PRACTICAL
ELECTRONICS

MAY 1970

PRICE 3/6

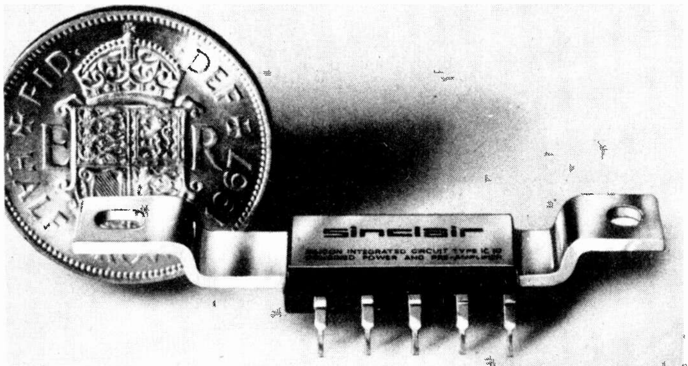
FOR THE SMALL BOAT OWNER....

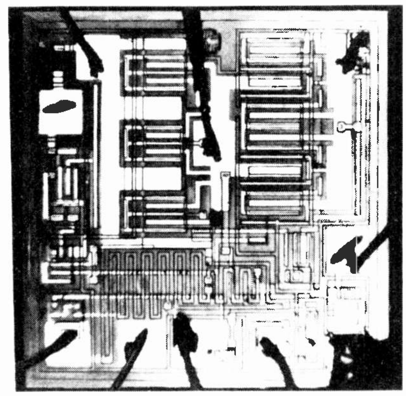
MARINE TACHOMETER

Also in this issue

MUSICAL STAVE * CAR CONVERSION FOR TOWING

MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP





the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required as part of the process of producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

■ SPECIFICATIONS

Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz±1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feed-back is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satis-factory.

■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

SINCLAIR

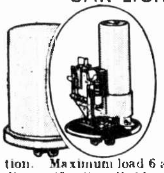
IC.10 *with IC-10 manual* **59/6**

POST FREE

sinclair

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD · CAMBRIDGE
Tel. 0223 52731

CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amps. Size 2 11/16" dia. 4". Supplied brand new at a fraction of original cost. **6/6** each. P. & P. 2/6. (3 for **17/6**. P. & P. 4/6.)

CLASS D WAVEMETERS

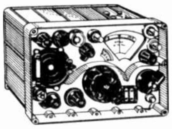
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

CLASS D WAVEMETERS No. 2

Crystal controlled. 1·2–19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

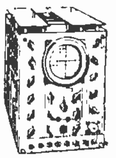
R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



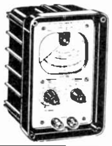
£15 Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



An excellent general purpose D/B oscilloscope. T.B. 2 c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

MARCONI CT44/TF956 AF ABSORPTION WATTMETER

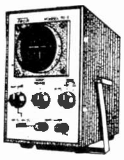


1 µwatt to 6 watts. **£20.** Carr. 20/-.

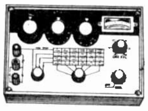
SOLARTRON CD. 71182 DOUBLE BEAM OSCILLOSCOPES. D.C. to 9 Mc/s. Perfect order. **£65.** Carr. 50/-. Few available less C.R.T. **£25.** Carr. 50/-.

TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS–1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. **£22.10.0.** Carr. 10/-.



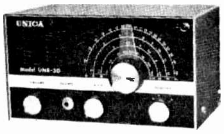
TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1%. L.1 µH – 111 HENRYS 6 Ranges ±2%. C. 10pF – 1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. **£20.** P. & P. 5/-.

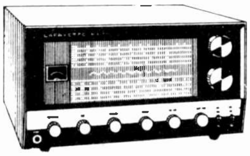
UNR-30 4-BAND COMMUNICATION RECEIVER

Covering 550 Kc/s–30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**



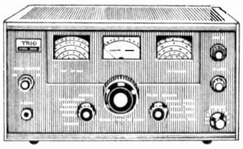
TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER. In stock. **£77.10.0.**

LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s–400 kc/s and 550 kc/s–30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in × 9½in 8¼in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver covering 550Kc/s to 30Mc/s. Continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£42** Carriage paid.

TRIO COMMUNICATION TYPE HEADPHONES Normally **£5.19.6.** OUR PRICE **£3.15.0** if purchased with above receiver.

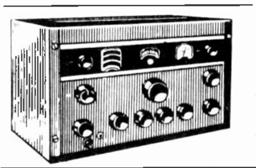
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER £65	**TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £180**

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s–30 mc/s continuous. Special features are use of FET transistors, S meter, built in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandspread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12¾" × 4½" × 7". Excellent value. ONLY **£24.** Carr. 7/6.

LAFAYETTE HA.800 6-BAND AMATEUR RECEIVER. £57.10.0. Carr. Paid.

RCA COMMUNICATION RECEIVER AR88D

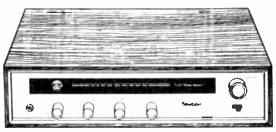


Latest release by ministry BRAND NEW in original cases. 110–250V a.c. operation. Frequency in 6 Bands. 535Kc/s–32Mc/s continuous. Output impedance 2·5–600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

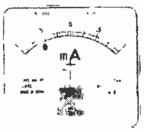
A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4 + 4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz FM 88-108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13¾" × 3½" × 9½" approx. Price **£34.** Carr. 7/6.

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. 1 21/32in square fronts.

50µA 40/-	500-0-500µA **27/6**	50mA **27/6**	150V. D.C. **27/6**
50-0-50µA **37/6**	1mA **27/6**	100mA **27/6**	300V. D.C. **27/6**
100µA **37/6**	1-0-1mA **27/6**	150mA **27/6**	500V. D.C. **27/6**
100-0-100µA **35/-**	2mA **27/6**	200mA **27/6**	750V. D.C. **27/6**
200µA **35/-**	5mA **27/6**	300mA **27/6**	15V. A.C. **27/6**
500µA 40/-	10mA **27/6**	500mA **27/6**	50V. A.C. **27/6**
	750mA **27/6**	3V. D.C. **27/6**	150V. A.C. **27/6**
	1 amp **27/6**	10V. D.C. **27/6**	300V. A.C. **27/6**
	2 amp **27/6**	20V. D.C. **27/6**	500V. A.C. **27/6**
	5 amp **27/6**	100V. D.C. **27/6**	S meter 1mA .**32/-**
	20mA **27/6**		VU meter **42/-**

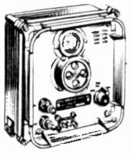
Full range of other sizes in stock. Send s.a.e. for leaflet.

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.

25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

CRYSTAL CALIBRATORS No. 10



Small portable crystal controlled wavemeter. Size 7" × 7½" × 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **89/6.** Carr. 7/6.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0·20 Kc/s on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5–1,500V. A.c. volts 1·5–1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F **35/-.** H.V. **42/6.**

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.c. coupled. Band width 1kc/s. Perfect order. **£25.** Carr. 30/-.

AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1µV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

PLESSEY SL 403A

3 watt Integrated Amplifier Circuit
49/6 POST PAID

EDDYSTONE VHF RECEIVERS MODEL 770R. 19–165 Mc/s. Excellent condition. **£150**

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz–30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

HOSIDEN DH-02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable headband. 8 ohm impedance. 20–12,000 cps. Complete with lead and stereo jack plug. ONLY **47/6.** P.&P. 2/6.

AUTO TRANSFORMERS

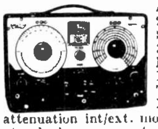
0/115/230v. Step up or step down. Fully shrouded.

150 W.	**£2.2.6,**	P. & P. 3/6
300 W.	**£2.19.6,**	P. & P. 4/6
500 W.	**£4.10.0,**	P. & P. 6/6
1,000 W.	**£6.10.0,**	P. & P. 7/6
1,500 W.	**£7.19.6,**	P. & P. 8/6
7,500 W.	**£15.10.0,**	P. & P. 20/-

G. W. SMITH & CO (RADIO) LTD.

Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600 Ω 3·8 V. P/P. TF 100 kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F 220/240 V a.c. **£32.10.0.** Carr. 7/6.

TE-20RF SIGNAL GENERATOR

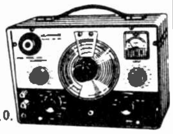
Accurate wide range signal generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£5.15.0.** P. & P. 7/6. **S.A.E.** for details.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20c/s to 200 kc/s on 4 bands. Square: 20c/s to 30 kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. **£16.10.0.** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS. Excellent condition. Fully tested. **£20.** Carr. 15/-.

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER



2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation. 200/250V a.c. **Brand New £17.10.0.** Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

J1B. AUDIO SIGNAL GENERATOR. 15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. **£30.0.0.**

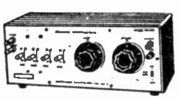
VM79. UHF MILLIVOLT METER. 100 Kc/s to 1,000 Mc/s. a.c. 10 mV to 3V. D.c. 10 mV to 3V. Current 0·01 μA to 0·3 mA. Resistance 1 ohm to 10 megohm. **£125.0.0.**

TT1S. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. **£37.10.0.** Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER

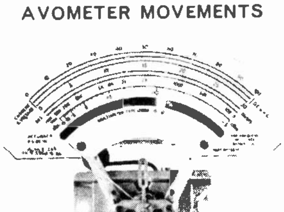
It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7-0·9967. B: 5-200. Ico: 0-50 microamps 0-5 mA. Resistance for diode 200 Ω-1 MΩ. Supplied complete with instructions, battery and lead. **£5.19.6.** P. & P. 2/6.

TE111. DECADE RESISTANCE ATTENUATOR



Variable range 0-111dB. Connections. Unbalanced T and Bridge T. Impedance 600 Ω range (0 1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600 Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

AVOMETER MOVEMENTS

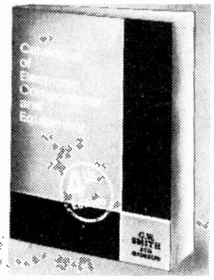


60μA 20 K Ω/V.

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed **69/6.** P.&P. 3/6.

Latest Catalogue

The latest edition giving full details of a comprehensive range of HI FI EQUIPMENT, COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT ... Over 230 pages, fully illustrated and detailing thousands of items—many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-



SEND NOW—ONLY 7/6 P&P 1/-

Note: 4th Edition now printing—reserve your copy now!

GARRARD

FULL CURRENT RANGE OFFERED, BRAND NEW AND GUARANTEED AT FANTASTIC SAVINGS

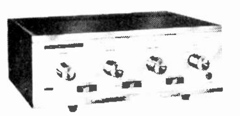
1025 stereo	**£7.19.6**	SL75	**£25.19.6**
2025T/C stereo	**£9.17.6**	SL75B	**£28. 0.0**
3000 stereo	**£9.19.6**	SL95B	**£35. 0.0**
SP25 MK II	**£11. 9.6**	A70/11	**£11.19.6**
SL55	**£11.12.6**	401	**£25. 0.0**
SL65B	**£14.19.6**	SL55 with Sonotone	
SL72B	**£25. 0.0**	9TAHCD	**£12.10.0.**
AP75	**£16.19.6**		

Carriage 7/6 extra each item.

