pulses being fed to the master control gate G13

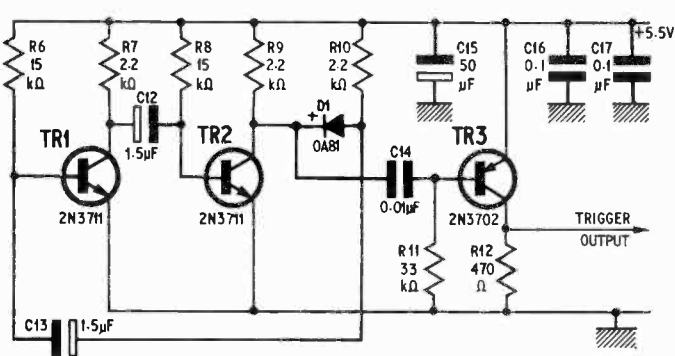


Fig. 5. Triggering is dependent on coincidence of an incoming clock pulse from this multivibrator and trigger circuit

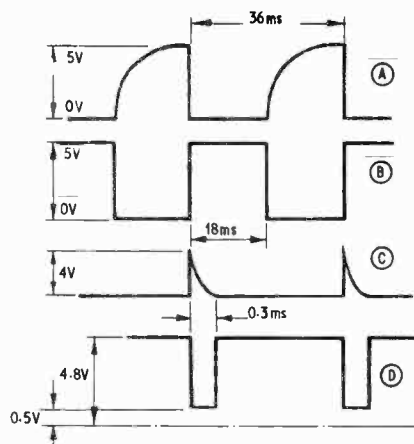


Fig. 6. The waveforms appearing at (a) TR1 collector, (b) TR2 collector, (c) TR3 base, (d) TR3 collector

## COMPONENTS . . .

CODER 1 (Figs. 4, 5, and 8)

### Resistors

- R1 to R5 470Ω (5 off)
- R6 15kΩ
- R7 2.2kΩ
- R8 15kΩ
- R9 2.2kΩ
- R10 2.2kΩ
- R11 33kΩ
- R12 470Ω
- All ±5%, 1/4W carbon

### Potentiometers

- VR1 to VR6 2.5kΩ for pre-selection of values, then replacement by fixed resistors (see text)

### Capacitors

- C1, C3, C5, C7, C9, C11 10μF tantalum or elect. 20V (6 off)
- C2, C4, C6, C8, C10 2μF polarised tantalum or elect. 25V (5 off)
- C12, C13 1.5μF elect.
- C14 0.01μF disc ceramic
- C15 50μF elect. 15V
- C16, C17 0.1μF disc ceramic (2 off)

### Integrated circuits

- IC1, IC2, IC3 SN7400 quad 2-input NAND gate (3 off)
- IC4 SN7430 8-input NAND gate

### Transistors

- TR1, TR2 2N3711 npn silicon
- TR3 2N3702 pnp silicon

### Diode

- D1 OAB1 or any 100mA signal diode

### Miscellaneous

- Fibreglass printed circuit board (see Fig. 7)

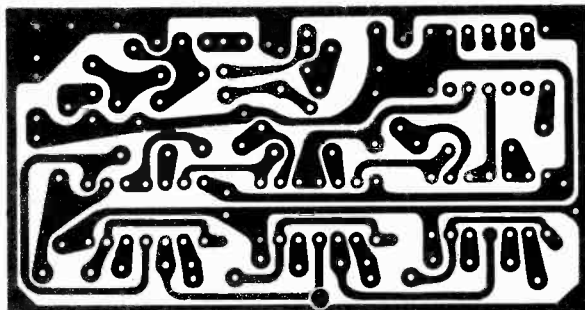


Fig. 7. The whole of "Coder 1" and clock pulse generator is made up on fibreglass printed circuit board; the pattern here is reproduced full size

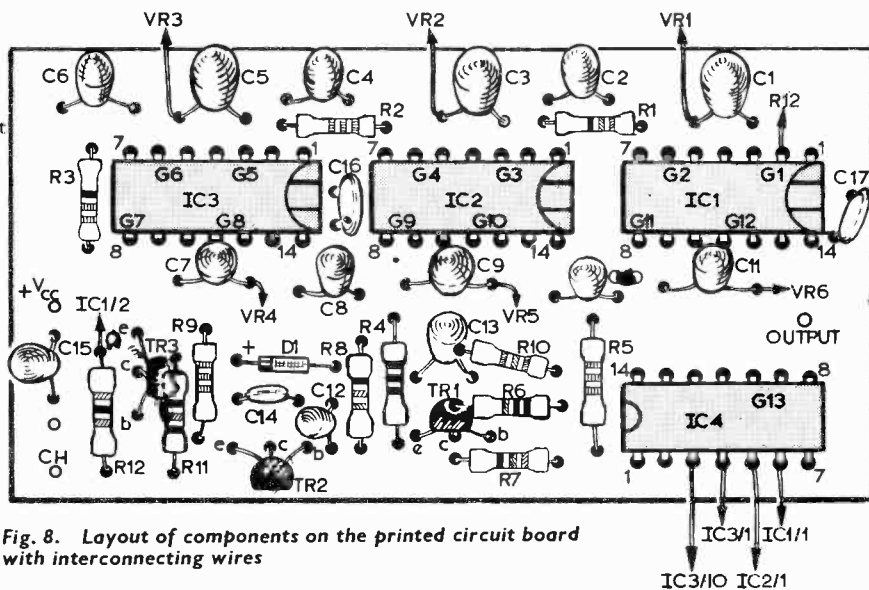


Fig. 8. Layout of components on the printed circuit board with interconnecting wires

# PATENTS REVIEW...

## INFLAMMABLE LIQUID LEVEL MONITOR

**A**n interesting new use of fibre optics occurs in BP 1 223 769 which is in the name of Maria and Giuseppe Panerai. Their Patent Specification is predominantly concerned with gauging the level of liquids in tanks.

Reading between the lines their main interest is in sensing the level of highly inflammable liquids such as petroleum where it is obviously far from ideal to use any electrical system in contact with the liquid. Of course, simple mechanical systems tend to be unreliable, especially if they are gravity dependent.

What these Italian inventors suggest is to arrange a sequence of prisms or equivalents in a vertical line, up from the base of the liquid tank, so that as the tank fills more and more prisms are submerged.

The prisms protrude from a removable pipe, each one backing onto a photosensitive cell. A lamp is fixed to the top of the tank so as to illuminate the interior. It is quite easy to see that, as the liquid level goes down, so more and more prisms will be exposed and illuminated and more and more photocells activated. The cells can be linked to any simple electronic circuitry outside the tank by wires with a consequent minimal risk of sparking and explosion.

But none of this concerns fibre optics so far. It turns up almost as an afterthought in one of the

examples given in the specification where it is suggested that instead of putting the photocells directly behind the prisms, i.e. in the pipe which is submerged in the liquid, the photocells can be arranged elsewhere and the light from the prisms taken to them by light pipes or optic fibres.

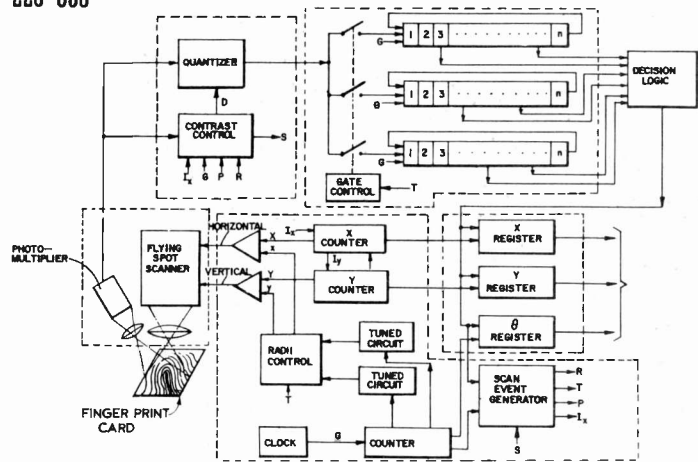
## AUTOMATIC FINGERPRINT IDENTITY

**T**HE North American Rockwell Corporation have a new British Patent BP 1 225 083 which applies to the automation of fingerprint

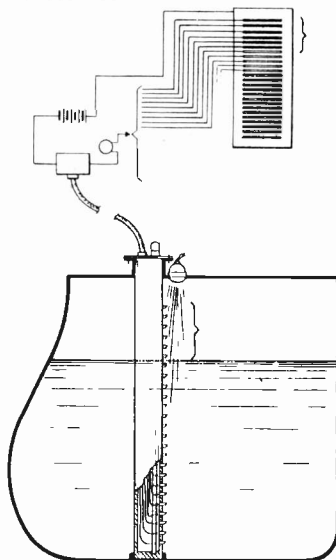
straightforward "off-the-shelf" electronics to provide means for scanning the fingerprint area. The major scan pattern has a minor scan pattern repeatedly superimposed over it.

The major scan pattern is a pre-determined linear pattern, which scans through a succession of relatively small area portions, and the minor pattern scans over each of these portions in a polar mode. This minor scan produces signals indicative of the pattern at that portion and these are stored in a bank of storage elements. The states of selected signals in these

BP 1 225 083



BP 1 223 769



checking. Rockwell start their specification with some sobering facts.

For instance, the FBI in America has a fingerprint file of over 182 million fingerprint cards, each having ten prints on it. So, if checking a suspect's prints against the records is to be finished in his lifetime, sophisticated automation is obviously necessary. What's more, with lost or stolen credit cards being an escalating problem, it may well be necessary one day to identify a legitimate card-holder by his fingerprints at the time of purchase.

Rockwell remind us that recognising the minutiae of a fingerprint is basically a problem in pattern recognition, which is complicated by the obvious fact that the minutiae occur at arbitrary orientations.

Whereas others have tended to concentrate on new techniques such as holography (matching prints with known masks), Rockwell propose a system which uses

storage elements are then sensed.

In more detail, Rockwell suggest the use of a flying spot scanner to derive an electrical analogue signal indicative of the fingerprint pattern at each small portion. This analogue signal is converted into digital form for storage and there is constant circulation of the signal in the memory through each of the storage elements so as to help the recognition of minutiae regardless of angular orientation.

An automatic contrast control circuit adjusts the detection process as a function of the general overall fingerprint image so that characteristics like ridge endings will produce distinctive light and dark areas to be encountered by the flying spot scanner moving in the orbits suggested.

Rockwell give plenty of details on suitable scanning techniques giving a total of 300,000 individual locations scanned on a single print. For present purposes, their block diagram gives the general picture.

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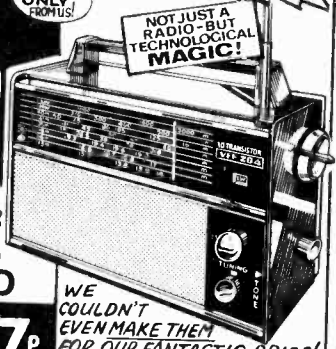
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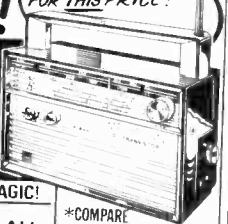
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4	150	3 0	8.9 x 6.4 x 7.6	0-115-200-220-240	1.74 36
66	300	6 0	10.2 x 10.2 x 9.5	.. ..	3.38 52
67	500	12 8	14.0 x 10.2 x 11.4	.. ..	5.03 67
84	1000	16 0	11.4 x 14.0 x 14.0	.. ..	9.12 82 *
93	1500	28 9	13.5 x 14.9 x 16.5	.. ..	13.22 *
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72	10	5	6 3 7.9 x 10.8 x 10.2	0-12V at 5A x 2	2.56 52
17	16	8	7 8 12.1 x 9.5 x 10.2	0-12V at 8A x 2	3.95 52
115	20	10	11 13 12.1 x 11.4 x 10.2	0-12V at 10A x 2	5.03 67
187	30	15	16 12 13.3 x 12.1 x 12.1	0-12V at 15A x 2	9.28 82 *
226	60	30	34 0 17.0 x 14.5 x 12.5	0-12V at 30A x 2	17.05 *

**30 VOLT RANGE**

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
112	0.5	1 4	8.3 x 3.7 x 4.9	0-12-15-20-24-30V	0.88 Np 22
79	1.0	2 0	7.0 x 6.4 x 6.0	.. ..	1.16 36
3	2.0	3 2	8.9 x 7.0 x 7.6	.. ..	1.75 36
20	3.0	4 4	10.2 x 8.9 x 8.6	.. ..	2.16 42
21	4.0	6 0	10.2 x 10.0 x 8.6	.. ..	2.56 52
51	5.0	6 8	12.1 x 10.0 x 8.6	.. ..	3.18 52
117	6.0	7 8	12.1 x 10.0 x 10.2	.. ..	3.79 52
89	10.0	12 2	14.0 x 10.2 x 11.4	.. ..	6.21 67

**50 VOLT RANGE**

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
102	0.5	1 11	7.0 x 7.0 x 5.7	0-19-25-33-40-50V	1.16 Np 30
103	1.0	2 10	8.3 x 7.3 x 7.0	.. ..	1.69 36
104	2.0	5 0	10.2 x 8.9 x 8.6	.. ..	2.34 42
105	3.0	6 0	10.2 x 10.2 x 8.3	.. ..	3.18 52
106	4.0	9 4	12.1 x 11.4 x 10.2	.. ..	4.20 52
107	6.0	12 4	12.1 x 11.4 x 13.3	.. ..	6.21 67
118	8.0	18 9	13.3 x 13.3 x 12.1	.. ..	8.10 92
119	10.0	19 12	16.5 x 11.4 x 15.9	.. ..	10.15 97

**60 VOLT RANGE**

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
124	0.5	2 4	8.3 x 9.5 x 6.7	0-24-30-40-48-60V	1.18 Np 36
126	1.0	3 0	8.9 x 7.6 x 7.6	.. ..	1.64 36
127	2.0	5 6	10.2 x 8.9 x 8.6	.. ..	2.56 42
125	3.0	8 8	11.9 x 9.5 x 10.0	.. ..	3.90 52
123	4.0	10 6	11.4 x 9.5 x 11.4	.. ..	5.03 67
120	6.0	16 12	13.3 x 12.1 x 12.1	.. ..	7.28 82
122	10.0	23 2	16.5 x 12.7 x 16.5	.. ..	12.05 *

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86	6.0	5 12	10.2 x 8.9 x 8.3	.. ..	2.67 52
146	8.0	6 4	8.9 x 10.2 x 10.2	.. ..	3.04 52
50	12.5	11 14	13.3 x 10.8 x 12.1	.. ..	4.52 67

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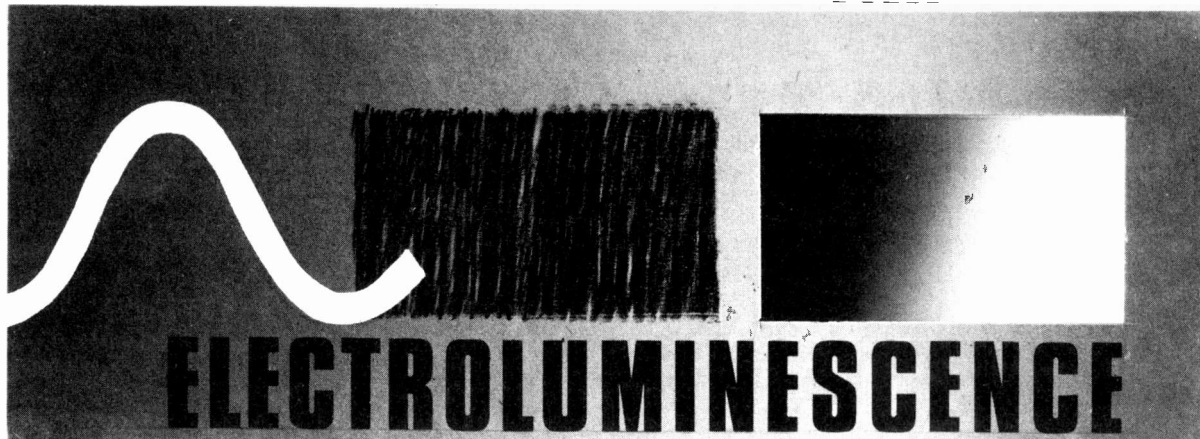
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By **K. J. Matthews** M.Sc.

**L**UMINESCENCE is the general term which is applied to the production of light, either visible or infra-red, by the direct conversion of some other form of energy. The general term is then subdivided to denote the particular energy conversion involved.

Therefore, the production of light from heat, an effect which has been known for some considerable time, is designated thermoluminescence. A more modern, but very popular effect, is cathodoluminescence. This is light from kinetic energy or particle bombardment and keeps millions of T.V. screens active.

**ELECTROLUMINESCENCE**

Other forms include chemiluminescence, and bioluminescence, which is a division of chemiluminescence and occurs in some deep sea fish and in glow-worms. Photoluminescence is a special case as it involves a light to light conversion, the emitted light differing from the stimulating radiation in frequency.

Finally, electroluminescence is the emission of light by direct conversion of electrical energy. The standard abbreviation for the effect is written EL. This process is not to be confused with the ordinary tungsten filament bulb, where there is an intermediate stage of heat making the process thermoluminescent.

A few EL devices are now available to the public. Unfortunately these are as yet only infra-red emitters, but visible light devices do exist and are certain to become available in the near future.

**USES**

Uses for these devices are self evident. In most cases they can be substituted wherever small panel lamps are employed, and their higher efficiency will

make them suitable for use with battery powered equipment. Numerical displays have been fabricated and because conventional read-out tubes require high voltages, EL devices of this type are likely to become very popular.

At the present stage in the development of EL devices, their use for general lighting seems a little remote. They cannot compete with fluorescent lighting for efficiency and only give monochromatic light.

It is not the aim of this article to describe practical applications but to give some insight into the mechanism of EL and of trends in present day research.

**SEMICONDUCTOR BAND STRUCTURE**

Some knowledge of semiconductor band theory is necessary before any understanding of electroluminescence is possible. Unfortunately this can be very complex and it is only possible to scratch the surface of the topic.

Fig. 1 depicts a semiconductor in energy band form. It consists of two bands, the conduction band and the valence band with an energy gap separating them. Electrons cannot exist with energies within this gap, and for this reason it is known as the forbidden gap or region.

For an electron to move from a valence band to a conduction band, it must "jump" the energy gap. A gradual transition is not allowed.

If the semiconductor has no energy, the conduction band will be void of electrons and the valence band full. In this state it is electrically inert—an insulator. However, a semiconductor always has some energy by virtue of its temperature, and this causes electrons to be propelled across the gap into the conduction band.

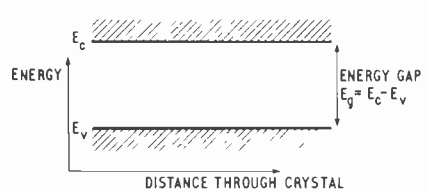


Fig. 1. Simple energy band diagram of a semiconductor

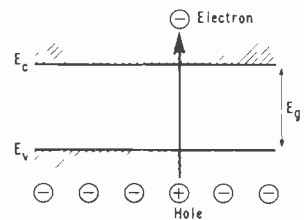


Fig. 2. The excitation process

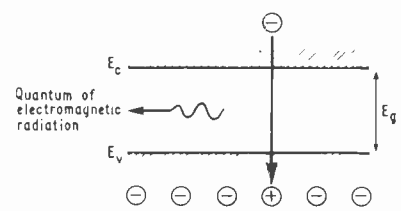


Fig. 3. Radiative recombination

To do this it is necessary that an electron receives an amount of energy at least equal to the energy represented by the width of the forbidden gap to enable it to make the jump. If it receives less it will not be able to do so. As we will see later, the size of the gap is constant for a particular semiconductor and is measured in terms of energy, in electron-volts (eV).

## EXCITATION

When an electron receives sufficient energy to jump the gap to the conduction band, it leaves behind in the valence band a vacancy known as a "hole." See Fig. 2. It is convenient to think of these holes as positive electrons, but with reduced mobility.

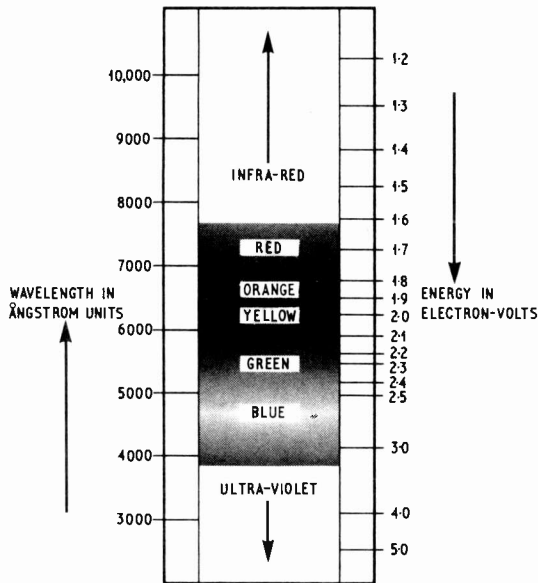


Fig. 4. Wavelength to energy conversion chart

If energy is now injected into the semiconductor for a short time and then removed, the internal equilibrium of the semiconductor is upset. There will be too many electrons in the conduction band and the semiconductor is said to be in an excited state.

There are many ways in which equilibrium may be restored. Here are three of the more important processes:

- (1) the electrons may be ejected from the material entirely—similar to thermionic emission.
- (2) the electrons may impart their energy to the crystal lattice of the semiconductor causing its atoms to vibrate. These vibrations are known as phonons.
- (3) the electrons may fall back across the gap to occupy holes in the valence band, emitting as it does so, quanta of electromagnetic radiation, the frequency of which is determined by the width of the forbidden gap. This process, known as electron-hole recombination, is illustrated in Fig. 3.

These three processes, and others unmentioned, all occur in any semiconducting material simultaneously competing with each other. It is obviously the latter radiative process which is of interest to

EL, and it is desired that this be the main process if good light emitting efficiencies are to be obtained.

## CRITERIA FOR ELECTROLUMINESCENT MATERIAL

In some semiconducting materials a radiative transition can only be achieved after a process of the phonon type has occurred. This is a characteristic of the material and cannot be altered. As this process is a two stage one, the energy gap of the semiconductor is known as indirect, or the material is called an indirect semiconductor.

In other materials, known consequently as direct semiconductors, the radiative transition occurs singly. Other processes still compete but these are minor compared to the serious drawback of an indirect energy gap. They can in any case often be minimised by reducing the temperature of operation of the semiconductor if super-efficiency is required.

Clearly then, the first criterion for an electroluminescent material is that it be direct. The second is the width of the energy gap, as this determines the frequency of the emitted light.

According to quantum physics, energy and frequency of light are related by the equation.

$$\text{Energy} = h \times \text{frequency}$$

where  $h$  is Planck's constant =  $6.62 \times 10^{-27}$

$$\text{Since frequency} = \frac{\text{velocity}}{\text{wavelength}}$$

the energy equation becomes

$$\text{Energy} = \frac{h \times \text{velocity of light}}{\text{wavelength of light}}$$

Substituting for  $h$  and velocity of light and converting to convenient units yields

$$\text{Wavelength in angstrom units (\AA)} = \frac{12,400}{\text{Energy in electron volts (eV)}}$$

The visible spectrum runs from 8,000Å (red) to 4,000Å (blue) which on conversion gives red as equivalent to 1.55eV and blue to 3.0eV.

To recapitulate, the semiconductor must have a direct gap, and this must lie within the range, 1.55 to 3.00eV for visible light emission. If the gap is narrower than 1.55eV, infra-red emission will be obtained. See Fig. 4.

## DEVICES

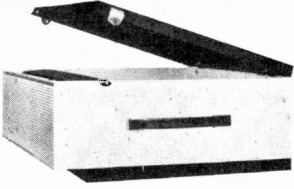
Before investigating the available EL materials consideration must be given to the method of its use in the production of a useful device.

As we have seen the trick lies in the method by which non-equilibrium conditions are set up in the semiconducting material. This can be done by any form of energy input, but for EL it must obviously be brought about by electrical energy. There are two known ways of doing this, and this causes a split in the research into EL devices as the resulting products are so unlike.

The older method is the electroluminescent panel in which excitation is brought about by a high electric field although the full theory is not understood.



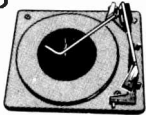
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32/450V	20p	8+8/450V	18p	32-32/450V	33p
25/25V	10p	8+16/450V	20p	350+50/325V	50p
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CERAMIC 1pF to 0.01mF, 4p. Silver Mica 2 to 5000pF, 4p. PAPER 350V-0.1pF, 0.5 13p; 1mF 15p; 2mF 150V 15p. 500V-0.001 to 0.05 4p; 0.1 6p; 0.25 8p; 0.47 25p. SILVER MICA. Close tolerance 1%, 2-2-500pF 5p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0.01, mid 30p each. TWIN GANG. "0-0" 208pF+178pF, 50p; 500pF slow motion, standard 45p; small 3-gang 50p £1.60.

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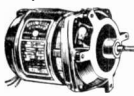
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### BODINE TYPE N.C.I. GEARED MOTOR



(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, 0.38 amp. (Type 2) 28 r.p.m. Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, 0.28 amp.

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5 amp. c/o contacts. Fitted with removable push button assembly. Ex. P.O. 20 for £1 inc. post. (Min. order 20)



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2.5 AMP

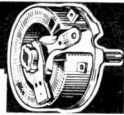
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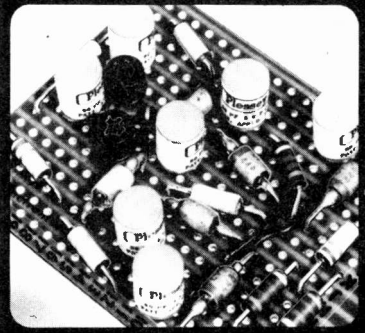
#### MINIATURE RELAYS - COMPETITIVE PRICES

1				2				3				4			
45	6-9	2 HD M	50p	700	15-35	2 c/o HD	73p*	185	6-12	4 c/o	73p*	700	16-24	6M	63p*
230	9-12	4 c/o	78p*	1,250	24-36	4 c/o	63p*	280	9-12	2 c/o	73p*	2,500	36-45	6M	63p*
600	18-32	4 c/o	78p*	2,400	30-48	4 c/o	50p	700	16-24	4M 2B	63p*	5,800	40-70	4 c/o	63p*
700	16-24	4 c/o	78p*	9,000	40-70	2 c/o	50p*	700	16-24	4 c/o	63p*	15k	85-110	6M	50p*

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price (HD) Heavy Duty. All Post Paid. \*Including Base.

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This method has been known for some time but modern materials research has improved the EL panel vastly, making d.c. operation feasible where before only a.c. was possible.

### STRUCTURE OF PANEL

The basic construction of a panel is simple, see Fig. 5, although more complicated, and more efficient geometries have been produced. In a d.c. display, the backing electrode which is the cathode is made of aluminium.

The anode, through which the light must pass, is of glass treated in such a way as to make it conductive. This is accomplished by placing a very thin coating of tin oxide on its surface, by vacuum evaporation or by a chemical method, so that it remains transparent.

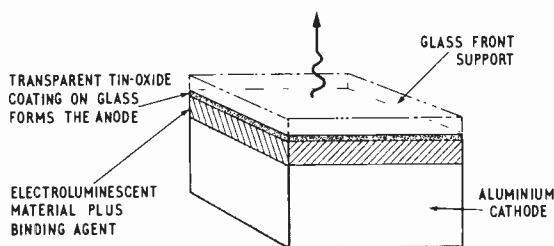


Fig. 5. Structure for a simple type of EL panel

The electroluminescent material is then mixed with a binding agent and spread very thinly between these electrodes, so that a high field is produced by a comparatively low voltage, typically 50 microns for 20 to 30 volt operation.

A newer method of stimulating EL and one which has been causing a great deal of interest, is based on the pn junction. The theory of this method of operation is better understood than the EL panel which still presents large areas of mystery.

If we suppose that a suitable material is available in both forms, i.e. *p*- and *n*-type, then a pn junction may be formed to make a diode.

In any junction diode, recombination of electrons and holes occurs at the junction when the diode is conducting in the forward direction as this is basic to its operation. If the semiconductor favours radiative recombination then the result will be light emission from the junction, produced directly by the passage of electric current through the diode.

To enable the light to escape the device, special geometries have to be employed in the manufacture of a crystal lamp if the bulk of the material is not to re-absorb it. Basically this means making a large area junction and arranging the emitting surface so that total internal reflection does not occur, which is by no means an easy job with the high refractive indices of most semiconductors. One type of arrangement is shown in Fig. 6.

### MATERIALS FOR ELECTROLUMINESCENCE

How many materials are useful or potentially useful semiconductors? Germanium and silicon certainly and gallium arsenide is by now fairly well

known, but the list doesn't stop there. Hundreds more are possible of which only a few as yet have been investigated. It would seem therefore that suitable EL materials would be commonplace but, unfortunately, this does not appear to be the case.

In the crystal lamp field if not in EL panels there is a desperate need for a good semiconductor. This shortage has led to the employment of one or two sophisticated tricks but the problem is by no means satisfactorily solved.

Consider the common semiconductors to see how they conform to the criterion laid down earlier. Germanium—indirect gap of 0.66eV, silicon—indirect gap of 1.08eV, both clearly of little use being so far in the infra-red as to make them inconvenient even if they were direct.

Gallium arsenide however is clearly much more

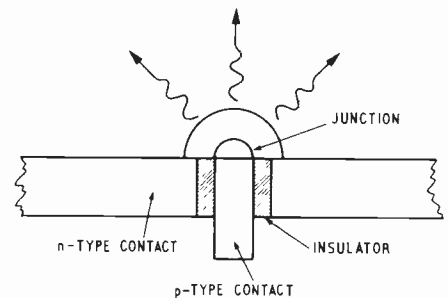


Fig. 6. Hemispherical structure of crystal lamp

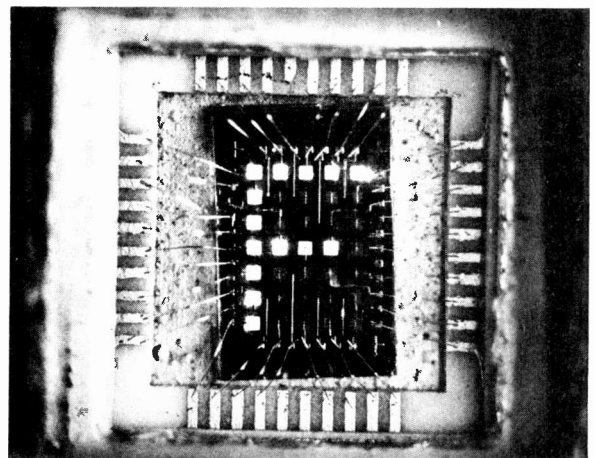
promising, having a direct gap of 1.5eV, tantalisingly close to visible. The available devices, 56CAY, MGA100, are made from gallium arsenide.

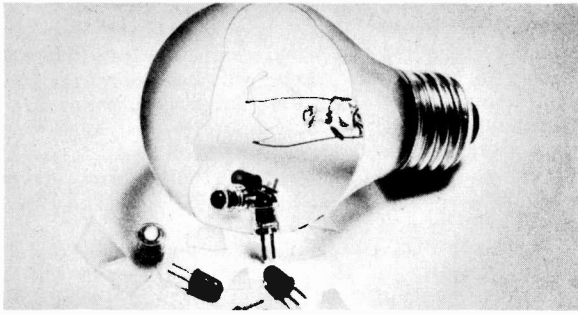
### PERIODIC TABLE

Why is gallium arsenide a semiconductor? A glance at a section of the periodic table of the elements, Fig. 7, throws some light on this question and indicates where we may look for additional material.

We see that germanium and silicon lie in group IV as do tin and carbon. As diamond can be regarded as a semiconductor and so, under certain

**An array of 35 gallium phosphide lamps within a package overall size  $\frac{1}{4}$ in  $\times$   $\frac{1}{2}$ in approximately. In this photograph, the lamps have been illuminated to form the initial letter of the maker's name, Ferranti**





**Plastic encapsulated gallium arsenide phosphide red light emitting diodes made by Hewlett-Packard. These solid state lamps are designed for panel mounting or for printed circuit board mounting**

conditions, can tin, there seems to be something about group IV elements which have some connection with semiconducting properties.

If one element from group III is combined with one from group V, this also produces a semiconductor. These are known as compound semiconductors or compounds and gallium arsenide falls into this class.

II	III	IV	V	VI
	B	C	N	O
	Al	Si	P	S
Zn	Ga	Ge	As	Se
Cd	In	Sn	Sb	Te
Hg	Tl	Pb	Bi	Po

**Fig. 7. Section of the Periodic table of the elements**

In a similar fashion II-VI compounds are possible. Thus many semiconducting materials are possible and the more well known ones are listed in Table I, with their relevant parameters.

Confining ourselves to direct gap materials restricts the field considerably. All of the group IV elements are excluded, as well as three of the III-V compounds, the potentially useful three moreover. This leaves gallium arsenide as the compound with the largest direct gap, but this as we have seen is not good enough for visible EL.

At first sight the II-VI compounds are much more promising, zinc and cadmium sulphides both seem ideal, and indeed they are employed in the EL panel form of device. These materials, however, resist all attempts to grow them in both *p* and *n*-type forms and therefore crystal lamps cannot be constructed from them.

## DOPING

The position for visible light crystal lamps would appear then to be hopeless, but two tricks are possible which partially solve the problem. Firstly, an indirect gap material with a larger than necessary gap can be used. Doping agents can be added to them which will create energy levels in the forbidden gap, effectively reducing it in size and giving it the characteristics of a direct gap.

Gallium phosphide doping in this way with zinc and oxygen will give a red emitting diode and the highest efficiency that has recently been obtained is in the order of 7 per cent. Inefficient green luminescence may also be produced from gallium phosphide, of approximately 0.1 per cent but this is

stretching the material's capabilities. Gallium phosphide of the high quality needed cannot, as yet, be consistently produced.

## MIXED CRYSTALS

The second trick consists of the formation of a mixed crystal. Most of the III-V compounds are intermixable, that is, they can be grown together as a single, homogenous crystal. If in the growing of gallium arsenide for example, a proportion of phosphorus is added to the molten material, the resultant crystal contains a percentage of gallium phosphide.

This is a mixed crystal and should not be considered to be a mixture of gallium arsenide and gallium phosphide, but as a crystal of gallium arsenide phosphide, written  $GaAs_xP_{1-x}$ , the *x* indicating a whole range of compositions from pure gallium arsenide to pure gallium phosphide.

As gallium arsenide is direct and gallium phosphide is indirect, somewhere in the mixed crystal composition there must be a change over from the one type of de-excitation to the other, and it is possible to increase the energy gap for a considerable way before it becomes indirect.

Red emitting lamps from gallium arsenide phosphide are possible if the crystal is grown with the correct composition. These lamps are becoming quite common in professional areas and it must only be a matter of time before they are generally available.

This is the state of the art at present as regards the crystal lamp field. Several other mixed systems have been tried and are workable propositions but they still only produce red light diodes. Present research is searching, rather desperately, for an efficient green emitter.