TEAK PLINTHS AND PERSPEX COVERS
1. For SP25, SL65, SL55, 3000, 2025T/C, 2025, 1000. **£4.10.0**
2. For AP75, SL75, SL95. **£5.19.6**
3. For SP25 etc. to operate with lid in place **£5.19.6**

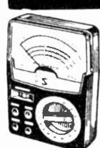
Carriage 7/6 extra each type. Full range of Garrard accessories available.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER



19 transistors, 8 diodes, IHF music power, 30W at 8 Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3-16 Ω. Separate L and R volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10½ × 3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£24.** Carriage 7/6.

MULTIMETERS *for EVERY purpose!*

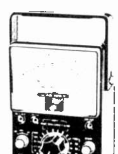


TE-51. NEW 20,000 Ω/VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200V a.c. 0/3/30/60/300/600/3,000V d.c. 0-60μA/12/300mA d.c. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.

TE-900 20,000 Ω VOLT GIANT MULTIMETER

6in full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0 / 25 / 12·5 / 10 / 50 / 250 / 1,000 / 5,000V d.c. 0 / 50μA / 110 / 100 / 500mA 10A d.c. 20K / 200K / 20 M Ω. **£15.** P. & P. 5/-.

MODEL AS-100D. 100K Ω/VOLT. 5in., mirror scale. Built-in meter protection. 0 / 3 / 12 / 60 / 120 / 300 / 600 / 1,200V d.c. 0/6/30/120/300/600V a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K / 200K / 2M / 200M Ω. −20 to +17dB. **£12.10.0.** P. & P. 3/6.



MODEL TE-10A. 20k Ω/Volt, 5/25/50/250/500/2,500 V, d.c. 10 / 50 / 100 / 500 / 1,000V. a.c. 0/50μA/2·5 mA./250mA. d.c. 0/6K/6 megohm. −20 to +22dB. 10-0, 100 mfd. t 0 0·100-0·1 mfd. **69/6.** P. & P. 2/6.

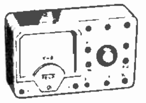
MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V d.c. 0·03/6/60/600MA d.c. 16k Ω / 160k Ω / 1·6/16M Ω. −20 to +63dB. **£7.10.0.** P. & P. 3/-.

MODEL TE 80. 20,000 O.P.V.

0 / 10 / 50 / 100 / 500 1,000V. a.c. 0/5/25/50, 250 / 500 / 1,000V d.c. 0·5μA. 5/50/500mA/0/6K/60/K/600K/6 Meg **£4.17.6.** P. & P. 3/-.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V. d.c. 0/6/30 / 120 / 600 / 1,200V. a.c. 0/30μA / 3/30 / 300mA. 0/16K/160K/1·6M / 16megohm **£5.10.0.** P. & P. 3/-.

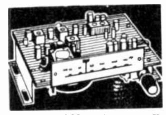
MODEL TE12. 20 000 O.P.V. 0/0·6/30/120/600/1,200 / 3,000 / 6,000V d.c. 1/6/30/120/600/1,200V a.c. 0 / 60μA / 6 / 60 / 600MA. 0 / 6K / 600K / 6meg./60. Megohm 50PF. 2 MFD **£5.19.6.** P. & P. 3/6.



MODEL PT-34. 1,000 O.P.V. 0/10/50 / 250 / 500 / 1,000V a.c. and d.c. 0/1/100/500 mA d.c. 0/100 K Ω **39/6.** P. & P. 1/6.

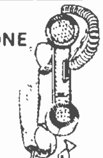
LAFAYETTE 57 Range Super 50,000 O.P.V. Multimeter. D.c. Volts 125V-1,000V A.c. Volts 1·5V-1,000V D.c. Current 25μA-10 Amp. Ohms. 0·15 Meg Ω dB.—20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

★ TRANSISTORISED FM TUNER ★



6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6. Stereo multiplex adaptors **99/6.**

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. **£6.19.6.** P. & P. 3/6.

SINCLAIR EQUIPMENT

Project 60 range of new models now in stock

Z30 Amplifier	**89/6**
Stereo 60 Control Unit	**£9.19.6**
PZ5 Power Supply	**£4.19.6**
PZ6 Power Supply	**£7.19.6**
Q16 Speakers	**£8.19.6**

All Post Paid.

SPECIAL PACKAGE OFFER!
2 × **Z30** Amplifiers, **Stereo 60** and **PZ5** Power Supply **£19** Carr. 7/6 or with 2 **Q16** Speakers **£35** Carr. 7/6
Micromatic Radio Kit **49/6** Built **59/6**
SINCLAIR IC/10 IN STOCK **59/6**
2000 Amplifier **£23.10.0.** Carr. 7/6
Neoteric Amplifier **£42.10.0.** Carr. 7/6

PEAK SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Light-weight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25–17,000 cps. 8 ohm imp. **67/6** P. & P. 2/6.

HOSIDEN DH04S 2-WAY STEREO HEADSETS

Each headphone contains a 2½in woofer and a ⅞in tweeter. Built in individual level controls. 8 Ω imp. 25-18,000c/s. with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

RECORDING HEADS

COSMOCORD ½-track heads. High imp. record/playback **65/-**. Low imp. erase **20/-**. **MARRIOTT** ½-track heads. High imp. record/playback **65/-**. Low imp. erase **20/-**. Post extra.

RACAL MA.168 TRANSISTORISED DIVERSITY SWITCH. Brand New Condition **£15.** Carr. 10/-.

AMERICAN TAPE

First grade quality American tapes. Brand new. Discount on quantities.

3in. 225ft. L.P. acetate	3 6
3¼in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5¾in. 1,200ft. L.P. acetate	12 6
5¾in. 1,200ft. L.P. mylar	16/-
5¾in. 1,800ft. D.P. mylar	22/6
5¾in. 2,400ft. L.P. mylar	39/6
7in. 1,200ft. std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. mylar	20/-
7in. 2,400ft. D.P. mylar	25/-
7in. 3,600ft. T.P. mylar	45/-

Postage 2/-. Over £3 post paid.

TAPE CASSETTES

Top quality in plastic library boxes.
C60 60 min **8/6** 3 for **24/6**
C90 90 min **12/6** 3 for **36/-**
C120 120 min **15/-** 3 for **43/6**
Cassette Head Cleaner **11/3.** All Post Extra.

G.W.SMITH & CO.(RADIO) LTD

All Mail Orders to—
147, Church Street, London, W.2
Tel: 01-262 6562
(Trade supplied)

3, LISLE STREET, LONDON, W.C.2 Tel: 01-437 8204
34, LISLE STREET, LONDON, W.C.2 Tel: 01-437 9155
311, EDGWARE ROAD, LONDON, W.2 Tel: 01-262 0387
OPEN 9-6 MONDAY TO SATURDAY (EDGWARE ROAD ½ DAY THURSDAY)

ELECTROVALUE

Everything brand new and to specification • Large stocks • Good service

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
C	$\frac{1}{20}$ W	5%	100 Ω–220k Ω	E12	18d	16d	15d
C	$\frac{1}{8}$W	5%	4·7 Ω–330k Ω	E24	2·5d	2d	1·75d
C	$\frac{1}{4}$W	10%	4·7 Ω–10M Ω	E12	2·5d	2d	1·75d
C	$\frac{1}{2}$W	5%	4·7 Ω–10M Ω	E24	3d	2·5d	2·25d
MO	$\frac{1}{2}$W	2%	18 Ω–1M Ω	E24	9d	8d	7d
C	1W	10%	4·7 Ω–10M Ω	E12	6d	5d	4d
WW	1W	10% $\pm\frac{1}{20}$ Ω	0·22 Ω–3·3 Ω	E12	15d all quantities		
WW	3W	5%	12 Ω–10k Ω	E12	15d all quantities		
WW	7W	5%	12 Ω–10k Ω	E12	15d all quantities		

CODES: C = carbon film, high stability, low noise. MO = metal oxide, Electrosil TR5, ultra low noise. WW = wire wound, Plessey.
VALUES: E12 denotes series: 1, 1·2, 1·5, 1·8, 2·2, 2·7, 3·3, 3·9, 4·7, 5·6, 6·8, 8·2 and their decades. E24 denotes series: as E12 plus 1·1, 1·3, 1·6, 2, 2·4, 3, 3·6, 4·3, 5·1, 6·2, 7·5, 9·1 and their decades.
Prices are in pence each for quantities of same ohmic value and power rating, not mixed values. (Ignore fractions of one penny on total resistor order.)

COLVERN 3 watt wire-wound potentiometers: 10 Ω, 15 Ω, 25 Ω, 50 Ω, 100 Ω, 150 Ω, 250 Ω, 500 Ω, 1k Ω, 1·5k Ω, 2·5k Ω, 5k Ω, 10k Ω, 15k Ω, 25k Ω, 50k Ω. Price only 5/6 each.

CARBON TRACK POTENTIOMETERS: Double wiper ensures minimum noise level Long plastic spindles.

	each
Single gang linear: 220 Ω, 470 Ω, 1k Ω, etc. to 2·2M Ω	2/6
Single gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2·2M Ω	2/6
Any type with ½ amp double pole mains switch: extra	2/3
Dual gang linear: 4k Ω, 10k Ω, 22k Ω, etc. to 1M Ω	8/6
Dual gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2M2 Ω	8/6
Log/Anti-log: 10k Ω, 47k Ω, 1M Ω only	8/6
Dual anti-log: 10k Ω only	8/6

FETS n-channel. Low cost general purpose 2N5163, 25V, only 5/- each. Audio/r.f., Texas 2N3819 8/6, Motorola 2N5459 (MPF105) 9/9 each.

NEW PLESSEY INTEGRATED CIRCUIT POWER AMPLIFIER, Type SL403A. Only 48/- nett. Operates with 18V power supply. Sensitivity 20MV into 20M Ω, 3W into 7.5 Ω. Application data with two or more. P.E., Nov. 69, Stereo Amplifier kit less metalwork £11.18.2 net complete.

30 WATT BAILEY AMPLIFIER COMPONENTS
Transistors for one channel £7.5.6. list, with 10% discount only £6.11.0. Transistors for two channels £14.17.6. list, with 15% discount £12.7.5. Capacitors and/resistors for one channel list £2. Printed circuit board free with each transistor set. Complete unregulated power supply kit £4.17.6. mono or stereo, subject to discount. Complete regulated power supply kit £9.5. subject to discount. Further details on application.

SINCLAIR IC10 Integrated Circuit Amplifier and Pre-amplifier. This remarkable monolithic integrated circuit amplifier and pre-amp is now available from stock. The equivalent of 13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is d.c. coupled and applicable to an unusually wide range of uses as detailed in the manual provided with it. As advertised, post free 59/6 net.

CARBON SKELETON PRE-SETS. Small high quality, type PR: Linear only, 100 Ω, 220 Ω, 470 Ω, 1k Ω, 2k Ω, 4k Ω, 10k Ω, 22k Ω, 47k Ω, 100k Ω, 220k Ω, 470k Ω, 1M Ω, 2M Ω, 5M Ω, 10M Ω vertical or horizontal mounting, 1/- each.

S-DeC's put an end to "birdsnesting". Components just plug in. Saves valuable time. Use components again and again. S-DeC only 30/6 post free. Compact T-DeC, increased capacity, may be temperature-cycled. T-DeC only 50/- post free. Full range stocked.

LARGE CAPACITORS. All new stock. High ripple current types: 2,000μF 25V 7/4; 2,000μF 50V 11/4; 5,000μF 25V 12/6; 5,000μF 50V 21/11; 1,000μF 100V 16/3; 2,000μF 100V 28/9; 5,000μF 70V 36/–; 5,000μF 100V 58/3; 1,000μF 50V 8/2; 2,500μF 64V 15/5; 2,500μF 70V 19/6.

MEDIUM ELECTROLYTICS. Axial leads: Values (μF/V): 50/50 2/–; 100/25 2/–; 100/50 2/6; 250/25 2/6; 250/50 3/9; 500/25 3/9; 1,000/10 3/–; 500/50 4/6; 1,000/25 4/6; 1,000/50 6/–; 2,000/25 6/–. Small electrolytics, axial leads: 5/10, 10/10, 25/10, 50/10, 1/– each; 25/25, 47/25, 100/10, 220/10, 1/3 each.

PEAK SOUND ENGLEFIELD KITS

Build it 12 + 12 or 25 + 25. Brilliant new styling and available in two forms: **STEREO 15 WATTS PER CHANNEL.** In kit form with complete amplifier and pre-amplifier modules and power supply. Output per channel into 15 Ω — 12W R.M.S. Price £38.9.0. net. **STEREO 25 WATTS PER CHANNEL.** As above but output per channel into 15 Ω — 25W R.M.S. Price £58.15.0. net. Brief specification: Total harmonic distortion 0·1%.
Inputs: Magnetic, Ceramic, Tape, Radio, Signal to noise ratios: Better than 60dB all inputs.
O/Load factor 28dB all channels.
ENGLEFIELD CABINET to house either above assemblies (as illustrated) £5.0.0. net. *Other peak sound products as advertised.*

MULLARD SUB-MIN ELECTROLYTICS C426 RANGE. Price 1/3 each. Axial leads, Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

WAVECHANGE SWITCHES: 1P 12W; 2P 6W; 3P 4W; 4P 3W long spindles, 4/9 each. Slider switches, double pole double throw, 3/– each.

BARGAINS IN NEW TRANSISTORS

All power types supplied with free insulating sets

2N696	5/6	2N5192	25/–
2N697	5/6	2N5195	29/3
2N706	2/9	40361	12/6
2N1132	9/9	403612	16/–
2N1302	4/–	AC126	6/6
2N1303	4/–	AC127	6/–
2N1304	4/6	AC128	6/–
2N1305	4/6	AC176	11/–
2N1306	6/9	ACY22	3/9
2N1307	6/9	ACY40	4/–
2N1308	8/9	AD140	19/–
2N1309	8/9	AD149	17/6
2N1613	6/–	AD161 }	16/– pr.
2N1711	7/4	AD162 }	
2N2218	10/6	AF118	16/6
2N2147	18/9	AF124	7/6
2N2369A	6/9	AF127	7/–
2N2646	10/9	BA102	9/–
2N2924	4/3	BC107	2/9
2N2925	5/3	BC108	2/6
2N2926R	2/6	BC109	2/9
2N2926O	2/3	BC147	4/3
2N2926Y	2/3	BC148	3/3
2N2926G	2/3	BC149	4/3
2N3053	5/6	BC153	10/–
2N3054	14/3	BC154	11/–
2N3055	16/6	BC157	3/9
2N3391A	5/6	BC158	3/6
2N3702	3/6	BC159	3/9
2N3703	3/3	BC167	2/6
2N3704	3/9	BC168	2/3
2N3705	3/5	BC169	2/6
2N3706	3/3	BC177	6/3
2N3707	4/–	BC178	5/8
2N3708	3/–	BC179	6/–
2N3709	3/–	BD121	18/–
2N3710	3/3	BD123	24/3
2N3711	3/11	BF178	10/6
2N3904	7/6	BFX29	10/9
2N39086	7/6	BFX85	8/3
2N3731	23/–	BFX88	7/9
2N4058	5/3	BFY50	4/6
2N3325	10/9	BFY51	4/3
2N3794	3/3	BSX20	3/9
2N4286	3/3	MJ480	21/–
2N4289	3/3	MJ481	27/–
2N4291	3/3	MJ491	30/–
2N4292	3/3	P346A	5/9
2N4410	4/9	IN4001	4/2
		IN4005	8/–

MAIN LINE AMPLIFIER KITS, as advertised. Prices net. Authorised dealer.

COMPONENTS DISCOUNTS
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
No discount on net items.

POSTAGE AND PACKING
Free on orders over £2.
Please add 1/6 if under.
Overseas orders welcome: carriage charged at cost.

ELECTROVALUE

Dept. PE4, 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY
Opening Hours: 9—5.30; Sat. 9 a.m. to 1 p.m. Tel.: Egham 5533 (STD 0784-3)

VOL. 6 No. 5
May 1970

PRACTICAL ELECTRONICS

Editor F. E. BENNETT **Assistant Editor** M. A. COLWELL **Editorial Assistants** D. BARRINGTON G. GODBOLD M. KENWARD
Art Editor J. D. POUNTNEY **Technical Illustrators** J. A. HADLEY P. A. LOATES
Advertisement Manager D. W. B. TILLEARD

INDUSTRY'S BEST INVESTMENT

DESPITE all those interesting developments in computerised design, the electronics industry is far from the stage of being able fully to automate itself in all processes, from conceptual design, through development, to final production and testing of its products. If that day ever comes, it certainly will not be in this decade.

According to the report just published by the Economic Development Committee for the Electronics Industry, on the Economic Assessment to 1972, the U.K. electronics industry will be facing a serious shortage of skilled labour after that year. Any further expansion of the industry will then depend almost solely upon the availability of the right kind of trained and qualified manpower.

Having identified the major problem of the future, the Report makes a number of suggestions relating to education. The most perceptive and important point it makes in this connection is that *the industry can do much more to help itself.* The Report states that the industry should make greater efforts to improve its image with school leavers; and that more practical assistance is required by schools in order for them to undertake building projects.

Regarding this last point, presumably the EDC is referring to the supply of components, since there is no shortage of design information for projects to suit a wide range of students of various age groups and levels of intelligence. The Schools Council, for example, disseminates information amongst educational establishments, notably in their publication "Project Technology" which lists abstracts of suitable scientific and technological projects selected from a hundred or more different sources, including PRACTICAL ELECTRONICS. But many schools, especially those at the lower end of the education spectrum, have a limited budget for expenditure on technical pursuits. The electronics industry could afford to act as Mr. Bountiful to a greater degree than at present.

We suspect another obstacle is one frequently encountered by the private constructor—the non-availability through normal distributive channels of some of the more important recently developed circuit devices.

What better recruitment pool can industry wish for than one composed of thousands of youngsters and teenagers who have acquired familiarity with electronic components and have built projects which demonstrate the truth of their text book theory. If the electronics industry is blind to this latent enthusiasm and interest among the younger generation, or refuses to make the special effort required to allow its products to reach these eager hands, it will have no right to complain five or ten years hence of a shortage of skilled manpower. Its future is in its own hands, right now.

F.E.B.

THIS MONTH

CONSTRUCTIONAL PROJECTS

MUSICAL STAVE 370
MARINE TACHOMETER 374
50 PLUS 50 HIGH POWER AMPLIFIER 400
CAR CONVERSION FOR TOWING 402
P.E. COMMUNICATIONS RECEIVER—8 413

SPECIAL SERIES

DEMONSTRATION SWITCHING CIRCUITS—6 379

GENERAL FEATURES

SOUNDS INCREDIBLE 387
INGENUITY UNLIMITED 406

BEGINNERS

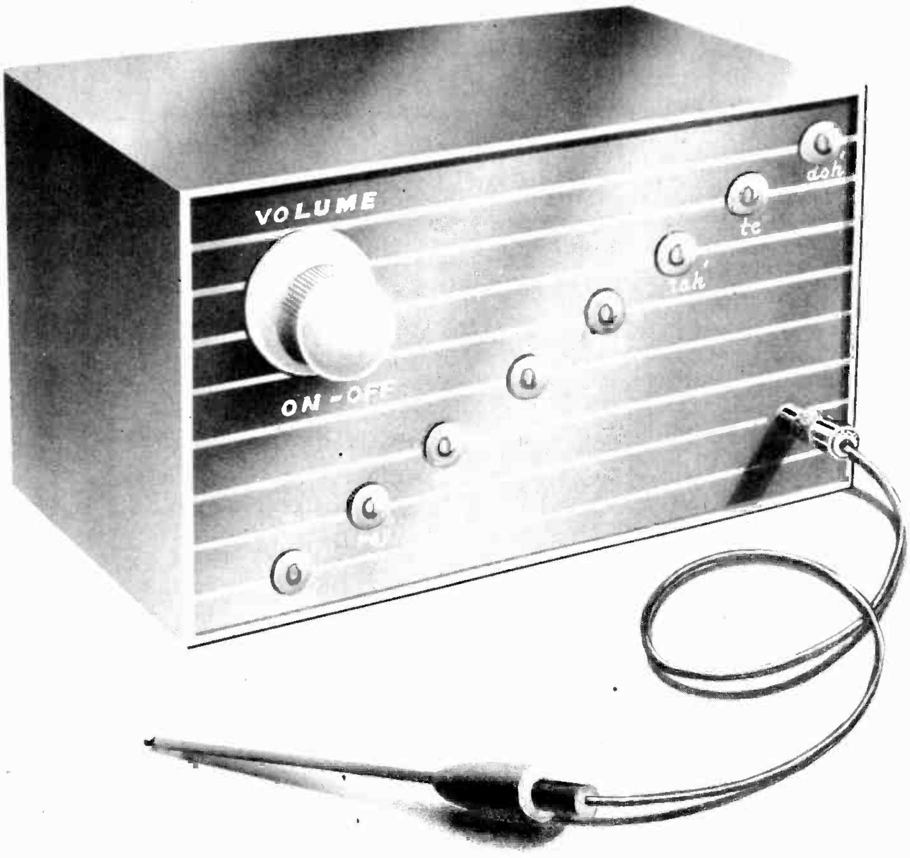
THIS WAY TO ELECTRONICS—2 392

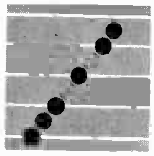
NEWS AND COMMENT

EDITORIAL 369
NEWS BRIEFS 384
SPACEWATCH 391
BOOK REVIEWS 397
ELECTRONORAMA 398
MARKET PLACE 409

Our June issue will be published on Friday, May 15

 Subscription Rates including postage for one year, to any part of the world, 45s.
Editorial and advertisement offices: Fleetway House, Farringdon St., London, E.C.4. Phone 01-236 8080





musical stave

By C. Cartlidge

THE simple instrument to be described was devised to provide children with an elementary teaching aid for an awareness of musical intervals in the treble stave.

Eight notes, with an appealing harmonic content, are available to the user by simply touching electric contacts with a baton. This eight note, diatonic scale, has syllable, or sol-fa identification so that melodies picked out can be easily sung.

With an overall frequency coverage from 200Hz to 2kHz, this instrument can be tuned within the piano range from middle C to nearly three octaves above.

Of course, only eight notes of a diatonic scale can be selected in this range but they can be chosen to suit a voice which means that a key note or commencing note *doh*, can be any one contained in the first two octaves from middle C.

CIRCUIT DESCRIPTION

The tone generator circuit is given in Fig. 1. It is a simple astable multivibrator where frequency variation is made possible by linking different resistance values at the points x–x.