**Table I: PROPERTIES OF THE BETTER KNOWN SEMICONDUCTORS**

Material	Type	Formula	$E_g$ (eV)	De-Excitation Process
Diamond	IV	C	5.2	indirect
Silicon	IV	Si	1.08	indirect
Germanium	IV	Ge	0.66	indirect
Silicon Carbide	IV	SiC	2.9	indirect
Gallium Arsenide	III-V	GaAs	1.5	direct
Gallium Phosphide	III-V	GaP	2.25	indirect
Gallium Antimonide	III-V	GaSb	0.67	direct
Indium Arsenide	III-V	InAs	0.36	direct
Indium Phosphide	III-V	InP	1.29	direct
Indium Antimonide	III-V	InSb	0.17	direct
Aluminium Phosphide	III-V	AlP	3.00	indirect
Aluminium Antimonide	III-V	AlSb	1.62	indirect
Zinc sulphide	II-VI	ZnS	3.7	direct
Cadmium Sulphide	II-VI	CdS	2.6	direct
Cadmium Telluride	II-VI	CdTe	1.45	direct
Cadmium Selenide	II-VI	CdSe	1.74	direct

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2N697	18p	2N2925	22p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	12p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	11p	BSX20	16p
2N1131	29p	2N3055	60p	AC133K	22p	BC159	12p	C407	17p
2N1132	29p	2N3702	13p	AC176	16p	BC167	11p	MCI40	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	10p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	11p	MPS6534	30p
2N1304	26p	2N3705	13p	AD140	63p	BC177	14p	NKT211	25p
2N1305	26p	2N3706	13p	AD142	50p	BC178	13p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	58p	BC179	14p	NKT214	23p
2N1307	33p	2N3708	10p	AD161	33p	BC182L	11p	NKT274	18p
2N1308	36p	2N3709	11p	AD162	36p	BC183L	10p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	24p	BC184L	11p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	24p	BC212L	16p	OC71	38p
2N1711	26p	2N3819	23p	AF117	22p	BC213L	16p	OC81	25p
2N1893	54p	2N3904	35p	AF124	24p	BC214L	16p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	22p	BCY70	7p	ZTX300	14p
2N2181	33p	2N4058	13p	AF139	33p	BCY71	13p	ZTX301	16p
2N218A	44p	2N4059	11p	AF239	16p	BF15	15p	ZTX302	16p
2N2219	38p	2N4060	11p	ASY26	27p	BF15	23p	ZTX303	22p
2N2219A	53p	2N4061	11p	ASY28	27p	BF167	18p	ZTX304	27p
2N2270	62p	2N4062	12p	BC107	12p	BF173	19p	ZTX500	18p
2N2369A	19p	2N4124	18p	BC108	11p	BF194	14p	ZTX501	21p
2N2483	35p	2N4126	27p	BC109	12p	BF195	15p	ZTX502	25p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	23p
2N2646	47p	2N4286	15p	BC126	15p	BFX29	25p	ZTX504	52p
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C	1/8W	5%	4.7 $\Omega$ -470K $\Omega$	E24	1	0.8	0.7
C	1/4W	10%	4.7 $\Omega$ -10M $\Omega$	E12	1	0.8	0.7
C	1/2W	5%	4.7 $\Omega$ -10M $\Omega$	E24	1-2	1	0.9
CO	1W	10%	4.7 $\Omega$ -10M $\Omega$	E12	2-5	2	1.9
WW	1/2W	2%	10 $\Omega$ -1M $\Omega$	E24	4	3-5	3
WW	1W	10% $\pm$ 1/20 $\Omega$	0.22 $\Omega$ -3.9 $\Omega$	E12	7	7	6
WW	3W	5%	12 $\Omega$ -10K $\Omega$	E12	7	7	6
WW	7W	5%	12 $\Omega$ -10K $\Omega$	E12	9	9	8

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WW=wire wound, Plessey.

Values:  
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.  
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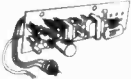
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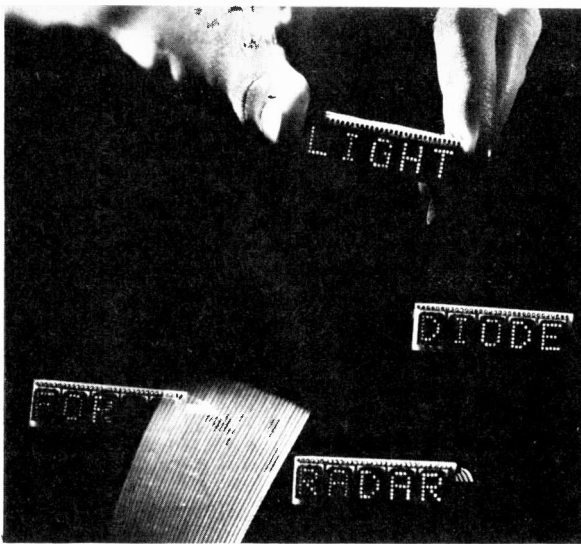
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The crystal systems  $\text{In}_x\text{Ga}_{1-x}\text{P}$  and  $\text{In}_x\text{Al}_{1-x}\text{P}$  are the most promising materials as yet investigated as they can provide direct energy gaps of the order of 2.2eV. These materials are exceptionally difficult to grow, however, and while InP-GaP can be grown to the right composition, InP-AlP has not yet been produced.

Even if these materials were available, they only give green, what do we do to obtain blue? At this stage we enter the realms of conjecture, the nitrogen III-V compounds, largely unknown, appear to hold out some promise although they have a different crystal structure to all of the other semiconductors mentioned here. Aluminium nitride and gallium nitride appear to be the favourites for investigation.

#### FOR THE FUTURE

With their limitations therefore, both crystal lamps and EL panels are working propositions. The red crystal lamp is quite well established and will undoubtedly become a part of the vast range of common semiconducting devices, but the EL panel is held up by one snag—its short working lifetime. This is caused by impurities slowly diffusing into the luminescent material and is a major problem, which until it can be overcome, will limit its usefulness seriously.

The "flat" television screen seems to be a very long term project indeed. A panel's electrodes can be patterned so that any particular part of the screen may be addressed in a similar manner to a computer memory matrix, but the definition possible by this method is severely limited and in any case only one colour is possible.

When green and blue crystal lamps are available perhaps this will provide the answer, but the inter-connection problems with such a vast number of individual elements is enough to make even the bravest engineer apprehensive.

However, these problems are not insurmountable since the Sony Corporation have shown, by presenting full colour TV on a large screen consisting of a vast array of red, green and blue light bulbs. It remains therefore to obtain the devices and then await the consequences.



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In this the second and final part, constructional details for the electronic ignition system are given together with installation instructions and testing procedures, for both positive and negative earth cars.

## CONSTRUCTION

The prototype system was housed in a  $7\frac{1}{4}$ in  $\times$   $4\frac{1}{2}$ in  $\times$  2in Eddystone die-cast box. All the components are mounted on the printed circuit board (Fig. 11) with the exception of the transformer, TR4, TR5 and the thyristor. These are bolted to the case which acts as a heatsink.

## PRINTED CIRCUIT BOARD

It is strongly recommended that turret tags be used to make connection to the printed circuit board and these should be inserted and soldered before any of the components are mounted. Fig. 12 shows the component locations.

## INVERTER TRANSFORMER

The inverter transformer T1 is wound on a Mul-lard FX2243 pot core with a DT2206 bobbin and should preferably be impregnated when finished to keep out moisture which could cause leakage or damage to the windings of the transformer.

The first job is to wind on 400 turns of 34 s.w.g. enamelled wire in eight neat layers of fifty turns, with thin insulation between each layer. Take great care not to cross adjacent turns. This high voltage winding is now insulated from the others with about four layers of insulation tape.

Now wind on 12 turns of 20 s.w.g. bifilar (i.e. two wires wound together) in two layers, and lastly the three turns of 30 s.w.g. bifilar feedback winding. The wires should be colour coded with sleeves as shown in Fig. 13 and another layer of insulation tape wrapped around the bobbin. Try to ensure that the sleeves go as far as possible into the bobbin so that when it is placed inside the ferrite cups the enamel insulation is not scratched by the core.

If the core cannot be impregnated then it is recommended that the faces are firmly joined with a thin layer of Araldite or the transformer may shriek objectionably. This does not happen of course if the transformer is impregnated.

The reliability of the whole system depends on the care with which the transformer is made.

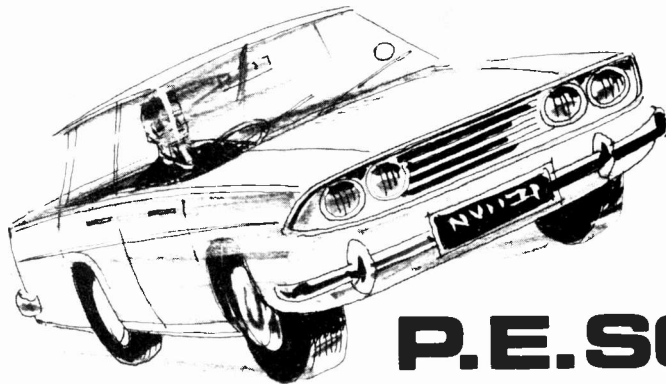
## UNIT ASSEMBLY

The box should be drilled as shown in Fig. 14 and the holes deburred with larger drills, taking care to remove any roughness where the mica washers are to be placed for TR4, TR5 and the thyristor.

All the components can now be assembled in the box ready for the final wiring. Cadmium plated nuts and bolts should be used, with the exception of the bolt securing the thyristor, since steel ones will soon rust.

Interwiring details for the ignition system are given in Fig. 15.

The thyristor should be mounted with a nylon bolt to remove the possibility of any flash over at this point due to the high voltages. The transistors



# P.E. SCORPIO CAR IGNITION

By **D. S. GIBBS** and **I. M. SHAW** (Ferranti Ltd)



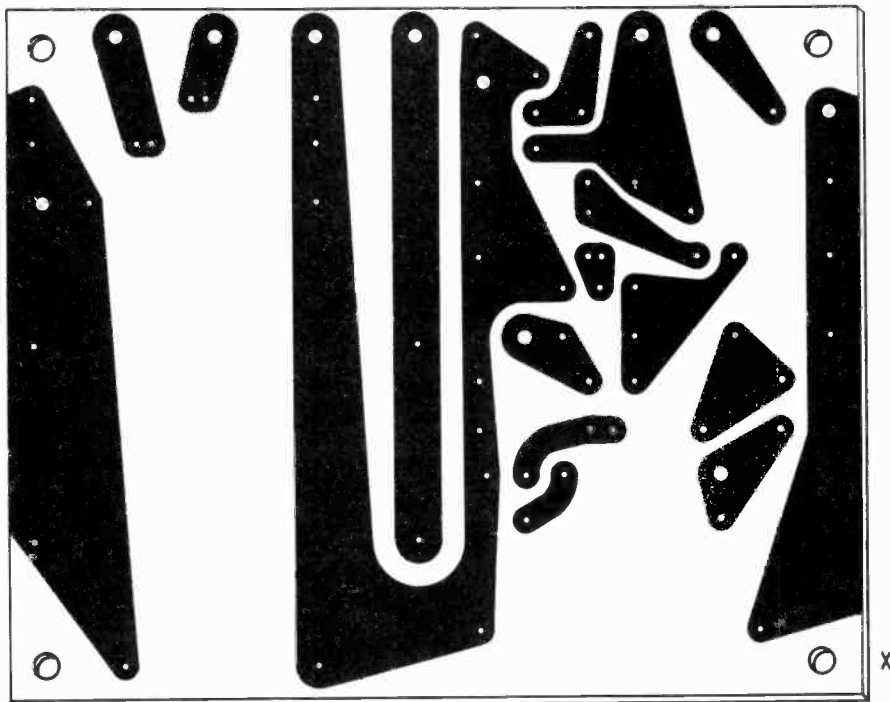


Fig. 11. Printed circuit board for ignition system, shown full size

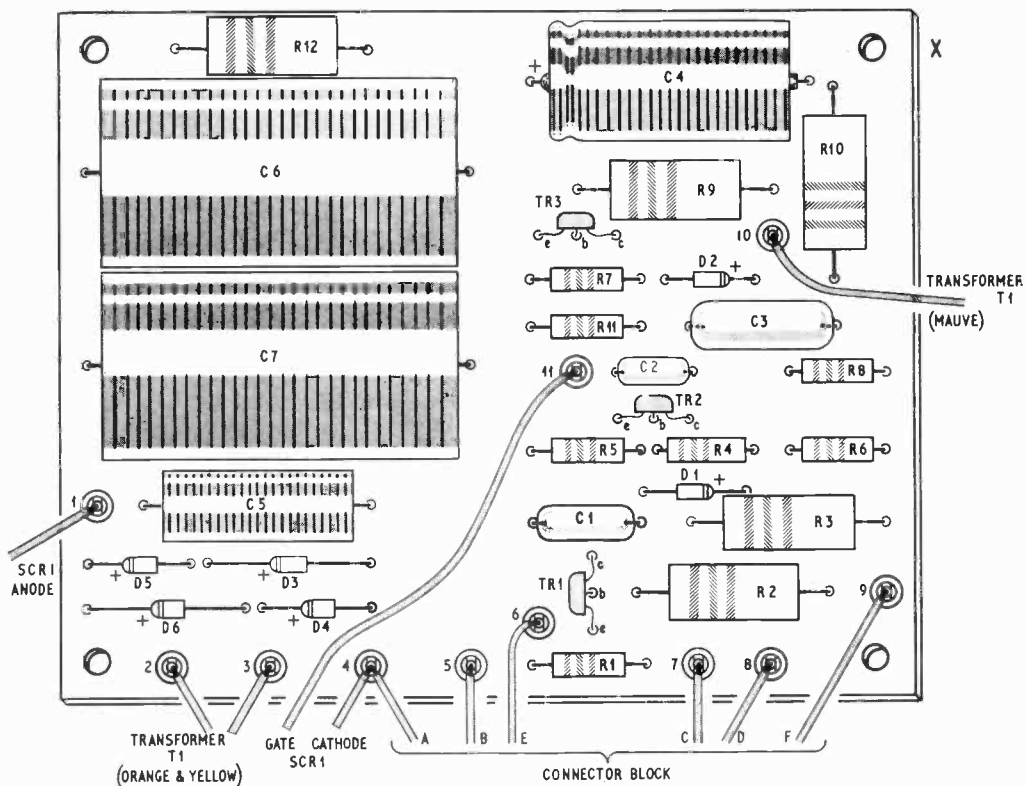


Fig. 12. Component layout and wiring for printed circuit board

... reliability depends on careful transformer construction

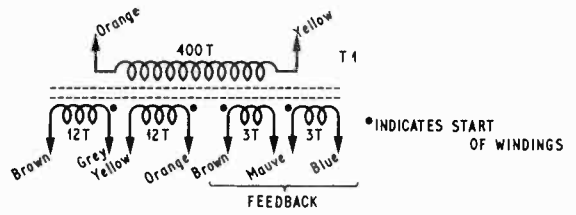


Fig. 13. Winding details, for inverter transformer

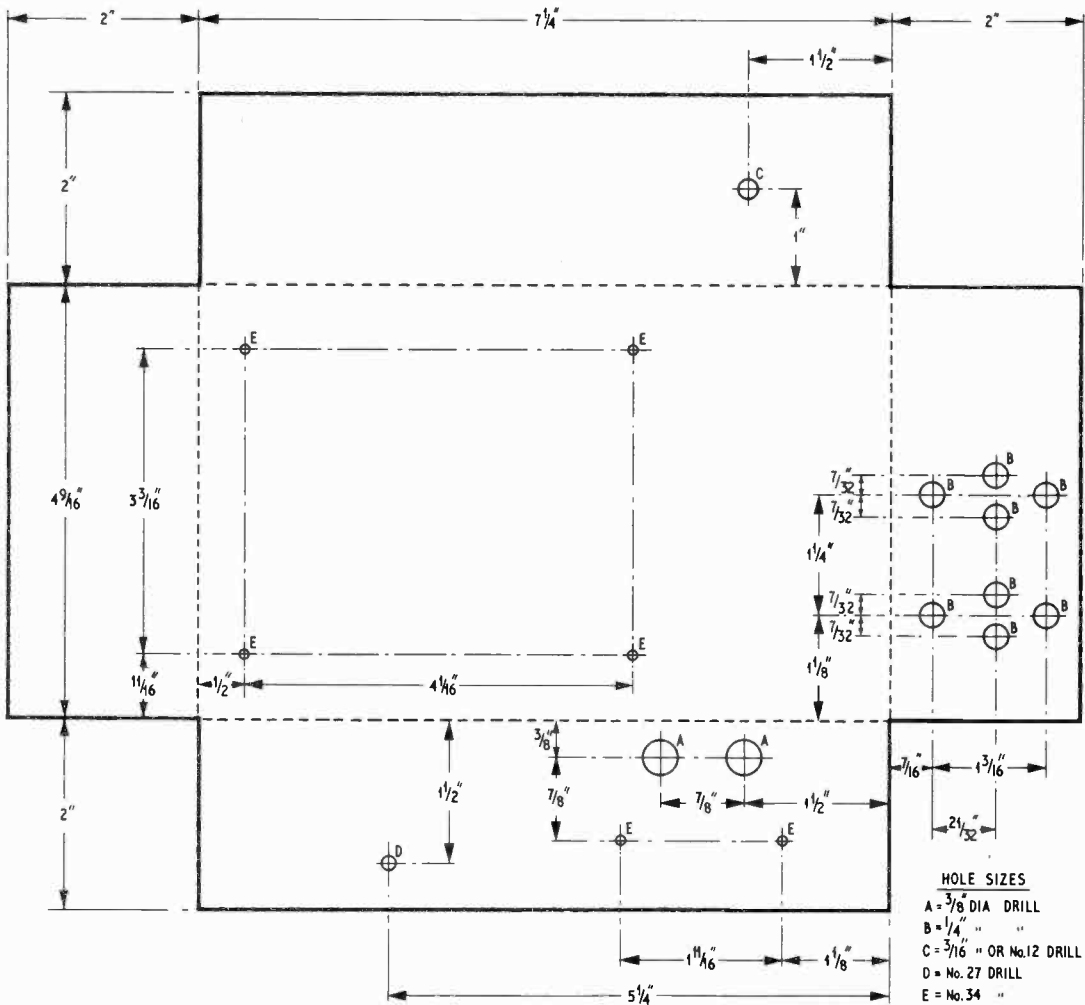


Fig. 14. Drilling details for die-cast box

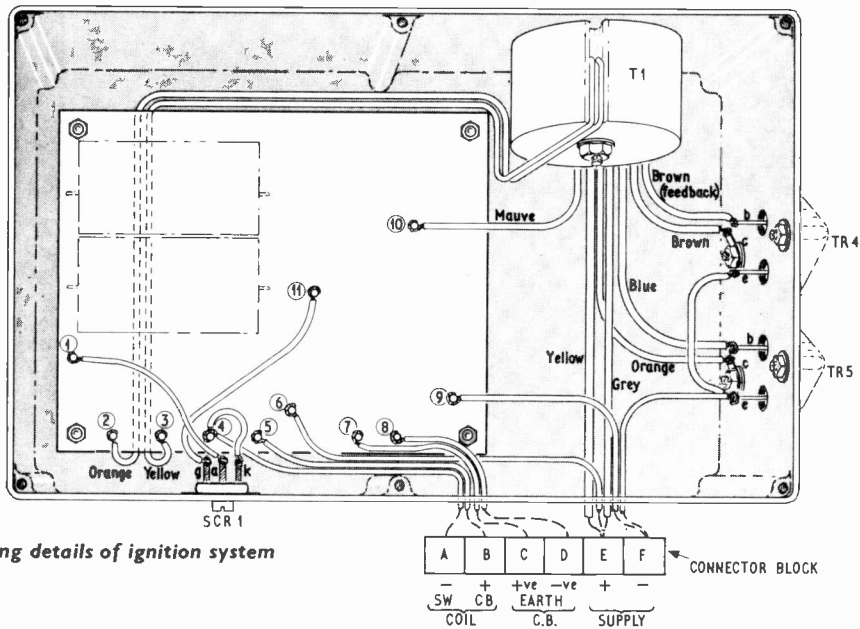
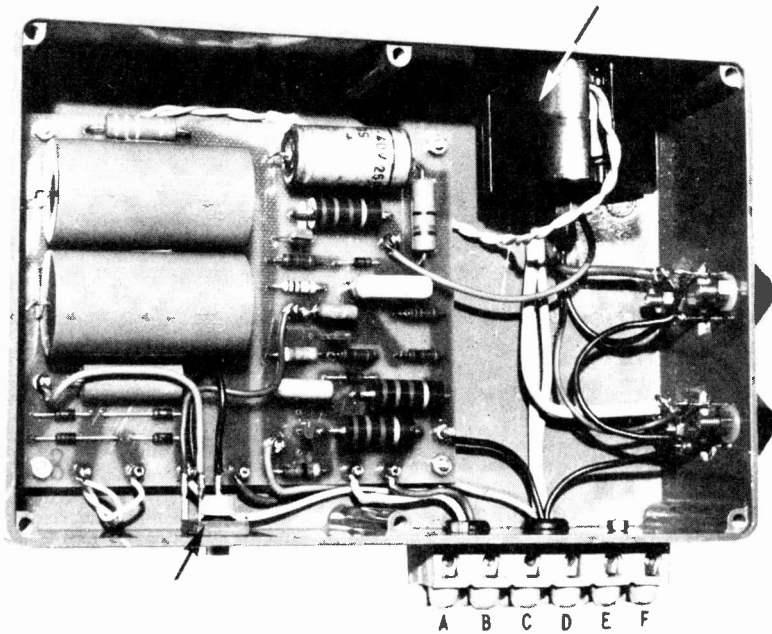


Fig 15. Interwiring details of ignition system

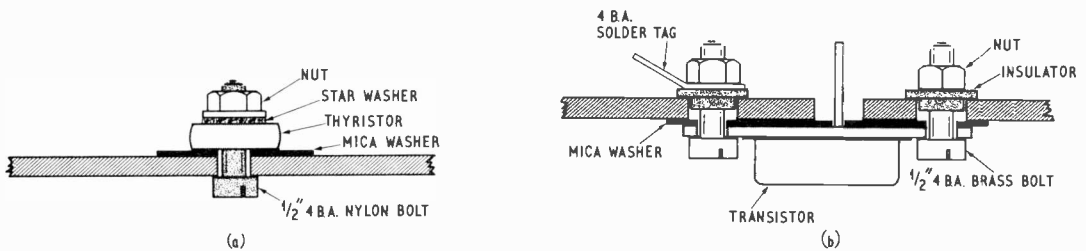
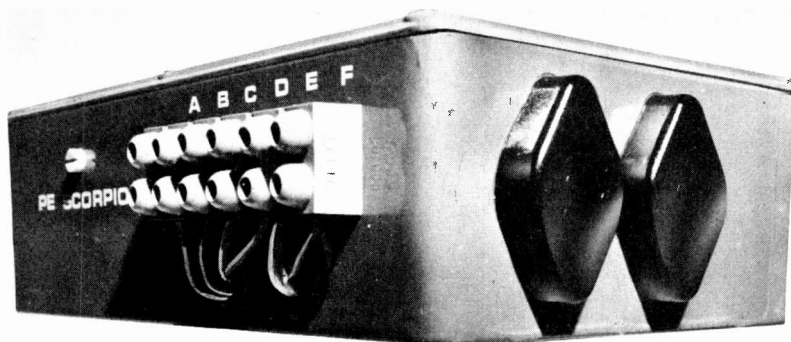


Fig 16. (a) Mounting details for thyristor. (b) mounting details for inverter transistors



Plastic covers are fitted over the inverter transistors to prevent accidental short circuits

TR4 and TR5, and the thyristor, must be mounted on mica insulating washers as indicated in Fig. 16 with solder tags on the lower two transistor fixing screws for the collector connections. Plastic covers should be fixed to the transistors to prevent accidental short circuits when the unit is installed in the car.

The printed circuit board is mounted on spacers of about  $\frac{1}{4}$  in length. Use a spring washer between the transformer mounting bolt and the core so that the transformer can be secured firmly without danger of cracking the ferrite core.

The unit can now be wired with 14/0076 wire in assorted colours for identification. Care must be taken to connect the transformer windings correctly or the inverter will not oscillate.

The wires to the six-way connector block are brought out via two grommets just below it.

### CHECKING THE UNIT

After checking the wiring carefully some simple checks should be performed before installation, if the constructor does not have facilities to fully test the operation of the unit.

If the construction has been carried out as described using only good quality components the only check necessary is that the inverter transformer windings have been correctly connected and that it delivers the correct output voltage.

To do this connect the car battery between (E) and (F) on the connector block. The transformer should be heard to "sing" immediately and approximately 500 volts d.c. can be measured between tags 1 and 4 on the printed circuit board (positive on tag 1). If this is not correct then the phases of the transformer windings will have to be examined and corrected before installation.

The current taken from the battery is approximately 500mA when the inverter is operating correctly.

### INSTALLATION

All connections from the car for both positive and negative earth are made to the connector block, but since there are some differences they will be explained separately.

First, a suitable place in the engine compartment should be found to mount the unit so that the wires can be cut to the correct lengths. In both systems the wire connecting the ignition coil to the contact breaker must be removed but kept, so that the car can be reconstructed to the conventional system if necessary at any time.

### POSITIVE EARTH CARS

The wire or wires connected to the SW or negative terminal of the ignition coil for positive earth systems, must be connected instead to the negative supply input to the unit (F) since this supply is via the ignition switch.

The two connections between the unit and the coil are made next; SW or negative to (A) and CB or positive to (B). These must be the only connections to the coil terminals.

The contact breaker is connected to (C) and good earth from the car chassis or positive battery terminal to (E). There are a total of five wires to the unit for positive earth cars with contact (D) left disconnected.

### NEGATIVE EARTH CARS

The connections for negative earth cars are somewhat simpler since the wires to the positive terminal of the coil can be left connected and the positive supply terminal of the unit (E) connected to it.

The contact breaker is connected to (D) and the negative coil terminal to (B). Contact (F) is earthed making a total of four wires to the unit with contacts (A) and (C) left unconnected.

The astute reader will deduce that the first half cycle of the spark in the negative earth system is positive and not negative as is usually recommended. This can be corrected by reversing the connections to the coil. In some cases this may be inconvenient as the positive terminal is sometimes used as a junction point for leads from other equipment and the coil is supplied with more than one tag on the positive side to accommodate them. It is not really necessary to go to the trouble of reversing the initial spark polarity since the unit generates a dual polarity spark (Fig. 6a, Part One).

The unit can now be fitted to a convenient place in the engine compartment by drilling at least two suitable holes in the bottom of the box, and the car, and screwing the unit in place with self tapping screws.

### COLD START COILS

Some cars are fitted with a "cold start" coil, which is a low voltage coil with a series ballast resistor that is shorted out when starting, to give an increased spark voltage under cold starting conditions. The ballast resistor is usually attached to one of the terminals of the coil but it may take the form of a resistance cable between the ignition switch and the coil.

**. . . . never attempt to remove spark plug leads while engine is running**

It does not actually make any significant difference to the spark produced by the unit whether the resistor is left in series with the coil or not, but the resistance cable should not be used to supply power to the unit as there will be a considerable loss of voltage along it. In this case it is best to remove the resistance cable and replace it with a length of wire. In all cases the connection between the coil and the starter solenoid *must* be removed.

## PRECAUTIONS

Because of the high open circuit voltage produced by this unit *never* attempt to remove the spark plug leads whilst the engine is running, since not only is there a danger of breaking down the insulation of the coil but the experimenter stands a good chance of getting a nasty shock.

In addition the thyristor can be exposed to transient voltages of up to 1,000V under these conditions and may be destroyed.

## PERFORMANCE

In most capacitor discharge ignition systems the usual fault is for the thyristor to "latch on" with the short circuit current available from the inverter, especially when an iron cored transformer is used. This cannot occur in the system described here as explained in Part One.

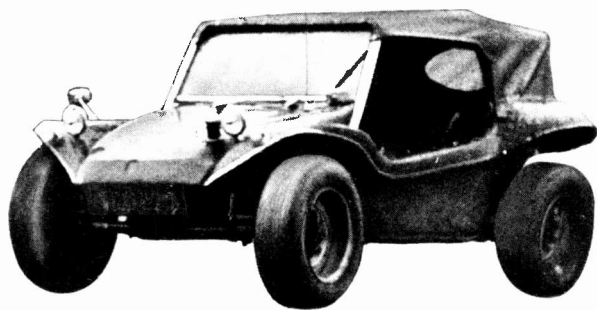
The spark gap of the plugs may be increased with advantage for smoother idling, but not above 0.04in or the insulation of the ignition coil will be unduly taxed, especially in cars with high compression engines ( $> 10:1$ ).

The unit will perform satisfactorily down to at least 8 volts thus giving a good spark at the plugs even under very cold starting conditions when the battery is at its lowest capacity.

The points and timing should be checked when installing the unit since from now on they can be left for many thousands of miles. Cars fitted with this unit can be expected to operate more economically since the car is kept in "peak tune" all the time. This is because the points do not wear and the timing and dwell angle do not change with time, except for the very slight wear on the heel of the contact breaker.

Four units as described in this article have been built and tested in various types of British car under different driving conditions and it can be stated that "P.E. Scorpio" is without doubt an effective transistor ignition system achieving improved performance.

Brake horse power has been measured on a "rolling road" and has shown to be about 5 per cent higher with a subsequent improvement in the "liveliness" of the car. One particular feature is the more consistent performance of the car after tuning has occurred from thousands of miles of driving. ★



# LOGICAL RADIO CONTROL

continued from page 985

## TIMING COMPONENTS

The interval timing resistors R1 to R5 have a maximum value of approximately 490 ohms due to the input threshold of the gates; lower values may be used with a corresponding change (increase) in the capacitors C2, C4, C6, C8, C10 but the CR product must remain the same.

The signal pulse timing potentiometers VR1 to VR6 will provide a maximum and minimum value. The minimum value of approximately 200 ohms corresponding to a pulse length of approximately 0.5ms and the point at which the following gate will just open. The maximum value is given as 1.2 kilohms. With 10 $\mu$ F capacitors for C3, C5, C7, C9, C11, a pulse of 2ms will be given, while 800 ohms setting for the potentiometers will provide 6ms pulses.

The recommended arrangement is 240 $\Omega$  in series with a 500 $\Omega$  potentiometer to ground. The cycle time is derived from the trigger circuit (Fig. 5) in which TR1 and TR2 form a multivibrator, the period of which is approximately 1.4CR. If C12 is 1.5 $\mu$ F and R6 and R8 are both 15 kilohms, the pulse time will be approximately 18ms (Fig. 6).

The positive going edges at the collector of TR1 are slowed by the action of the timing capacitors, so the output is taken from TR2. Diode D1 and R10 form an isolation circuit so that C13 will not discharge through the trigger circuit. The output waveform is differentiated by C14 and R11 to give a positive pulse of time constant approximately 0.3ms (Fig. 6c). The trigger transistor TR3 switches off producing the sharp-edged negative going pulse (Fig. 6d) to the trigger output every 36ms.

## LAYOUT

Fig. 7 shows the printed circuit layout full size; it is recommended that extra space along one side is provided for mounting purposes. All holes should be drilled clean and vertical from the copper side with an HSS or tungsten carbide number 58 drill, and a small clean tipped soldering iron used.

Fig. 8 shows component layout, the i.c.s being inserted and soldered in first, followed by the fixed resistors and capacitors. Using thin flexible covered wire the four final interconnections to IC7 should be made as shown in Fig. 9, together with the trigger connections, supply leads and six various coloured wire leads which go to the control panel for connection to VR1 to VR6.

**Next month: Two more coders and a decoder**

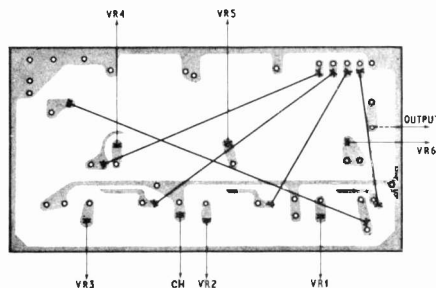
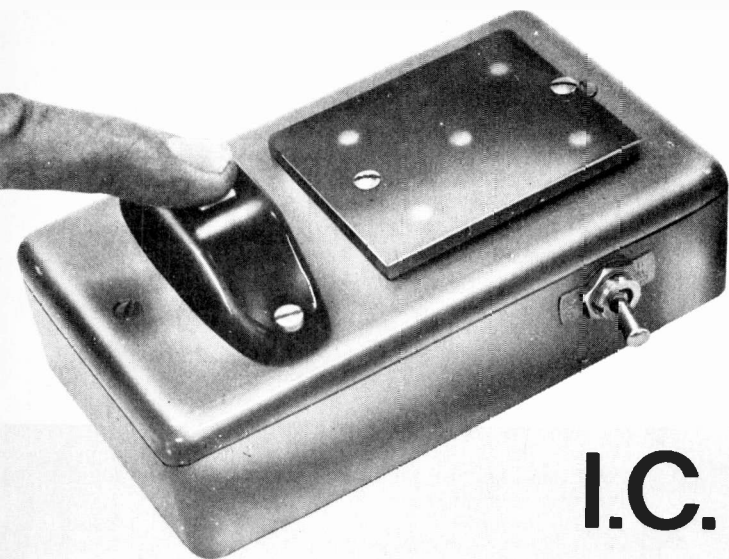


Fig. 9. Potentiometer connections to Coder 1



BY J. D. CROFT

# I.C. DIGITAL DICE

**T**HIS circuit is a revised version of the circuit published in "Ingenuity Unlimited," April 1971, now using integrated circuits.

When re-designing the circuit to use integrated circuits it was found that not only is the finished dice smaller and neater, but by using the low price i.c.s. now available, it is also cheaper to build.

## THEORY

The logic diagram of this dice is shown in Fig. 1.

The circuit is basically a divide-by-six counter driven via the control gate G11 by a 4.8kHz clock pulse.

The count is stopped by the control gate when the player presses the play button, and the binary output of the counter is decoded by gates one to nine to light lamps LP1-LP7 set in the usual dice pattern.

The binary output is decoded into four lamp outputs, the first of which decides "even or odd." If the count is odd, the centre lamp, LP3, lights. Next, gate G1 decides "NOT 1" which lights two diagonally opposite lamps LP6 and LP7—except during a "1."

A third gated output, gates G5, G6 and G7 decide 4, 5, or 6 and lights the two remaining diagonally opposite lamps, LP4 and LP5 on these counts. The last output, gates G8 and G9, decide "6" and lights the two remaining lamps on this count. A little thought will show that these combinations will automatically light the correct number of bulbs in the correct patten for each dice position.

Player intervention is prevented in two ways. Firstly, by extinguishing the display lights while the counter is operating, and secondly, by the high clock pulse speed adopted which is far higher than any human reflex.

## CIRCUIT CONSTRUCTION

The circuit is built on a piece of Veroboard (0.1in matrix) as shown in Fig. 2. The board should be cut to size and some strips cut as shown in Fig. 3, before the integrated circuits are fitted.

It is recommended to leave the soldering of the i.c.s. until all the other components and straps have been fitted as it is almost impossible to remove them should they be soldered in the wrong position.

When soldering on 0.1in matrix Veroboard great care should be taken as the solder easily bridges the closely spaced strips, and if the strips are overheated they could come adrift from the laminate causing intermittent faults.

## COMPONENTS . . .

### Resistors

R1, R2, R3, R4 4.7k $\Omega$  (4 off)  
R5 47 $\Omega$   
R6 100 $\Omega$   
All 5%, 1/4W carbon

### Capacitors

C1, C2 0.1 $\mu$ F 15V (2 off)

### Semiconductors

TR1, TR2, TR3, TR4 2N3704 (4 off)  
D1, D2 OA91 (2 off)

### Integrated circuits

IC1, IC3, IC4 SN7400 (BPOO) Quad 2-input gates (3 off)  
IC2 SN7492 (BP92)  $\div$  12 counter  
IC5 SN7410 (BP10) triple 3-input gate

### Switches

S1 Single pole on/off toggle  
S2 Single pole push button

### Lamps

LP1-7. 6V 0.3W l.e.s. type (7 off)

### Miscellaneous

Lampholders for lamps (7 off)  
Veroboard, 2 1/2in  $\times$  2 1/2in (0.1in matrix)  
Battery 6V (4  $\times$  1.5V in series, type HP7)

### CASE

The dice case may be varied to suit individual requirements and materials available. The case in the suggested design is a standard M.E.M. plastics box for mounting a double mains socket, fitted with the appropriate blanking plate. This will make a neat, strong case, which will accommodate the circuit board and lamp display and also four pen-light cells in a four-cell battery holder.

If due to anticipated prolonged use a larger battery or 6V mains power unit is required, a larger case should be used which can be constructed from wood or Perspex.

The lamp display in the author's unit was wired for miniature 6V l.e.s. lamps and lampholders held in position by using stout copper wire, which acts as both support and electrical common positive bus bar. If required the lampholders could be secured in their correct position by using Araldite.

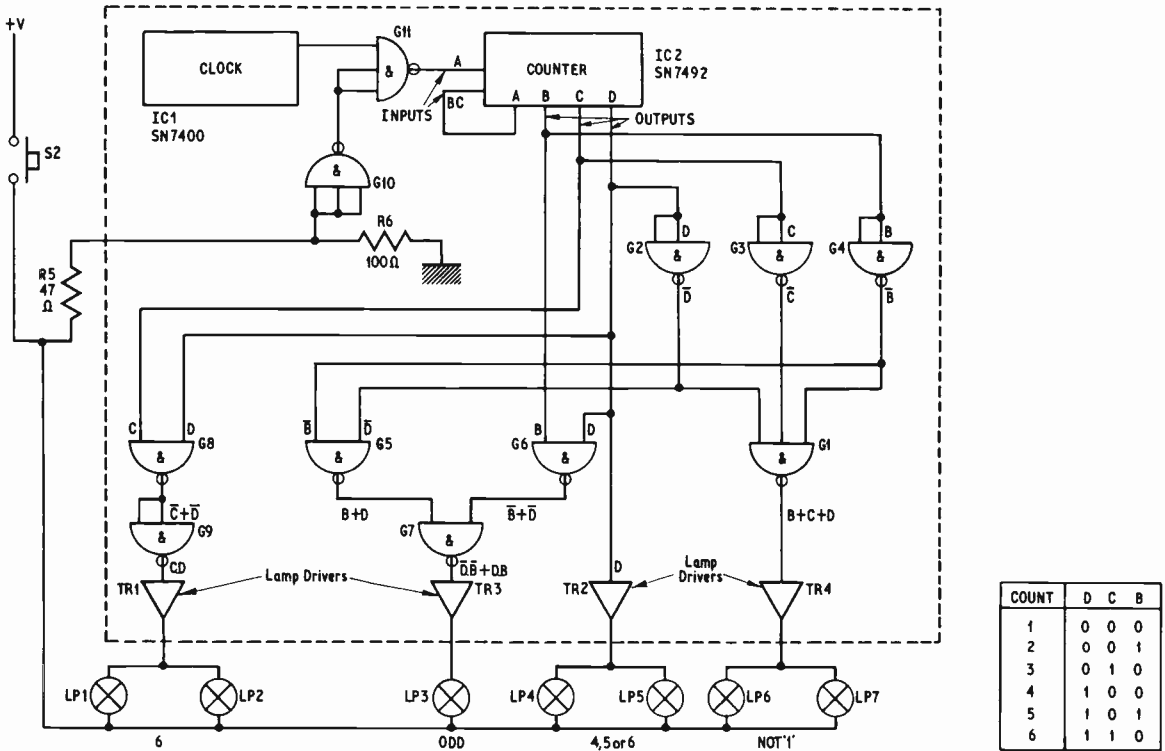


Fig. 1. Circuit diagram of the electronic dice with the logic gates "taken out" of the integrated circuit packs. Circuitry within the grey area is mounted on the 0.1in matrix Veroboard

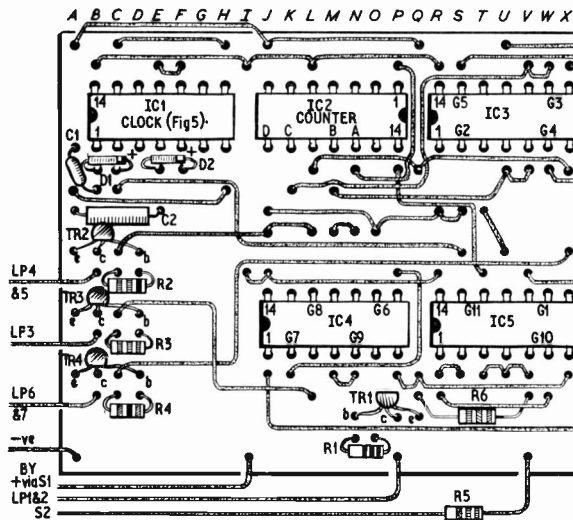


Fig. 2. Wiring and layout of the logic integrated circuits and lamp drivers

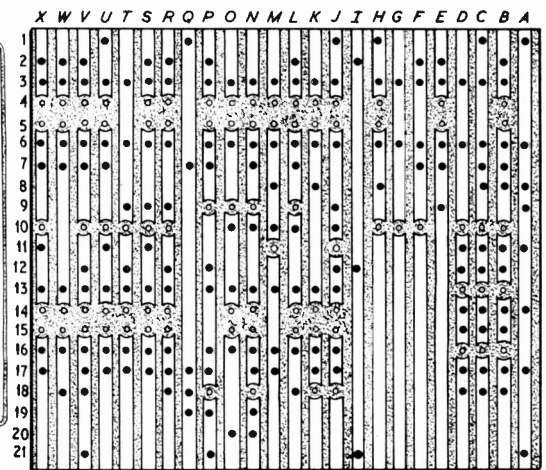


Fig. 3. View of the underside of the Veroboard showing the copper regions that must be removed

## DISPLAY PANEL

The holes for the display are covered by a piece of  $\frac{1}{4}$  in translucent Perspex to hide the non-illuminated holes.

This Perspex should be chosen with care, as some colours tend to diffuse the light spots making reading of the display panel difficult.

The Perspex may be selected by holding a sample against a piece of cardboard with a small hole in it and viewing it against background illumination to check that a clean-edged spot can be seen. A blue or violet Perspex was found to be best.

## CHECKING

After assembling the dice, the connections should be rechecked before fitting the batteries since a single wrong strap could easily permanently damage an integrated circuit.

If desired the correct working of the dice can be verified in the following manner.

## CLOCK CHECK

The clock output can be checked by connecting an oscilloscope between holes 8C and 8A on the Veroboard where a 4.8kHz square wave should be observed. In the absence of an

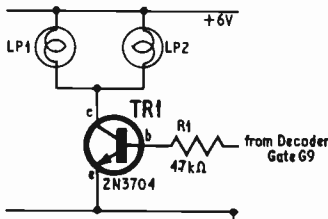


Fig. 4 (a). The lamp driver circuit that amplifies the output from the 4 decoders to light the lamps; (b) Pictorial view of the transistor used in this circuit showing base connections

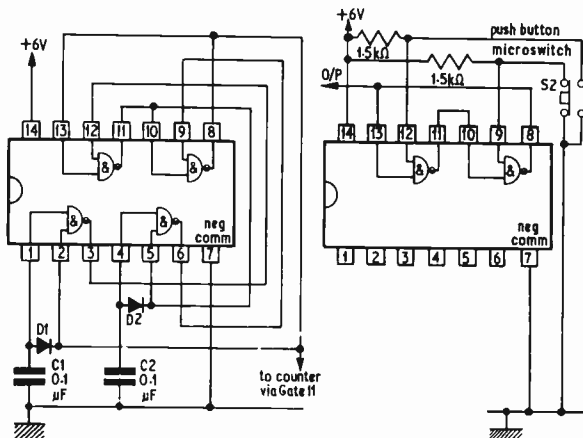
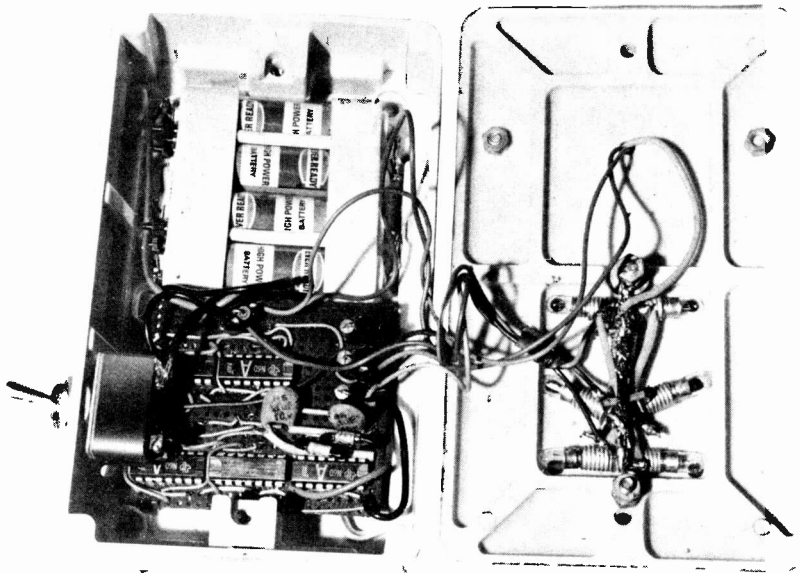


Fig. 5. Wiring of the SN7400N Quad 2-input nand gate to give a 4.8kHz multivibrator for use as clock

Fig. 6. Use of half a SN7400N to provide test input signals to the counter



oscilloscope, a pair of high resistance headphones in series with an  $0.1\mu\text{F}$  capacitor may be used to detect the output from the clock which will be observed as a high pitch whistle.

## TESTING COUNTER AND DECODER

The counter and decoding gates may be checked by injecting test signals into the counter.

This is done by the use of a microswitch buffered by a bistable to remove switching transients. The bistable is constructed from half a SN7400N quad 2-input gate i.c. connected as shown in Fig. 8. This circuit is worth building as a permanent unit as it is invaluable in all testing work on TTL and DTL circuits.

The output from the bistable should be connected to hole 7P on the Veroboard with the wire to 13T temporarily removed. On operating the microswitch the display should be found to advance one count for every two depressions of the microswitch. The reason why two pulses are required to step the display by one count is that the SN7492N is a divide-by-twelve counter, and in the present application the "A" stage output is not used. The reset line of the counter SN7492N is disabled by applying a permanent "O" on pin 7 of the reset gate, which is the  $R_0$  gate in this package.

## SWITCHING TRANSIENTS

If any trouble is experienced due to an uneven count, noise on the supply line may be the cause, in which case this is rectified by connecting  $0.1\mu\text{F}$  capacitors between the negative and positive supply lines as near to the i.c.s as possible. This should remove the sharp fronts of any switching transients transmitted on to the supply lines.

This expedient should not be required if the unit is powered by batteries but may be required if the unit incorporates a mains power supply.

As the i.c.s are already working at 0.75 volts over the manufacturers' recommended working voltage, on no account must the supply voltage be raised above six volts.

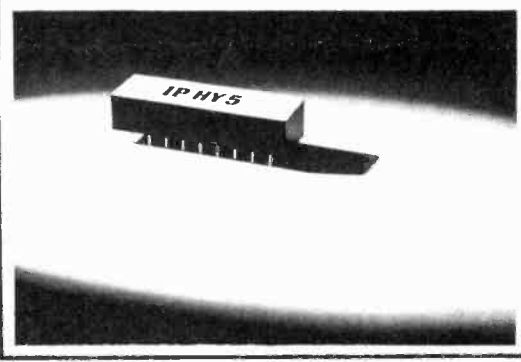
Providing this value is not exceeded, no damage to the i.c.s should occur.







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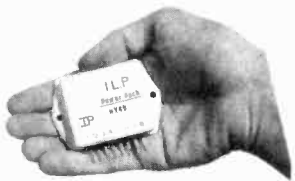
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Tape Replay (external components to suit head). 4mV.  
Microphone (flat) 10mV.  
Ceramic Pick-up (equalized and compensatable) 20 — 2000mV variable.  
Tuner (flat) 250mV.  
Auxiliary 1 250mV.  
Auxiliary 2 2—20mV.
- OUTPUTS**  
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Direct tape output 120mV.
- ACTIVE TONE CONTROLS**  
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**INTERNAL STABILIZATION**  
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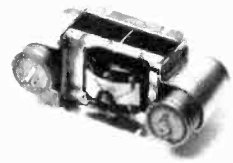
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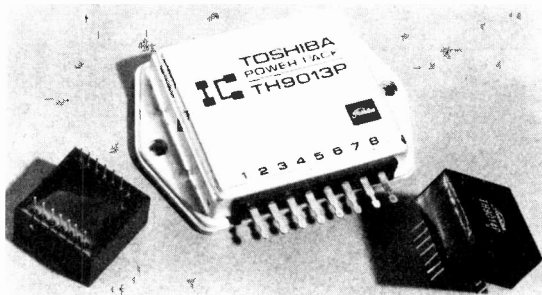
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Set of 4 for £1.02, DAF96, DF96, DK96, DL96, 4 for £1.48.

1R5	-.28	30C1	-.28	DY87	-.25	EL500	-.82	PCL82	-.32	UABC80	-.32
1R5	-.22	30C15	-.58	DY802	-.35	EM80	-.41	PCL83	-.57	UAF42	-.51
1T4	-.16	30C17	-.79	EABC80	-.32	EM81	-.41	PCL84	-.64	UBC41	-.52
3B4	-.26	30C18	-.61	EAF42	-.50	EM84	-.32	PCL85	-.38	UBF80	-.34
3V4	-.37	30F5	-.69	EB41	-.40	EM87	-.36	PCL86	-.39	UBF89	-.32
5U4G	-.26	30FL1	-.61	EB91	-.11	EY51	-.33	PCL88	-.85	UCB84	-.33
5V4G	-.35	30FL12	-.70	EBC33	-.40	EY86	-.29	PCL800	-.75	UCB85	-.35
6T3GT	-.26	30FL14	-.68	EB41	-.54	EZ40	-.43	PEN A4	-.77	UCF80	-.33
3Z4G	-.25	30L1	-.59	EBC90	-.22	EZ41	-.43	PEN30C	-.70	UCH42	-.58
6J30L2	-.54	30L15	-.57	EBF80	-.32	EZ80	-.22	PFL200	-.53	UCH81	-.38
6AL5	-.11	30L17	-.71	EBF89	-.29	EZ81	-.23	PL36	-.49	UCL82	-.32
6AM6	-.13	30P4	-.57	ECC81	-.17	G230	-.35	PL81	-.44	UCL83	-.55
6AQ5	-.22	30P12	-.72	ECC82	-.20	GZ32	-.40	PL81A	-.49	UF41	-.56
6AT6	-.20	30P19	-.57	ECC83	-.35	GZ34	-.48	PL82	-.31	UF89	-.30
6AU6	-.20	30PL1	-.62	ECC86	-.26	K741	-.77	PL83	-.33	UL41	-.57
6BA6	-.50	30PL13	-.78	ECC90A	-.54	K761	-.55	PL84	-.30	UL44	£1.00
6BE6	-.21	30PL14	-.65	ECCF80	-.27	K766	-.78	PL500	-.62	UL84	-.30
6BJ6	-.41	30PL15	-.90	ECCF82	-.26	LN319	-.63	PL604	-.63	UM84	-.42
6BW7	-.52	35L6GT	-.45	ECH35	-.30	LN329	-.72	PM84	-.35	UY41	-.22
6CD6G	£1.07	35W4	-.25	ECH42	-.61	LN339	-.63	PX25	£1.00	UY85	-.25
6F14	-.42	35Z4GT	-.25	ECC81	-.29	N78	-.87	PY32	-.55	VP4B	-.77
6P23	-.69	807	-.45	ECH83	-.56	P61	-.45	PY33	-.55	Z77	-.22
6P25	-.57	6063	-.62	ECH84	-.36	PABC90	-.34	PY81	-.25	Transistors	
6K7G	-.12	AC/VP2	-.77	ECL80	-.30	PC86	-.47	PY82	-.25	AC107	-.17
6K8G	-.17	B349	-.65	ECL82	-.31	PC88	-.47	PY83	-.28	AC127	-.18
6Q7G	-.27	B729	-.82	ECL96	-.36	PC96	-.42	PY88	-.33	AD140	-.37
68N7GT	-.30	CCH35	-.67	EP39	-.38	PC97	-.39	PY800	-.34	AP115	-.20
6V8G	-.23	CP31	-.30	EP41	-.60	PC90	-.38	PY901	-.34	AP116	-.20
6V6GT	-.31	DAF91	-.22	EP80	-.23	PC94	-.29	R19	-.30	AP117	-.20
6X4	-.23	DAF96	-.36	EP85	-.28	PC85	-.27	R20	-.58	AF118	-.48
6X5GT	-.28	DF33	-.38	EP86	-.30	PC88	-.42	U25	-.64	AF125	-.17
7B7	-.33	DF91	-.16	EP89	-.29	PC89	-.45	U26	-.58	AF127	-.17
10P13	-.58	DF96	-.36	EP91	-.13	PC189	-.48	U47	-.64	OC26	-.25
12AT7	-.17	DI77	-.20	EP98	-.65	PC305	-.58	U49	-.58	OC44	-.12
12AU6	-.20	DK32	-.37	EP183	-.28	PCF90	-.28	U50	-.39	OC82	-.12
12AU7	-.20	DK91	-.28	EP184	-.31	PCF82	-.31	U52	-.31	OC71	-.12
12AX7	-.22	DK92	-.38	EP90	-.37	PCF86	-.45	U78	-.24	OC72	-.12
19BG6G	-.87	DK96	-.38	EL33	-.55	PCF800	-.58	U191	-.59	OC75	-.12
20F2	-.67	DL35	-.40	EL34	-.45	PCF801	-.30	U193	-.42	OC81	-.12
20F3	-.80	DL32	-.28	EL41	-.54	PCF802	-.40	U251	-.68	OC81D	-.12
20P4	-.62	DL94	-.37	EP183	-.28	PCF805	-.61	U301	-.39	OC82	-.12
25U6GT	-.20	DL96	-.38	EL90	-.28	PCF806	-.58	U329	-.68	OC82D	-.12
25U4GT	-.57	DY86	-.25	EL95	-.33	PCF808	-.68	U801	-.98	OC170	-.22

## READERS RADIO

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# LINEAR & LOGIC I.C SURVEY

A look at most of the linear and logic integrated circuits now readily available to experimenters, private constructors and designers. More detailed technical information and pin connection diagrams are usually to be found in manufacturers' literature, often available from i.c. suppliers. Devices shown as being in TO5 packages may also be in similar packages (e.g. TO99, TO100, etc.) but with a different number of lead-outs.

## PART 1 LINEAR I.Cs

THE first linear integrated circuits to be produced were operational amplifiers designed for instrumentation and similar applications. Introduced by Fairchild in 1963 the "A702 gave a performance equal to or better than the available discrete component amplifiers at a similar cost. The first "high performance" operational amplifier was the "A709 which Fairchild introduced in 1965. It had more gain, a reduction of input offset current, and allowed a higher output level.

While all operational amplifiers have many characteristics in common, some conditions peculiar to individual amplifiers may be found. For example, the "A702 has a limited input voltage range of +1.5V to -6.0V indicating the possibility of "latch-up" if this is exceeded.

The "A709 output stage uses complementary emitter followers with no bias between the two bases. This produces a dead zone which can cause an excessive distortion of the output signal when only a small amount of overall negative feedback is used.

The first of the "second generation" amplifiers was the "A741. This has built-in frequency compensation, short-circuit protection, no crossover distortion, an offset voltage null capability, low power consumption, no latch-up, and a large common-mode and differential voltage range.

At first sight this built-in frequency compensation appears to solve the problems of operating down to an overall gain of unity, without instability occurring and without using external components. However, it means that the frequency compensation is NOT optimum for overall gains greater than unity.

For a 40dB gain the 741 has a bandwidth of 10kHz compared with the 1MHz bandwidth obtainable with the 709 and recommended compensation.



Circuit Function	*Package	Ferranti	Motorola	Mullard	National Semi- conductor	RCA	RS Com- ponents	Siemens	SGS	Texas
High speed differential comparator 710C	TO5 DIL		MC1710CG MC1710CP		LM710C LM710CN		710MOPA 710 OPA		U5B771039X U6E7710393	SN72710L SN72710N
General purpose operational amplifier 702C	TO5 DIL		MC1712CG MC1712CP	TAA241		CA3032			U5B771239X U6E7712393	SN72702L SN72702N
High performance operational amplifier 709C	TO5 DIL	ZLD709C ZLD709CE	MC1709CG MC1709CP	TAA521	LM709C LM709CN		709MOPA 709 OPA	TAA251	U5B770939X U6E7709393	SN72709L SN72709N
Dual version of 709C in one package	DIL		MC1437P							SN72709DN
Frequency compensated high performance operational amplifier	TO5 DIL	ZLD741C ZLD741CE	MC1741CG MC1741CP	TBA221	LM741C LM741CN	CA3056	741 OPA	TBA221	LI41TI LI41BI	SN72741L SN72741N
Version 741C without compensation 748C	TO5			TAA811	LM748C					SN72748L
Dual version of 741C	DIL				LM747C				LI47BI	SN72747N

\* DIL packages here are 14-lead versions except 7410PA which has 8 leads. Texas also make SN72709P, SN72741P, SN72748P in 8-lead DIL  
Most manufacturers make operational amplifiers and comparators

# FERRANTI

## A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
ZLA10	Wideband linear amplifier for video and i.f. stages	T05
ZLA15	Wideband linear amplifier, improved version of ZLA10	T05

## D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
ZLD2S/T/U	Differential d.c. amplifiers	T05
ZLD12C/D	Complementary output stages for ZLD2 series	T05
ZLD709C	Operational amplifier	T05
ZLD709CE	Operational amplifier	DIL
ZLD741C	Operational amplifier	T05
ZLD741CE	Operational amplifier	DIL

## OTHER CIRCUITS

TYPE	FUNCTION	CASE
ZN400E	Analogue switch	DIL
ZN402E	Gated operational amplifier	DIL
ZN403E	Servo amplifier	DIL

# GENERAL ELECTRIC

## A.C. AMPLIFIERS

TYPE	TYPE	FUNCTION
Old Number	New Number	
PA222	GEL222FI	800mW audio amplifier. 22Ω load
PA230	GEL230FI	Low level audio preamplifier. 72db gain
PA234	GEL234FI	1W audio amplifier. 22Ω load
PA237	GEL237FI	2W audio amplifier. 16Ω load
PA239	GEL239FI	Stereo version of PA230
PA246	GEL246SI	5W audio amplifier. 16Ω load
PA263	GEL263SI	3.5W audio amplifier
PA266	GEL266FI	1.6W audio amplifier

## OTHER CIRCUITS

TYPE	TYPE	FUNCTION
PA264	GEL264SI	Voltage regulator
PA265	GEL265SI	Voltage regulator
PA424	GEL300FI	Zero voltage switch
PA436	GEL301FI	Phase controller for SCR
PA494	GEL304AI	Threshold detector

All the above devices have a special package

# MOTOROLA

## A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
MC1303L	Stereo pre-amplifier. 68dB gain. 60dB separation	DIL
MC1304P	Stereo demodulator for f.m.	DIL
MC1305P	Stereo demodulator for f.m.	DIL
MC1306P	Complementary amplifier and pre-amplifier	DIL
MC1307P	Stereo demodulator for f.m. No audio mute	DIL
MC1330P	Low level video detector	DIL
MC1350P	I.F. amplifier with a.g.c.	DIL
MC1445L	Wideband amplifier circuits 16dB gain	DIL
MFC6010	F.M./I.F. differential amplifier 40dB gain at 10MHz	S
MFC8000	Dual differential amplifiers designed for input stage of stereo power amplifiers	S
MFC8001		S
MFC8002		S
MFC8010		S
MFC8020	1W audio amplifier and preamp	S
MFC8030	Class B driver	S
MFC8030	Flexible differential amplifier, 32dB gain	S
MFC8040	Audio preamp 3dB noise, 80dB gain	S
MFC9000	4W audio amplifier and preamp	S
MFC9010	2W audio amplifier and preamp	S

## D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
MC1430P	Operational amplifier 69dB gain	DIL
MC1433G	Operational amplifier 89dB gain	T05
MC1435G	Dual operational amplifiers of 71dB gain	T05
MC1435L	Dual operational amplifiers	DIL
MC1435P	Dual operational amplifiers	DIL
MC1437L	Dual MC1709	DIL
MC1439G	Internally compensated operational amplifier of 84dB gain	T05
MC1709CP	Differential amplifier	DIL
MC1710CP	Differential comparator	DIL
MC1712CP	Operational amplifier	DIL
MC1741CP	Fully compensated op. amplifier	DIL

## OTHER CIRCUITS

TYPE	FUNCTION	CASE
MC1460G	Voltage regulator 2.5 to 17V 250mA	T05
MC1461G	Voltage regulator 2.5 to 32V 250mA	T05
MC1463G	Voltage regulator 3.8 to 32V 250mA	T05
MC1466L	Wide range voltage and current regulator	DIL
MC1459R	Voltage regulator 2.5 to 32 volts 600mA	*
MFC4060	Regulator 4V 200mA	S
MFC6030	Regulator 4V 200mA	S
MFC6040	Electronic attenuator	S

S Special package

\* 9-lead small power transistor case

# NATIONAL SEMICONDUCTOR & SILICON GENERAL

## D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
LM709CN/SG709CN	Operational amplifier	DIL
LM710CN/SG710CN	Differential comparator	DIL
LM711CN/SG711CN	Core memory sense amplifier	DIL
LM741C/SG741CT	Fully compensated operational amplifier	T05
LM748C/SG748CT	As LM741C without compensation	T05

## OTHER CIRCUITS

TYPE	FUNCTION	CASE
LM103*	Voltage regulator 1.8V to 5.6V available	T046
LM305/SG305T	Positive voltage regulator 4.5 to 30V 20mA	T05
LM309/SG309T	Voltage regulator 5V 200mA. No external components	T05
LM309K/SG309K	Voltage regulator 5V 1A. No external components	T03

\*LM103 is specified as "LM103-1-8" etc. depending on voltage required.

# MULLARD

## A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA263	Three stage cascade amplifier	T072
TAA293	Medium frequency, general purpose amplifier	T074
TAA300	Audio amplifier. 1 watt into 8ohms	T074
TAA310	Low noise audio preamplifier for tape recorders	T074
TAA320	Metal oxide silicon i.f. preamplifier	T018
TAA350	Wideband limiting f.m./i.f. amplifier	T074
TAA570	Limiting—amplifier with f.m. detector	T05
TAA960	Three stage active filter amplifier. 39dB gain per stage	T074
TAA970	Microphone amplifier	T074
TAB101	Four transistor ring modulator/demodulator	T074
TAD100	A.M. receiver circuit	DIL
TAD110	A.M./F.M. i.f. amplifiers, three gain blocks	DIL

## D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA241	Operational amplifier (702C)	T05
TAA242	Operational amplifier (702)	T05
TAA521	Operational amplifier (709C)	T05
TAA811	Operational amplifier (741C with-out compensation)	T05
TBA221	Fully compensated operational amplifier (741C)	T05
TBA222	Fully compensated operational amplifier (741)	T05

## OTHER CIRCUITS

TYPE	FUNCTION	CASE
TBA281	Voltage regulator 2 to 37V 150mA	T074
TBA673	Modulator/demodulator. Ring of four transistors	T074
TBA750	Limiting amplifier	16DIL

# PLESSEY

## A.C. AMPLIFIERS

TYPE	FUNCTION	CASE	TYPE	FUNCTION	CASE
SL201B	Video amplifier, current gain 26, 15MHz BW	T05	SL621C	SSB a.g.c. generator used with SL610/11/12	T05
SL301B	Matched pair of transistors, $h_{FE}$ 25 to 250, $f_T$ 600MHz	T05	SL630C	Microphone/headphone amplifier with a.g.c. Gain 40dB	T05
SL303B	Matched trio of transistors, $h_{FE}$ 25 to 250, $f_T$ 600MHz	T05	SL640C	Double balanced modulator	T05
SL403D	3 watt audio amplifier 8 ohms load, 18V supply	*	SL641C	Receiver mixer, double balanced modulator	T05
SL610C	R.F./I.F. amplifiers. 18dB gain at 30MHz. 4dB noise. 85MHz BW	T05	SL701B/C	D.C. AMPLIFIERS	
SL611C	R.F./I.F. amplifiers. 24dB gain at 30MHz. 4dB noise. 50MHz BW	T05	SL702B/C	Operational amplifier, output symmetrical about earth	T05
SL612C	R.F./I.F. amplifiers. 32dB gain at 1.7MHz. 3dB noise. 10MHz BW	T05		Operational amplifier, output not symmetrical. The minimum gain is 66dB, open loop bandwidth 250kHz on all SL701, 702 i.c.s	T05
SL620C	Voice operated gain adjusting device used with SL630C	T05			

## TEXAS

Texas Instruments produce all the common operational amplifier circuits (702, etc.)  
SN76013N 4W audio amplifier similar to Sinclair IC12

\* Special package with heat sink, DIL style  
SL201 B/C are now maintenance types

# R.C.A.

## A.C. AND D.C. AMPLIFIERS

TYPE	FUNCTION	CASE	TYPE	FUNCTION	CASE
CA3000	Differential amplifier gain 28dB BW 650kHz	T05	CA3019	Package with six diodes	T05
CA3001	Differential amplifier gain 16dB BW 16MHz	T05	CA3020	Wideband amplifier gain 75dB BW 8MHz	T05
CA3002	R.F./I.F. amplifier gain 19dB BW 11MHz	T05	CA3021	Wideband amplifier gain 50dB BW 800kHz	T05
CA3005	R.F./I.F. differential amplifier gain 16dB BW 120MHz	T05	CA3022	Wideband amplifier gain 50dB BW 3MHz	T05
CA3007	Differential audio amplifier gain 20dB BW 20kHz	T05	CA3023	Wideband amplifier gain 50dB BW 10MHz	T05
CA3010	Operational amplifier gain 57dB BW 200kHz	T05	CA3026	Two darlington transistor pairs $h_{FE}$ of 110 $f_T$ of 550MHz	T05
CA3011	Wideband amplifier gain 65dB BW 20MHz	T05	CA3028A	R.F./I.F. differential amplifier gain 35dB BW 5MHz	T099
CA3012	Wideband amplifier gain 65dB BW 20MHz	T05	CA3029	Operational amplifier gain 57dB BW 200kHz	DIL
CA3013	Wideband amplifier gain 65dB BW 20MHz	T05	CA3030	Operational amplifier gain 66dB BW 200kHz	DIL
CA3014	Wideband amplifier gain 65dB BW 20MHz	T05	CA3035	Wideband amplifier gain 40dB BW 2.5MHz	T05
CA3015	Operational amplifier gain 66dB BW 200kHz	T05	CA3036	Two darlington pair transistors $h_{FE}$ 82 $f_T$ 150MHz	T05
CA3018	Package with transistors $h_{FE}$ of 30 $f_T$ 300MHz	T05	CA3039	Six diodes 5V p.i.v. 25mA max. current	T05

## R.C.A.

TYPE	FUNCTION	CASE	TYPE	FUNCTION	CASE
CA3040	Wideband amplifier gain 34dB BW 40MHz	T05	CA3055	Voltage regulator 1.8 to 34V 115mA	T05
CA3041	Wideband amplifier/f.m. detector/a.f. preamp	14Q	CA3056	Operational amplifier gain 86dB (741C)	T05
CA3042	Wideband amplifier/f.m. detector/a.f. preamp	14Q	CA3059	Zero voltage switch for thyristor control 105mA	DIL
CA3043	I.F. amplifier/limiter/f.m. detector/audio preamp	T05	CA3060	Operational amplifier, characteristics can be varied by user	DIL
CA3044	Wideband amplifier/phase detector, for a.f.c. systems	T05	CA3062	Photo detector and power amplifier	T05
CA3045	Five transistors $h_{FE} 110 f_T 300\text{MHz}$	DIL	CA3065	I.F. amplifier, limiter, f.m. detector, audio driver	14Q
CA3046	Five transistors $h_{FE} 110 f_T 300\text{MHz}$	DIL	CA3070	Television chroma system, chroma signal processor	DIL
CA3047	Operational amplifier gain 84dB BW 20kHz	DIL	CA3071	Television chroma system, chroma amplifier	DIL
CA3048	Audio amplifier 53dB gain BW 250kHz	DIL	CA3072	Television chroma system, chroma demodulator	DIL
CA3049	Six npn transistors $f_T 1.3\text{GHz}$	T05	CA3075	F.M./I.F. amplifier, limiter, detector, audio preamplifier	14Q
CA3050	Two darlington differential amplifiers $f_T 600\text{MHz}$	DIL	CA3078	Operational amplifier gain 80dB BW 20MHz	T05
CA3051	Two darlington differential amplifiers $f_T 600\text{MHz}$	DIL			
CA3052	Audio amplifier gain 53dB BW 300kHz	DIL			
CA3053	R.F./I.F. differential amplifier gain 35dB BW 5MHz	T099			
CA3054	Differential amplifier gain 32dB	DIL			

Most of the values given for RCA i.c.s are minimum values, except that in some cases the bandwidth figures for wideband devices are the maximum useful frequency, not the 3dB down frequency

## S.G.S. A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA611B	2W audio amplifier	S
TAA611C	3W audio amplifier	S
TAA621	3W audio amplifier	S
TAA621A	4W audio amplifier	S
TAA661B	F.M./I.F. amplifier and detector	S
TBA231	Dual low noise operational amplifier gain 70dB	DIL
TBA271	Voltage stabiliser for varicap diode	T018
TBA311	Television signal processing	DIL
TBA581	I.F./F.M. amplifier, detector, preamp	S
TBA591	I.F./F.M. amplifier, detector, preamp	S
TBA641A	2.5W audio amplifier	S
TBA641B	4W audio amplifier	S
TBA651	A.M. receiver circuit	S
TBA631	Television sound circuit	S

### D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
$\mu$ A710C	High speed differential comparator	T05
$\mu$ A702C	General purpose operational amplifier	T05
$\mu$ A709C	High performance op.-amplifier	T05
$\mu$ A741C	Fully compensated op.-amplifier	T05

Q = quad-in-line

## SIEMENS A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA141	Three stage audio amplifier 70dB gain 20kHz BW	T072
TAA151	Three stage audio amplifier 70dB gain 600kHz BW	T0100
TAA420	Low noise five stage amplifier 70dB gain 20kHz BW	T0100
TAA435	Audio amplifier for driver stages	T0100
TBA120	F.M./I.F. amplifier and demodulator 60dB gain	DIL
TBA400	Broadband amplifier r.f./i.f. 75dB power gain at 35MHz	S
TBA450	Stereo decoder	S
TBA460	A.M./F.M. i.f. l.f. amplifier	S

### D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA521	Operational amplifier (709C)	T05
TAA522	Operational amplifier (709)	T05
TAA861	Operational amplifier 70mA output current 90dB gain	T078

S = Special package

## APPLICATIONS OF LINEAR I.C.s

Both the 709 and 702 require several external components to frequency-compensate the amplifier so that it is stable under closed-loop conditions and cannot oscillate. The 702, 709 and the 710 comparator were the "first generation" amplifiers.

Although fully compensated, operational amplifiers can be used in any feedback circuit without instability occurring, and without external compensation components, bandwidth and slew rate are reduced. The 710, 702, 709, 741 are produced by many manufacturers. A "C" suffix (for example 702C) has a slightly reduced temperature range and specification over the version without the suffix.

### SERIES 741C OPERATIONAL AMPLIFIER

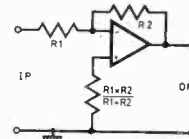
Although operational amplifiers are perhaps the most useful of the vast range of available linear integrated circuits, with varied applications from multivibrators to active filters, many circuits are designed for specific applications. A glance at this survey will reveal a small part of the range available to commercial and industrial organisations. Most of those listed are also readily available to the home constructor.