The chain of pre-set resistors which make up this arm, is given in Fig. 2. Note selection consists of shorting out resistances by applying a probe or baton, at the appropriate sol-fa annotated contacts. The frequency of the note so selected can be approximately calculated by the equation:—

$$f = \frac{1}{0{\cdot}7(C_1.R_T + C_2.R_3)}\text{Hz}$$

where R_T is the total resistance between the base of TR2 and the negative line.

The output is taken from the emitter of TR2 to reduce the effect of loading by the following amplifier which would cause frequency changes.

A suitable amplifier for the output square waves is given in Fig. 3. Here the driver transformer has two secondaries, working in antiphase, two single-ended class B amplifiers. The bias resistor chain R12–R15 are chosen to offset crossover distortion of the output signal, an effect which would be apparent if ideal class B operation is worked.

POWER OUTPUT

The maximum power produced can easily be estimated in an output stage of this kind, for the output transistors can be considered as causing point A in the Fig. 3 to swing between plus and minus 9 volts. This swing is sinusoidal so that the r.m.s. output voltage is

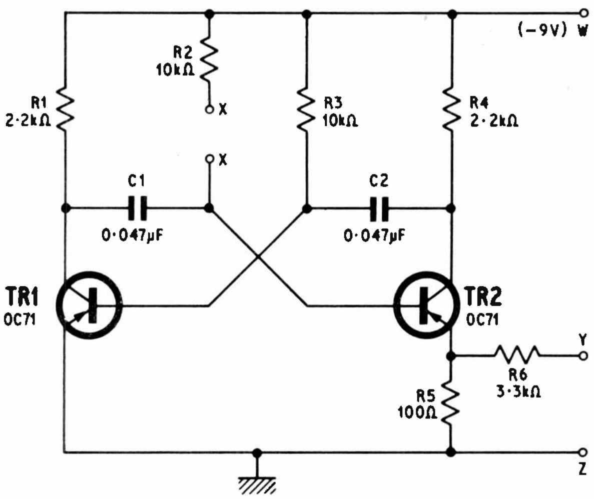


Fig. 1. Circuit of tone generator

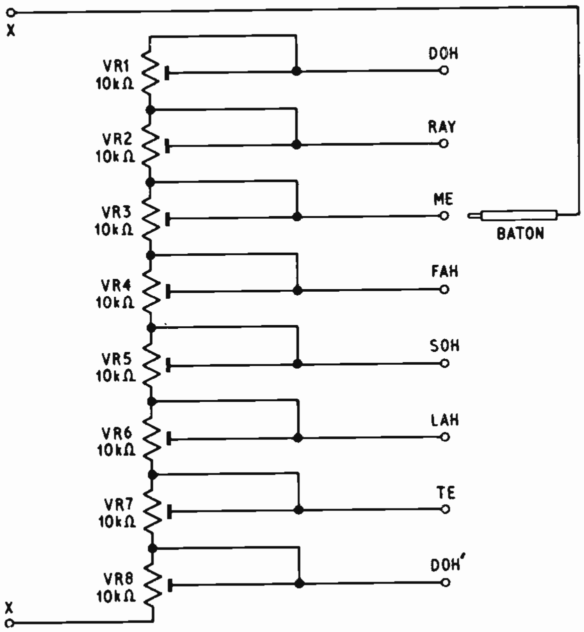


Fig. 2. Resistor chain used for varying frequency of tone generator

$9/\sqrt{2}$. With a 35 ohm speaker load this means that the power available is approximately 1 watt which in practice is more than adequate.

CONSTRUCTION

The tone generator, with the exception of the trimmers, and the amplifiers are mounted on a single perforated s.r.b.p. board. Wiring pins are used to fix these components and serve as wiring junctions. Fig. 4 shows the component and wiring layout which is entirely on one side of the board.

The exploded view of Fig. 5 shows how the board and associated components are mounted on a 10in by 5in by 6in plywood box. As can be seen, the back panel accommodates the eight note preset controls VR1–VR8; the front panel carries the touch plates for the baton, the amplifier volume control, and combined on/off switch.

TOUCH PLATES

The eight touch plates are made up from 0B.A. nuts, bolts and washers with solder tags to make the connections to the wipers of the preset controls.

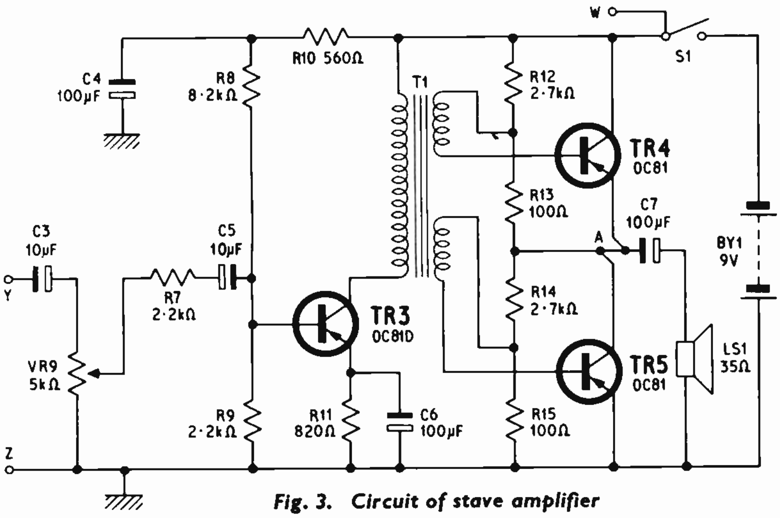
The bolts and washers face the panel arranged in a symmetrically spaced diagonal line with the nuts and solder tags completing the assemblies on the opposite face.

For the baton wire a ¼in hole should be drilled and a ¼in by 5/32in rubber grommet fitted.

LOUDSPEAKER

Before fitting the 35 ohm, 3⅜in round loudspeaker, a 3in hole should be drilled in the end panel and this covered with a piece of plastics grille or fabric.

The s.r.b.p. board should now be mounted, using stand-off bushes and screws, and all flying leads connected.



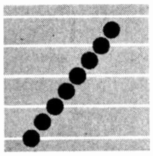


Fig. 3. Circuit of stave amplifier

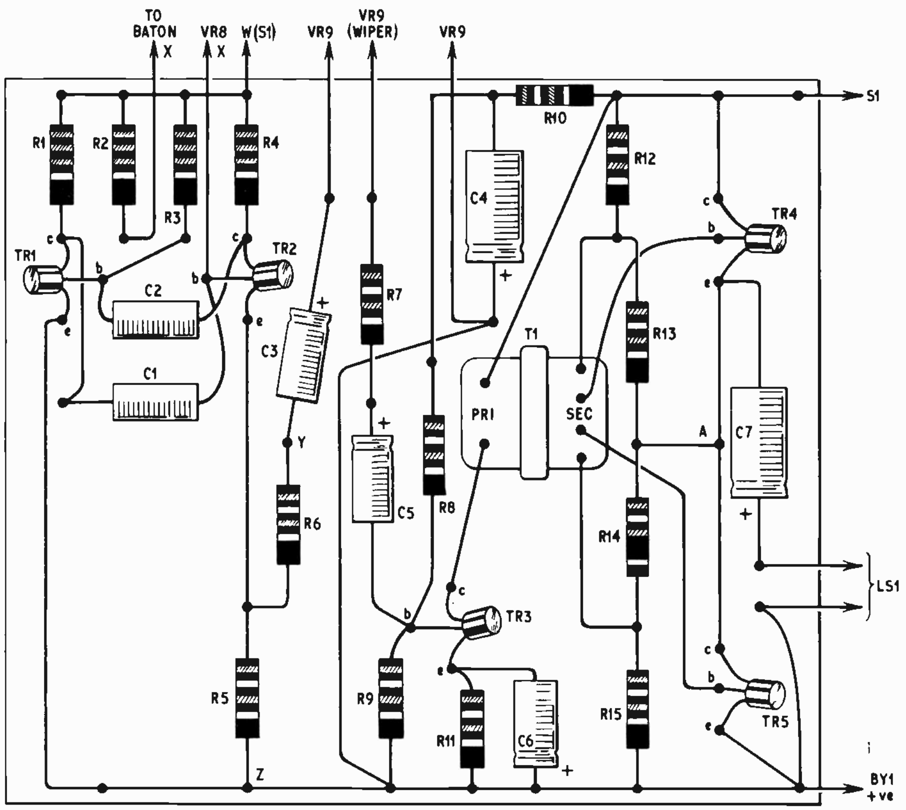


Fig. 4. Component layout and wiring of the s.r.b.p. board

BATON

The common contact, or baton, may be made up from a 6in length of 6B.A. brass rod and a 2ft length of stranded insulated wire connected and soldered to its end. A piece of sleeving is then pushed over the rod so as to cover the connection and leave about ½in of the rod tip exposed. The free end of the wire should now be connected to the main chassis board.

In the prototype a proprietary test probe terminating on a coaxial plug and socket were used. Whilst this is more expensive it does facilitate easy removal when transporting.

The case panels can now be glued together using triangular wooden fillets at the corners for strength.

TUNING

Initial tuning is as follows. The stave is switched on and the volume control turned up. The baton is applied to the lowest touch plate (low *doh* in fact) when a note should be heard. This note should fall within the compass of the first three octaves from middle C.

Any tonic, or first note, of the chosen scale should now be sounded on a piano within the first two octaves from middle C. When this keynote is decided upon,

COMPONENTS . . .

Resistors

R1	2·2kΩ	R9	2·2kΩ
R2	10kΩ	R10	560Ω
R3	10kΩ	R11	820Ω
R4	2·2kΩ	R12	2·7kΩ
R5	100Ω	R13	100Ω

All ½ watt, 10% carbon

Capacitors

C1	0·047μF polyester	C6	100μF elect. 16V
C2	0·047μF polyester	C7	100μF elect. 16V
C3	10μF elect. 16V		
C4	100μF elect. 16V		

Transistors

TR1	OC71	TR3	OC81D	TR5	OC81
TR2	OC71	TR4	OC81		

Loudspeaker

LS1 35Ω 3in loudspeaker

Potentiometers

VR1–VR8 10kΩ presets
VR9 5kΩ log

Transformer

T1 Transformer T/T5 (Radiospares)

Miscellaneous

0B.A. bolt, nut, washers and solder tags, plywood, wire, s.r.b.p. board (Lektrokit LK-141), push fit solder pins (Lektrokit LK-3011), 6B.A. brass rod, knob