### UNITY GAIN VOLTAGE FOLLOWER



Input impedance 400M $\Omega$   
Output impedance 1 $\Omega$   
Bandwidth 1MHz

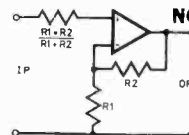
### INVERTING AMPLIFIER



Gain	R1	R2	BW
1	10k $\Omega$	10k $\Omega$	1MHz
10	1k $\Omega$	10k $\Omega$	100kHz
100	1k $\Omega$	100k $\Omega$	10kHz
1000	100 $\Omega$	100k $\Omega$	1kHz

$R_{in} < 10k\Omega$

### NON-INVERTING AMPLIFIER



Gain	R1	R2	BW
10	1k $\Omega$	9k $\Omega$	100kHz
100	100 $\Omega$	9.9k $\Omega$	10kHz
1000	100 $\Omega$	99.9k $\Omega$	1kHz

$R_{in} > 50M\Omega$

**Logic integrated circuits have opened up a whole new science in systems design that does not necessitate deep technical knowledge of the circuit inside the package. Given a basic set of parameters, logic i.c.s can be built into large systems with little difficulty.**

**R**EPRESENTING almost unbelievable value for money in terms of components per penny (the 7400 TTL gate, for example, can be purchased for as little as 15p and contains sixteen transistors, sixteen resistors and four diodes), the logic i.c. families are now available to the amateur from many suppliers who stock an incredibly wide range of types.

To those readers put off by such mystic terms as "fan-out", "flip-flop" and "truth-table", take heart, almost anything that can be built with logic i.c.s can also be built (mentally at least) using relays. Logic gates are simply switches with an "on" and

"off" state, and all the more complicated devices, such as bistables, can be built with gates. Logic really is easy to pick up and after a start has been made, the subtleties can be appreciated one by one.

For those who have always wanted to design something electronic, but have been put off by simultaneous equations and slide rules, this is the scene for you; after a comprehension of the principles is obtained, all you need to start designing is common sense; all the maths has been done by the manufacturers.

## LOGIC FAMILIES

The three main families are RTL, DTL, and TTL, while MSI (medium scale integration) uses TTL methods and incorporates several TTL circuits in each package to give a complex function, for example, a counter.

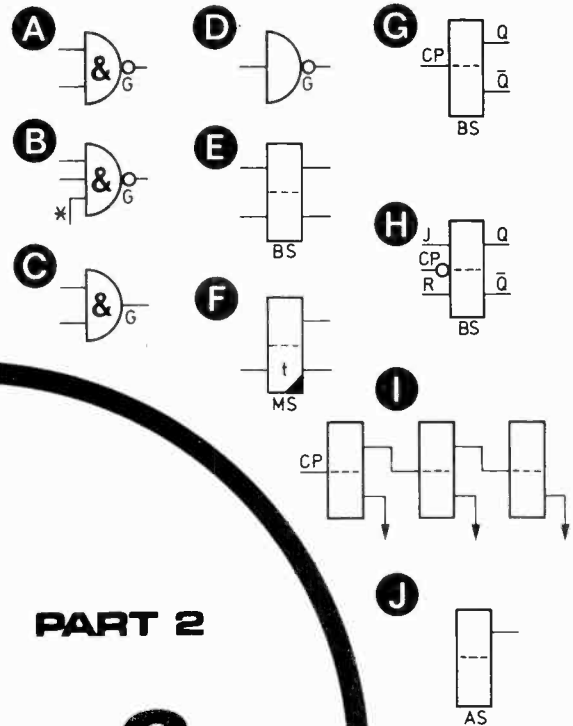
The tables given here are far from exhaustive because of the several manufacturers' different type numbers, but they do represent the majority of devices available through retail outlets.

RTL is gradually losing favour because of the competitive lowering of prices of the DTL and TTL.

In the DTL range, although a common coding can be found among many manufacturers, it is also worth obtaining the leaflets and handbooks on other types. Mullard and Siemens operate Pro Electron codings but they are not always interchangeable equivalents in all cases. Ferranti use different codings again for their Micronor series, prefixed ZS, which is divided into a 20ns range, medium speed range (15ns), and a high speed range (9ns).

Readily available types in the DTL range are mostly given a coding which includes digits 930 and 9090 upwards, other letters and figures being added according to manufacturers' choice. The Mullard range uses Pro Electron numbering prefixed by FC.

The widest range is TTL which extends into medium scale integration MSI. Again because of space limitations we have listed the most common in the 74 series, various manufacturers adding their own personal identity prefix. It is worth pointing out here that although many of the Mullard and Siemens TTL types (prefix FJ) are similar to the 74 series, they are not all identical.



**PART 2**

**&**

**LOGIC I.C.s**

## POSITIVE LOGIC

A—2-INPUT NAND GATE

B—2-INPUT NAND GATE EXPANDABLE

C—2-INPUT AND GATE

D—INVERTER

E—BISTABLE WITH NORMAL INPUTS AND OUTPUTS

F—MONOSTABLE MULTIVIBRATOR

G—BISTABLE WITH CLOCK INPUT

H—BISTABLE WITH CLOCK INPUT, SET AND RESET

I—MULTI-STAGE BISTABLE USED AS DIVIDER OR COUNTER

J—ASTABLE MULTIVIBRATOR

FAIRCHILD	FERRANTI	ITT	MOTOROLA	MULLARD	NATIONAL	SIEMENS	TEXAS
9002	ZN7400E	9002	MC7400P	FJH131	DM8000N	FLH101	SN7400N
	ZN7401E		MC7401P	FJH231	DM8001N	FLH201	SN7401N
	ZN7402E		MC7402P	FJH221	DM8002N	FLH191	SN7402N
				FJH291	DM8003N		SN7403N
	ZN7403E	9016	MC7404P	FJH241	DM8004N		SN7404N
9003	ZN7410E	9003	MC7410P	FJH121	DM8010N	FLH111	SN7410N
9004	ZN7420E	9004	MC7420P	FJH111	DM8020N	FLH121	SN7420N
	ZN7430E		MC7430P	FJH101	DM8030N	FLH131	SN7430N
9009	ZN7440E	9009	MC7440P	FJH141	DM8040N	FLH141	SN7440N
	ZN7441E			FJL101	DM8840N		SN7441AN
				FJH151	DM8842N		SN7442N
9005	ZN7450E	9005	MC7450P	FJH161	DM8050N	FLH151	SN7450N
	ZN7451E		MC7451P	FJH161	DM8051N	FLH161	SN7451N
	ZN7453E	9008	MC7453P	FJH171	DM8053N	FLH171	SN7453N
	ZN7454E		MC7454P	FJH181	DM8054N	FLH181	SN7454N
9006	ZN7460E	9006	MC7460P	FJY101	DM8060N	FLY101	SN7460N
	ZN7472E		MC7472P	FJJ111	DM8540N	FLJ111	SN7472N
	ZN7473E		MC7473P	FJJ121	DM8501N	FLJ121	SN7473N
	ZN7474E		MC7474P	FJJ131	DM8510N	FLJ141	SN7474N
	ZN7475E		MC7475P	FJJ181	DM8550N	FLJ151	SN7475N
	ZN7476E		MC7476P	FJJ191	DM8500N	FLJ131	SN7476N
				FJJ141	DM8530N	FLJ161	SN7490N
				FJJ251	DM8532N		SN7492N
			MC7493P	FJJ211	DM8533N		SN7493N

# RESISTOR TRANSISTOR LOGIC

# RTL

## General Characteristics

- Gate speed 30ns, power 20mW
- Supply  $\pm V_{CC}$  3-6V  $\pm 10\%$
- Frequency range 8MHz
- Noise immunity 0-3V

These RTL circuits are suitable for many simple switching operations where relatively medium speed operation is acceptable, for example, as an electronic relay.

## FAIRCHILD

- |             |                                                |     |
|-------------|------------------------------------------------|-----|
| $\mu$ L 910 | Single inverter/driver                         | T05 |
| $\mu$ L 914 | Dual 2-input gate, positive NOR, negative NAND | T05 |
| $\mu$ L 923 | Single JK flip-flop with preset and clear      | T05 |

## MOTOROLA

- |        |                              |        |                                       |
|--------|------------------------------|--------|---------------------------------------|
| MC711G | 4-input OR/NOR gate          | MC780P | Decade counter                        |
| MC714G | Dual 2-input NOR gate        | MC785P | Quad 2-input expander                 |
| MC715P | Dual 3-input NOR gate        | MC787P | 1 JK flip-flop, 1 inverter, 2 buffers |
| MC717P | Quad 2-input NOR gate        | MC788P | Dual 3-input buffer, non-inverting    |
| MC718P | Dual 3-input NOR gate        | MC789P | MC889P Hex inverter                   |
| MC719P | MC819P Dual 4-input NOR gate | MC790P | MC890P Dual JK flip-flop              |
| MC722P | JK flip-flop                 | MC791P | Dual JK flip-flop                     |
| MC723P | JK flip-flop                 | MC792P | MC892P Triple 3-input NOR gate        |
| MC724P | MC824P Quad 2-input NOR gate | MC793P | Triple 3-input NOR gate               |
| MC726P | JK flip-flop                 | MC799P | Dual buffer                           |
| MC7269 | JK flip-flop                 | MC825P | Dual 4-input NOR gate                 |
| MC778P | Dual D-type flip-flop        |        |                                       |

Suffix G — T05

P — plastic DIL

MC700 Series  $\pm 15^\circ\text{C}$  to  $\pm 55^\circ\text{C}$

MC800 Series 0 to  $\pm 75^\circ\text{C}$

# DIODE TRANSISTOR LOGIC

# DTL

## General Characteristics

The following type characteristics apply to all manufacturers' DTL i.c.s using the coding given in the DTL tables.

- Gate speed 25ns, power 5mW
- Supply  $\pm V_{CC}$  5V  $\pm 5\%$
- Frequency range 20MHz
- Input forward current — 10mA
- Input reverse current 1mA
- Noise immunity 0-7V at 25°C
- Temperature range 0°C to 75°C
- Case outline DIL

DTL is suitable for most medium speed applications and is compatible with TTL. Positive logic usually applies to DTL circuit descriptions.

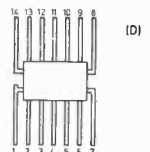
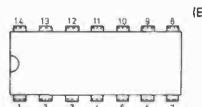
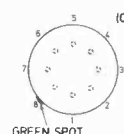
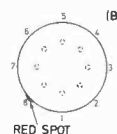
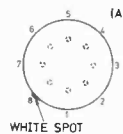
Temperature range  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$

## Common Code Digits

- |        |                                     |      |                                                                     |
|--------|-------------------------------------|------|---------------------------------------------------------------------|
| MC830P | Expandable dual 4-input NAND gate   | 930  | Dual 4-input NAND gate (expandable) fan-out 8                       |
| MC831P | Clocked flip-flop                   | 932  | Dual 4-input NAND driver gate (exp) fan-out 25                      |
| MC833P | Dual 4-input expander               | 933  | Dual 4-input expander                                               |
| MC836P | Hex inverter                        | 935  | Hex inverter (expandable)                                           |
| MC846P | Quad 2-input NAND gate              | 936  | Hex inverter fan-out 8                                              |
| MC848P | Clocked flip-flop                   | 944  | Dual 4-input NAND with open collector, lamp/relay driver fan-out 27 |
| MC849P | Quad 2-input NAND gate              | 945  | RS flip-flop with preset and clear (master/slave) fan-out 14        |
| MC851P | Monostable multivibrator            | 945  | Quad 2-input NAND gate fan-out 8                                    |
| MC856P | Dual JK flip-flop                   | 948  | RS flip-flop with preset and clear (master/slave) fan-out 13        |
| MC862P | Dual 2-input NAND gate and inverter | 951  | Monostable multivibrator fan-out 10                                 |
| MC886P | Dual 4-input expander               | 962  | Triple 3-input NAND gate fan-out 8                                  |
|        |                                     | 9093 | Dual JK flip-flops with preset inputs                               |
|        |                                     | 9094 | Dual JK flip-flops with preset inputs                               |
|        |                                     | 9097 | Dual JK with preset inputs and common clear                         |
|        |                                     | 9099 | Dual JK with preset inputs and common clear                         |

## CASE OUTLINES (view from above case)

- A — T05 — RTL  $\mu$ L900
- B — T05 — RTL  $\mu$ L914
- C — T05 — RTL  $\mu$ L923
- D — Flat-pack — 14 leads
- E — Dual-in-line — 14 leads
- F — Dual-in-line — 16 leads
- G — Dual-in-line — 24 leads





# TRANSISTOR TRANSISTOR LOGIC

# TTL

## General Characteristics

The following type characteristics apply to all manufacturers' TTL i.c.s using the 74 series coding given in the TTL table.

- Gate speed 10ns, power 10mW
- Fan-out 10
- Supply  $\pm V_{CC} 5V \pm 5\%$
- Frequency range 10MHz
- Input forward current  $-1.6mA$  (logic 0)
- Input reverse current 1mA
- Noise immunity 1V
- Temperature range (74 series) 0°C to +70°C
- Temperature range (54 series)  $-55^{\circ}C$  to  $+125^{\circ}C$

Case outlines: mainly DIL (suffix N), flat pack, TO5 can. TTL is the most comprehensive range of logic i.c.s. It is used in high speed low power applications, where very short connecting lines (12in) can be used to avoid unwanted triggering from noise spikes. Positive logic applies to TTL circuit descriptions. TTL is compatible with DTL, ECL, MSI, using current sinking logic.

Suffix H indicates high speed (6ns) series, 22mW per gate, and fan-out of 8. Suffix L indicates low power (1mW) series, low speed (33ns), high fan-out 49.

Suffix N indicates a dual-in-line package although not shown in this list. Some suppliers omit the N in their lists so check before buying whether DIL or flat-pack is available; DIL is usually cheaper and easier to use. DIL package holders are recommended for easy insertion and removal of the i.c.

## TTL GATES, BUFFERS, DRIVERS

- 7400 Quad 2-input positive NAND
- 7401 As 7400 but with open collector outputs
- 7402 Quad 2-input positive NOR
- 7403 As 7401 but pin connections as in 7400
- 7404 Hex inverters
- 7405 Hex inverters, open collector outputs
- 7406 Hex inverters, open collector buffer/drivers
- 7407 Hex buffers/drivers, open collector outputs
- 7408 Quad 2-input positive AND gates
- 7409 As 7408 but with open collector outputs
- 7410 Triple 3-input positive NAND gates
- 7413 Dual 4-input Schmitt triggered positive NAND gates
- 7420 Dual 4-input positive NAND gates
- 7430 Single 8-input positive NAND gate
- 7440 Dual 4-input positive NAND buffer
- 7450 Dual two-wide, 2-input AND-OR-INVERT (expandable)
- 7451 As 7450 but not expandable
- 7453 Single four-wide, 2-input AND-OR-INVERT (expandable)
- 7454 As 7453 but not expandable
- 7460 Dual 4-input expander for 7450 or 7453
- 7486 Quad 2-input exclusive-OR gates

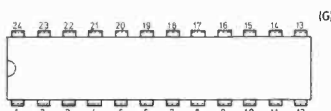
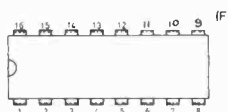
## TTL FLIP-FLOPS

- 7470 Single edge-triggered JK with preset and clear
- 7472 JK master/slave flip-flop with preset and clear
- 7473 Dual JK master/slave flip-flops with clear inputs
- 7474 Dual D-type edge-triggered flip-flops with preset and clear
- 7475 Quad D-type 4-bit bistable latches with paired clocks (no clear)
- 7476 Dual JK master/slave flip-flops with preset and clear
- 74107 Dual JK master/slave flip-flops as 7473, different connections
- 74118 Hex set/reset latch with common reset
- 74119 Hex set/reset latch with common and separate reset
- 74121 Gated or d.c. triggerable monostable multivibrator

## MSI

## TTL MEDIUM SCALE INTEGRATION

- 7441A BCD to decimal decoder/drivers
- 7442 BCD to decimal decoders
- 7445 BCD to decimal decoder drivers high power 30V output
- 7445 BCD to seven segment display decoder/drivers open collector outputs 30V
- 7447 As 7446 but 15V output
- 7448 As 7445 but with passive pull-up outputs
- 7449 BCD to seven segment display decoder/drivers, open collector outputs, blanking input
- 7480 Gated full adder
- 7481 Sixteen-bit active-element read/write memory
- 7482 Two-bit binary full adder
- 7483 Four-bit binary full adder
- 7484 As 7481 but with gated write-amplifier inputs
- 7488 256-bit read-only memory
- 7490 Decade ripple counter with reset and preset to 9
- 7491A Eight-bit shift register (serial-in, serial-out)
- 7492 Divide-by-two and divide-by-six counter ( $\div 12$ ) with reset
- 7493 Four-bit binary counter with reset ( $\div 16$ )
- 7494 Four-bit shift register, dual entry parallel-in, serial-out
- 7495 Four-bit right-shift left-shift register
- 7496 Five-bit shift register, parallel-in, parallel-out
- 74100 Eight-bit bistable latches
- 74141 Improved version of 7441 to minimise switching transients
- 74145 Four-line to ten-line decoder, open collector outputs
- 74150 16-bit multiplexer with strobe input
- 74151 8-bit multiplexer with strobe input
- 74153 Dual 4-bit multiplexer with strobe inputs
- 74154 Four-line to sixteen-line decoder with strobe input
- 74155 Dual two-line to four-line decoder with strobe inputs
- 74156 As 74155 but with open collector outputs
- 74160 Synchronous decade counter with parallel inputs
- 74161 Synchronous binary counter with parallel inputs
- 74190 Synchronous up/down decade counter
- 74191 Synchronous up/down binary counter
- 74192 Synchronous up/down BCD counter
- 74193 Synchronous up/down 4-bit binary counter

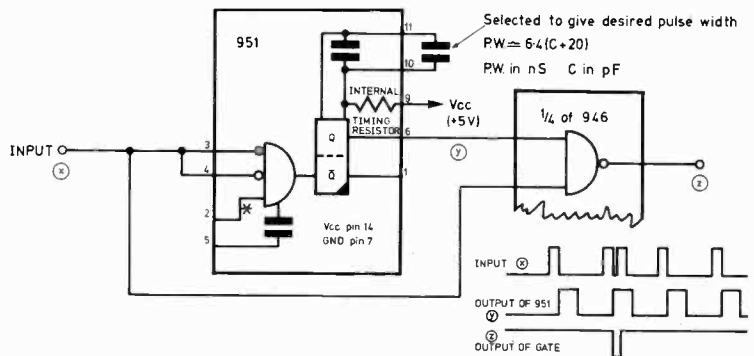


# APPLICATIONS OF LOGIC I.C.s

Fig. 1 shows a simple double pulse detector using a couple of DTL devices, especially handy for detecting index marks in position sensing equipment. If the input trigger pulses are derived from slowly

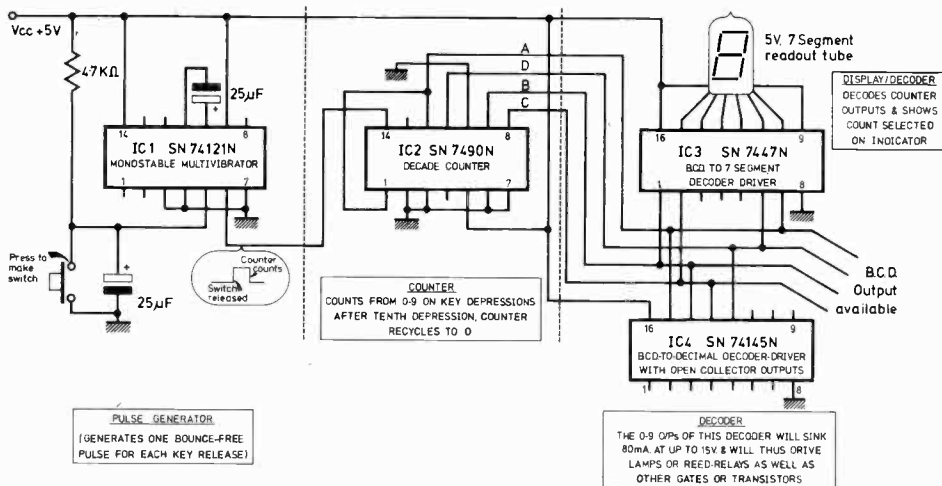
**Fig. 1**  
**DOUBLE LINE PULSE DETECTOR**

Gives an output pulse when a double pulse occurs. Monostable triggers on negative edge of input pulse. One application is to detect a double slot in rotating discs using a photo-electric cell



**Fig. 2**  
**SOLID STATE STEPPING SWITCH**

This switch uses four TTL/MSI integrated circuits and provides seven segment digital readout for ten position channel selection



changing sources a couple of gates will be required ahead of the circuit shown to speed up the edges ready to fire the monostable (these are available anyway in the 946 range of DTL).

Fig. 2 shows a scheme for a solid state stepping switch which could be useful for example for channel selection in a radio or television receiver.

The operation is simple, the single push-button control is pushed an appropriate number of times until the required channel number is displayed on the readout. At this point the selected output of the 74145 is low, and can be used to drive a wide variety of external circuitry.

Many variations of this circuit are possible, and the whole thing can be made little larger than a cigarette packet. This example illustrates an interesting substitute for a wafer switch for some applications.

## I.C. SUPPLIERS

The following advertisers in this magazine specialise in the supply of integrated circuits to readers:

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An example of a complex group of sunspots. This was an extremely active area on the sun which lasted for several days. The small spot below the main group is about the size of the earth. The magnitude of the group is apparent from this comparison.

# RADIO ASTRONOMY TECHNIQUES

By F. W. Hyde

PART 7

HAVING now had some experience in the operation of the simple radio telescope, the "feel" of the subject will no doubt have been acquired. After the experience of sorting out what is interference, what is random noise, and what is the real signal to be acquired, the limitations of the simple unit will be apparent. However, although this article will begin the description of interferometers and details of their construction, it is recommended that the observer should continue with the programme of the first project for two reasons.

The first reason is that it takes some time to become facile at recognition of the many different forms of interference, some of which will be man-made and some random signals due to odd reflections from the upper atmosphere. The second reason is that the data acquired and entered in the log will be of considerable importance when compared with the measurements made with the interferometer.

Of course, some constructors will not have the space to set up an interferometer and so must in any case continue with the single aerial unit. Bearing this in mind, some suggestions that may help these people will be given in the last article of this series.

## IDENTIFICATION OF SPACE SIGNALS

If the unit has been used during the night with the aerial pointed upwards, it is certain that there will be some signs of the radiation from the sources in Cygnus and Andromeda, and also the Crab Nebula. Also, the general rise in level of the recording at different times during each successive day and night will enable the positive identification of extra terrestrial radiation.

This was, in fact, the way in which the original pioneer Karl Guthe Jansky identified the existence of signals or radiation from space. To quote from his original paper, "In conclusion data have been presented which show the existence of electromagnetic waves in the Earth's atmosphere which apparently come from a direction that is fixed in

space. The data obtained give for the coordinates of this direction a right ascension of 18.00 hours and a declination of  $-10^{\circ}$ ."

Bearing in mind that the width of the aerial beam is quite wide in the vertical direction, tip the aerial so that the dipoles are directed at the Milky Way. Let the system run for a week every night or every three nights if this is more convenient. After the run compare the recordings by laying them side by side with the time marks aligned so that the same time is shown. Examine them for some significant event and check the difference in time that has elapsed. There should be a change of some 15 minutes in three days and some 30 minutes in a week. The exact times can be checked from the charts and the figures given are for the purpose of guidance only.

If it is possible obtain a copy of the *Ephemeris* issued by the Nautical Almanack Office. This may be available from the library or it can be obtained from the Stationery Office Bookshop in Holborn, London.

Table 7.1 indicates some of the radio sources that should be detectable quite easily on the simple radio telescope. Since there are bound to be satellites recorded, it will be quite clear from the table which these are, because they can be compared with the tracings shown in Part 6 of this series.

## SIDEREAL TIME

The table gives the usual astronomical coordinates of hour angle and declination. This involves certain corrections on the part of the observer for the hour angle or right ascension. This hour angle is in *Sidereal Time* which differs from ordinary astronomical time by an acceleration of 10 seconds in each hour, or approximately four minutes per day. The time is reckoned from the entry of the first point of ARIES which occurs between the twenty-first and twenty-third of March each year. This is the Vernal Equinox, 00.00 hours right ascension. All of this may appear a little complicated but it can be reduced to fairly simple terms for the purpose of the project.

In Table 7.2 a summary is given of the sidereal time for noon G.M.T. for each day of the year. This is approximate, but will not vary by more than about five minutes for each day and this error is insignificant with the system being used. In any case the source will be well within the beam of the aerial.

### SIMPLE INTERFEROMETER

The simple two-aerial interferometer was briefly described in Part 2 of this series, and the modification required to convert the existing simple telescope is really one of addition. Firstly the existing aerial must be duplicated, together with the pre-amplifier if this is located at the aerial. The two aerials should be set up preferably on an east to west baseline. Within certain limits this is not an absolute requirement, but this will be dealt with later in this article. The distance between the aerial centres should be, if possible, at least five wavelengths. At the frequency that has been adopted this will mean a distance of 36 feet.

It is necessary to connect the aerials together. This may be done at the observing point, or if this distance is greater or about the same length as the distance between the aerials, then the following alternative arrangement is possible.

Having set up the aerials, cut two lengths of cable which will leave sufficient slack for the aerials to be moved further apart and to facilitate stowage. These

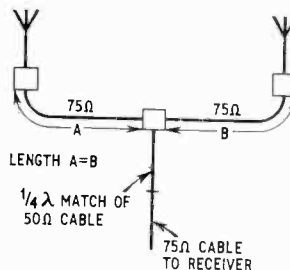


Fig. 7.1. Coupling two aerials together as a simple interferometer

two lengths of cable must be exact to within about one half inch, and of the same type of cable. These two points are very important. As both ends of the cables will terminate in coaxial plugs the equality of length includes the plugs. At the junction of the two aerial cables there will be a connection box as shown in Fig. 4.6 of Part 4. The outlet from this box will go to the converter in the same way as for the simple telescope, that is, with the matching section of 50 ohm cable followed by the 75 ohm cable. The diagram in Fig. 7.1 gives the layout.

The importance of the length of the cables has been stressed because the operation of the two aerial system depends on the combining of the signals which are alternately in phase and out of phase with the other.

TABLE 7.1. LIST OF RADIO SOURCES

CONSTELLATION	I.A.U. NO.	RIGHT ASCENSION	DECLINATION	IDENTIFICATION
*Cassiopeia	00N6A	00h 22m ± 2m	64° 15' ± 35'	(12) Supernova 1572 (no visible remnants)
Andromeda	00N4A	00h 40m 15s ± 30s	40° 50' ± 20'	(11) M31 NGC224
Perseus	03N4A	03h 16m 37s ± 4s	41° 25' ± 6'	(17) NGC1275 Colliding galaxies?
Auriga	04N4A	05h 08m ± 4m	46° ± 1°	(13) Angular size of source is 1° 4' Identified with galactic nebulosity
*Taurus	05N2A	05h 31m 35s ± 5s	22° 04' ± 5'	(4) M1 NGC1952 Crab Nebula
Orion	05S0A	05h 33m 0 ± 0m 2	-05° 27' ± 5'	(18) Orion Nebula M42 NGC1976
Gemini	06N2A	06h 13m 37s ± 4s	22° 38' ± 5'	(19) IC443
Monoceros	08S0A	08h 08m ± 10m	-06° ± 30°	(13)
Lynx	08N4A	08h 09m ± 2m	48° ± 1°	(8)
Puppis	08S4A	08h 20m ± 4m	-42° 30' ± 1°	(13) Galactic nebulosity
Lynx	09N4A	09h 16m ± 4m	47° ± 1°	(8)
Hydra	09S1A	09h 16m ± 2m	-12° ± 2°	(13)
Ursa Major	09N6A	09h 51m 20s ± 2m	69° ± 1°	(15) NCG3031
Vela	10S4A	10h 10m ± 4m	-42½° ± 20'	(2)
Ursa Major	10N5B	10h 30m ± 2m 5	57° ± 2°	(11)
Crater	11S1A	11h 38m ± 8m	-15° ± 2°	(13)
Canes Venatici	12N4A	12h 15m ± 3m	47° ± 1½°	(11) NGC4258
Virgo	12N1A	12h 28m 11s ± 37s	12° 41' ± 10'	(1) M87 NGC4486
Centaurus	13S4A	12h 22m 24s ± 1m	-42° 37' ± 8'	(1) NGC5128
Canes Venatici	13N4A	13h 27m 30s ± 3m	47° ± 1°	(11) NGC5195
Boötes	14N5A	14h 10m ± 2m	51° 30' ± 1°	(11) NGC5457
Serpens Caput	15N1A	15h 10m ± 4m	11° ± 1½°	(2)
Triangulum Australe	16S6A	16h 10m ± 8m	-60½° ± 5'	(2)
Hercules	16N4A	16h 36m ± 10m	41° ± 2°	(13)
Hercules	16N0A	16h 45m ± 2m	6° ± 1° 5	(2)
Sagittarius	17S2A	17h 42m ± 1m	-28° 5' ± 0° 2	(21) May be associated with the galactic nucleus. The presence of neighbouring intense emission regions makes the measurements of flux density difficult
Ophiuchus	18S0A	18h 16m ± 4m	-8° ± 2°	(13)
Sagittarius	18S1A	18h 17m 9 ± 0m 2	-16° 14' ± 5'	(18) Omega Nebula M17 NGC6618
*Cygnus	19N4A	19h 57m 44s ± 2½s	40° 35' ± 1½'	(3) Colliding galaxies
*Cygnus	20N4A	20h 22m	40°	(11) Cyg X extended source possibly associated with galactic nebulosity
*Cassiopeia	23N5A	23h 21m 36s ± 30s	58° 35' ± 10'	(11) Galactic nebulosity

\* Very strong sources

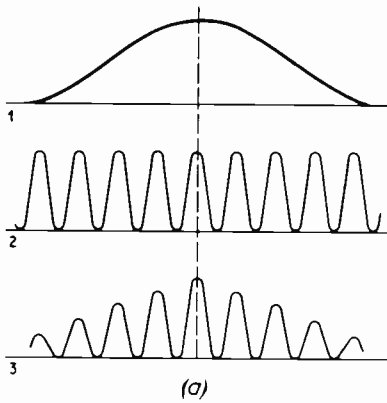


Fig. 7.2a. The effects of differing aerial parameters. (1) Single aerial pattern. (2) Two aerial pattern. (3) Interferometer pattern (point source)

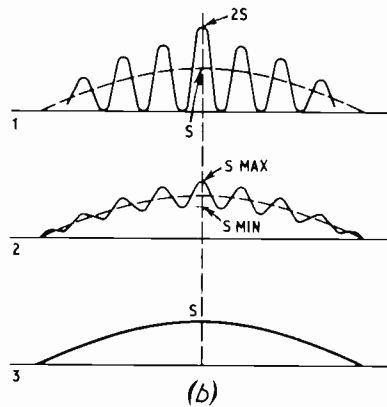


Fig. 7.2b. (1) Point source pattern. (2) Uniform extended source comparable but smaller than lobe spacing. (3) Uniform extended source equal to or greater than lobe spacing

When using an interferometer it is usual to have the aerials aligned and fixed in azimuth facing south in the northern hemisphere and north in the southern hemisphere. The altitude will depend on the section of sky to be observed, but each will normally be at the same angle of altitude. This will apply to each sweep of the sky. The sweeping will be done by the rotation of the earth so that in the course of 24 hours the whole 360 degrees of sky, as seen from the earth, will be scanned by the width of the aerial beam.

### RESOLUTION

The resolution or ability to distinguish between sources will be dependent on two parameters. One is the distance between the aerials, for this governs the width of the fringes, and the width of a fringe

determines the size of the smallest source that can be recognised. The diagrams in Fig. 7.2a and b illustrate the effects of these varying conditions.

It is essential that the beginner goes through this step of the simple interferometer in order to make practical observations and again have experience of the working conditions.

### FRINGE WIDTH

Before moving on to the more complicated phase-switched interferometer there are one or two points which need to be covered. Firstly, the simple calculation to be made to determine the fringe width. The relationship between the fringes and the distance between the two aerials is in this form. The beam width between first null points (the fringe spacing) is  $1/D\lambda$  radians which equals  $57.3/D\lambda$ .

TABLE 7.2

DAY	JAN.	FEB.	MAR.	APR.	MAY	MONTH JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	18 40	20 43	22 33	00 35	02 33	04 36	06 34	08 36	10 38	12 37	14 39	16 37
2	44	46	37	39	37	40	38	40	42	41	43	41
3	48	50	41	43	41	43	42	44	46	44	47	45
4	52	54	45	47	45	47	46	48	50	48	51	49
5	56	58	49	51	49	51	50	52	54	52	55	53
6	19 00	21 02	53	55	53	55	54	56	58	56	59	57
7	04	06	57	59	57	59	58	09 00	11 02	13 00	15 02	17 01
8	08	10	23 00	01 03	03 01	05 03	07 01	04	06	04	06	05
9	12	14	04	07	05	07	05	08	10	08	10	09
10	16	18	08	11	09	11	09	12	14	12	14	13
11	20	22	12	15	13	15	13	16	18	16	18	17
12	24	26	16	18	17	19	17	19	22	20	22	20
13	28	30	20	22	21	23	21	23	26	24	26	24
14	32	34	24	26	25	27	25	27	30	28	30	28
15	35	38	28	30	29	31	29	31	34	32	34	32
16	39	42	32	34	33	35	33	35	37	36	38	36
17	43	46	36	38	36	39	37	39	41	40	42	40
18	47	50	40	42	40	43	41	43	45	44	46	44
19	51	53	44	46	44	47	45	47	49	48	50	48
20	55	57	48	50	48	51	49	51	53	52	54	52
21	59	22 01	52	54	52	54	53	55	57	55	58	56
22	20 03	05	56	58	56	58	57	59	12 01	59	15 02	18 00
23	07	09	24 00	02 02	04 00	06 02	08 01	10 03	05	14 03	06	04
24	11	13	04	06	04	06	05	07	09	07	10	08
25	15	17	08	10	08	10	09	11	13	11	13	12
26	19	21	11	14	12	14	12	15	17	15	17	16
27	23	25	15	17	16	18	16	19	21	19	21	20
28	27	29	19	22	20	22	20	23	25	23	25	24
29	31		23	26	24	26	24	27	29	27	29	28
30	35		27	29	28	30	28	30	33	31	33	31
31	39		31		32		32	34		35		35

SIDEREAL TIME FOR NOON G.M.T. FOR 0° LONGITUDE

Using three examples of spacing, the first five wavelengths, the second 10 wavelengths, and a third 20 wavelengths, the approximate figures are 11.5 degrees, 5.73 degrees, and 2.86 degrees respectively. Since this is the point of the nulls the actual fringe width is half each value given at the half power points. The half power points were explained in Part I and illustrated in Fig. 1.4.

### CHART SPEED

The second point to be noted is the appropriate speed of the chart on the pen recorder consistent with obtaining a useful trace.

Taking the case of the least spacing 11.5 degrees, it will take 46 minutes for passing from the one null to the next, since it takes about four minutes of time for the earth to move 1.0 degree of arc. Therefore in this instance it will be wise to choose a slow speed for the recorder in order that the fringes may be clearly visible. A preferred speed would be 0.5 inches per hour, though 1.0 inch per hour would

be permissible. For the widest spacing quoted a speed of 3.0 inches per hour would give best results. It will be clear from this that the greater spacing offers a better chance of detecting sources than the lesser spacing.

### THE BASE LINE

Finally the setting up of the base line must be considered—for those who have the space to accommodate the interferometer. It is not sufficient to set up the south point using a compass, though this is a first step. The south point required is *geographical south* and this differs by several degrees. The exact amount of difference is obtainable for each year from ordnance survey maps. It was 8 degrees 40 minutes West in 1948, and decreasing by about 8 minutes annually.

Next month's article will be concerned with the phase-switched interferometer.

## NEWS BRIEFS

### TRAFFIC SPEED METER

A COMPLETELY new road traffic speed measurement system is being developed by GEC-Marconi Electronics, under contract to the Director of Telecommunications, Home Office.

The new system uses an optical method of measurement and the complete system can be contained in a single unit which can be placed at the side of the road. The unit looks at right angles to the traffic flow and as soon as a vehicle passes, and comes within the field of view of the optical system, its speed will be measured almost instantaneously, and shown on a three-digit display, probably using a liquid crystal system.

The image of the vehicle is split into a succession of vertical strips, which are viewed by a photodiode. Any irregularities in the image, whether bright spots or shadow, will move across the slits of the "virtual" grating and produce a fluctuation of the light falling on the diode. The frequency of this fluctuation is measured and, from it, solid-state micrologic circuitry calculates the speed of the vehicle.