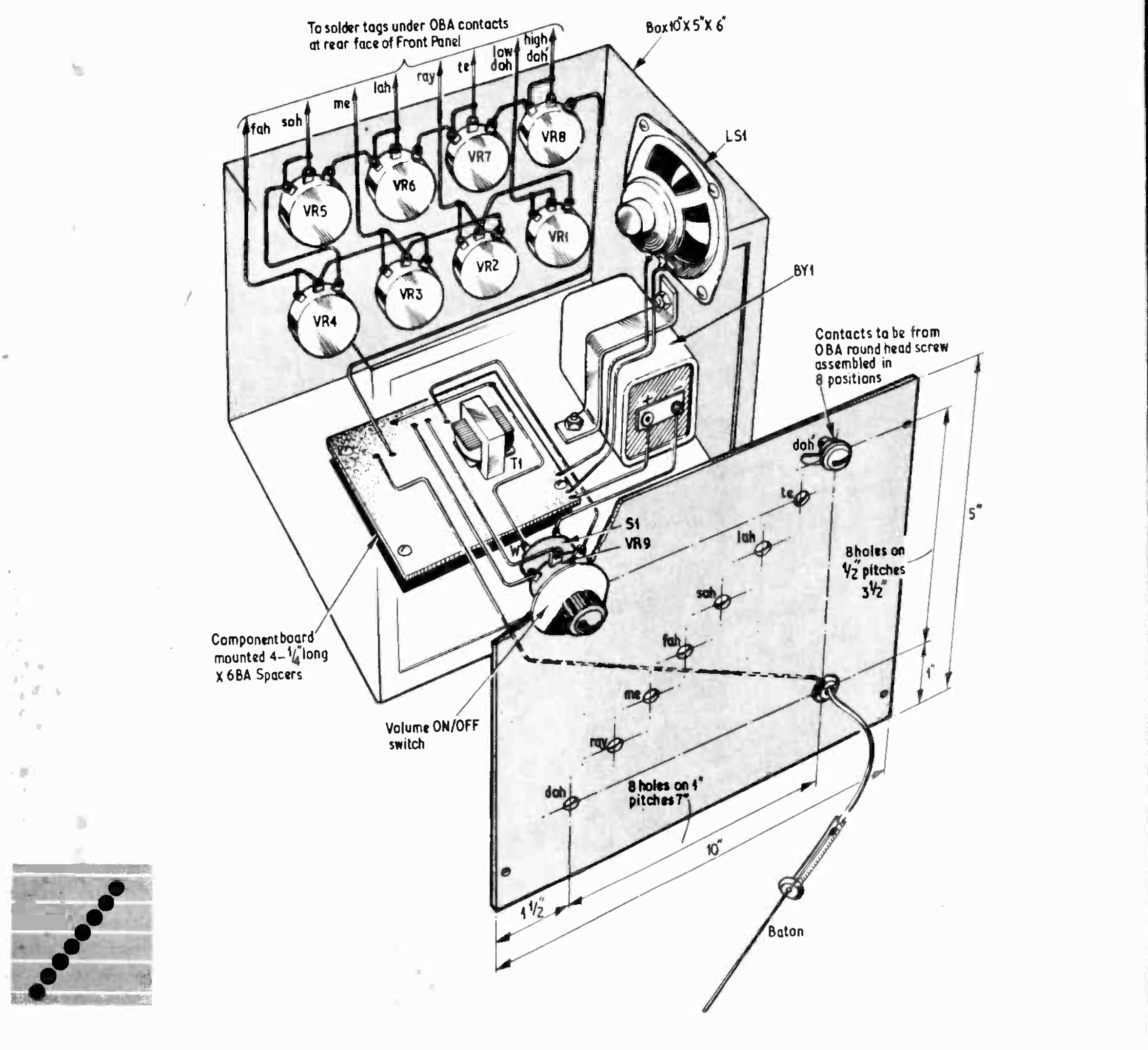


Fig. 5. Exploded view of the completed musical stave

potentiometer VR1 is carefully adjusted to provide an identical note with the one on the piano.

When this first note has been tuned the baton is held to the touch plate (*ray*), the second one up, and tuning to the second note of the chosen key on the piano continued.

This procedure is continued for the remaining six notes of the stave.

It should be mentioned here that skeleton presets should not be substituted for the potentiometers VR1–VR8 as the reduced track diameter makes accurate tuning difficult.

Whilst battery deterioration will change the frequency of the tonic, or commencing note of the scale, the drift from original tuning is not important as the intervals between notes will remain the same.

USING THE STAVE

Anyone who wishes to develop skill in singing from staff notation will find the sol-fa syllables the best mnemonics to the related sounds.

To use this instrument, the simple written melody to be sung should be placed in front of the pupil. Suppose the tune was "Three Blind Mice" in the key of "C Major". Here the tonic is low *doh*.

With the instrument tuned to this key the baton is applied to the touch plate at low *doh*. The pupil should sing this tonic C which establishes the key.

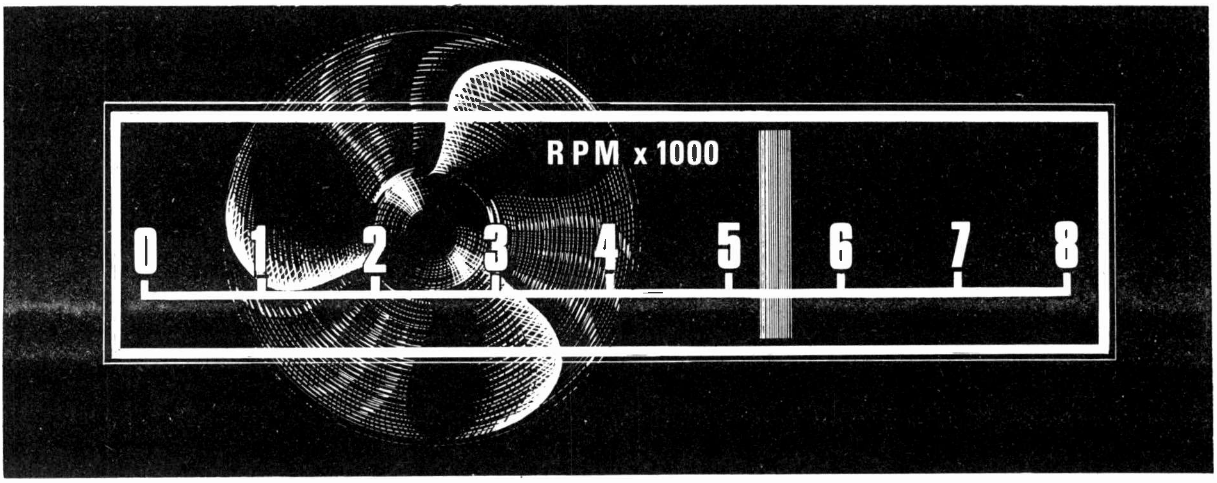
The sol-fa pattern is now as follows:

Me, ray, doh; me, ray, doh
Soh, fah, me, soh; soh fah, fah, me
Soh, doh′, doh′, te, lah, te, doh, soh, soh
Soh, doh′, doh′, doh′, te, lah, te, doh′, soh, soh
Soh, doh′, doh′, doh, te, lah, te, doh′, soh, soh, soh
Fah, me, ray, doh.

After practice in this key with other simple nursery rhymes, the pupil will have established the link between "solfa-ing", which gives the sounds, and the tune's staff notation, which gives the musical symbols.

Other keys can be tried if the stave is retuned. Here, of course, low *doh* will be the tonic of the new scale.

★



MARINE TACHOMETER

By C. M. Dance and D. W. Nelson

Boating is an increasingly popular pastime and is now within the financial reach of almost everyone. The tachometer described in this article is designed to aid the small boat owner particularly when using an outboard motor.
This tachometer can also be used with almost any engine, including motorcycle and car engines

Apart from the normal safety precautions one takes while "riding the waves" it is worth sparing a thought for the boat's engine; after all a motor car engine is well monitored by instruments so why not a marine engine. To monitor the engine revs is a very useful thing when dealing with a high revving outboard motor, not only for the obvious reasons as regards fuel economy and engine life but also with respect to "cavitation". This is the phenomenon whereby air gets trapped in and around the propeller blades giving rise to very poor engine performance. By employing a tachometer, cavitation may be easily spotted and corrected—a sharp increase in engine revs would indicate that cavitation is taking place.

The unit described is ideal for a one or two cylinder two-stroke outboard engine of either the magneto or battery type.

TACHOMETER CIRCUIT

The tachometer circuit is shown in Fig. 1. A simple monostable multivibrator is used (TR1 and TR2); TR1 is normally non-conducting (this being the stable state), its base being held at three volts positive by the bias battery. C2 and R3 form a differentiating network giving one positive and one negative pulse for each input square wave from the contact breakers. Diode D1 is employed to eliminate the positive going spike and ensures reliable triggering. The average current in the collector of TR1 is monitored by a 500 microamp moving coil meter which acts as a simple pulse integrator. Since the collector current will be directly proportional to the triggering frequency, determined by the engine revolutions, the meter may be directly calibrated in terms of revs per minute. The accuracy of the reading is determined essentially by the accuracy of the meter used. The meter used was the edgewise type and could be either a Sew or a Taylor type. Of course the larger the meter used the better, but any 0–500 microammeter may be used with reasonable accuracy.

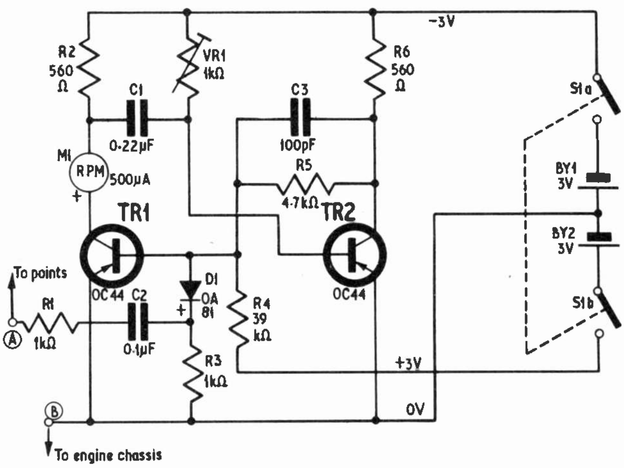


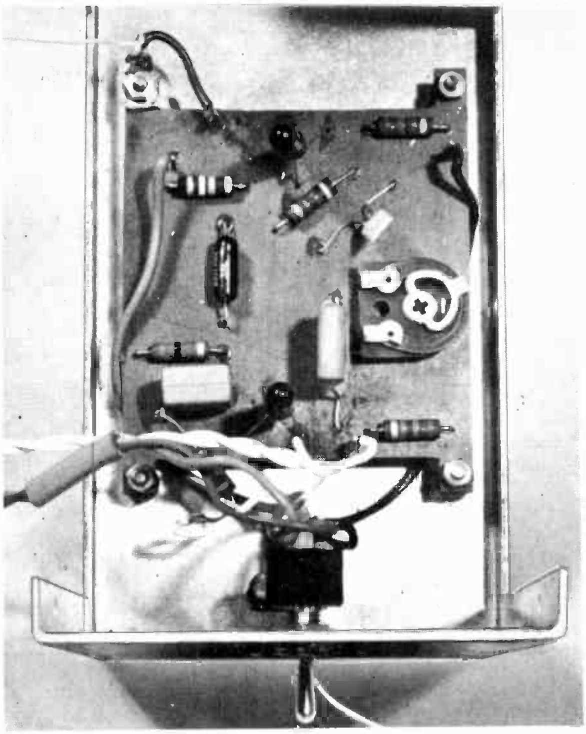
Fig. 1. Circuit diagram of the marine tachometer

The meter scale can be altered to read directly in engine revs per minute, the relevant maximum revs as quoted by the engine manufacturer being marked directly on the new scale.

Practically any transistors may be used in the circuit without affecting performance. Good quality silicon transistors will decrease the effect of temperature on circuit operating conditions.

TACHOMETER CONSTRUCTION

Tag board may be used to accommodate the components if desired although in the original unit a printed circuit board was employed to give greater reliability. The circuit board is shown actual size in Fig. 2 together with component layout and wiring details. When making the board it is best to trace around the diagram shown and use this as a pattern.



COMPONENTS . . .