### EUROPE'S FIRST FULLY AUTOMATIC NAVIGATIONAL BUOY

IN ALMOST every field nowadays man is rapidly being replaced by electronic equipment. This is the case at Portland Bill, Dorset, where a fully automatic navigational buoy has recently replaced the manned Shambles lightship.

The 84 ton buoy, made by Hawker Siddeley Dynamics and named Lanby (Large Automatic Navigational Buoy) has a 40ft latticework mast topped with a main light beacon giving a luminous range of 16 miles. Also on board is a powerful fog signalling device, with an audible range of more than 3 miles.

The buoy is monitored every 30 minutes by a shore control station using a radio telemetry link. Should any failure occur, standby services operate automatically, and the nature of the fault is relayed to the control station.

The buoy can be moored in depths from 30 to 300ft, and can withstand winds up to 100 mph, waves up to 40ft and tidal currents up to seven knots.

### UNDERWATER TELEVISION EQUIPMENT

THE present system of searching for and locating underwater wreckage, such as crashed aircraft and sunken ships by use of drag lines towed by surface craft seems soon to be superseded by a more efficient electronic method. This is evident following recent trials carried out by EMI Systems & Weapons Division, Middlesex, with their newly developed "low light" television equipment.

The television camera can quickly scan large underwater areas where visibility is poor and transmit clear pictures of the sea bed to a mother ship on the surface where they can be viewed and recorded. The television equipment will be housed in a midget submarine capable of depths down to 3,000ft.

The "low light" television camera used in the trial is claimed to be the smallest in Britain, measuring 128 × 128 × 152mm. Its ability to obtain clear pictures in very low lighting conditions is provided by an E.M.I. Ebitron tube. This intensifier-vidicon is 300 times more sensitive than a normal 26mm vidicon tube.

### COMPUTER NURSE

THE United Birmingham Hospitals have received approval from the Department of Health and Social Security to proceed with the purchase of a UNIVAC 418-111 computer as part of the Department's experimental programme in hospital computing. Delivery will be made early in 1972 and specially designed accommodation to house it is nearing completion at the Queen Elizabeth Medical Centre. The first real-time application is expected to go live early in 1973.

The initial configuration will provide for complete patient administration and laboratory reporting systems for the Queen Elizabeth Hospital. It is planned to introduce other experimental systems such as laboratory requesting, drug prescribing, nursing records, physical examination of the patients and other medical applications at later stages in the project.

### NORTH MIDLANDS READERS *Please note*

A short course of six evening lectures entitled "Practical Electronics" will be held at North Staffordshire Polytechnic, College Road, Stoke-on-Trent, commencing Wednesday, January 12. The lecturers include well-known contributors to this Magazine.

Further details will be given next month.

## SPECIAL PURCHASE!

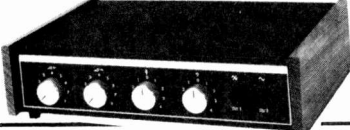
**BRAND NEW FM MULTIPLEX STEREO DECODER UNITS.** Manufactured by PHILIPS, Size 2 1/2" x 1 1/2". All transistor 24V, at 6mA. Supplied pre-aligned with full circuit diagram and connection details. 24 each. Post free.

**LEAK MK 1 TRANSCRIPTION PICK-UP ARMS.** Using the world famous gimbal pivot system. Complete but less pick-up head. £2.50. P. & P. 20p.

**INPUT MATCHING TRANSFORMER.** Beautifully made in heavy Mu-metal cylindrical case for minimum hum pick-up. Size 1 1/2" high x 1 1/4". Ratio 150:1 approx. Especially suitable for matching dynamic or ribbon mikes or pick-up from low to high impedance or vice versa. 75p each. Post Free.

**BLACK ANODISED 16g. ALUMINIUM HEAT SINKS.** For TO3, complete with mica's and bushes. Size 2 1/2" x 3". 25p pair. P. & P. 2p.

## HARVERSON SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



**NEW IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD FOR EASY CONSTRUCTION**

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, attractive front panel, knobs, wire, solder, nuts, bolts, no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response 1.3dB 12-20,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth 1.3dB 12-15,000Hz. Bass boost approx. to 12dB. Treble cut approx. to -16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1.0 amp. Overall size—12" wide 8" deep 2 1/2" high. Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

**PRICES** AMPLIFIER KIT, £1.50 P. & P. 15p.  
POWER PACK KIT, £3 P. & P. 30p.  
CABINET, £3 P. & P. 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, £20.50. Post Free.

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

**SPECIAL PURCHASE OF MANUFACTURER'S GURANTEED** All Transistor 10M under head with twin A.M. Gang incorporated. Beautifully engineered with precision geared reduction drive. F.M. R.F. Transistor, oscillator/Mixer and first I.F. stage (10.7 Mc/s output) with optional APC connection. Built on printed circuit panel and fully screened. Extremely stable over range 88-160 Mc/s. Brand new and pre-aligned. Size 2 1/2" H. x 1 1/2" W. x 2 1/2" D. For 6V D.C. or 2.8mA. A.M. Gang fitted with trimmers which can be connected to standard A.M. aerial and oscillator circuits if required. LIMITED NUMBER, only £2.25 post free. Connection details supplied.

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5in 3 ohm 80p. P. & P. 15p. 7 x 4in 3 ohm £1.05. P. & P. 20p. 10 x 6in 3 or 15 ohm £1.90. P. & P. 30p. E.M.I. 8 x 6in 3 ohm with high flux magnet £1.62. P. & P. 20p. E.M.I. 13 x 8in 3 ohm with high flux ceramic magnet £2.10 (15 ohm £2.25). P. & P. 30p. E.M.I. 13 x 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network £4.20. P. & P. 30p. E.M.I. 13" x 8" twin cone (parasitic tweeter) 8 ohm £2.25. P. & P. 30p.

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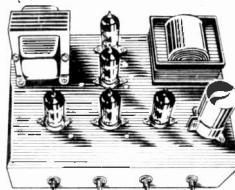
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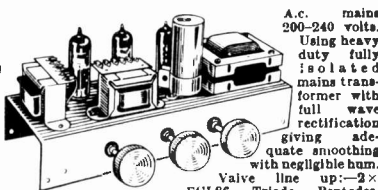
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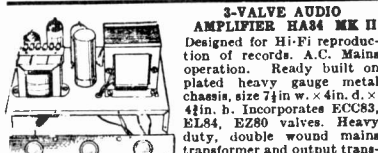


A.C. mains 200-240 volts. Using heavy duty fully fitted 4:1 A.C. mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up 2 x ECL86 Triode Pentodes. 1 x E280 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w. x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price £8.92. P. & P. 45p.

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**HARVERSON'S SUPER MONO AMPLIFIER** A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer. FEW ONLY. **OUR ROCK BOTTOM BARGAIN PRICE** £2.75 P. & P. 35p

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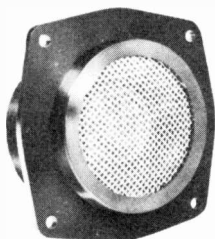
### Din 20 Kit

20 watt, high fidelity loudspeaker kit contains all parts necessary to complete the system, except timber and other material for the cabinet itself, with detailed, illustrated instructions.

**Specification:** 20 Watts DIN, 4 ohms impedance, 8 ins bass unit, dome HF radiator, crossover frequency 4,000 Hz.



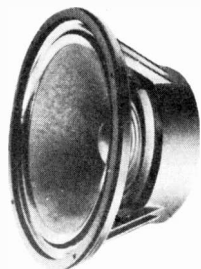
### Axent 100



Dome HF Radiator with integral crossover. Capable of high frequency sound reproduction with negligible distortion in systems rated up to 30 Watts DIN, this 'state of the art' drive unit has an integral crossover which cuts frequencies below 3kHz at a rate of 12dB/Octave.

### Audiom 100

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<b>C6U</b>	1.6 amp general purpose 25V SCR in TO5 case	3 for 50p
<b>D16P4</b>	(Equals 2N5306) Darlingtion transistor Hfe min = 7000	3 for 50p
<b>2N3390</b>	Silicon NPN ultra high gain transistor Hfe 400-800	3 for 50p
<b>2N3391A</b>	Silicon high gain low noise transistor (better than BC109)	3 for 50p

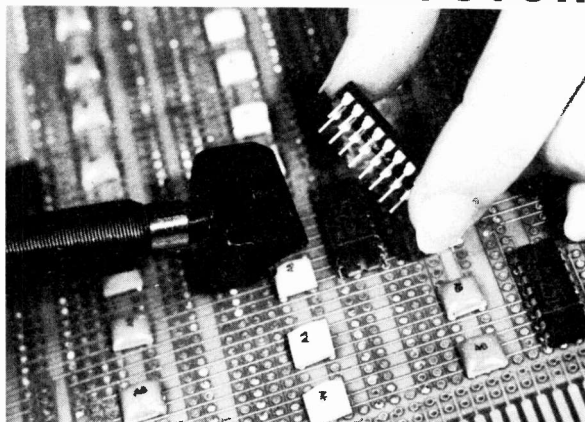
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## SURPRISE SURPRISE!!

The decision by RCA to pull out of the computer mainframe business sent a chill down the spine of the United States' electronics industry—and of Europe too.

Everyone was taken by surprise. It happened almost exactly a year after RCA chairman Robert W. Sarnoff had announced firm plans for a frontal attack on the market held so lucratively by IBM. As recently as July, Sarnoff was still denying that RCA had any intention of pulling out.

The RCA debacle follows a similar withdrawal by U.S. General Electric a year earlier. GE's move, however, was well regulated and involved lengthy negotiations before the sale of its computer interests to Honeywell.

Industry experts on both sides of the Atlantic are asking themselves: if giants like U.S. General Electric and RCA can't stand the pace, who can? Except, of course, the almighty IBM.

Unstoppable IBM has 70 per cent the U.S. domestic market and not far short of that figure in the rest of the world. RCA's share was under 4 per cent with a growth target of 10 per cent of the market by 1975. The crunch came when it was realised that another £200 million of capital, on top of the £200 million already spent, would be required before breaking into profit.

Now the RCA market share will be distributed among the survivors with the bulk going to IBM, still further tightening IBM's stranglehold.

## THE AFTERMATH

Britain's ICL is involved only through System 4, a development of RCA's Spectra 70 Series. ICL say they will remain unaffected. But Siemens in Germany will be affected because they rely strongly on close technical links with RCA.

RCA customers have been told that all existing orders and service contracts will be honoured. But the demise of two major mainframe manufacturers in a period of 16 months will influence new buyers toward the most stable source which means even more business for IBM.

Component suppliers to RCA such as Motorola, Signetics and Advanced Memory Systems will all suffer from the closure. Some smaller suppliers stand to lose 10 per cent of their total business.

At the time of writing there was no firm news that RCA had been able to sell its computer interests either in whole or in part. In the present depressed state of the computer market few firms are interested in acquiring extra plant and manufacturing capacity.

One possibility emerging from the debacle is that Britain's ICL and Germany's Siemens could now get together to form a new and potentially extremely powerful computer force in Europe.

## DATA SATELLITE

The computer industry may be suffering at the moment but the demand for data processing and data transmission will continue to increase at a growing rate. In 1970 there were 14,000 data terminals in Britain. By 1980 there might be, and probably will be, 300,000. This figure will be matched by other major European nations and so far no international agreements on data network standards have been made.

An interesting new development is a study contract awarded to Marconi Communications Systems Ltd. by the European Space Research Organisation (ESRO). The idea is that data links should be through a geo-stationary satellite used in conjunction with large numbers of small and inexpensive earth terminals.

The earth terminals would have dishes no larger than 9ft in diameter sited within 100yds of the data terminal. Use of such a system, dedicated entirely to data transmissions, would obviate many of the difficulties of international connections through existing public telephone and data networks where data rates are comparatively low due to line variations.

The preliminary study, involving analysis of present and future traffic, prospective users and costs of the system, should be completed by April 1972

## WHERE THE GIANTS MAY GO

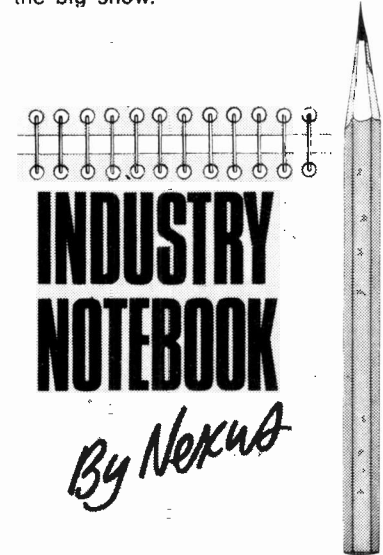
Although the great electronic exhibitions aimed at industry such as the IEA and ILECS at Olympia are by no means on the way out, increasing costs have been forcing companies to look more closely at the less expensive small shows which tend to be more cost-effective.

One of the brightest operators in the field is John McNeill, managing director of Electromation Exhibitions Ltd. I have just seen the company's forward programme with electronics shows starting at Birmingham in November and moving round the country to Harrogate, Southend, Stevenage, Portsmouth, Croydon, Glasgow, Dublin, Bristol, Manchester and back to Birmingham in November 1972. This is an impressive programme which includes, apart from exhibitor stands at each venue, a technical convention. Admittance is reserved for professional engi-

neers and you need an invitation before you can get admission.

Another bright operator in small exhibitions is Evan Steadman who has already sold out for his Seminec due to be held next April. This one is for semiconductor manufacturers. Yet another is Gordon Johns who organised the successful Compec '71 computer peripheral exhibition in London last September.

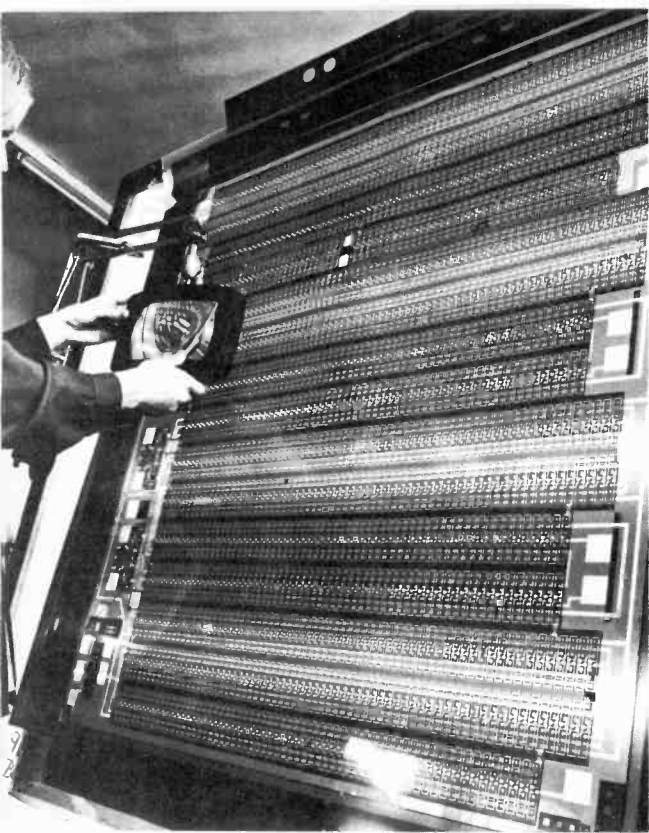
It is too early to predict the effect of this type of exhibition on the IEA at Olympia next year but one thing seems certain. With Mullard, TI, Fairchild, RCA, Emihus, Ferranti, to name but a few who have already booked for Seminec and its accompanying technical symposium, it seems clear that the bulk of the semiconductor companies have already opted out of the big show.



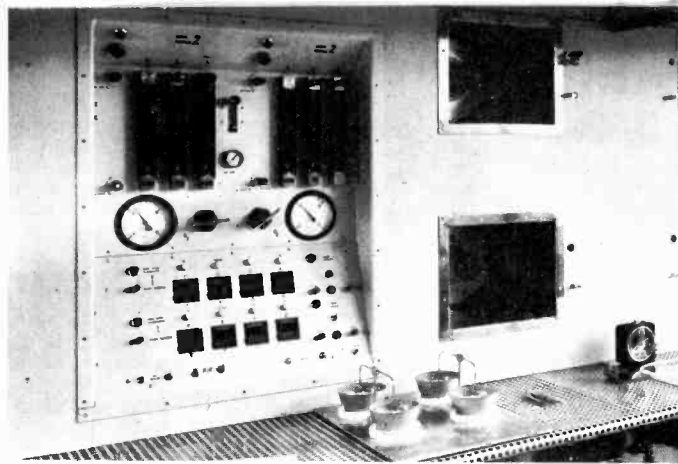
## BRIGHTER OUTLOOK— BUT SLOW

Sir John Clark, chairman of Plessey, thinks the worst may be over but it will be a long haul back to the halcyon days of pre-recession. Ernie Harrison, Rascal chairman, believes that it could be another 18 months before business takes off in any big way. Dr F. E. Jones, managing director of Mullard was not exactly cheerful when we last met despite the boom in colour TV sales.

On the whole, however, I have found most industry leaders optimistic. Smaller companies with their greater level of flexibility have in many cases proportionately weathered the storm better than the giants. But 1972 could see further "re-structuring" of the industry through takeover or merger. On one thing they all agree. Even if the bottom has now passed, don't expect a dramatic revival. Recovery will be slow.



Physical inspection of rubyliths (artwork) of a 1,024-bit CDI shift register



Part of the pre-production line for CDI

## New LSI Combines Logic and Linear Functions on one chip

How does the thought of a high performance computer on a single slice or even a chip strike you—impossible? Well it is not as far fetched as it may seem. While we are just getting accustomed to MOS integrated circuit technology, along comes another—the CDI process of producing LSI (large scale integration).

CDI (collector diffusion isolation) is a simple bipolar process originally developed in the Bell Laboratories in the U.S.A. and has now been further developed by Ferranti at Manchester for large scale



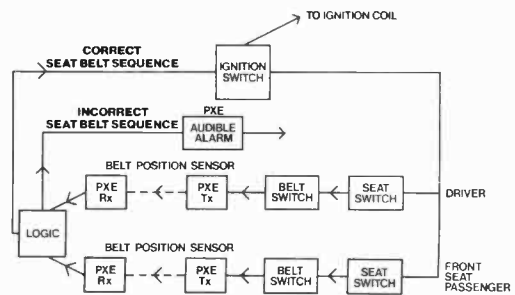
## Ultrasonic Car Safety Belt System

ONE of the results of a new car safety belt system, developed by Mullard and the Ford Motor Co., means that even the car thief will have to strap himself in if he wishes to make off with his "booty". The belt must not only be fastened but also be correctly positioned across the wearer.

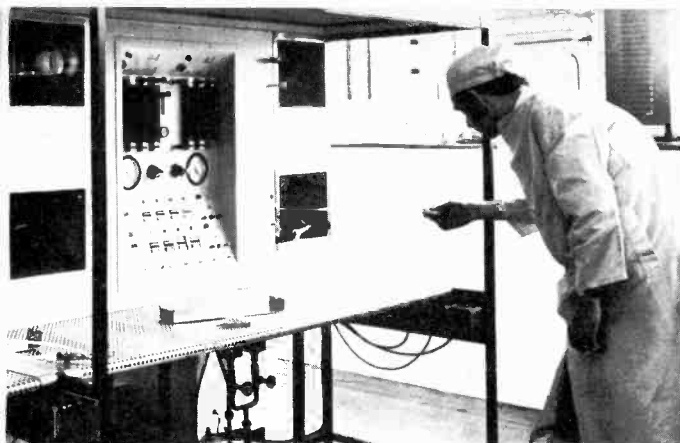
As the block diagram shows, before the ignition will function the driver must occupy his seat, activating a pressure switch fitted beneath it, buckle the belt across his lap and close the belt switch. Provided the belt is worn correctly a 40kHz signal emitted from an ultrasonic transmitter, mounted in the belt, is received by a detector built in the windscreen pillar, which in turn completes the ignition circuit. If the front passenger seat is occupied then a 50kHz signal must be received from the passenger's



Layout of the car safety belt system as installed in a car. Note the narrow ultrasonic beam directed at the receiver mounted in the windscreen pillar



Block diagram of the car safety belt system

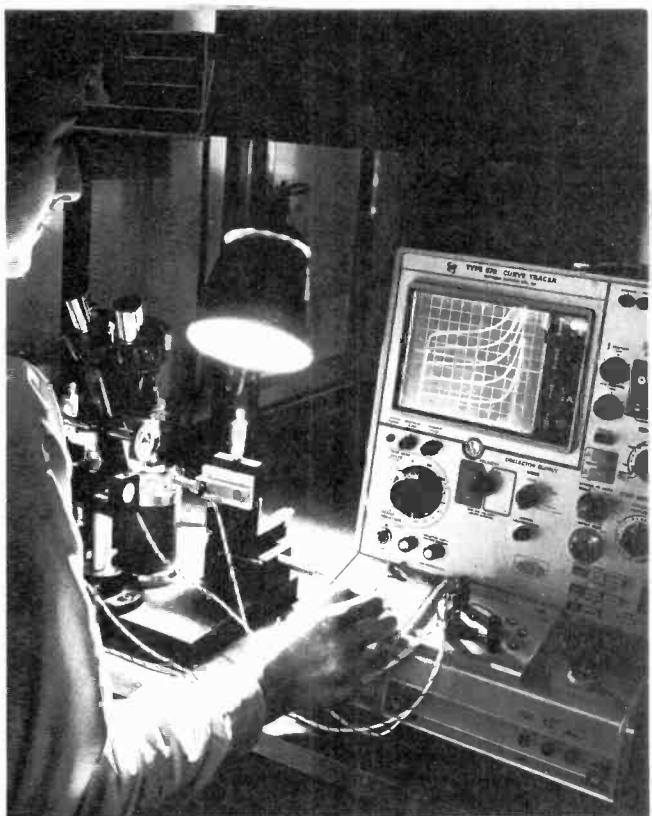


*bipolar integrated circuits at Ferranti*

production at an economic cost. This is said to be the first time that LSI has become a practical proposition, combining the high complexity of MOS with the performance advantages of bipolar technology.

The breakthrough is in the combination of both high speed switching logic and linear capability for a common supply of 5V on the same monolithic chip. The system is completely compatible with existing TTL i.c.s.

Only five masking operations are required compared with nine steps involved in current bipolar processing. It is expected that this new bipolar LSI technology will be used where digital and analogue control, computers and telecommunications already require complex and sophisticated circuitry.



*An operator carrying out a process control check using a curve tracer which shows the collector-emitter characteristics of a CDI transistor in a digital array*

# NORAMA

safety belt before the ignition switch will be functional.

If the correct sequence has not been carried out a logic circuit will trigger an audible and visible alarm mounted on the dashboard.

The system can be arranged so that if the belt is unfastened while the car is moving the ignition is not immediately affected. Instead, the alarm is sounded and if, at the end of a specified time, the belt still remains unfastened, the ignition will then be cut out.

For very short operations, such as parking or garaging the car, the logic arrangement can be adjusted to allow for car movement in first or reverse gear for a specified time without the driver being belted.

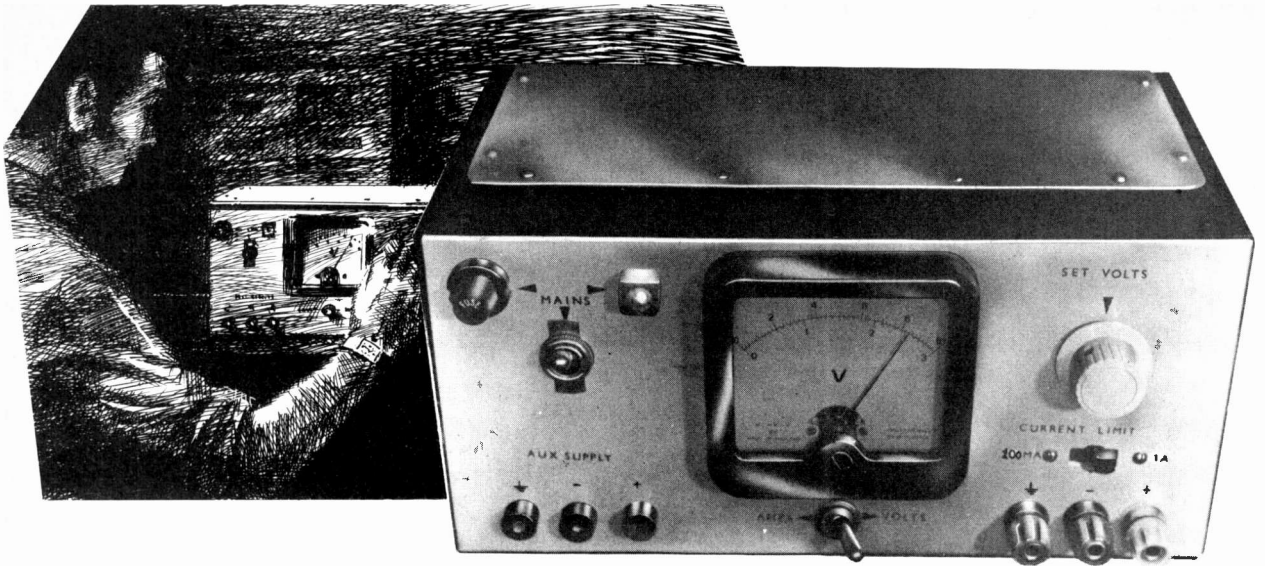
As a method of enforcing the wearing of safety belts by driver and passengers, thus cutting down the death and injury toll on the roads, this contribution to road safety should be closely looked at by the Police and the Ministry of Transport.



*The ultrasonic transmitter (top) and receiver circuit boards*

*The ultrasonic transmitter mounted on a car safety belt*





# Labpack Power Supply

BY H.T. KITCHEN

THE stabilised power supply to be described was designed and built to provide a power source for transistorised equipment undergoing development. As such, it had to fulfil certain basic requirements.

A long and varied experience of development and service work had shown the need for a power supply capable of being varied from near zero to a maximum of some 25V, with a maximum current capacity, within this voltage range, of 1A.

A further requirement was that the output voltage had to be regulated. The output current also had to be controlled, so that even if the load terminals were made short circuit, the maximum current rating could not be exceeded.

The final requirement was that the maximum current output should be capable of being adjusted

to values less than the 1A maximum. In the prototype, two switched ranges of 1A and 100mA are provided.

A block diagram of the power supply is shown in Fig. 1 which should be studied in conjunction with the circuit diagram of Fig. 2.

## SERIES REGULATOR

The regulator element of this design is of the series type and is made up of the transistors TR5, TR6 and TR7.

This is a compound configuration where TR5 controls the base to emitter voltage of the output pair TR6 and TR7. The base feed resistor of TR5 also functions as the collector load of TR2. This transistor, together with TR1, constitute a differential amplifier.

## DIFFERENTIAL AMPLIFIER

The differential amplifier provides an output voltage which is proportional to the difference of the input voltages applied to the transistor bases. At the base of TR1 is connected a fixed Zener voltage which is derived from a double diode rectifier and filter circuit.

This stable reference at one base means that any changes in the output voltage—either up or down—will be fed back by way of VR2 to provide a collector current change through R5. If the current flow is low the volt drop at this resistor is low, which corresponds to a movement of the base potential of TR5 towards the collector potential. Increased emitter current therefore flows, and as this current is into the bases of TR6 and TR7, their emitter currents also increase.

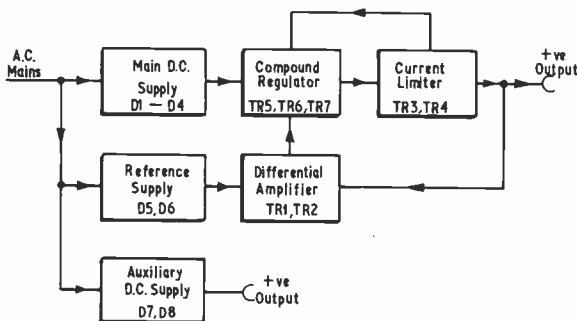


Fig. 1. Block diagram of power supply

If the output load is a resistive one, this will result in an increase of output voltage. A converse feedback action will decrease the output.

The overall gain of TR2, TR5 and the output pair is very high, and very small changes in output voltage can be sensed and automatically corrected. Rapid changes in output voltage, corresponding to a residual 100Hz ripple, or the signal frequency of a connected high power amplifier, can also be sensed and corrected. In this instance, feedback is via C5, again to the base of TR2 which treats it also as an error signal.

### CURRENT LIMITING

The current limiter circuit comprises TR3 and TR4, in conjunction with VR3, R8 and VR4 and R10.

The transistor TR3 is connected so as to function as a cheap form of Zener diode which fixes the emitter potential of TR4. Under no load or small load conditions TR4 is reverse biased and does not pass any collector current.

Dependent on the switch position of S2 and limit setting of VR3 or VR4, load current limiting occurs when the voltage drop across these resistance combinations is sufficient to drive TR4 out of its cut-off state.

With TR4 conducting the volt drop across its shared load resistor R5 will increase. The polarity of this voltage is such as to reduce the  $V_{be}$  of TR5 and so reduces the emitter current passed by TR6 and TR7.

By controlling the  $V_{be}$  of TR5 it is possible to set a limit to the maximum current that can be drawn from TR6 and TR7, even if the output is short circuited.

### CHOICE OF LIMITING RESISTANCE

Since any volt drop across R8 and R10 is lost to the output voltage, and since a certain minimum voltage at the base of TR4 is necessary for reliable current limiting, the absolute minimum resistance

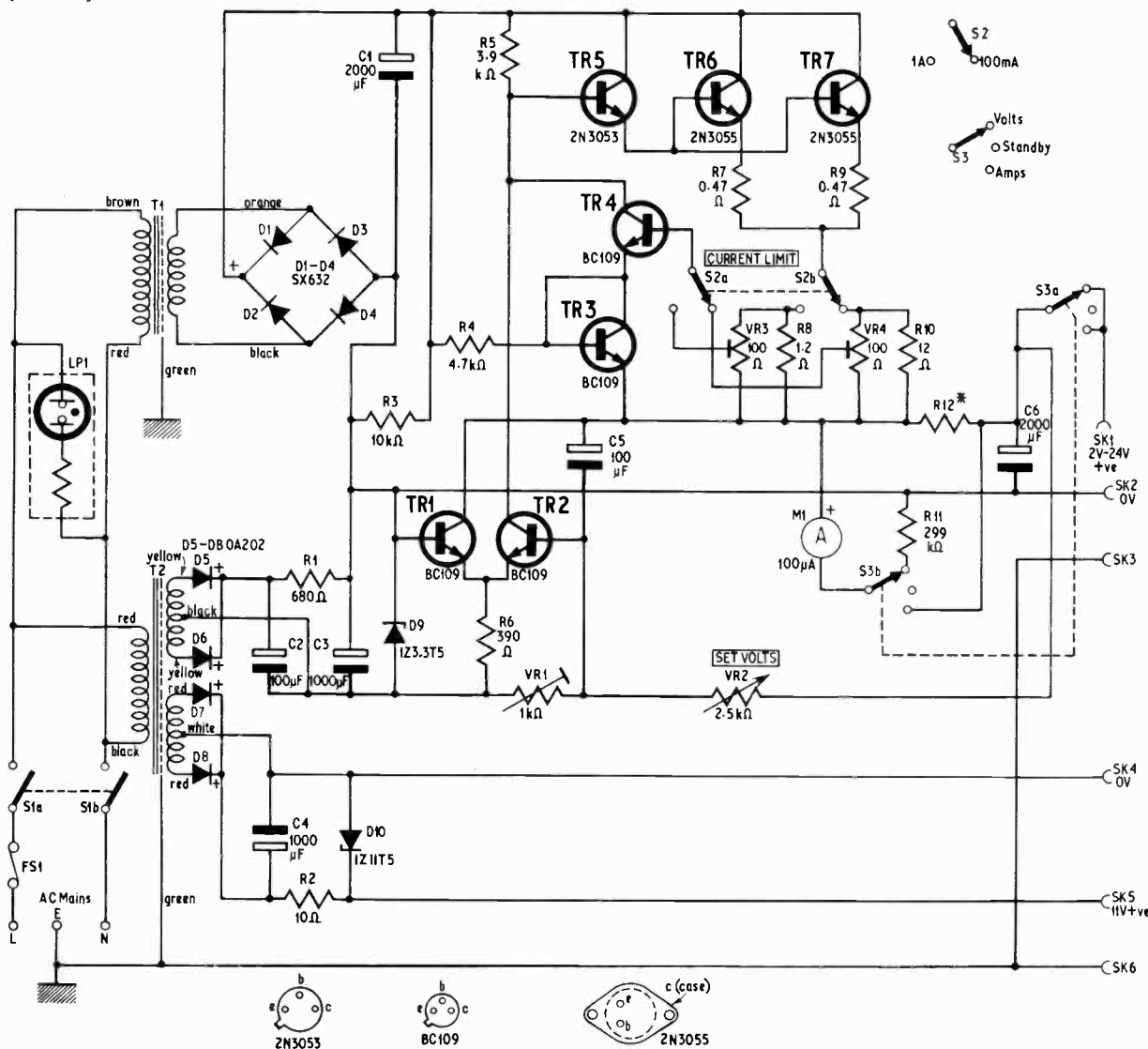
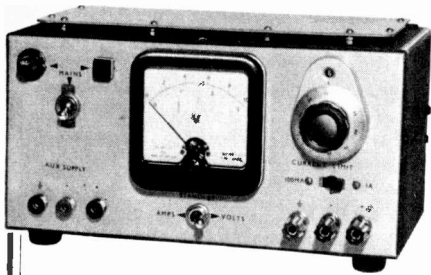


Fig. 2. Circuit diagram of power supply

# SPECIFICATION...



## MAIN SUPPLY

**Output Voltage** 2V to 24V  
**Output Current** 1A max  
**Current Limiting** 1A and 100mA  
**Output Resistance** 50 milliohms at 1A  
**A.C. Ripple** With no load is 250 $\mu$ V r.m.s.  
 At 20V, 1A is 5mV r.m.s.  
**A.C. Ripple**  
**Output Variation** 0.1% for 10% mains variation

## AUXILIARY SUPPLY

**Output Current** 30mA max  
**Output Voltage** 11V  $\pm$  5% at 30mA

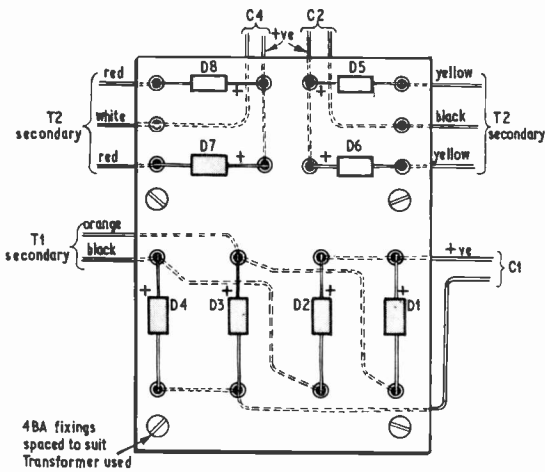
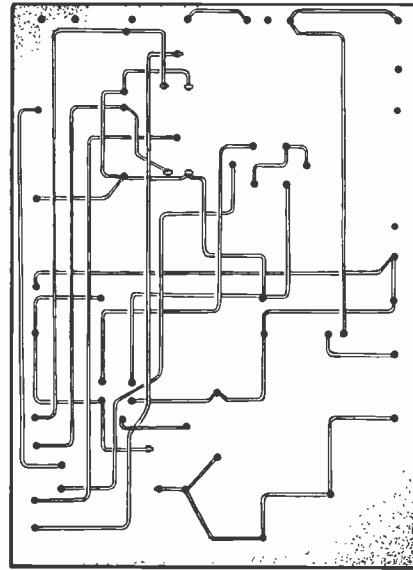
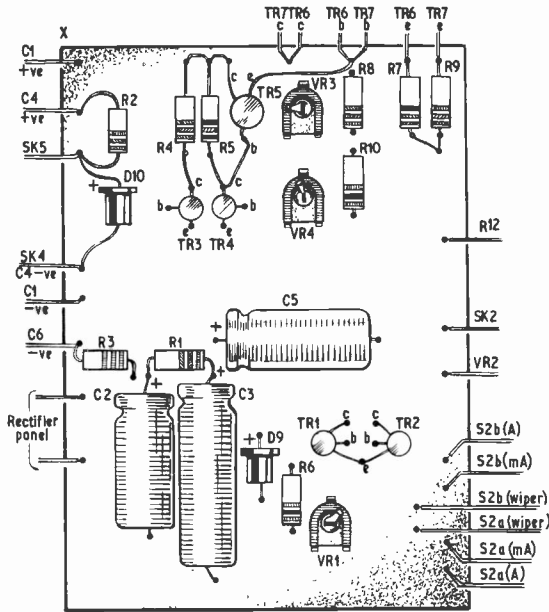
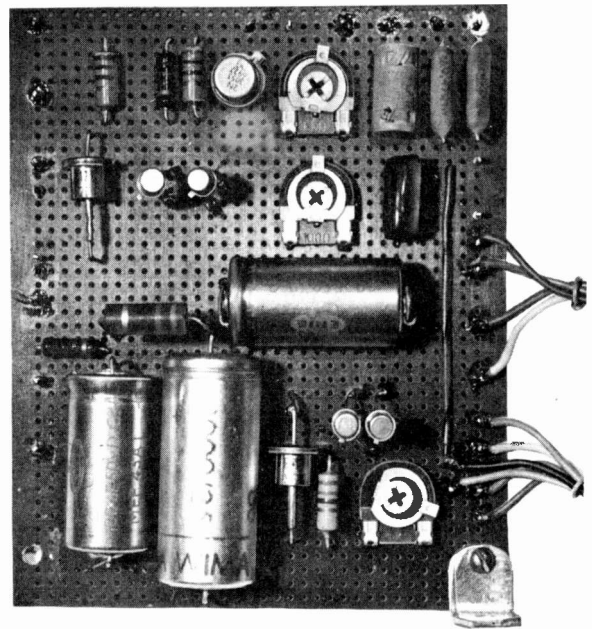


Fig. 4. Component layout and wiring of rectifier panel



values must be selected. The exact values used may require some adjustment, dependent on the gains of the transistors used in individual versions.

The action of the limiting circuit is not an abrupt one. The limiting process on the 1A range begins at about 0.8A and gradually increases. This will affect the output resistance above and below about 1A.

## AUXILIARY SUPPLY

The transformer T2 has two windings, one of which provides the reference voltage for the differential amplifier, the other provides a stabilised 11V

## COMPONENTS...

### Resistors

R1	680Ω	R7	0.47Ω	1W	wirewound
R2	10Ω	R8	1.2Ω	2.5W	wirewound
R3	10kΩ	R9	0.47Ω	1W	wirewound
R4	4.7kΩ	R10	12Ω	2.5W	wirewound
R5	3.9kΩ	R11	299kΩ	1%	metal film (see text)
R6	390Ω	R12*	See text		

All 5%, ¼ watt carbon except where shown

### Capacitors

C1	2,000μF	elect.	50V	C4	1,000μF	elect.	50V
C2	100μF	elect.	50V	C5	100μF	elect.	50V
C3	1,000μF	elect.	50V	C6	2,000μF	elect.	50V

### Transistors

TR1-TR4	BC109	(4 off)
TR5	2N3053	
TR6-TR7	2N3055	(2 off)

### Diodes

D1-D4	SX632	(4 off)
D5-8	OA202	(4 off)
D9	1Z3-3T5	1W 3.3V Zener
D10	1Z11T5	1W 11V Zener

### Potentiometers

VR1	1kΩ	miniature	horizontal	preset
VR2	2.5kΩ	multi-turn	potentiometer	(see text)
				(R.S. Components)
VR3-VR4	100Ω	miniature	horizontal	presets
				(2 off)

### Switches

S1	Double pole	mains on/off	switch
S2	Double pole,	double throw	slide switch
S3	Double pole,	double throw	"centre-off"
			toggle switch

### Meter

M1	100μA	Type MR26	(R.S. Components)
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### Transformers

T1	Mains transformer:	Primary 0-240V
		Secondary 26V at 1.6A
		Type X6705 (Belclere Ltd)
T2	Mains transformer:	
		Primary 0-240V
		Secondaries 26-0-26V, 23mA
		and 11-0-11V, 33mA
		Type X676X (Belclere Ltd)

### Miscellaneous

LPI	Mains neon	indicator, FS1	500mA fuse with
			holder, 3½in × 4½in
			pegboard 0.1in pitch, 2½in ×
			3½in pegboard, 0.15in
			pitch, 20 s.w.g. aluminium
			sheet cut as required
			Heat sink 4.875in × 1.05in
			extruded aluminium
			4in long with eight pairs
			of fins, SK1-SK6 insulated
			sockets (6 off)

at 33mA and can be used for powering any permanently attached piece of equipment, provided it does not draw current in excess of the rated figure.

## METER CIRCUIT

For monitoring purposes a fairly large 100μA meter is used. The one on the prototype was arbitrarily scaled 0-3 and 0-10, which is convenient, since with the multiplier R11 and shunt R12 no scale marking is necessary for the ranges 0-30V and 0-1A.

A two pole, two way, "centre-off" switch (S3) provides the measurement requirement. The centre position provides a standby facility which can be used when changing connections or reversing supply polarities.

The multiplier resistor R11, should ideally have a resistance of 299 kilohms and can be ordered with the meter. It is possible to use a 300 kilohm, 1 per cent type as the loss of accuracy is not severe.

The construction of the meter shunt will be dealt with later.

## OUTPUT TRANSISTORS

The more knowledgeable constructor will have noticed the use of two 2N3055 transistors for the series regulator TR6 and TR7, when one would suffice.

For maximum dissipation to occur in these transistors requires the output to be made short circuit and is approximately 45W. Clearly, a good heatsink and ample ventilation are required, for even under normal load conditions the dissipation can be as much as 30W.

Since the unit was intended to be used for long periods at fairly high dissipations, it was decided to use two output transistors for the reliability offered.

## CONSTRUCTION

The disposition of the components, whilst permitting the use of a relatively small cabinet, does result in a high packaging density.

Most of the semiconductors, capacitors and resistor are mounted on a 3½in × 4½in plain piece of 0.1in pitch pegboard as in Fig. 3. Veroboard can be used if desired.

The rectifier panel of Fig. 4 is a 2½in × 3½in plain pegboard of 0.15in pitch. This should be drilled for mounting to the frame of T1 (see photograph). When the rectifiers are mounted the panel should be attached to the transformer using 4B.A. nuts and bolts and ½in spacers.

## INTERWIRING

Interwiring details for the complete power supply are given in Fig. 5. The arrowed connections to the boards can be determined by referring to Figs. 3 and 4.

The front panel carries all the controls, the meter, fuse, indicator neon and output terminals (Fig. 5). On the prototype, the output voltage control, VR2 was a ten turn potentiometer, though somewhat expensive it is to be recommended since it enables precise setting to be achieved. Of course, an ordinary wirewound potentiometer can be substituted.

Transformer T2 is one of the clamp type of construction and is secured to the rear wall of the case. So too is a five way tag strip, to which the mains input is connected, and the heat sink for TR6 and TR7.

# LABPACK INTERWIRING

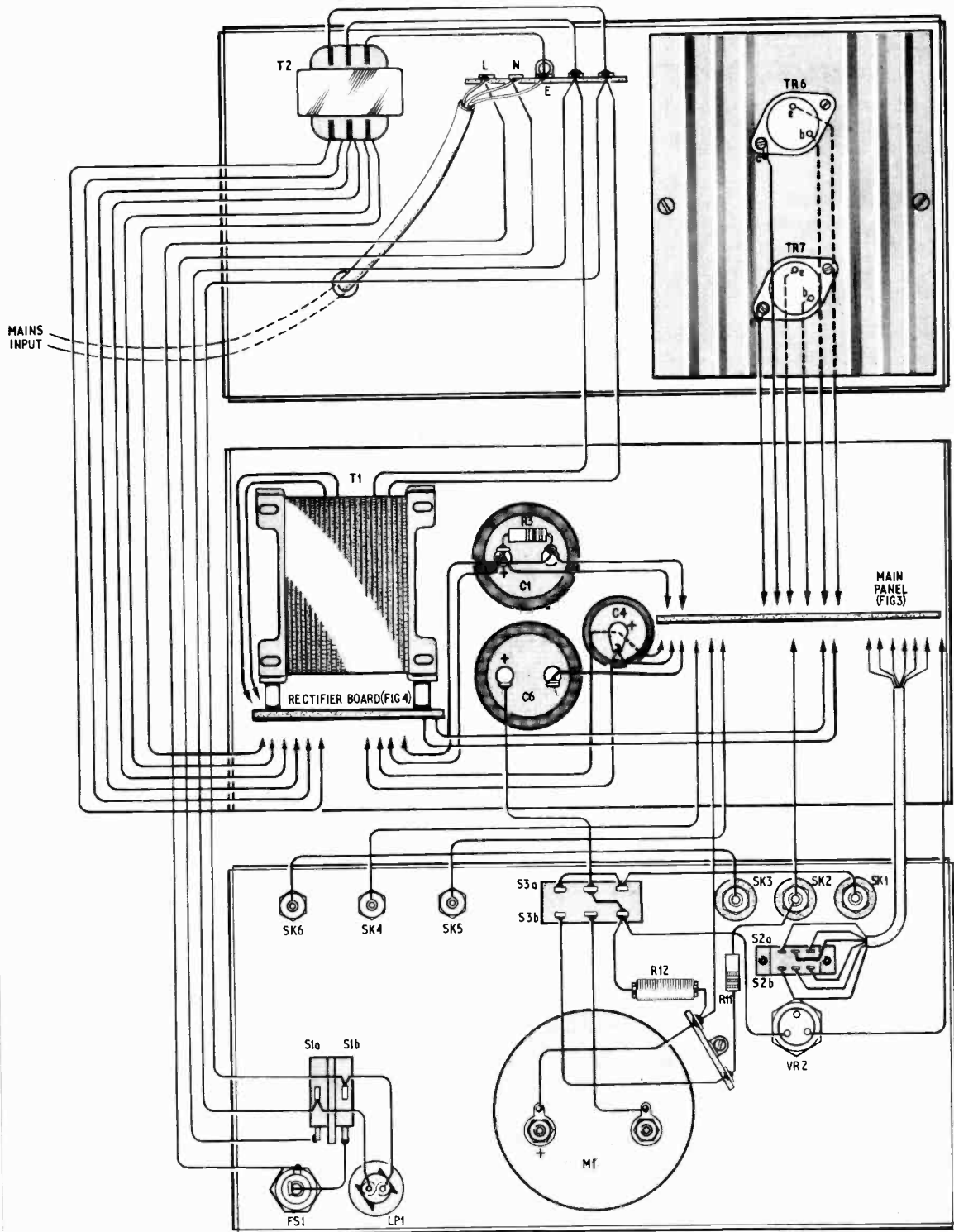


Fig. 5. Interwiring details of power supply



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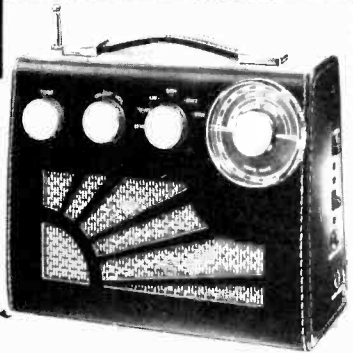
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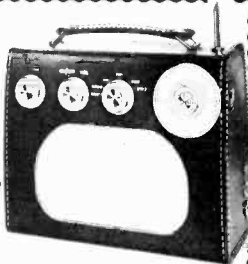
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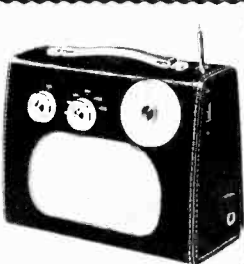
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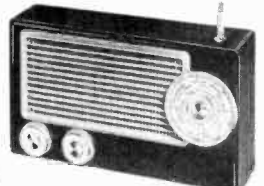
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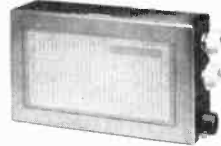
### ROAMER SIX



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

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### POCKET FIVE



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

TOTAL BUILDING COSTS **£2.23** P.P. & INS. 21p (OVERSEAS P. & P. 63p)

### TRANSONA FIVE

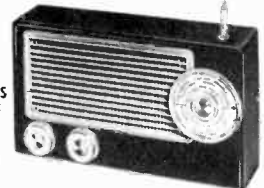


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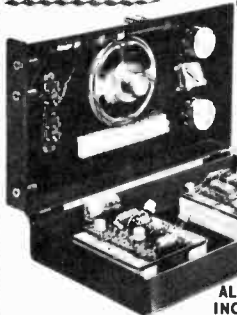
TOTAL BUILDING COSTS **£2.50** P.P. & INS. 22p (OVERSEAS P. & P. 63p)

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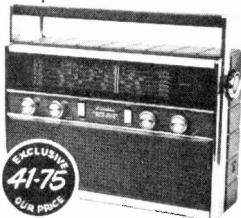
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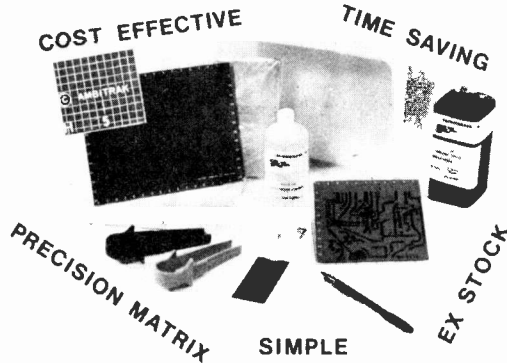
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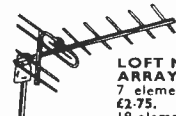
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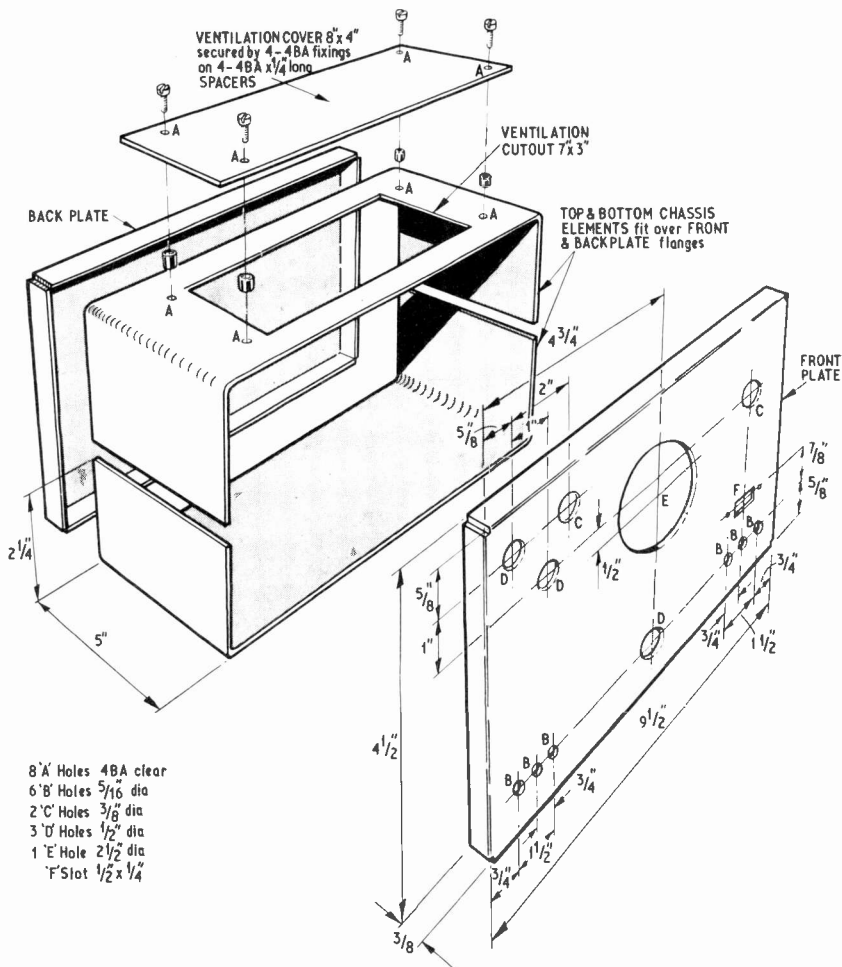
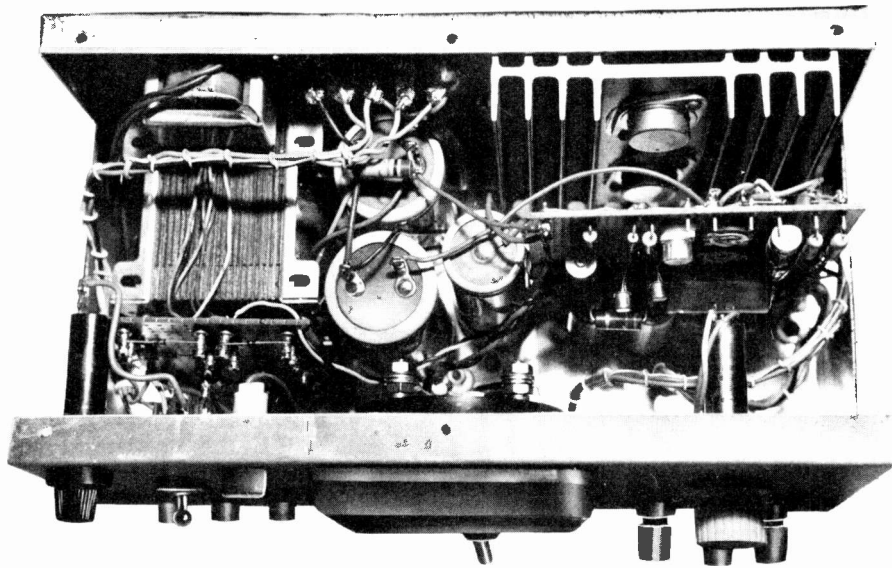
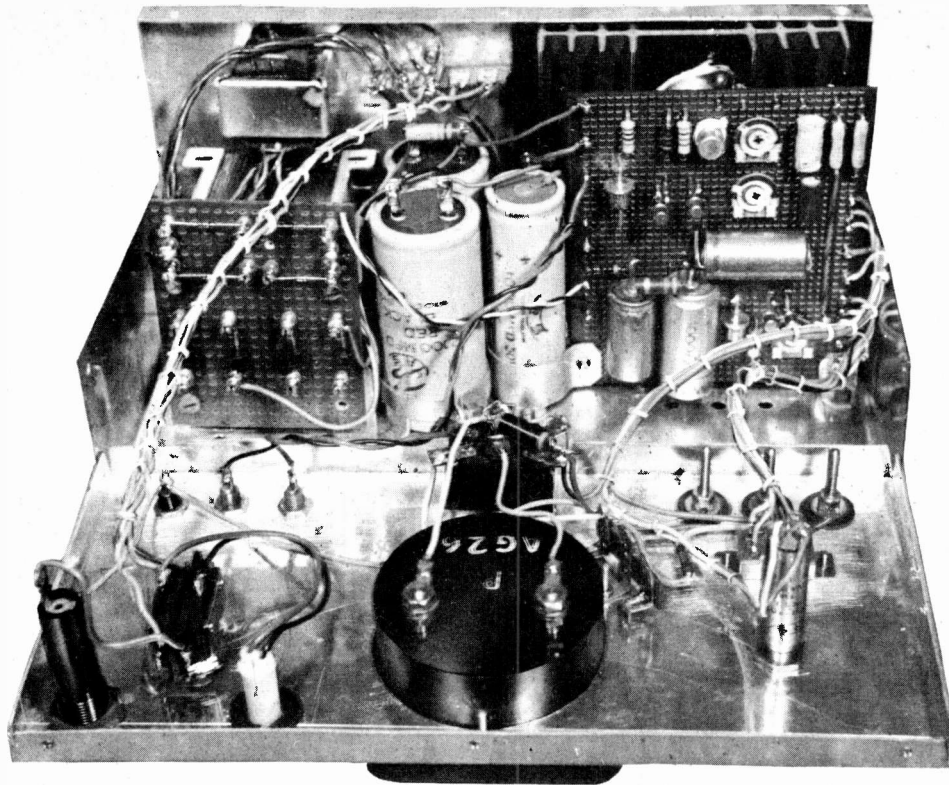


Fig. 6. Case assembly and drilling details. Self tapping screws are used for all fixings



Transformer T1 and capacitors C1, C4 and C6 are mounted on the cabinet base. The main component board is attached vertically at its two lower corners, one corner by means of a small right angled bracket, the other by the clamp of C4.

### MAKING THE CASE

The cabinet used for the prototype was made from 20 s.w.g. aluminium, bent and cut as in Fig. 6. In assembling, the various panels are all secured together by small self tapping screws.

Ventilation must be adequate and is effected by means of a rectangular hole 3in  $\times$  7in cut out of the top panel. This is covered by an aluminium plate 4in  $\times$  8in separated from the top by  $\frac{1}{4}$ in spacers.

To maintain air flow through this port  $\frac{1}{8}$ in holes should be drilled below the heat sink and around T1.

### TESTING

When all of the components have been assembled and connected, a careful check for wiring errors should be made. If everything appears satisfactory set VR1 and VR2 for maximum resistance, and VR3 and VR4 to mid-range. S3 should be set for a voltage reading. A load is not required.

With the unit connected to the mains and switched on, the voltmeter should indicate. VR2 should be rotated anti-clockwise, when the voltage should fall, then rise again as VR2 is returned to its original fully clockwise position.

The preset VR1 should now be set for a maximum output voltage of 24V.

### METER SHUNT

The meter shunt, R12, is made up of resistance wire with a measured value of 0.125 ohms. Since the formula for calculating this includes the meter resistance the meter specified, or one with a resistance of 1,250 ohms, must be used.

To actually construct the shunt, a length of resistance wire, somewhat longer than is required, is connected in the position of R12. With S3 set to "Volts" adjust the output of the unit for 10V. Switch off and connect a 10 ohm, 10W resistor, in series with a multimeter switched to 1A d.c., across the output terminals.

If S3 is switched to "Amps" and the unit switched on, R12 can be adjusted so that 1A flows in the multimeter when meter M1 registers full scale deflection.

A high value resistor can be used as a mounting for the resistance wire, it being simply wrapped round the resistor body with the wire ends soldered to the resistor leads.

### CURRENT LIMIT SETTING

Having set the output voltage, attention can now be turned to the current limiting potentiometers VR3 and VR4.

With S2 switched to the 1A range a multimeter switched to the 1A d.c. range can be connected directly across the output terminals and VR3 adjusted for a reading of 1A.

The time taken for this adjustment should be a minimum as the dissipation in the output transistors is high. Adjustment for the 100mA range is identical with suitable multimeter range switching. Here, of course, VR4 is adjusted.

**0-8 Ammeter**, 2in square full vision face for flush mounting. Moving iron instrument. Ideal for charger. Price **43p** each. 10 for **£3.90**.

**9 Volt Gramophone Unit**. Collaro battery operated with pick up on unit plate. 4 speed auto-stop turnover cartridge. Price **£2.50** plus 40p post and insurance.

**Buy Time Slot Meter**. Made by Sangano Weston. 3 types—one for each coin, 21p, 5p or 10p. Price **£1.75** each plus 25p post and insurance.

**Photo Electric Kit**. Contains photo cell, relay, transistor and all parts to make light operated switch. Originally £2. Limited quantity to clear. **£1.25** plus 20p post and insurance.

**Desk/Hand Mike**. Made by Aco. Crystal insert in neat plastic case which opens at right angles for desk or opens completely for hand holding. Good general purpose mike. Price **85p** each.

**Printed Circuit Kits**. Hagato Pk. 3 facilities in kit form include printing, etching, resist removal, polishing and complete manufacture of printed sets to own specifications. Price **£1.25 + 20p**.

**4 Station Transistorised Intercom**. Solid state three transistor printed ckt. master and 3 substation push button/press talk system. 200mW output complete with installation accessories and 9V. Eveready power pack. Approx. dimensions: Master 4½ x 1½ x 2½in. Substation 3 x 1½ x 4in. Price **£2.50 + 20p**.

**Laboratory Instruments**. For horizontal use in strong black reinforced bakelite cases with screw down terminals especially suitable for experiments and demonstrations. All have precision meters (manufacturers quoted accuracy of better than 1.5%). Following available:

**D.C. Voltmeter 0-300V I.s.d.** moving coil mirror scale meter size approx. 5 x 4½ x 1½in. Price **£1.75**.

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**A.C./D.C. Milliameters 3 range**, moving iron mirror scale meter. Range selection 25, 50 and 100mA by selection switch mirror scale (coil resistance marked) size. 7½ x 5 x 3½in type 3599/1. Price **£2.75**.

**Micrommeter 100 micro amps I.s.d.** moving coil mirror scale precision meter (coil resistance marked) size 5 x 4½ x 2½in type M/109/1. Price **£3**.

**Galvanometer 20-0-20 I.s.d.** moving coil precision laboratory instrument of extremely high sensitivity (3 10-7A per division). Size approx. 6½ x 3½ x 2in. Price **£5**.

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Long and medium wave 7 transistor, size 6 in x 4 in x 1½ in. With larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carry sling, earplug and case **£3.75** plus 25p post and ins.



**Parmeko Neptune Series C. Core Transformers**. These transformers are beautifully made, steel encased, stove enamelled black, upright mounting. All have normal 50cps primary 250/240V with primary screen and are new and unused. Small quantities only of each type available as follows:

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**Model 49**. 10H at 70mA. **£1.50 + 30p** post.

**Model 69**. 10H at 10mA. Price **£2 + 40p** post.

### RHYTHMETRON

As featured in November issue. Electronic parts kit, less case and knobs, but including Vero panels. **£4.25p + 20p** post.

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	Price per each
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1 Watt	1p 8p 6p 5p
1 Watt	2p 18p 15p 125p
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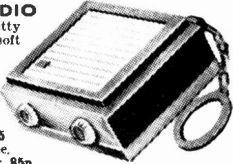
**12 Way Sub-Mixture Multi-core Cable** 7-0076 copper cores each core p.v.c. insulated and of different colour. P.v.c. covered overall and approx. ¼in thick. Price **20p** per yard.

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In transit from the East these sets suffered corrosion as the batteries were left in them but when this corrosion is cleared away they should work—offered without guarantee except that they are new. Price only **£1.25** less batteries plus 13p, post 6 for **£7** post free.

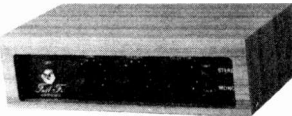
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Made by Smiths, these are a.c. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2.50** post and ins. 25p. Additional time contacts **50p** pair.

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The amplifier sensation of the year

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled in simulated teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6W R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include 'treble lift and cut', 'balance' and separate mains on/off switch. UNREPEATABLE PRICE is **£29** plus 38p post and insurance.

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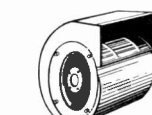
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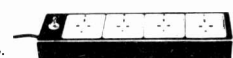
### CENTRIFUGAL FAN

Mains operated, turbo-blower type. Pressed steel housing contains motor and aluminium impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½in wide by 12in dia. Outlet into trunking 10½in x 4½in. **£4.95 + £1**.



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This system which has proved to be amazingly efficient and reliable was first described in the Wireless World about a year ago. We can supply kit of parts for improved and even more efficient version, (P.W. June), price **£4.95**. When ordering please state whether for positive or negative systems. Plus 30p post.



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### 15 WATT 12in HI-FI SPEAKER

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



### TREASURE TRACER

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Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1.80** plus 13p post and insurance. Made up model also available, **£2.25** plus 13p post & p.

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**Commutator Motor**, Small Size approx. 3in plus 1in of shaft, 3in high x 1½in wide, but high speed and very powerful. These motors operate from the mains. Are particularly useful as they can be speed controlled by our thyristor kit or by variable resistor. **£1** each.

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### DIGITAL DICE

as featured in this issue. Send S.A.E. for parts list.

### MAINS RELAY BARGAIN

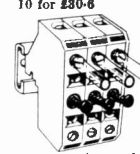
Special: this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V A.C. Good British Make. Ex-unused equipment. Size approx. 1½in x 1in.



Open construction  
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AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p	2N929	22p	2N2904	25p	2N3705	12p
AC115	17p	AF118	20p	BC142	45p	BCY33	17p	BF274	30p	MAT103	15p	ST140	12p	2N930	25p	2N2904A	30p	2N3706	12p
AC125	17p	AF120	20p	BC143	45p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p	2N1131	20p	2N2905	25p	2N3707	13p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p	2N1132	22p	2N2905A	30p	2N3708	8p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p	2N1302	17p	2N2906	25p	2N3709	8p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BF310	15p	MPF102	43p	V405A	25p	2N1303	17p	2N2906A	27p	2N3710	10p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BF329	20p	MPF105	43p	V410A	45p	2N1304	20p	2N2907	25p	2N3711	10p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p	2N1305	20p	2N2907A	30p	2N3819	40p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p	2N1306	22p	2N2923	13p	2N3820	1p
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	30p	2N1307	22p	2N2924	13p	2N3903	25p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p	2N1308	27p	2N2925	13p	2N3904	27p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p	2N1309	27p	2N2926	13p	2N3905	25p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p	2N1613	17p	(G)	12p	2N3906	27p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p	2N1711	20p	2N2926(Y)	11p	2N4058	15p
AC166	17p	AF211	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	20p	2G339	17p	2N1893	35p	2N2926	35p	2N4059	10p
AC167	20p	AF212	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p	2N1890	35p	(O)	10p	2N4060	12p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p	2N1893	35p	2N3010	45p	2N4061	12p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p	2N2148	60p	2N3011	20p	2N4062	12p
AC176	23p	ASV26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p	2N2149	60p	2N3012	20p	2N5172	12p
AC177	20p	ASV27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p	2N2192	30p	2N3055	63p	2N5459	43p
AC187	30p	ASV28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p	2N2193	30p	2N3391	17p	2S034	75p
AC188	30p	ASV29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p	2N2194	27p	2N3391A	20p	2S034	75p
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC70	15p	2G378	15p	2N2217	27p	2N3392	17p	2S034	75p
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC71	9p	2G382	15p	2N2218	25p	2N3393	15p	2S034	75p
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC72	12p	2G401	10p	2N2219	27p	2N3394	15p	2S034	75p
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC73	12p	2G401	10p	2N2220	25p	2N3395	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC74	12p	2G414	12p	2N2221	22p	2N3402	22p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC75	15p	2G417	25p	2N2222	22p	2N3403	22p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC76	12p	2G417	25p	2N2223	22p	2N3404	22p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC77	25p	2N388A	50p	2N2224	22p	2N3405	45p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC78	15p	2N404	22p	2N2225	22p	2N3406	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC79	15p	2N404A	30p	2N2226	22p	2N3407	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC80	15p	2N404A	30p	2N2227	22p	2N3408	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC81	15p	2N404A	30p	2N2228	22p	2N3409	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC82	15p	2N404A	30p	2N2229	22p	2N3410	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC83	15p	2N404A	30p	2N2230	22p	2N3411	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC84	15p	2N404A	30p	2N2231	22p	2N3412	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC85	15p	2N404A	30p	2N2232	22p	2N3413	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC86	15p	2N404A	30p	2N2233	22p	2N3414	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC87	15p	2N404A	30p	2N2234	22p	2N3415	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC88	15p	2N404A	30p	2N2235	22p	2N3416	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC89	15p	2N404A	30p	2N2236	22p	2N3417	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC90	15p	2N404A	30p	2N2237	22p	2N3418	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC91	15p	2N404A	30p	2N2238	22p	2N3419	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC92	15p	2N404A	30p	2N2239	22p	2N3420	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC93	15p	2N404A	30p	2N2240	22p	2N3421	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC94	15p	2N404A	30p	2N2241	22p	2N3422	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC95	15p	2N404A	30p	2N2242	22p	2N3423	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC96	15p	2N404A	30p	2N2243	22p	2N3424	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC97	15p	2N404A	30p	2N2244	22p	2N3425	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC98	15p	2N404A	30p	2N2245	22p	2N3426	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC99	15p	2N404A	30p	2N2246	22p	2N3427	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC100	15p	2N404A	30p	2N2247	22p	2N3428	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC101	15p	2N404A	30p	2N2248	22p	2N3429	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC102	15p	2N404A	30p	2N2249	22p	2N3430	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC103	15p	2N404A	30p	2N2250	22p	2N3431	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC104	15p	2N404A	30p	2N2251	22p	2N3432	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC105	15p	2N404A	30p	2N2252	22p	2N3433	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC106	15p	2N404A	30p	2N2253	22p	2N3434	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC107	15p	2N404A	30p	2N2254	22p	2N3435	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC108	15p	2N404A	30p	2N2255	22p	2N3436	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC109	15p	2N404A	30p	2N2256	22p	2N3437	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC110	15p	2N404A	30p	2N2257	22p	2N3438	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC111	15p	2N404A	30p	2N2258	22p	2N3439	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC112	15p	2N404A	30p	2N2259	22p	2N3440	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p	BF159	25p	BSY29	15p	OC113	15p	2N404A	30p	2N2260	22p	2N3441	20p	2S035	£1
AC189	30p	ASV30	25p	BC174	13p</														

## RADIO FREQUENCIES USED IN SPACECRAFT

A large number of enquiries are received about the communication frequencies used by the *Apollo* missions and other spacecraft.

The frequencies that are used on spacecraft depend on the matter to be transmitted and also on the propagation conditions. There are normally three bands in use. These are the h.f., v.h.f. and u.h.f. bands. The latter includes the S-band which is of considerable importance since it is less susceptible to propagation anomalies and has perhaps the best noise level characteristic. Noise is at a minimum on this band.

Taking the *Apollo* spacecraft as an example, there are three units involved. These are the command module, the service module and the lunar module. Communication between ground and the spacecraft from the count down through launch and into earth orbit is maintained by v.h.f. on frequencies of 259MHz and 296MHz (exact values for *Apollo 15* were 259.7MHz and 296.8MHz). The command and lunar modules also operate on these frequencies. Within the spacecraft the u.h.f. frequencies are used as well as sound frequencies.

After leaving earth orbit and heading toward the target, communications change to the S-Band. These frequencies are 2273.5MHz for the television channel and 2106.4MHz for speech and exchange of data between the spacecraft and earth. Another channel on 2287.5MHz gives a link between the command module and the ground for speech, directly given data on the course position and other real time information.

The lunar module has two transceivers one of which is used for speech and data and operates on a frequency of 2101.8MHz. The other channel uses a frequency of 2282.5MHz and can be used for data, speech or television. In addition to these systems the craft operates another transceiver which uses a frequency of 10,006MHz. The powers that are used are quite low being 2.8 watts and 11.2 watts on the S-band.

## PARACHUTE TESTING

NASA is to carry out free-flight tests on the *Viking* landers to test the parachute system to be used in the *Viking* spacecraft when they are launched in 1975. This is a new departure in technique for no parachute landing of spacecraft has been attempted before.

The *Viking* system is operated by a mortar which is fired automatically and deploys a 50ft diameter parachute. During tests units will be dropped from 50,000ft and drogue parachutes will slow a ten foot container to the speed at which the mortar will fire.



BY FRANK W. HYDE

## PROJECT EOLE

The new French *Eole* world wide system of weather watch reported previously ran into difficulties.

One hundred and forty-one balloons had been launched in the southern hemisphere and when the satellite was instructed to interrogate it sent instead a destruct signal to 72 balloons which were lost with all their sensors. This occurred on the 364th orbit.

The origin of the wrong signal was traced to one of the control centres at Bretigny. The French space organisation, CNES, consider that the programme will still be valuable since up to 500 balloons will be released during the 180 day period of observation.