Resistors

R1 1kΩ
R2 560Ω
R3 1kΩ
R4 39kΩ
R5 4·7kΩ
R6 560Ω
All ±10%, ¼ watt carbon

Capacitors

C1 0·22μF 200V
C2 0·1μF 200V
C3 100pF

Semiconductors

TR1, 2 OC44 or equivalent (2 off)
D1 OA81

Miscellaneous

M1 500μA moving coil meter (edgewise type)
VR1 1kΩ skeleton preset potentiometer
S1 D.P.S.T. toggle switch
BY1, 2 3V battery (2 off)
Copper laminate board $2\frac{5}{8}$in × $2\frac{1}{2}$in
Case (see text)
Clips and 6B.A. fixings

After etching away the excess copper the respective holes are drilled using a 0·8mm drill It is advisable to use a heat sink such as a pair of long nosed pliers when soldering the transistors and diodes into place. To fix the variable resistor VR1 in place it will be necessary to enlarge the two drilled holes slightly ! cut off one of the connecting pins. To facilitate mounting the board, three holes are provided, the copper being etched away around the hole in the −3V segment. Screws and spacers are used to mount the panel.

The entire unit plus batteries is best housed in a plastic or Duraloy box to minimise temperature effects and protect the unit against the elements. In the prototype a 4in × 3in × 4in case was used to house the meter, batteries and circuit board, the batteries being firmly located in the case using spring clips which are insulated from the case with fibre washers and nylon screws.

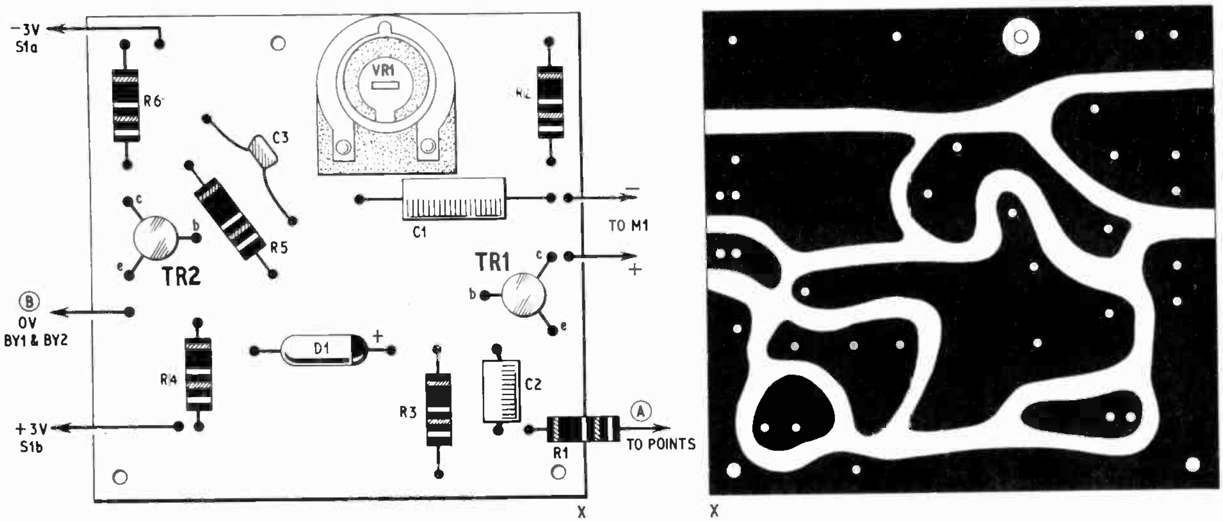
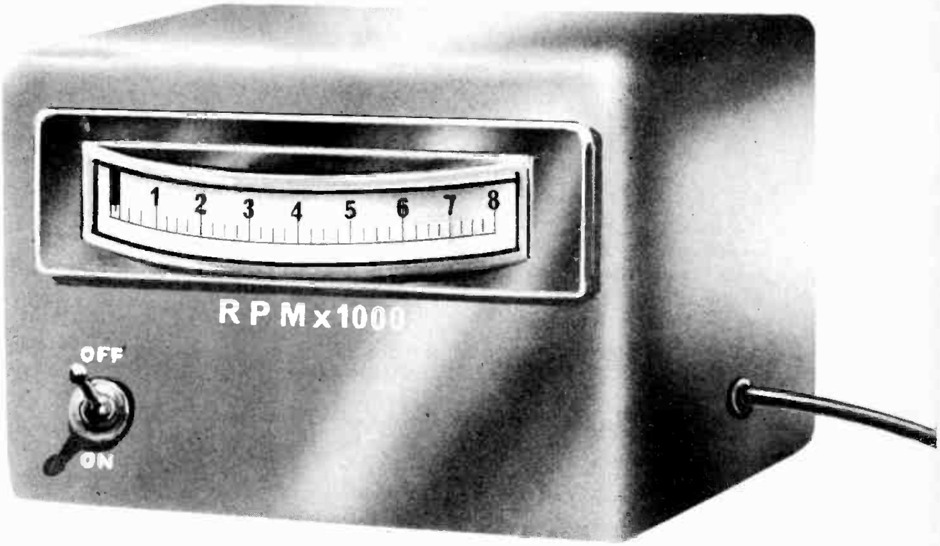


Fig. 2. Circuit board layout and wiring diagram



Completed tachometer housed in a water resistant case, showing the linear meter scale for a maximum r.p.m. reading of 8,000

Table 1. TACHOMETER CALIBRATION FREQUENCY CORRESPONDING TO 1,000 r.p.m.

No. of cylinders	Frequency 2 stroke	4 stroke
1	16·7Hz	8·4Hz
2	33·4Hz	16·7Hz
3	50Hz	—
4	—	33·4Hz
6	—	50Hz
8	—	67Hz

The connection marked OV(B) in Fig. 2 is taken to the centre connection of BY1 and BY2, to earth on the tachometer case and to earth on the engine.

In the case of multi-cylinder engines, triggering pulses may be obtained by connecting the zero rail (B) to the engine chassis, and one end of R1 (A) to the contact breakers. For a single cylinder engine, pulses may be obtained either as above or by using a ten turn pick up coil of 24 s.w.g. enamelled copper wire wound around the spark plug h.t. lead and connected to (A).

CALIBRATION

Once the device has been completed, it is ready for calibration. Before the actual calibration is carried out the full scale reading of M1 must be decided upon, this will depend on the engine with which the tachometer is to be used but will probably be in the region of 6,000 to 8,000 r.p.m. Once the full scale reading has been decided the meter scale can be divided up into equal 1,000 r.p.m. segments. The meter can then be adjusted for zero using the set screw on the meter case.

Calibration is best carried out using a low frequency square wave generator giving an output of between 6 and 10 volts. The frequency settings to give a reading corresponding to 1,000 r.p.m. are shown in Table 1. These frequencies are given for both two stroke and four stroke engines, enabling the tachometer to be used with almost any engine.

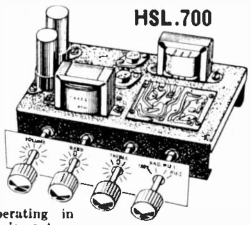
To calibrate the tachometer the required frequency is selected and VR1 adjusted so that the meter indicates 1,000 r.p.m.

The device may also be calibrated by direct comparison with another tachometer if desired. By this method both tachometers are placed in parallel, the engine throttled up to a suitable speed and VR1 adjusted so that both tachometer readings are the same.

Once calibration has been carried out the resistance of VR1 may be determined and a high quality wire wound resistor used in its place if desired, thus minimising temperature effects.

One last point is worth mentioning; unless the unit is to be fitted inside a car it should be waterproofed to protect the components from the elements. ★

MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200–240v. Controls:, bass, treble, volume/on/off. Function selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9½ × 5 × 4½in. high.

Sensitivity—PU1—50m/v, 56K input impedance.
PU2—110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6·2 watts RMS into 3 ohms, 5·8 watts RMS into 15 ohm. Overall frequency response 30c/s-18Kc/s: Continuously variable tone controls: Bass, +8db to −12db at 100c/s. Treble, +10db to −10db at 10Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

OUR SPECIAL PRICE £7.19.6. P. & P. 7/6.

LOUDSPEAKER BARGAINS

5in 3 ohm **16/-**, P. & P. 3/-. 7 × 4in 3 ohm **21/-**, P. & P. 4/-. 10 × 6in 3 ohm **27/6**, P. & P. 6/-. E.M.I. 8 × 5in 3 ohm with high flux magnet **26/-**, P. & P. 4/-. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet **42/-**, (15 ohm **45/-**), P. & P. 6/-. E.M.I. 13 × 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network **4 gns**, P. & P. 6/-.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0**, P. & P. 7/6. Guitar models: 25w **£6.0.0.** 35w **£8.0.0.**

E.M.I. 3½in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohm **15/-** each; 15 ohm **18/6** each. P. & P. 2/6.

12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3 or 15 ohm, **37/6**, P. & P. 6/-.

35 OHM SPEAKERS
3½in **14/-**, P. & P. 2/6; 7 × 4in **21/-**, P. & P. 4/-.

80 OHM MOVING COIL SPEAKERS
High Flux Magnet 2½" dia. **12/-** each. P. & P. 1/6.

BALANCED ARMATURE EARPHONE
Approx. 70 ohm impedance. Can be used as ultra sensitive mike or speaker. ONLY **3/6**. P. & P. 1/6

CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity, **18/6**. P. & P. 1/6.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **21/-**. P. & P. 1/6.

HIGH IMPEDANCE DYNAMIC STICK MIKES. High sensitivity. **39/6**. P. & P. 2/6.

HONEYWELL MICROSWITCHES S/P. C/O. Push-button action. Rating 250v. AC at 15 amps. Size approx. 1⅛" × ⅞" × ⅜". **5/-** each. P. & P. 1/- (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7" to approx. 56". Maximum diameter ½". **10/-** each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6" to approx. 22½". Maximum diameter ⅜". **5/-** each. P. & P. 1/-.

TRANSFORMER BARGAINS!

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **32/6**. P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. **11/-**. P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. **14/6**. P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. **27/6**. P. & P. 3/6. Tapped Primary 200-220-240V. Sec. 21·5V at 500mA. **12/6**. P. & P. 2/6.

BATTERY CHARGER TRANSFORMERS. 200/240V. input. Nominal output for 6 or 12V. batteries 4 amps. Size approx. 3 × 2½ × 2½in. Brand New. Price **22/6**. P. & P. 7/-.

HIGH GRADE COPPER LAMINATE BOARDS
8 × 6 × 1/16 in. FIVE for **10/-**. P. & P. 2/-.

SPECIAL OFFER ! !

Your opportunity to acquire a first class HI-FI LOUDSPEAKER SYSTEM at an extremely moderate price! Beautifully made teak finish enclosure with most attractive Tygan front. Size 16½" high × 10½" wide × 6" deep. Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, two H.F. tweeter units and crossover. Power handling 10 watts. Available 3 or 15 ohm impedance.

OUR PRICE WHILE LIMITED STOCKS LAST 8 Gns. Carriage 10/-

TRANSISTOR STEREO 8 + 8 MK II

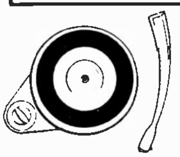
Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit 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: Freq. response ±3dB. 20-20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

PRICES: AMPLIFIER KIT **£10.10.0**; POWER PACK KIT **£3.0.0**; CABINET **£3.0.0.** All Post Free.

Also available STEREO 10 + 10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT **£12.** POWER PACK KIT £3.10.0.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

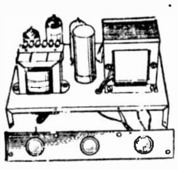
GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. Can be operated from 9–18V. Battery supply or direct from H.T. line 200/300V. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1⅛ × 1⅛ × ⅝in. Brand new—complete with instructions. Price **17/6**. P. & P. 2/6.



SPECIAL PURCHASE!
E.M.I. 4-SPEED PLAYER
Heavy 8½in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY **63/-**. P. & P. 6/6.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **75/-**. P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **97/6**. P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **79/6**. P. & P. 9/6.



3-VALVE AUDIO AMPLIFIER HA34 MK II
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0.** P. & P. 6/-.

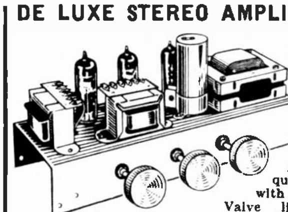
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **79/6**. P. & P. 6/-.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer, EZ80 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 7½in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE 55/- P. & P. 6/-

DE LUXE STEREO AMPLIFIER



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

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.

LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6.19.6.** Carr. 6/6. With stereo cartridge **£7.19.6.** Carr. 6/6.

LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for Latest Prices!

PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE **5 gns.** complete. P. & P. 8/6.

LATEST ACOS GP91/1SC Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. **30/-**. P. & P. 1/6.

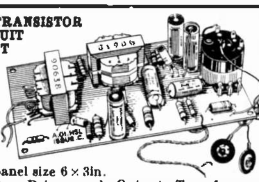
SONOTONE 2539 High output Stereo Cartridge. T/O stylus for Stereo/LP/78. Complete with universal mounting bracket. List Price **48/7**. OUR PRICE **25/-**. P. & P. 1/6.

SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus **50/-**. P. & P. 2/-.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **32/6**. P. & P. 2/-.

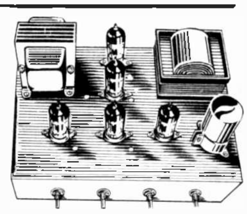
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **30/-**. P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel size 6 × 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder etc. ● Comprehensive easy to follow instructions and circuit diagram **2/6** (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-**, P. & P. 3/-. Also ready built and tested, **52/6**, P. & P. 3/-.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **2/6** (Free with parts). **All parts sold separately. ONLY £7.9.6.** P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0.** P. & P. 8/6.

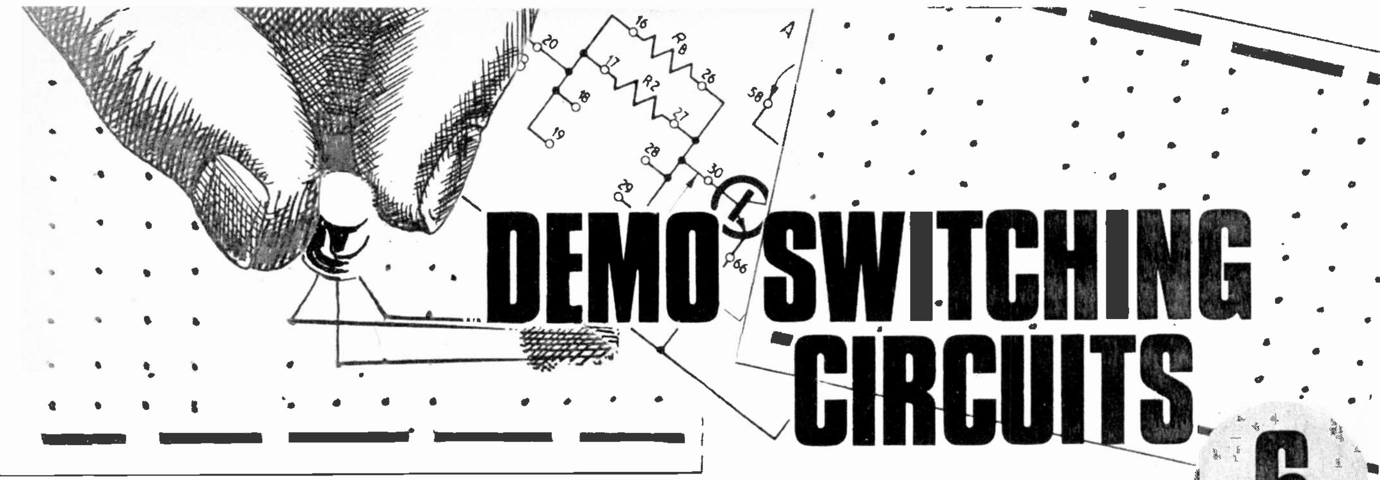
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) **15/-**; V15/10p, **10/-**; OC71 **5/-**; OC76 **6/-**; AF117 **3/6**; 2G339 (NPN) **3/-**.
Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 **25/-**; ORP12 Cadmium Sulphide Cell **10/6**. All post free.

VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price **15/-** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

Open all day Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, LONDON, S.W.19 Tel. 01-540 3985
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.



DEMO SWITCHING CIRCUITS 6

BINARY DIVIDER By B. Pounder

THE bistable multivibrator described last month can be extended to provide some useful switching functions. A gated alarm system described below uses a bistable, whereby trigger pulses set the circuit to switch on an oscillator.

Further modification to the basic bistable circuit can convert it to perform binary division, as described later.

GATED ALARM

The μ-Dec circuit shown in Fig. 6.1 illustrates the 5mA bistable, considered previously, coupled to an audio frequency relaxation oscillator. Except for TR3, the oscillator is exactly the same as that described in last month's article. The circuit is set initially so that TR2 is on. This can be done by momentarily shorting the base and emitter leads of TR1.

When TR2 is on, its collector voltage is approximately zero, so there will be no base current path for TR3. This transistor is therefore off, so TR4 is also off, for TR3 and TR4 are connected in series.

If the trigger link of C1 is in socket 2C, C1 will be charged to the supply voltage. On swinging the trigger link to socket 1C, C1 will discharge, then on swinging back to 2C, the circuit will trigger. TR2 turns off on triggering, and its collector voltage rises to that of the supply. R7 is now able to pass base current into TR3 which switches on; this in turn allows the relaxation oscillator to operate and produce an audible alarm note. The alarm is reset by a similar operation of the trigger link of capacitor C2. The base current resistor R7 is easily calculated.

The on collector current of TR4 is chosen as 2mA, so assuming a minimum h_{FE} of 20, the maximum base current which must be supplied will be 0·1mA. Thus $R_7 = 6/0{\cdot}1 = 60$ kilohms (68kΩ can be used). The circuit can be assembled on a pair of S-Decs or one μ-Dec as shown in the photograph.

SPEED-UP OR COMMUTATING CAPACITORS

The presence of stray base-emitter capacitances has been ignored in the paragraphs above. Although these strays are small, they are not necessarily unimportant, for it must be noted that they must be charged by the applied trigger voltage before the base voltages reach their triggering values.

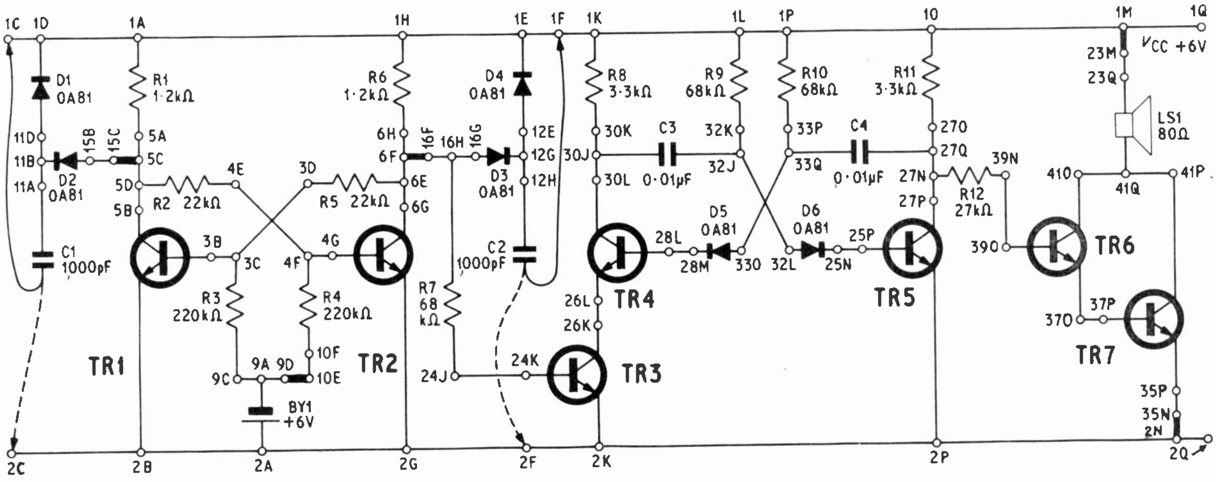
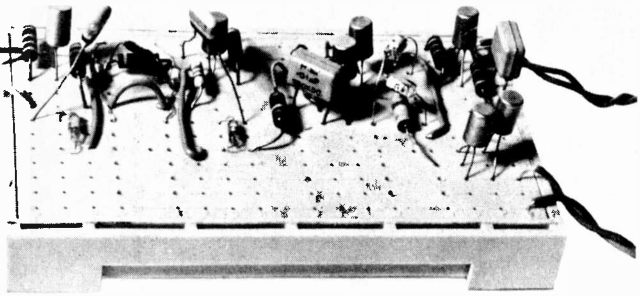


Fig. 6.1. Gated alarm circuit with μ-DeC connections. The bistable TR1 and TR2 triggers a relaxation oscillator TR4 and TR5 via TR3. The sound is amplified by TR6 and TR7 and fed to an 80 ohm loudspeaker. Positive and negative trigger pulses are supplied by the connection of C1 or C2 to either supply rail



Gated alarm circuit made up on μ-Dec

The strays reduce the rates at which the base voltages change, and if the rates are so slow that the trigger pulse has been removed before any appreciable change can take place in a base voltage, triggering may not occur. This possibility can be eliminated by connecting speed-up or commutating capacitors between the collector of each transistor and the base of the other as shown in Fig. 6.2a.

With the speed-up capacitor in the circuit, any change in voltage at the collector of, say, TR2 will be coupled rapidly to the base of TR1 provided that the speed-up capacitor is large enough to swamp the effect of the stray at the base of TR1. We are in effect, converting an integrating circuit comprising the coupling resistor R2, in series with the input impedance of the transistor, into a differentiating circuit, comprising C and the input impedance of the transistor. The effects are illustrated in Fig. 6.2b.

The calculation of suitable values for speed-up capacitors is difficult, the equations requiring a knowledge of the physical processes which take place within a transistor when it is switched from a state of saturation to cut-off. The usual procedure is to find by trial and error a value which ensures reliable switching at the highest operational trigger frequency.

BINARY DIVIDER

We saw in the previous article how the bistable multivibrator could be switched by the application of SET and RESET trigger pulses. The circuit acted as a "gate", being "opened" by the SET pulse and "closed" by the RESET pulse. A useful modification is achieved by connecting both the input terminals together in such a way that triggering takes place on receipt of any of a train of input pulses.

A bistable multi operated in this way is called a "binary divider". A circuit is shown in Fig. 6.3a. Note that this circuit is the same as that shown in Fig. 5.5 of the previous article except that the SET and RESET terminals have been strapped together as a single trigger input.

The important voltage waveforms of the circuit are shown in Fig. 6.3b. Note that since we are assuming that *npn* transistors are used, triggering occurs on the negative-going edges of the input pulses (see last month's article).