## SEARCH FOR EXTRA-TERRESTRIAL LIFE

At the final session of a Conference on Communication there was a discussion for a programme to organise a search for intelligent beings in the space of the galaxy. The conference was attended by many countries and the delegates were from many disciplines: astro-physicists, theoretical astronomers, radio astronomers, sociologists, archaeologists and anthropologists.

## LUNOKHOD

The Russian roving vehicle Lunokhod was shut down after its eleventh day. The last test period resulted in a movement of only 100 metres. It has been shut down because Russian scientists are unwilling to risk the possible misalignment of the on-board laser reflector.

## LAST LUNAR MISSION

The *Apollo 17* is, at the moment, the last lunar mission of the series for manned landing on the Moon. The planning of its landing site is therefore of considerable importance. Last June the target decided upon was the area near the crater Alphonsus. It still is the prime candidate.

There are important reasons for the examination of this area. It was from here that the Russian astronomers noted the emission of gases and changes in the spectrum which suggested vulcanism. Since then, this area has been the subject of close study by professionals and amateurs. Many instances of transient changes in the crater have been noted, some of them detected by spacecraft photographs.

However, after examination of the *Apollo 15* data, recovered with much new information, it may be that another site would be of greater scientific value. This sets a problem because the time for crew training is affected particularly as this is the last mission.

## SPACECRAFT COMPUTER

A low power spacecraft computer has been developed by Honeywell. It is suitable for a wide range of unmanned spacecraft missions and its power requirements are only 26.9 watts. It provides a one microsecond memory cycle time.

NASA's satellites for application technology will use two of these computers in parallel. The package weighs 23lb and is known as *HDC 401*.

## SATELLITE GANYMEDE

Ganymede is one of the four satellites originally discovered by Galileo to revolve round Jupiter. It has virtually no atmosphere and it was thought, till recently, that the surface would be like that of the Moon. Recent observations, however, have shown that the atmosphere is below one millibar and the surface may be rock powder or ammonia snow.

These observations were carried out at a wavelength of 25 micrometres at the University of Hawaii. Led by Dr. D. Morrison the team at the University and the Los Alamos Scientific Laboratory observed the satellite before, during and after the eclipse by Jupiter, revealing that except for the presence in the spectrum of features which suggest ammonia frost, the surface is indeed moonlike in character.

The presence in the spectrum of features which suggest ammonia frost still leaves some puzzling questions.

# Substitutes for ZENERS

By J. N. WATT

THE regulation of fairly low voltages using Zener substitutes is fairly straightforward, if a little unconventional, as was illustrated last month. In this final part we shall look at the application of these substitutes in power supply circuits and give some examples of their applications.

## SHUNT REGULATOR

Fig. 9 shows a typical shunt regulator, where the extra transistor handles the additional power.

The Zener substitute and the power transistor's base-emitter voltage hold the output voltage at  $V_o = V_Z + V_{BE}$ .

The resistor R2 ensures that sufficient current flows through the Zener substitute to give stability.

The current through the shunt transistor is about  $h_{FE}$  times that through the Zener substitute (ignoring the current in R2). It is this that gives the greater power handling capability, which is that of the shunt transistor. This latter could well be one of the unmarked npn devices mentioned earlier as being suitable for use as a Zener substitute.

Calculation of the value of R1 follows the same procedure as in the simple shunt regulator in Fig. 2.

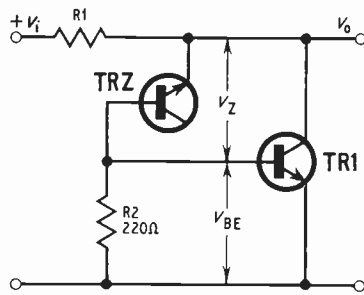


Fig. 9. Transistor shunt regulator

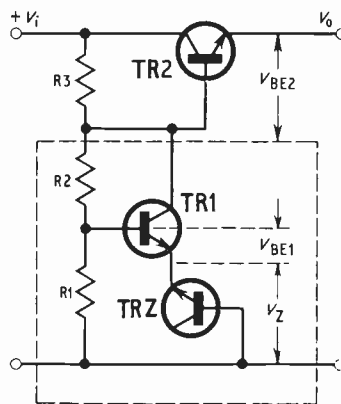
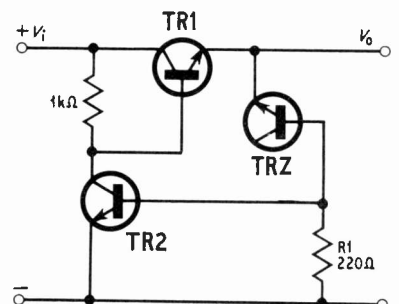
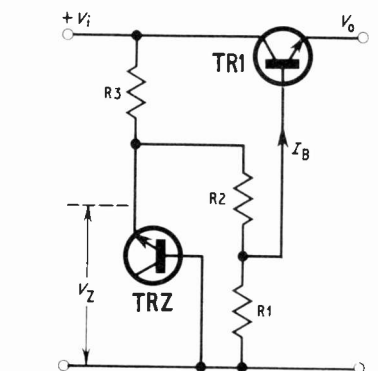


Fig. 10 (left). Simple series regulator

Fig. 11 (above). Series regulator using an "amplified Zener"

Fig. 12 (above right). Division of Zener voltage

Fig. 13 (right). Shunt regulator with improved performance





# BUDGET HIGH-FIDELITY STEREO SYSTEMS



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Rogers Ravensbourne Stereo Amplifier in teak case (List £64) **£49-00**

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Garrard SP25 111 with Goldring G800 cartridge (List £28-35) **£15-50**  
Garrard AP76 less cartridge **£19-50**

Garrard 3500 with Sonotone 9TAHC stereo cartridge (List £15-50) **£9-97**

Garrard 2025 T/C with Sonotone 9TAHC Diamond Cartridge **£8-97**

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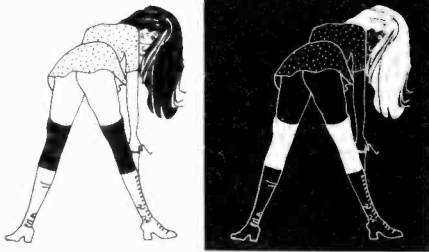
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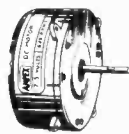


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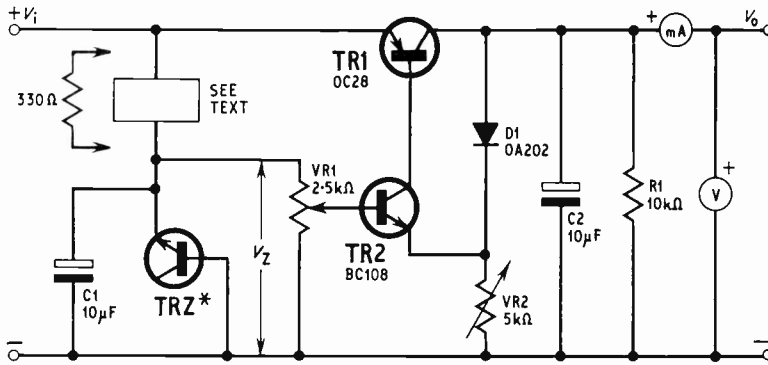
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\* TRZ is a silicon planar npn transistor, e.g. BSY95A, BC107, BC108, 2N2926

Fig. 14. Stabiliser with variable output voltage and short circuit protection

It is as well, therefore, by suitable choice of  $R_1$  to arrange for the current through the latter to be, say, 50% greater than this value of  $I_B$ .

With no load current, the current taken from the supply is only that through the Zener substitute. However, as it stands the arrangement is unprotected against short circuit of its output, an event which would be most likely to destroy the series transistor, unless protective measures are taken.

### SHUNT TO SERIES CONVERSION

To provide an output voltage greater than  $V_Z$ , the circuit in Fig. 6 can be adapted to series operation, as shown in Fig. 11.

$$V_o = \frac{R_1 + R_2}{R_1} (V_Z + V_{BE1}) - V_{BE2}$$

An output voltage less than the Zener voltage is easy to arrange by simple division of  $V_Z$ .

$$V_o = \frac{R_1}{R_1 + R_2} V_Z - V_{BE}$$

This is shown in Fig. 12.

With these last two circuits sufficient base current must be supplied to permit the series transistor to pass the required full load current.

Thus in Fig. 12,  $R_1$  and  $R_2$  should be chosen to allow a standing current of, say, five times  $I_B$  to flow through them. This current can be looked upon as the load of the simple circuit comprising the Zener substitute and its series resistor  $R_3$ .

With  $R_1$  and  $R_2$  so chosen,  $R_3$  can be selected as before.

### VOLTAGE AMPLIFIER

Regulation of the output voltage can be improved by incorporating a further transistor, used as a voltage amplifier, shown in Fig. 13.

If  $V_o$  tries to rise in level, then so does the voltage at the base of TR2, since the Zener substitute has a constant voltage developed across it. Transistor TR2 amplifies this change, with reversal of sign, so that a larger fall in voltage appears at TR1 base. Emitter follower action in TR1 thus tends to reduce  $V_o$ , so correcting the original rise. TR1 can be a member of the OC28 to OC36 family, while TR2 can be almost any of the popular silicon npn devices so readily available.

Besides the better regulation given by the gain of TR2, it is noteworthy that the Zener substitute is driven by the regulated output voltage,  $V_o$ . Since this is constant, better stability of Zener voltage is obtained. In those circuits where the Zener is fed from the unregulated supply, some change of Zener voltage can occur with variation in that supply, due to change of current through the Zener.

An alternative method of obtaining better Zener voltage stability will be mentioned later.

### STABILISED POWER SUPPLY

Having thus briefly described many of the circuits in which Zener substitutes can be employed, we can now turn to the design of a stabilised power supply, using a circuit configuration not previously mentioned, see Fig. 14. It has the following advantages:

1. Being a series regulated supply, it can efficiently handle moderately large currents—up to 1A or even greater, depending on the transistor and heat sink employed.
2. It gives a variable stabilised output.
3. Despite the series regulator configuration, short circuit protection is provided.
4. Constant current output, in place of constant voltage output, is possible, the level of such constant current being easily adjustable.

### SERIES RESISTANCE FOR ZENER

Initially, consider the "black box" (between  $V_i$  and TRZ) feeding the Zener substitute to consist of a resistor of an appropriate value, say 330 ohms. Alternative components for the "black box" will be considered later.

Let us assume that an output current of 1A is required. Then the base current of TR1 will be  $I_{B1} = 1/h_{FE1}$ . Since this current is provided by TR2, its base current will be  $I_{B2} = 1/(h_{FE1}h_{FE2})$ .

Assuming  $h_{FE1} = 25$  (OC28 family) and  $h_{FE2} = 100$  (BC108), then the base current of TR2 is  $400\mu A$ .

We should allow, say, 10 times this current to flow through VR1 as a standing current, i.e. 4mA. If  $V_Z$  is made 8 volts (a reasonable value for a Zener substitute), then the value of VR1 is equal  $V_Z/4 = 2k\Omega$ .

A 2.5k $\Omega$  potentiometer will be suitable; it does of course give us the means of providing a variable stabilised output.

Capacitor C1 ensures that the Zener voltage is held smoothly, despite any rapid, large changes in supply voltage ( $V_i$ ) which could occur if the mains were used

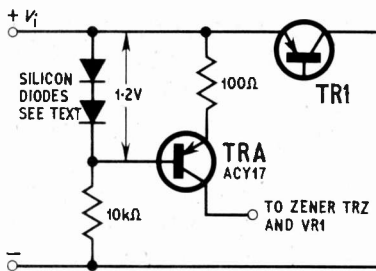


Fig. 15. Constant current drive for Zener substitute

as a primary supply, while C2 reduces any similar changes at the output due to rapid variations in load current. Resistor R1 is necessary to turn on TR1, thereby providing control, by drawing a small load current when no, or only a very small, load current would otherwise be taken. Without R1,  $V_0$  could rise above the stabilised voltage, due to leakage in TR1.

### SHORT CIRCUIT PROTECTION

Turning now to D1 and VR2, it is these components that provide the short circuit protection and constant current output facility.

In normal running, D1 is forward biased. Should a short circuit be applied to the output of the power supply, it will no longer be so biased, since its anode will then be at negative rail potential (via the short circuit). This results in TR1 passing a current determined by its then existing base current; this will be set largely by the value of VR2, since the lower end of VR2 is now connected directly to the collector of TR1 (via the short circuit).

Thus by choice of an appropriate setting of VR2, limiting of the current to any desired value is obtained.

The constant current mode is brought into play by ensuring that the output voltage setting is such as to attempt to deliver more current than the setting of VR2 allows. Output current is then constant despite supply voltage changes and load changes, provided of course the necessary output voltage can in fact be reached by the supply.

The short circuit protection and constant current output facility are possible in this way because of the method of connection of TR1. It is not, as in previous examples of series stabilised supplies, connected so that emitter follower action takes place. With the output

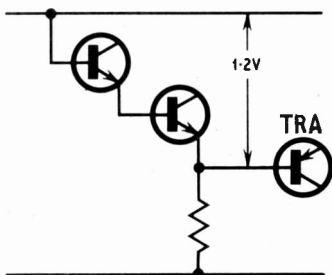


Fig. 16. Use of npn transistors in place of the silicon diodes shown in Fig. 15

taken from the collector as shown, the output impedance is still low, however, because of the heavy negative feedback present.

### CONSTANT SERIES CURRENT FOR ZENER

There is, of course, a disadvantage in this method of connection.

It has been noted above, in connection with the circuit in Fig. 13, that better output voltage stability is obtained if the Zener substitute is driven from the stabilised supply,  $V_0$ . Because of the circuit arrangement, in Fig. 14, of the series transistor being used with its collector as the output, it is not possible to drive the

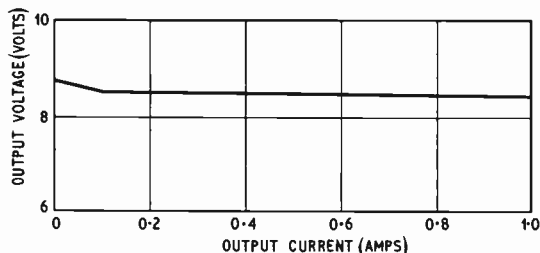


Fig. 17a. Graph of output voltage versus output current for the circuit in Fig. 15

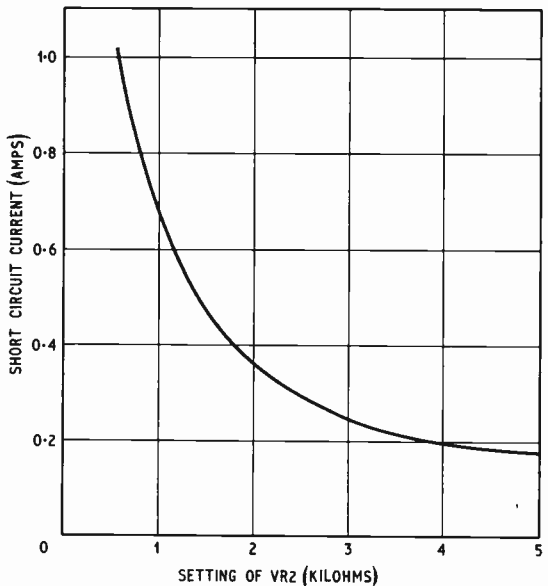
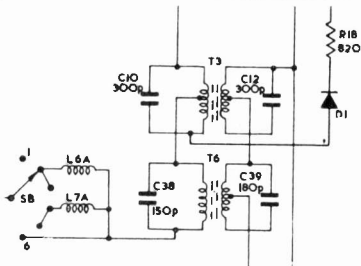


Fig. 17b. Output short circuit current versus setting of VR2

Zener substitute from the stabilised side. Consequently, other means of providing a more constant voltage need to be investigated.

That adopted here concerns the replacement of the "black box" with a constant current circuit similar to that in Fig. 7. The arrangement of this is given in Fig. 15, where a current of 7mA is given by TR1, 4mA through VR1, and 3mA through the Zener substitute.

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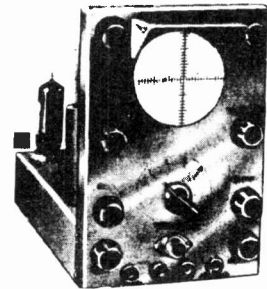


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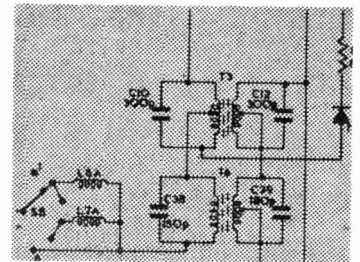
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Armstrong 524 FM	31.75	31.75
Armstrong M8 Decoder	7.95	7.95
*New Leak Delta FM	61.95	61.95
*New Leak Delta FM/AM	78.95	78.95
Nikko FAM10	42.00	42.00
Nikko FAM12	55.75	55.75
Nikko FAM14	79.75	79.75

\*New Release. P. & P. 75p.

**Headphones**

Model	S.S.A. Price	£p
Akai ASE9	5.50	5.50

\*New Release. P. & P. 35p.

All goods supplied are brand new and carry manufacturer's guarantee. All prices correct at time of going to press (E. & G.E.) and are subject to alteration without notice.

**Sonic Sound Audio Ltd**  
DEPT. SS.1, 372 EDGWARE ROAD, LONDON, W.2  
Telephone 01-723 0094

# INST VALVE MAIL ORDER CO.

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Inst	Sp	Inst	Sp	Inst	Sp	Inst	Sp
1N21	0-17	AC127	0-25	BF173	0-30	GJ43M	0-38
1N23	0-20	AC128	0-20	BF181	0-35	GJ5M	0-28
1N85	0-88	AC187	0-25	BF184	0-20	GJ7M	0-37
1N253	0-50	AC188	0-25	BF185	0-20	HG1005	0-50
1N256	0-50	ACY17	0-30	BF194	0-17	H8100A	0-20
1N845	0-25	ACY39	0-50	BF237	0-25	NKT218	0-40
1N725A	0-20	ACY19	0-25	BF196	0-15	MAT101	0-30
1N914	0-07	ACY20	0-20	BF197	0-15	MAT120	0-25
1N4007	0-20	ACY21	0-20	BF861	0-28	MAT121	0-30
1B021	0-20	ACY22	0-10	BF898	0-28	MJE520	0-87
1B113	0-15	ACY27	0-25	BFX12	0-20	MJE255	1.37
1B130	0-18	ACY28	3-17	BFX13	0-25	MJE3055	0-87
1B131	0-13	ACY39	0-50	BFX27	0-25	NKT218	0-40
1B929	0-23	ACY40	0-15	BFX30	0-25	NKT219	0-30
2G240	1-98	ACY41	0-15	BFX35	0-98	NKT211	0-25
2G301	0-20	ACY44	0-25	BFX63	0-20	NKT213	0-25
2G302	0-22	AD140	0-50	BFX84	0-25	NKT214	0-15
2G306	0-30	AD149	0-50	BFX85	0-25	NKT216	0-37
2G371	0-22	AD161	0-37	BFX86	0-25	NKT217	0-35
2G381	0-25	AD162	0-37	BFX87	0-25	NKT218	0-40
2G414	0-30	AF106	0-30	BFX88	0-25	NKT219	0-33
2G417	0-22	AF114	0-25	BFY10	1.00	NKT222	0-20
2N214	0-43	AF115	0-25	BFY11	1.25	NKT224	0-22
2N247	0-25	AF116	0-25	BFY17	0-25	NKT231	0-24
2N250	0-50	AF117	0-25	BFY18	0-25	NKT271	0-25
2N404	0-20	AF118	0-25	BFY19	0-25	NKT272	0-25
2N497	0-15	AF119	0-25	BFY21	0-45	NKT273	0-25
2N698	0-40	AF124	0-25	BFY44	1.00	NKT274	0-20
2N706	0-10	AF125	0-20	BFY50	0-22	NKT275	0-25
2N706A	0-12	AF126	0-17	BFY51	0-20	NKT277	0-20
2N708	0-15	AF127	0-17	BFY52	0-22	NKT278	0-25
2N709	0-37	AF139	0-30	BFY53	0-17	NKT301	0-40
2N711	0-37	AF178	0-55	BFY64	0-45	NKT304	0-75
2N767	0-45	AF179	0-45	BFY90	0-65	NKT403	0-75
2N1090	0-30	AF180	0-62	BSX27	0-60	BT7404	0-55
2N1091	0-32	AF181	0-42	BSX60	0-93	NKT678	0-30
2N1131	0-25	AF186	0-40	BSX76	0-15	NKT713	0-25
2N1132	0-25	AFY19	1-13	B8Y26	0-18	NKT773	0-25
2N1302	0-18	AFY21	0-10	B8Y27	0-17	NKT777	0-38
2N1303	0-23	AFY21	0-50	BSY61	0-50	BT818	0-38
2N1304	0-25	ASY26	0-25	BSY95A	0-12	OA5	0-20
2N1305	0-22	ASY27	0-32	BSY95	0-12	OA6	0-12
2N1306	0-25	ASY28	0-25	BT102/500R	0A47	0-10	OC204
2N1307	0-25	ASY29	0-30	BTY42	0-92	OA70	0-10
2N1308	0-25	ASY36	0-25	BTY79/100R	0A73	0-10	OC205
2N1309	0-25	ASY50	0-17	BTY79/400R	0A79	0-10	OC206
2N1420	0-93	ASY51	0-20	0A73	0-10	OC207	0-30
2N1507	0-28	ASY53	0-20	0A79	0-10	OC208	0-30
2N1526	0-38	ASY55	0-20	0A81	0-10	OC209	0-40
2N1909	0-25	ASY62	0-25	0A85	0-12	OC210	0-30
2N2147	0-75	ASY86	0-35	0A86	0-15	ORP12	0-50
2N2148	0-60	ASZ21	0-42	0A90	0-08	ORP16	0-42
2N2149	0-75	ASZ23	0-75	0A91	0-08	ORP21	0-50
2N2218	0-20	ALY10	0-88	BY182	0-85	OA95	0-07
2N2219	0-20	AU101	1-50	BY213	0-25	OA97	0-07
2N2287	1-03	BC107	0-10	BZ210	0-35	OA202	0-10
2N2297	0-20	BC108	0-10	BZ211	0-32	OA210	0-25
2N2369A	0-15	BC109	0-10	BZ212	0-30	OA215	0-30
2N2613	0-28	BC113	0-15	BZ213	0-25	OAZ200	0-55
2N2646	0-45	BC115	0-20	BZ215	1.00	OAZ201	0-50
2N2712	0-25	BC116	0-25	BZ216	0-25	OAZ202	0-40
2N2784	0-50	BC116A	0-30	BZ216	0-62	OAZ203	0-42
2N2846	0-75	BC118	0-25	BYZ88C3V3	0A204	0-30	OX642
2N2848	0-42	BC121	0-20	0-15	OAZ205	0-42	OX644
2N2904	0-20	BC122	0-20	0-85	OAZ206	0-42	OX645
2N2904A	0-33	BC122	0-33	0-25	OAZ207	0-37	V1730P
2N2906	0-20	BC126	0-65	CRS14/20	0-32	V30-201P	0-75
2N2907	0-23	BC140	0-45	CS48	0-60	OAZ209	0-83
2N2924	0-23	BC147	0-15	CS10B	3-13	OAZ210	0-32
2N2925	0-15	BC148	0-12	DD000	0-18	OAZ211	0-32
2N2926	0-10	BC149	0-20	DD003	0-15	OAZ222	0-45
2N3054	0-50	BC157	0-15	DD006	0-18	OAZ223	0-45
2N3055	0-75	BC157	0-40	DD007	0-40	OAZ224	0-45
2N3702	0-10	BC158	0-12	DD008	0-38	OAZ241	0-22
2N3705	0-10	BC160	0-63	GD3	0-33	OAZ242	0-23
2N3706	0-23	BC169	0-12	GD4	0-05	OAZ244	0-23
2N3707	0-12	BCY31	0-30	GD5	0-33	OAZ246	0-23
2N3709	0-13	BCY32	0-55	GD8	0-25	OAZ290	0-38
2N3710	0-13	BCY33	0-25	GD12	0-05	OC18	0-50
2N3711	0-10	BCY38	0-20	GET102	0-30	OC19	0-38
2N3819	0-35	BCY34	0-30	GET103	0-22	OC19	0-37
2N3823	0-60	BCY38	0-40	GET113	0-20	OC20	0-98
2N3823	0-75	BCY39	1-00	GET114	0-15	OC22	0-50
2N5027	0-53	BCY40	0-50	GET115	0-45	OC23	0-60
2N5088	0-33	BCY42	0-25	GET116	0-50	OC24	0-60
2S005	1-00	BCY70	1-15	GET120	0-25	OC25	0-37
2S801	0-50	BCY71	0-20	GET872	0-30	OC25	0-37
2S804	0-75	BCZ10	0-35	GET875	0-25	OC26	0-25
2S801	0-32	BCZ11	0-50	GET880	0-37	OC28	0-60
2S703	0-62	BD121	0-65	GET881	0-25	OC29	0-60
AA129	0-20	BD12					

A modification of the original constant current circuit is employed, due to the need for it to function correctly with a varying supply voltage,  $V_1$ . The two silicon diodes (these can be of any low power type, or alternatively two *npn* silicon transistor base-emitter junctions, forward biased as shown in Fig. 16) provide a constant voltage at the base of TRA—constant, that is, with respect to the positive supply line. With the base and hence emitter so held constant, the 100 ohm resistor passes a constant 7mA current through TRA and hence to the TRZ and VR1 in parallel.

It was from this configuration that the graphs in Fig. 17 were obtained, to show how output voltage varies with output current, and how the level of short circuit current varies with the setting of VR2.

In passing, note that the driving of the TRZ from the input voltage allows the output voltage to be made variable down to zero volts. If TRZ is driven from the output side, output voltages of less than Zener voltage would cease to give regulation.

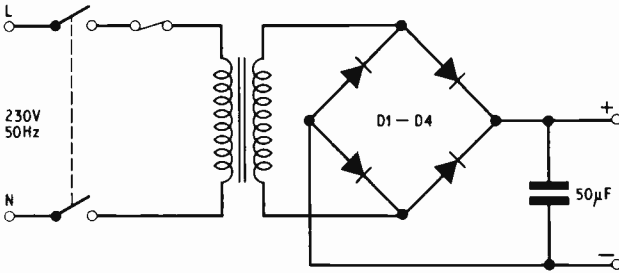


Fig. 18. Suggested mains supply unit for the stabiliser shown in Fig. 14

### VOLTAGE FEEDER

Practical construction of such a stabilised power supply can follow usual techniques. After maximum output current and maximum output voltage have been decided upon, a decision is made on the method of driving the regulator. A simple mains unit is shown in Fig. 18, and the voltage rating of the transformer secondary is chosen to give, at full load current, a value of  $V_1$ , about 4 volts more than the maximum regulated output voltage. Alternatively, a battery or accumulator could provide power.

### HEAT SINK FOR TR1

As for the size of the heat sink required for TR1, calculate first the maximum power dissipated in that transistor. This will be:

$$V_1 - (\text{minimum output voltage used}) \times \text{maximum load current}$$

It is at minimum output voltage and maximum load current that maximum power will be dissipated in TR1, and a suitable heat-sink should be chosen.

Generally speaking, for an OC28 or similar transistor, bolted to a heat-sink with an insulating mica washer, a rise in heat-sink temperature of about 40°C above ambient room temperature can be permitted.

Heat-sinks of various °C/watt ratings are readily available from components stockists.

As an example, for a 1A 9 volts output, driven from a 13 volts supply, with operation down to 3 volts expected, maximum power dissipated in TR1 is  $(13 - 3) \times 1 = 10$  watts, so a heat-sink of 4°C/watt is needed for an OC28. About 20 sq in of 16 s.w.g. aluminium sheet will suffice.

Having thus decided on transformer and heat-sink requirements, the size of the final unit can be settled. VR1, and possibly VR2, are front panel controls, but otherwise layout is unimportant, and can be adapted to suit individual requirements.

### TRICKLE CHARGER FOR SMALL BATTERIES

Mention was made earlier of deriving the supply from an accumulator and this is a useful way of obtaining a good general purpose stabilised voltage for powering many circuits. Recharging of the accumulator can be carried out overnight or a trickle charger can be used while the power supply is in use.

It is worth noting that many 12 volt car batteries can still provide a handy 1A even after their useful life in a car is over.

Constant current output can prove useful in the charging of some types of small batteries.

Batteries such as nickel-cadmium have a low internal resistance; hence, when in a discharged state, they would draw very large currents if the usual constant (or almost constant) voltage charging system is employed. This large current could give rise to overheating, tending to reduce the internal resistance still further and hence allowing thermal runaway to take place, and so leading to destruction of the battery.

However, for battery charging applications, adjust VR2 to give the required current, ensuring that VR1 is set to give a high enough voltage to charge the battery in question when it reaches its full final voltage. The battery manufacturer's instructions should be followed if in doubt.

Otherwise, the constant current circuitry is used as an overload limiter. With VR2 at maximum resistance, short circuit the output terminals; then bring down VR2 until the output current is a little greater than the maximum expected to flow in the unit being powered, under normal conditions.

Thereafter, should excessive current attempt to flow due to a fault, such current will be safely limited to that previously set by VR2.

Although the uses of Zener substitutes so far described have been in power supplies, this does not exhaust their usefulness.

### OTHER USES

Clipping and limiting of waveforms to specific amplitudes can easily be accomplished. In the design of d.c. amplifiers, shifts of voltage by the constant voltage of the Zener substitute enable large gains to be achieved without limiting due to saturation of later stages.

With the ready availability of *npn* silicon transistors for use as substitute Zeners, it is hoped that experimenters will be encouraged to make greater use of them in stabilised power supplies, on the lines suggested, with corresponding improvement in equipment performance. ★

# MARKET PLACE

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

## PHOTOCONDUCTIVE CELL DESIGNERS' KIT

Designed primarily for educational establishments as well as industrial organisations interested in developing light activated controls, **Photain Controls** have produced a Photoconductive Cell Designers' Kit which readers may like to experiment with.

The kit consists of five different photoconductive cells together with 13 circuit diagrams each complete with a brief explanation of the circuit. Each diagram enables the student to build devices embracing light intensity measurement; feedback gain controllers; photo switches; signal modulating and musical instrument volume controller.

The kit is available from Photain Controls Ltd., Randalls Road, Leatherhead, Surrey, price £2.

## SOLDERING ACCESSORIES

Leaving one hand free to hold the work piece, the Anextra Solder Feed fits the majority of soldering irons and carries up to 4oz reels of flux cored solder.

Solder from 22 to 18 s.w.g. can be used and is fed to the joint by operating the solder feed trigger.

Supplied with an initial 1oz reel of 60/40 cored 22 s.w.g. solder, the recommended retail price is £4.25. Further details of the Solder Feed is obtainable from **Anextra Ltd.**,

Chiltern Works, 77-78 Chiltern View Road, Uxbridge, Middlesex.

Standard package integrated circuits, despite their numerous advantages, suffer from one major drawback as far as the amateur is concerned. The removal of these units from printed circuit boards, since it is necessary either to remove all traces of solder from all the connecting pin joints or melt all the joints simultaneously.

A range of desoldering heads for the Solderstat HMS miniature irons is an accessory which, using the method of simultaneous desoldering, removes the standard dual-in-line packages within a few seconds is claimed by **Solderstat Ltd.**

The desolder head is placed on the iron in place of the copper bit and aligned with the i.c. connecting pins on the printed circuit board. Both 14-way and 16-way dual-in-line heads are available.

Readers can, of course, use standard i.c. holders available from advertisers when they construct prototype circuits.

## LOW VOLTAGE TOOLS

A range of battery-operated miniature tools capable of operating drills, cleaning brushes, abrasive stones, cutting burrs, polishing mops and other tools for precision work has been introduced by **Expo (Drills) Ltd.**

Two basic models are available. The "Reliant" designed for lighter work such as model making, and has a full load current of 1.5A, and the "Titan Super". Rated torque of the "Reliant" is 1.38oz in (100gm cm.).

For jobs requiring a more powerful tool and for professional applications the "Titan Super", rated at 3.5A on full load, should be used. It has a rated torque of 350 c.m.p. operating at 4,000-9,000 r.p.m.

Accessories include a diamond bonded drill, for gem stones up to 7MOHS, various types of abrasives, cutters and saws. Different

collets and accessories are supplied according to model.

Prices range from £3 to £5.50 and full details are obtainable from Expo (Drills) Ltd., 62 Neal Street, London, W.C.2.

## INSTANT LETTERING

To help finish-off equipment **Instant Plastic Ltd.** have introduced a range of p.v.c. self-adhesive plastic lettering kits.

Designated type K, the kits consist of 40 different sets in five colours, sizes from 10mm ( $\frac{3}{8}$ in) high upwards, in capitals and lower case letters and numerals.

The smallest set contains 578 letters and numerals and the number in each set reduces as the letter size increases.

The K sets cost approximately £1 per set, and details of their other ranges can be obtained from Instant Plastic Ltd., 101 Bramley Road, London, W.10.

## PRINTED CIRCUIT BOARDS

A new price list of printed circuit boards for previously published P.E. projects has just been issued by **P.H. Electronics.**

Copies of the price list can be obtained from P.H. Electronics, Industrial Estate, Sandwich, Kent.

## SWITCH KIT

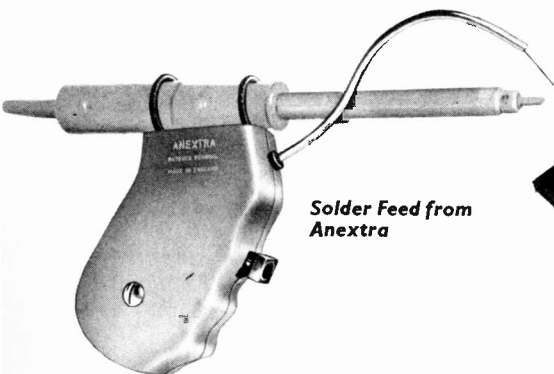
The mention of the versatile switch kit in the September issue should have included the following firms who are all part of the buying group set up by Home Radio (Components Ltd.).

Crescent Radio, 40 Mayes Road, London, N.22.

Garland Bros., Chesham House, Deptford Broadway, London, S.E.8.

Radioparts, 5 Market Way, Plymouth, Devon.

Servio Radio, 156-158 Merton Road, Wimbledon, London, S.W.19.



Solder Feed from Anextra



Solderstat I.C. Desolder Heads

Miniature electric tool made by Expo (Drills) Ltd





# SEW PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.  
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50V d.c.	\$3-10	100-0-100μA	\$3-10
300V d.c.	\$2-10	500μA	\$3-00
1A d.c.	\$3-10	1mA	\$2-60
5A d.c.	\$3-10	20V d.c.	\$2-60
300V a.c.	\$3-10	50V d.c.	\$2-60
100-0-100μA	\$3-45	300V d.c.	\$2-60
50μA	\$3-60	1A d.c.	\$2-60
50-0-50μA	\$3-45	5A d.c.	\$2-60
100μA	\$3-20	300V a.c.	\$2-60
100-0-100μA	\$3-45	VU Meter	\$3-37

### "SEW" CLEAR PLASTIC METERS

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50-0-50μA	\$3-10	200mA	\$1-60
100μA	\$3-10	300mA	\$1-60
100-0-100μA	\$3-00	500mA	\$1-60
200μA	\$3-00	750mA	\$1-60
500μA	\$2-80	1A	\$1-60
100-0-500μA	\$2-80	2A	\$1-60
1mA	\$2-80	5A	\$1-60
5A a.c.*	\$2-80	10A	\$1-60
10A a.c.*	\$2-80	30V d.c.	\$1-60
1-0-1mA	\$2-80	15V d.c.	\$1-60
5mA	\$2-80	20V d.c.	\$1-60
10mA	\$2-80	100V d.c.	\$1-60
		150V d.c.	\$1-60
		300V d.c.	\$1-60
		500V d.c.	\$1-60
		1A	\$1-60
		2A	\$1-60
		5A	\$1-60
		10A	\$1-60
		30V a.c.	\$1-70
		15V a.c.	\$1-60
		20V d.c.	\$1-60
		100V d.c.	\$1-60
		150V d.c.	\$1-60
		300V d.c.	\$1-60
		500V d.c.	\$1-60
		1A	\$1-60
		2A	\$1-60
		5A	\$1-60
		10mA	\$1-60
		20mA	\$1-60
		50mA	\$1-60
		100mA	\$1-60
		1mA	\$1-70
		VU meter	\$2-10

Type MR.52P. 2 1/2in. square fronts.		Type MR.45P. 2 1/2in. square fronts.	
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50-0-50μA	\$2-60	50-0-50μA	\$2-10
100μA	\$2-60	100μA	\$1-90
100-0-100μA	\$2-60	100-0-100μA	\$1-75
200μA	\$2-60	200μA	\$1-75
500μA	\$2-60	500μA	\$1-65
100-0-500μA	\$2-60	500-0-500μA	\$1-60
1mA	\$2-60	1mA	\$1-60
5A a.c.*	\$2-60	2mA	\$1-60
10A a.c.*	\$2-60	5mA	\$1-60
10V d.c.	\$2-60	10mA	\$1-60
		20mA	\$1-60
		50mA	\$1-60
		100mA	\$1-60
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100μA	\$2-75	5A	\$1-90
100-0-100μA	\$2-65	15A	\$1-90
200μA	\$2-65	30A	\$1-90
500μA	\$2-40	50A	\$1-90
100-0-500μA	\$2-20	5V d.c.	\$1-90
1mA	\$2-20	10V d.c.	\$1-90
5A a.c.*	\$2-20	15V d.c.	\$1-90
10A a.c.*	\$2-20	30V d.c.	\$1-90
10V d.c.	\$2-20	50V d.c.	\$1-90
		150V d.c.	\$1-90
		300V d.c.	\$1-90
		500μA a.c.*	\$1-95
		1mA a.c.*	\$1-95
		5A a.c.*	\$1-95
		10A a.c.*	\$1-95
		50A a.c.*	\$1-95
		500μA a.c.*	\$1-95
		1mA a.c.*	\$1-95
		5A a.c.*	\$1-95
		10A a.c.*	\$1-95
		50A a.c.*	\$1-95
		VU meter	\$2-10

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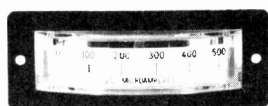
### "SEW" EDUCATIONAL METERS



Type ED.107. Size overall 100mm x 90mm x 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The easily accessible to working. Available in the following ranges:

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100μA	\$4-65	50V d.c.	\$4-40
1mA	\$4-40	300V d.c.	\$4-40
50-0-50μA	\$4-65	Dual range	
1-0-1mA	\$4-40	500mA/5A d.c.	\$4-65
1A d.c.	\$4-40	5V/50V d.c.	\$4-65
5A d.c.	\$4-40		
10V d.c.	\$4-40		

### EDGEWISE METERS



PE.70 3 1/2in. 1 1/2in. deep.	
50μA	\$3-10
50-0-50μA	\$3-00
100μA	\$3-00
100-0-100μA	\$2-90
200μA	\$2-90
500μA	\$2-75
1mA	\$2-45
300V a.c.	\$3-45
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2G399	2N3514	2N3557	40p	BC213	15p	BFW189	20p	NK2321	27p
2G400	2N3515	2N3558	40p	BC214	15p	BFW190	20p	NK2322	27p
2G401	2N3516	2N3559	40p	BC215	15p	BFW191	20p	NK2323	27p
2G402	2N3517	2N3560	40p	BC216	15p	BFW192	20p	NK2324	27p
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2G404	2N3519	2N3562	40p	BC218	15p	BFW194	20p	NK2326	27p
2G405	2N3520	2N3563	40p	BC219	15p	BFW195	20p	NK2327	27p
2G406	2N3521	2N3564	40p	BC220	15p	BFW196	20p	NK2328	27p
2G407	2N3522	2N3565	40p	BC221	15p	BFW197	20p	NK2329	27p
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ACV40 15p	CSV6 15p	OA7 8p	2N711 37p
AD140 55p	C6V2 15p	OA7 8p	2N711A 37p
AD149 57p	C6V8 15p	OA7 8p	2N914 20p
AD161 37p	C7V5 15p	OA7 8p	2N918 42p
AD162 37p	C8V2 15p	OA7 8p	2N1090 30p
AF106 24p	C8V2 15p	OA7 8p	2N1091 33p
AF114 25p	C9V1 15p	OA7 8p	2N1131 30p
AF115 25p	C10 15p	OA7 8p	2N1132 30p
AF116 25p	C11 15p	OA7 8p	2N1133 30p
AF117 25p	C12 15p	OA7 8p	2N1134 30p
AF118 44p	C13 15p	OA7 8p	2N1135 30p
AF124 25p	C15 15p	OA7 8p	2N1136 30p
AF126 17p	C16 15p	OA7 8p	2N1137 30p
AF139 33p	C18 15p	OA7 8p	2N1138 30p
AF186 40p	C21 15p	OA7 8p	2N1139 30p
AF239 37p	C24 15p	OA7 8p	2N1140 30p
ASV26 25p	C27 15p	OA7 8p	2N1141 30p
ASV27 30p	C30 15p	OA7 8p	2N1142 30p
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BC158 17p	NKT125 30p	OA7 8p	2N1154 30p
BC167 11p	NKT126 37p	OA7 8p	2N1155 30p
BC168 10p	NKT128 25p	OA7 8p	2N1156 30p
BC169 19p	NKT135 26p	OA7 8p	2N1157 30p
BC169C 19p	NKT137 32p	OA7 8p	2N1158 30p
BC182 12p	NKT210 25p	OA7 8p	2N1159 30p
BC182L 10p	NKT211 25p	OA7 8p	2N1160 30p
BC183 9p	NKT212 25p	OA7 8p	2N1161 30p
BC183L 9p	NKT213 25p	OA7 8p	2N1162 30p
BC184 15p	NKT214 23p	OA7 8p	2N1163 30p
BC184L 15p	NKT215 21p	OA7 8p	2N1164 30p
BC212 17p	NKT216 46p	OA7 8p	2N1165 30p
BC212L 12p	NKT217 50p	OA7 8p	2N1166 30p
BCY30 25p	NKT218 25p	OA7 8p	2N1167 30p
BCY31 48p	NKT219 25p	OA7 8p	2N1168 30p
BCY32 50p	NKT223 27p	OA7 8p	2N1169 30p
BCY33 20p	NKT224 25p	OA7 8p	2N1170 30p
BCY34 25p	NKT225 21p	OA7 8p	2N1171 30p
BCY38 30p	NKT229 29p	OA7 8p	2N1172 30p
BCY70 19p	NKT237 31p	OA7 8p	2N1173 30p
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BSY27 20p	NKT773 25p	OA7 8p	2N1211 30p
BY29 25p	BY29 25p	OA7 8p	2N1212 30p
BY100 20p	BY100 20p	OA7 8p	2N1213 30p
BYX10 15p	BYX10 15p	OA7 8p	2N1214 30p
BYZ10 40p	BYZ10 40p	OA7 8p	2N1215 30p
BYZ12 30p	BYZ12 30p	OA7 8p	2N1216 30p
BYZ13 20p	BYZ13 20p	OA7 8p	2N1217 30p
BZV8/ 15p	BZV8/ 15p	OA7 8p	2N1218 30p
C3V3 15p	C3V3 15p	OA7 8p	2N1219 30p
C3V6 15p	C3V6 15p	OA7 8p	2N1220 30p
C3V9 15p	C3V9 15p	OA7 8p	2N1221 30p
CAV3 15p	CAV3 15p	OA7 8p	2N1222 30p
CAV7 15p	CAV7 15p	OA7 8p	2N1223 30p
CSV1 15p	CSV1 15p	OA7 8p	2N1224 30p
CSV6 15p	CSV6 15p	OA7 8p	2N1225 30p
C6V2 15p	C6V2 15p	OA7 8p	2N1226 30p
C6V8 15p	C6V8 15p	OA7 8p	2N1227 30p
C7V5 15p	C7V5 15p	OA7 8p	2N1228 30p
C8V2 15p	C8V2 15p	OA7 8p	2N1229 30p
C8V2 15p	C8V2 15p	OA7 8p	2N1230 30p
C9V1 15p	C9V1 15p	OA7 8p	2N1231 30p
C10 15p	C10 15p	OA7 8p	2N1232 30p
C11 15p	C11 15p	OA7 8p	2N1233 30p
C12 15p	C12 15p	OA7 8p	2N1234 30p
C13 15p	C13 15p	OA7 8p	2N1235 30p
C15 15p	C15 15p	OA7 8p	2N1236 30p
C16 15p	C16 15p	OA7 8p	2N1237 30p
C18 15p	C18 15p	OA7 8p	2N1238 30p
C21 15p	C21 15p	OA7 8p	2N1239 30p
C24 15p	C24 15p	OA7 8p	2N1240 30p
C27 15p	C27 15p	OA7 8p	2N1241 30p
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MPF105 40p	MPF105 40p	OA7 8p	2N1252 30p
NKT124 30p	NKT124 30p	OA7 8p	2N1253 30p
NKT125 30p	NKT125 30p	OA7 8p	2N1254 30p
NKT126 37p	NKT126 37p	OA7 8p	2N1255 30p
NKT128 25p	NKT128 25p	OA7 8p	2N1256 30p
NKT135 26p	NKT135 26p	OA7 8p	2N1257 30p
NKT137 32p	NKT137 32p	OA7 8p	2N1258 30p
NKT210 25p	NKT210 25p	OA7 8p	2N1259 30p
NKT211 25p	NKT211 25p	OA7 8p	2N1260 30p
NKT212 25p	NKT212 25p	OA7 8p	2N1261 30p
NKT213 25p	NKT213 25p	OA7 8p	2N1262 30p
NKT214 23p	NKT214 23p	OA7 8p	2N1263 30p
NKT215 21p	NKT215 21p	OA7 8p	2N1264 30p
NKT216 46p	NKT216 46p	OA7 8p	2N1265 30p
NKT217 50p	NKT217 50p	OA7 8p	2N1266 30p
NKT218 25p	NKT218 25p	OA7 8p	2N1267 30p
NKT219 25p	NKT219 25p	OA7 8p	2N1268 30p
NKT223 27p	NKT223 27p	OA7 8p	2N1269 30p
NKT224 25p	NKT224 25p	OA7 8p	2N1270 30p
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7409	Quad 2-input positive AND gate open collector	391	25p	21p	18p	7472	J-K master-slave flip-flop	111	32p	27p	23p	7496	5-bit shift register	261	£1.48	£1.21	£1.05
7410	Triple 3-input NAND gate	111	20p	16p	14p	7473	Dual J-K master-slave flip-flop	121	45p	40p	35p	74107	Dual J-K master-slave flip-flop with preset and clear	301	£1.64	£1.37	£1.17
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IN4007	1000	190	150	120

p.i.v.	500+	1000+	
IN4001	50	045	040
IN4002	100	055	045
IN4003	200	060	050
IN4004	400	070	060
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Mfd.	250v.	350v.	500v.
0.01	...	...	3p
0.015	...	...	3p
0.022	...	...	3p
0.033	...	...	3p
0.047	...	...	4p
0.068	...	...	4p
0.1	...	...	4p
0.15	...	...	5p
0.22	...	...	5p
0.33	...	...	7p
0.47	...	...	8p
0.68	...	...	11p
1.0	...	...	14p
1.5	...	...	20p
2.2	...	...	24p

### Mullard Electrolytic C437 series

Mfd.	Volt.	Wkg.
250	16	9p
160	16	12p
640	16	15p
1,000	16	18p
160	25	9p
250	25	12p
400	25	15p
640	25	18p
100	40	9p
160	40	12p
250	40	15p
400	40	18p

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63 volt working. Range 18pf to 220pf (usual pref. values). Packs of 6 (any values) 15p

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10	16	6p
20	16	6p
40	16	6p
80	16	6p
1.6	25	8p
6.4	25	6p
12.5	25	6p
25	25	6p
50	25	6p
80	25	6p
1	40	8p
4	40	6p
8	40	6p
16	40	6p
32	40	6p
50	40	6p

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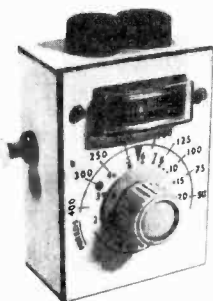
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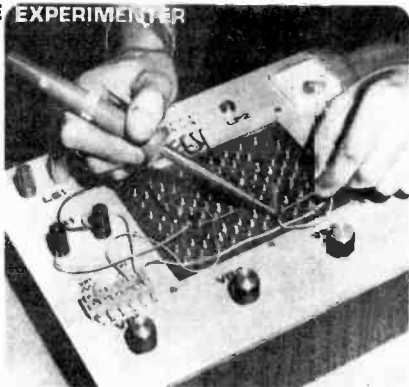
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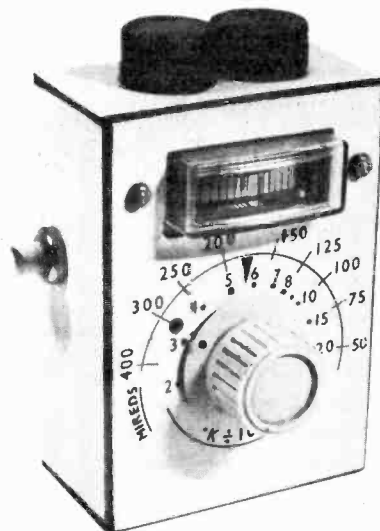
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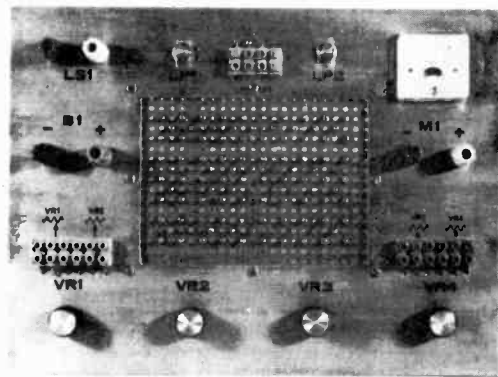
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2 B.A.	100 50p
<b>METAL SPEAKER GRILLES</b>	
7in. x 3in.	6 50p
<b>EARPIECES, MAGNETIC</b>	
No Plug	6 50p
2.5mm Plug	4 50p
3.5mm Plug	4 50p
<b>500 MICRO-AMP LEVEL METERS</b>	
VEROBOARD. TRIAL PACK	1 50p
5 BOARDS + CUTTER	50p

<b>TRANSISTORS</b>	
P.N.P. Untested but mainly O.K.	50 50p
N.P.N. Untested but mainly O.K.	50 50p
OCP 71 equivalent	5 50p
Light-sensitive Diodes (These produce up to 1ma from light)	10 50p
OC44 Mullard 1st grade	4 50p
OC45 Mullard	5 50p
2G378 Output, Marked	5 50p
ASY 22, Marked	5 50p
BY 127 Rectifiers	4 50p
IN4007 Rectifiers (1200V peak)	4 50p
STC 3/4 Rectifiers	6 50p
DIODES (0A 81 & 0A 91)	40 50p
<b>WIRE</b>	
Solid Core. Insulated 100yds.	50p
Stranded ditto	50yds. 50p
<b>SOLAR CELLS</b>	
Large Selenium	2 50p
Small	3 50p
(6 cells will power a Micromatic radio)	
<b>CO-AXIAL CABLE</b>	
Semi Air-spaced	15yds. 50p
<b>CRYSTAL TAPE RECORDER MIKES</b>	
CRYSTAL EARPIECES	1 50p
3.5mm Plug	2 50p
<b>TRANSISTORISED Signal Injector Kit</b>	
TRANSISTORISED Signal Tracer Kit	1 50p
<b>TRANSISTORISED CAR REV. COUNTER KIT (Needs 1 ma. meter as indicator)</b>	
	1 50p

**Unrepeatable Offer ! ! ! !**  
**Surplus VEROBOARDS, 3 3/4" x 2 1/2" x .15"**  
**Only 10p each or £1.00 per dozen**

## TANTALUM CAPACITORS. COMPARE THE PRICE—ONLY 10p EACH ! ! ! !

<b>Sub-miniature types</b>		<b>Miniature types</b>			
0.047µF	50 volts	0.022µF	20 volts	5.6 µF	35 volts
0.056µF	50 volts	0.033µF	20 volts	8.2 µF	10 volts
0.07 µF	20 volts	0.047µF	20 volts	8.2 µF	35 volts
0.1 µF	20 volts	0.068µF	35 volts	15 µF	35 volts
0.1 µF	50 volts	0.1 µF	35 volts	18 µF	35 volts
0.18 µF	20 volts	0.12 µF	35 volts	22 µF	15 volts
0.33 µF	35 volts	0.15 µF	35 volts	27 µF	120 volts
0.47 µF	35 volts	0.22 µF	50 volts	56 µF	15 volts
0.68 µF	20 volts	0.47 µF	50 volts	56 µF	20 volts
1.0 µF	15 volts	0.68 µF	35 volts	150 µF	6 volts
2.2 µF	3 volts	1.0 µF	50 volts		
2.7 µF	15 volts	1.0 µF	75 volts	<b>Standard</b>	
2.7 µF	35 volts	1.8 µF	20 volts	6.8 µF	50 volts
3.0 µF	15 volts	1.8 µF	20 volts	7.5 µF	20 volts
10.0 µF	1.5 volts	2.2 µF	20 volts	8.2 µF	150 volts
		2.7 µF	50 volts	12 µF	35 volts
		3 µF	12 volts	12 µF	50 volts
		3.3 µF	15 volts	39 µF	20 volts
		4 µF	20 volts	82 µF	20 volts
		4.7 µF	35 volts	150 µF	15 volts
		5.6 µF	6 volts	270 µF	6 volts

## NEW ! NEW ! NEW ! NEW !

An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly.  
**Method:** Spray copper laminate board with light-sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light. (No need to use ultra-violet.)  
**Spray with developer, rinse and etch in normal manner.**  
 Light sensitive aerosol spray . . . . . **£1**  
 Developer spray . . . . . **50p**

### STOCKTAKING CLEARANCE! IMPOSSIBLE TO REPEAT!

We have huge numbers of components in quantities too small to advertise individually. In order to "clear the decks" we have made up parcels containing a mixture of carbon and wire-wound resistors, electrolytic and paper condensers, controls, transistors, diodes etc., for a tiny fraction of normal price. It is emphasised that these are mixed parcels only—contents cannot be stipulated! Sold only by weight.

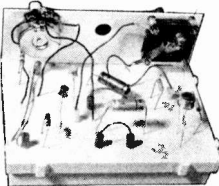
Gross weight 2 lb. . . . . **£1** (postage 20p)  
 Gross weight 5 lb. . . . . **£2** (postage 30p)

**G. F. MILWARD, Drayton Bassett, Tamworth, Staffs.** Postage (minimum) per order 15p.



**S.D.C. FESTIVE**

# BONANZA



**S-DeC SPECIAL OFFER**

**25p OFF**

- YES!** The ideal present for any electronics enthusiast, so do not miss this great opportunity.
- JUST TAKE THIS COUPON TO YOUR LOCAL STOCKIST WHO WILL SUPPLY ONE S-DeC for only £1.19**
- OR** in case of difficulty send coupon and cash to:—

**S.D.C. ELECTRONICS (SALES) LTD., 34 ARKWRIGHT ROAD ASTMOOR INDUSTRIAL ESTATE, RUNCORN, CHESHIRE WA7 1NU**

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 Address.....  
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(4) Offer closes January 31, 1972.

## ELEKON CLEARANCE OFFERS

Pye Transistorised Car Radio Panels includes 2 x Double Tuned IFs, 5 NKT Transistors, etc., etc. Your bargain for 50p, post 10p U.K.  
 Assorted Coil Formers includes Aladdin types, etc., etc. Amazingly cheap. 100 for £1.50, post free U.K.  
 Assorted Paxolin Panels marked A.E. Speaker, P.U., etc., etc. Look at the price! 100 for only £1.50, post free U.K.  
 Assorted Paxolin Voltage Panels. Various mains voltage markings. An absolutely fantastic selection. 100 for £1.50, post free U.K.  
 Assorted Valve Holders. A lot of old types that you never expected to see again. So many for so little. 100 for £1.50, post free U.K.  
 Assorted Fibre Washers. Miniature types rarely ever advertised. Knock-out price, 1,000 for 25p, post free U.K.  
 Assorted Plessey Moulded Track Potentiometers. Don't miss these. 10 for 50p, post 14p U.K.  
 For other bargains see our advert on page 542 October Practical Wireless. Our location near Goudge St. Station, opposite Heals of Tottenham Court Road.

**ELEKON ENTERPRISES**  
**12A TOTTENHAM STREET, LONDON W1P 9PQ**  
**TELEPHONE 01-580 7391**

## IN 15 MINUTES YOU COULD HAVE CAPACITIVE DISCHARGE ELECTRONIC IGNITION FITTED TO YOUR CAR

Capacitive Discharge Ignition is recognised as being the most efficient ignition system and will give you:

- CONTINUAL PEAK PERFORMANCE
- UP TO 20% REDUCED FUEL CONSUMPTION
- EASIER ALL-WEATHER STARTING
- INCREASED ACCELERATION & TOP SPEED
- LONGER SPARK PLUG LIFE
- INCREASED BATTERY LIFE
- CONTACT BURN ELIMINATED
- PURER EXHAUST GAS EMISSION
- RADIO INTERFERENCE SUPPRESSED



For all petrol engines—cars, boats, etc. Guaranteed for 5 yrs.

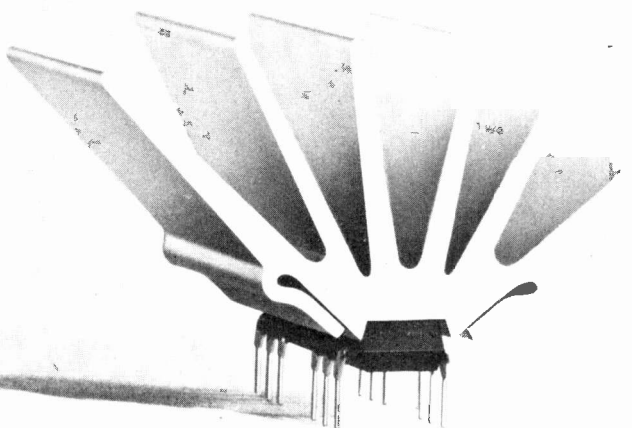
Complete Installation Kit for 12-volt vehicles £12.95 + 35p P. & P. State earth polarity of vehicle POSITIVE or NEGATIVE earth. Unit Construction Kit also available for the radio electronics constructor £9.95 + 35p P. & P. The construction kit includes instructions and all components for wiring as positive or negative earth, and is complete with the stove enamelled steel case and aluminium base. All components are available separately.

**ELECTRONIC DESIGN ASSOCIATES** 82 BATH STREET, WALSALL WS1 3DE



# new

## Super IC-12



### High fidelity Monolithic Integrated Circuit Amplifier

Two years ago Sinclair Radionics announced the World's first monolithic integrated circuit Hi-Fi amplifier, the IC.10. Now we are delighted to be able to introduce its successor, the Super IC.12. This 22 transistor unit has all the virtues of the original IC.10 plus the following advantages:

1. Higher power.
2. Fewer external components.
3. Lower quiescent consumption.
4. Compatible with Project 60 modules.
5. Specially designed built-in heat sink. No other heat sink needed.
6. Full output into 3, 4, 5 or 8 ohms.
7. Works on any voltage from 6 to 28 volts without adjustment.
8. NEW 22 transistor circuit.

**Output power** 6 watts RMS continuous (12 watts peak).

**Frequency Response** 5 Hz to 100KHz  $\pm$  1 dB.

**Total Harmonic Distortion** Less than 1%. (Typical 0.1%) at all output powers and all frequencies in the audio band.

**Load Impedance** 3 to 15 ohms.

**Power Gain** 90dB (1,000,000,000 times) after feedback.

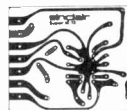
**Supply Voltage** 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

**Size** 22 x 45 x 28 mm including pins and heat sink.

**Input Impedance** 250 Kohms nominal.

**Quiescent current** 8mA at 28 volts.

With the addition of only a very few external resistors and capacitors the Super IC.12 makes a complete high fidelity audio amplifier suitable for use with pick-up, F.M. tuner etc. Alternatively, for more elaborate systems, modules in the Project-60 range such as the Stereo 60 and A.F.U. may be added. The comprehensive manual supplied with each unit gives full circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include car radios, oscillators etc. The very low quiescent consumption makes the Super IC.12 ideal for battery operation.



Price, inc. **FREE** printed circuit board for mounting.

**£2.98** Post free

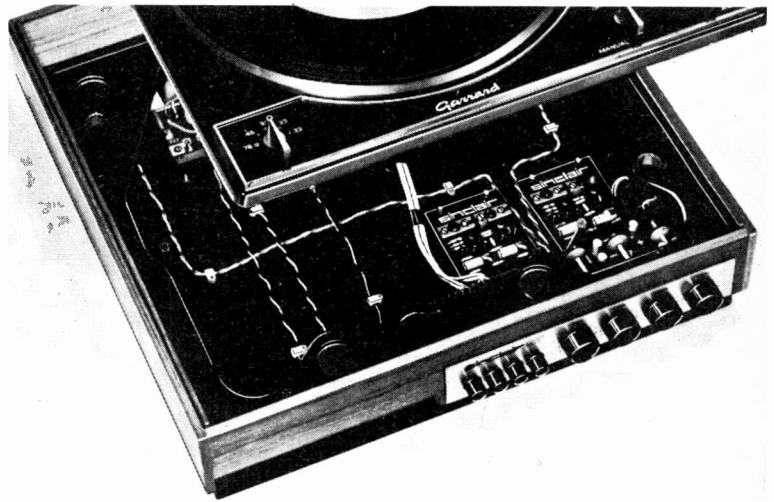
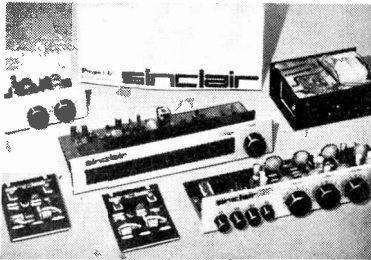
Sinclair Radionics Ltd, London Rd, St. Ives Huntingdonshire PE17 4HJ  
Telephone St Ives (048 06) 4311

**sinclair**

**SINCLAIR GENERAL GUARANTEE**  
Should you not be completely satisfied with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

# Sinclair Project 60

The World's leading range of high fidelity modules



## New! Project 605

The easy way  
to buy and  
build  
Project 60



Project 605 is one pack containing: one PZ.5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

All you need for a superb 30 watt high fidelity stereo amplifier.

Sinclair Radionics Limited, London Road,  
St. Ives, Huntingdonshire PE17 4HJ.  
Tel: St. Ives (048 06) 4311

**sinclair**

Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.

Performance characteristics are so good they hold their own with any other available system irrespective of price or size.

Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

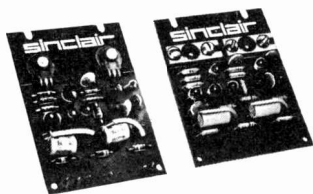
### Typical Project 60 applications

System	The Units to use	together with	Cost of Units
Simple battery record player	<b>Z.30</b>	Crystal P.U., 12V battery volume control	<b>£4.48</b>
Mains powered record player	<b>Z.30, PZ.5</b>	Crystal or ceramic P.U. volume control etc.	<b>£9.45</b>
20 + 20 W. stereo amplifier for most needs	<b>2 x Z.30s, Stereo 60, PZ.5</b>	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	<b>£23.90</b>
20 + 20 W. stereo amplifier with high performance spkrs.	<b>2 x Z.30s, Stereo 60, PZ.6</b>	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	<b>£26.90</b>
40 + 40 W. R.M.S. de-luxe stereo amplifier	<b>2 x Z.50s, Stereo 60 PZ.8, mains transformer</b>	As above	<b>£34.88</b>
Indoor P.A.	<b>Z.50, PZ.8, mains transformer</b>	Mic., guitar, speakers, etc., controls	<b>£19.43</b>

F.M. Stereo Tuner (**£25**) & A.F.U. Filter Unit (**£5.98**) may be added as required.

# from a simple amplifier to a complete stereo tuner amplifier with Project 60 modules

## 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).**

### Power Outputs

**Z.30** 15 watts R.M.S. into 8 ohms using 35 volts; 20 watts R.M.S. into 3 ohms using 30 volts.

**Z.50** 40 watts R.M.S. into 3 ohms using 40 volts; 30 watts R.M.S. into 8 ohms using 50 volts.

**Frequency response:** 30 to 300,000Hz  $\pm 1$  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:** 14 x 80 x 57 mm.

### Z.30

Built, tested and guaranteed with circuits and instructions manual.

**£4.48**

### Z.50

Built, tested and guaranteed with circuits and instructions manual.

**£5.48**

## Power Supply Units

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

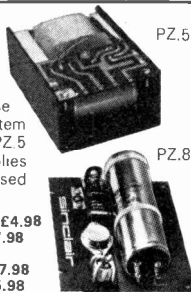
**PZ.5** 30 volts un stabilised **£4.98**

**PZ.6** 35 volts stabilised **£7.98**

**PZ.8** 45 volts stabilised

(less mains transformer) **£7.98**

**PZ.8** mains transformer **£5.98**



## Project 60 Stereo F.M. Tuner



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

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

**SPECIFICATIONS—Number of transistors:** 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 2 $\mu$ V for 30dB quieting; 7 $\mu$ V for lock-in over full deviation. **Squelch level:** 20 $\mu$ V. **A.F.C. range:**  $\pm 200$  KHz. **Signal to noise ratio:** > 65dB. **Audio frequency response:** 10 Hz – 15 KHz ( $\pm 1$ dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2 $\mu$ V. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC. **Indicators:** Power on/tuning/stereo.

**Size:** 93 x 40 x 207 mm.

**£25**

Built and tested. Post free.

## Stereo 60 Pre-amp/control unit



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

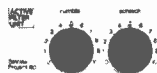
**SPECIFICATIONS—Input sensitivities:** Radio – up to 3mV, Mag. p.u. 3mV; correct to R.I.A.A curve  $\pm 1$ dB; 20 to 25,000 Hz. Ceramic p.u. – up to 3mV; Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 15 to –15dB at 10 KHz; BASS + 15 to –15dB at 100Hz.

**Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

**£9.98**

Built, tested and guaranteed.

## A.F.U. High & Low Pass 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 filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28KHz to 5KHz. L.F. cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V, supply) (0.02% at rated output. **Size:** 66 x 40 x 90 mm.

Built tested and guaranteed. **£5.98**

## The Sinclair Guarantee

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

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

Please send

Name

Address

I enclose cash/cheque/money order.

P.E. 1271

# Sinclair Q16/Micromatic

## 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. A 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 without loss.

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.

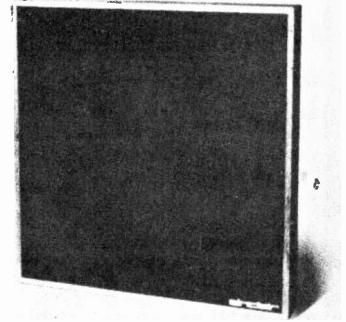
**Input Impedance:** 8 ohms.

**Frequency response:** From 60 to 16,000 Hz, confirmed by independently plotted B and K curve.

**Driver unit:** Special high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and special cone suspension for excellent transient response.

**Size and styling:** 9 $\frac{3}{4}$  in. square on face x 4 $\frac{3}{4}$  in. deep with neat pedestal base. Black all over cellular foam front with natural solid teak surround.

**Price £8.98.**



## 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; bandspread 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 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 (1.8 x 1.3 x 0.5 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 bandspread at higher frequencies (550 to 1,600 KHz).

**Earpiece:** Magnetic type.

**On/off switching:** By inserting and withdrawing earpiece plug.

Kit in pack with earpiece, case, instructions and solder **£2.48.**

Ready built, tested and guaranteed, with earpiece **£2.98.**

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

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Sinclair Radionics Ltd., London Rd, St. Ives  
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 BY **ATES · EMIHUS · FAIRCHILD · FERRANTI · I.T.T. · MULLARD · NEWMARKET · PHILIPS · R.C.A. · TEXAS**

# TRANSISTORS

A SELECTION FROM OUR LIST

AA730 10p	BD115 75p	OC16 80p	2N1303 18p
AA742 15p	BD123 85p	OC20 85p	2N1304 22p
AAZ13 10p	BD124 80p	OC22 50p	2N1305 22p
AAZ15 10p	BD131 75p	OC35 60p	2N1306 25p
AAZ17 10p	BD132 75p	OC24 60p	2N1307 25p
AC107 85p	BDY11 80p	OC25 60p	2N1308 25p
AC126 20p		OC26 25p	2N1308 25p
AC127 25p	BDY17 80p	OC28 60p	2N1309 25p
AC127Z 50p		OC29 60p	2N1613 20p
AC128 20p	BDY38 65p	OC35 60p	2N2147 75p
AC176 20p	BDY60 80p	OC36 60p	2N2180 60p
AC187 25p		OC42 40p	2N2217 25p
AC188 25p		OC43 60p	2N2218 20p
AC17 30p	BF115 25p	OC44 15p	2N2218A
AC18 30p	BF164 80p	OC45 15p	
AC19 25p	BF168 15p	OC70 15p	2N2219 20p
AC20 25p	BF169 85p	OC71 15p	2N2219A
AC21 20p	BF180 85p	OC72 20p	
AC22 20p	BF181 85p	OC73 25p	
AC23 20p	BF195 15p	OC76 25p	2N2220 25p
AC24 20p	BF196 15p	OC77 40p	2N2221 20p
AC25 20p	BF197 15p	OC81 20p	
AC26 20p	BF198 15p	OC82 20p	2N2222 20p
AD140 50p	BFX29 25p	OC81Z 40p	2N2222A
AD149 50p	BFX30 25p	OC83 25p	
AD161 35p	BFX31 25p	OC84 25p	2N2369 15p
AD162 35p	BFX32 25p	OC139 25p	2N2369A
AD163 35p	BFX33 25p	OC140 40p	
AD164 35p	BFX34 25p	OC141 60p	2N2646 40p
AD165 35p	BFX35 25p	OC170 25p	2N2904 20p
AD166 35p	BFX36 25p	OC171 30p	2N2904A
AD167 35p	BFX37 25p	OC200 40p	
AD168 35p	BFX38 25p	OC201 75p	2N2905 25p
AD169 35p	BFX39 25p	OC202 80p	2N2906 25p
AD170 35p	BFX40 25p	OC206 65p	
AD171 35p	BFY90 65p	OC271 97p	2N2906 20p
AD172 35p	BFY91 65p	ORP12 50p	2N2906A
AD173 35p	BFY92 65p	ORP40 40p	
AD174 35p	BFY93 65p	RT140 15p	2N2907 25p
AD175 35p	BFY94 65p	RT141 20p	2N2907A
AD176 35p	BFY95 65p	RT142 20p	
AD177 35p	BFY96 65p	RT143 20p	
AD178 35p	BFY97 65p	RT144 20p	
AD179 35p	BFY98 65p	RT145 20p	
AD180 35p	BFY99 65p	RT146 20p	
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AD188 35p	BFY107 65p	RT154 20p	
AD189 35p	BFY108 65p	RT155 20p	
AD190 35p	BFY109 65p	RT156 20p	
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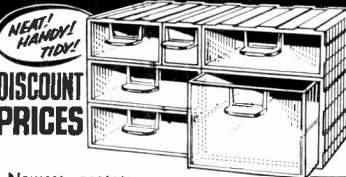
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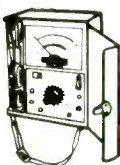
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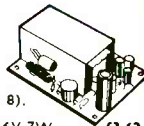
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