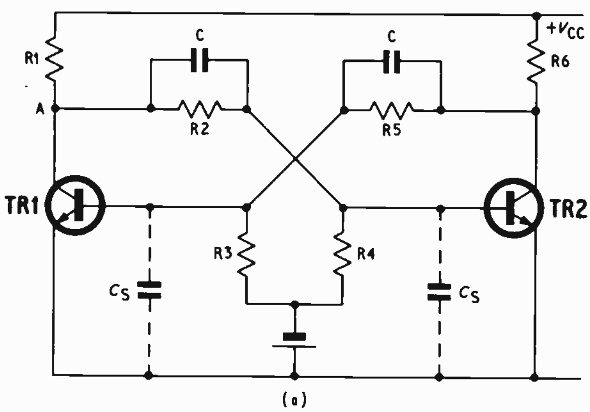


Fig. 6.2a. Speed-up capacitors marked C are connected across the coupling resistors to ensure triggering

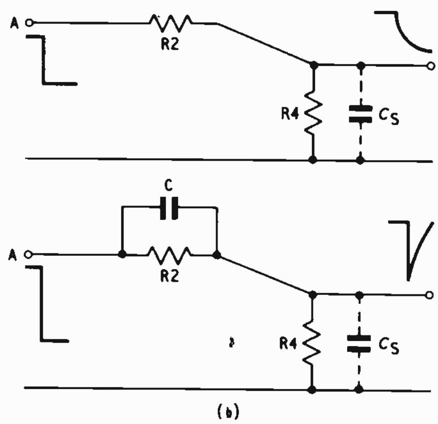


Fig. 6.2b. The effect of applying commutating capacitors to overcome the stray capacitors C_s

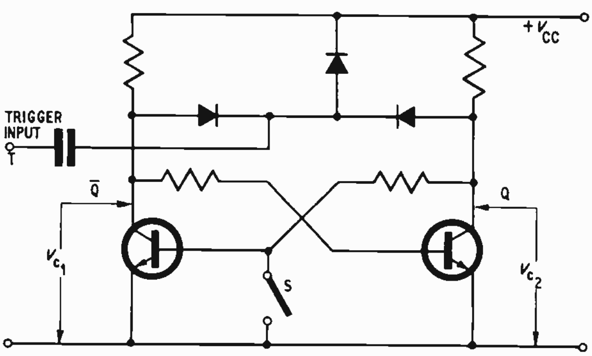


Fig. 6.3a. Bistable used as a binary divider

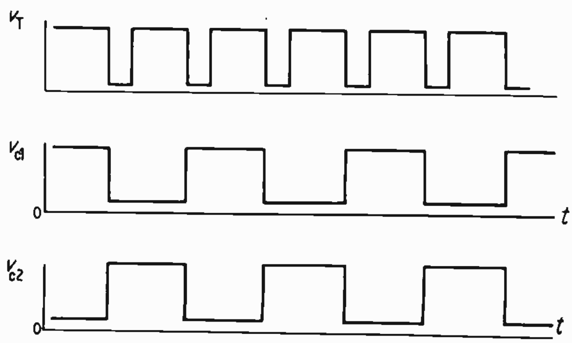


Fig. 6.3b. Waveforms for the binary divider

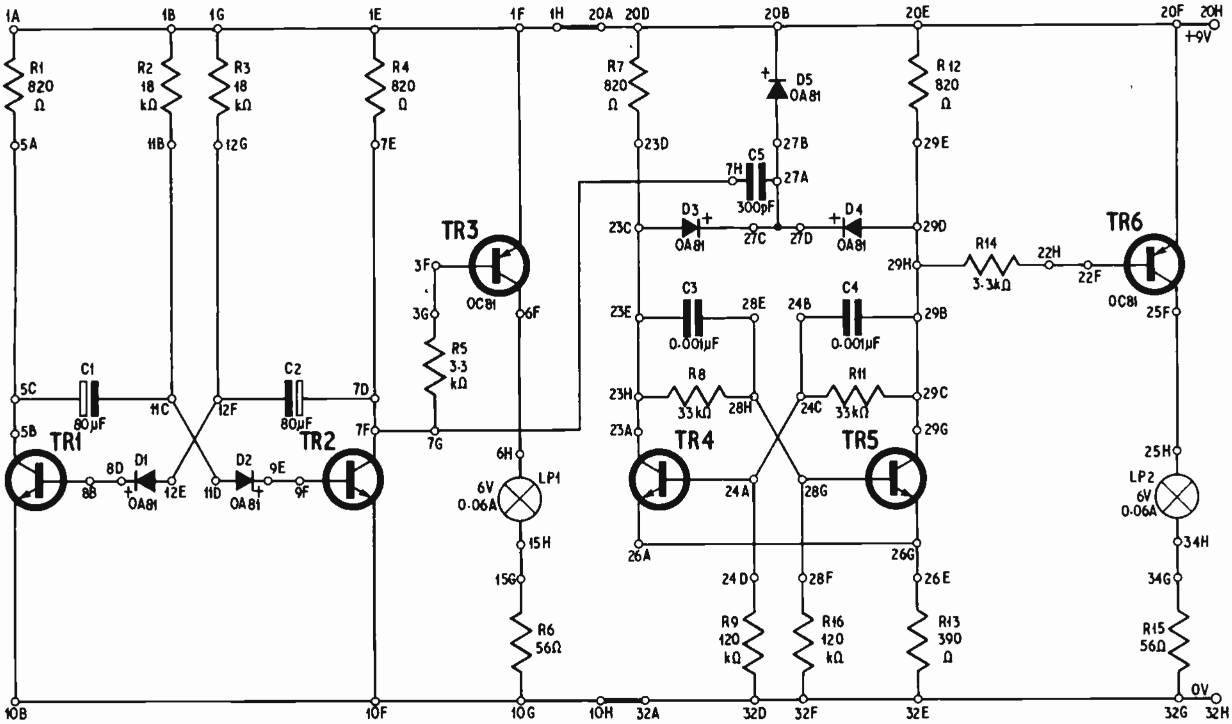


Fig. 6.4. Circuit of practical square wave generator and ÷2 divider with T-Dec connections

BINARY DIVISION

Suppose that the link S in Fig. 6.3a is momentarily closed to ensure that TR1 is off. The collector voltage V_{c1} of this transistor will therefore be at the supply voltage V_{CC}. The collector voltage of TR2 will be approximately zero. Now if a train of trigger pulses is applied to the trigger input T, the circuit will switch on receipt of each member of the train, and voltage changes, such as those illustrated in Fig. 6.3b, will occur. Examination of these waveforms immediately shows up an important property of the circuit: for every two input pulses, there will be one output pulse. The circuit acts as a "divide by two" or binary divider.

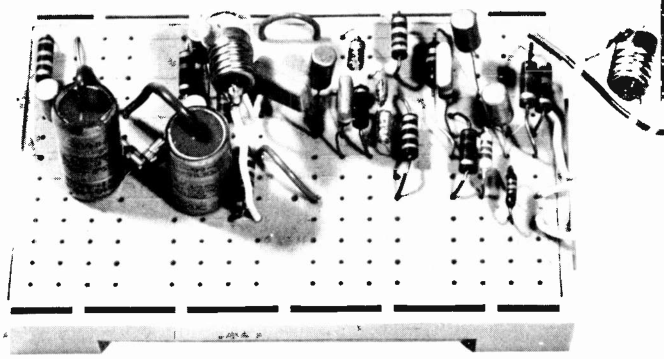
CIRCUIT EXAMPLE

A demonstration circuit is shown in Fig. 6.4. It consists of a low frequency astable multivibrator (TR1 and TR2), a binary divider (TR3 and TR4), and lamp driver stages TR5 and TR6. The outputs from the astable multi and the binary are made visible simultaneously. Component values for the circuit are calculated according to the design procedures outlined in previous articles in this series.

An alternative demonstration circuit can be made up by increasing the frequency of the astable multi to about 2kHz and replacing the lamp driver stages by simple amplifiers each driving a small loudspeaker. The circuit shown earlier in connection with the gated alarm would be suitable.

BINARY COUNTER

If a number of binaries are connected in cascade, division of a train of input pulses by 2, 4, 8, 16, and so on, occurs at each output. However, in addition to this property of frequency division, the circuit can also be used to count the number of trigger pulses applied.



Square wave generator and ÷2 divider made up on T-Dec

To see how this is achieved, first let us label the collectors of TR1 and TR2 in Fig. 6.4 by $\overline{Q}1$ and Q1 respectively. Now suppose that four binaries are connected in cascade; the Q output of binary 1 is connected to the T input of binary 2; the Q2 output of binary 2 is connected to the T input of binary 3, and so on. This is illustrated in Fig. 6.5.

Further, suppose that each of the binaries is first set so that TR1 is off and TR2 is on. This could be done by means of a trigger link such as S shown in Fig. 6.3a.

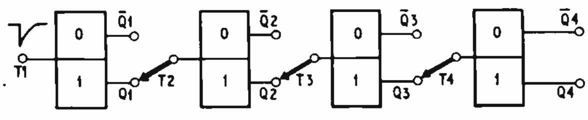


Fig. 6.5. Block diagram of a binary counter chain of dividers with trigger inputs T2, T3, T4 switchable to either preceding binary output

Table 6.1. LOGIC OUTPUT FROM EACH STAGE

Input		$\bar{Q}_1$	$\bar{Q}_2$	$\bar{Q}_3$	$\bar{Q}_4$	Q_1	Q_2	Q_3	Q_4
Initial condition	0	0	0	0	0	1	1	1	1
Just after pulse no.	1	1	0	0	0	0	1	1	1
" " " "	2	0	1	0	0	1	0	1	1
" " " "	3	1	1	0	0	0	0	1	1
" " " "	4	0	0	1	0	1	1	0	1
" " " "	5	1	0	1	0	0	1	0	1
" " " "	6	0	1	1	0	1	0	0	1
" " " "	7	1	1	1	0	0	0	0	1
" " " "	8	0	0	0	1	1	1	1	0
" " " "	9	1	0	0	1	0	1	1	0
" " " "	10	0	1	0	1	1	0	1	0
" " " "	11	1	1	0	1	0	0	1	0
" " " "	12	0	0	1	1	1	1	0	0

The collector voltage of each TR1 transistor is now equal to the supply voltage V_{CC}, while each TR2 collector voltage is almost zero.

Label these collector voltages by means of a "0" or a "1". Let V_{CC} be donated by "0", and zero voltage be denoted by "1". (This uses a system known as negative logic.) Thus at the start, all the $\bar{Q}$ outputs are at "0" and all the Q outputs are at "1". This situation is shown in the first row of Table 6.1.

LOGIC SWITCHING

Now let a negative-going pulse be applied to the input T1. Because it is negative-going, it causes the first binary to switch so the collector of TR1 drops from V_{CC} to almost zero voltage while the collector of TR2 rises from almost zero voltage to V_{CC}. In other words, $\bar{Q}1$ changes from "0" to "1" while Q1 changes from "1" to "0".

The Q1 change is coupled to input T2 of the second binary, but because it is a rising voltage (i.e. positive-going) it has no effect on this second binary. Now apply a second trigger to the first binary.

It switches again, but this time $\bar{Q}1$ changes from "1" to "0" while Q1 changes from "0" to "1". This change in Q1 is negative-going, so it causes the second binary to switch. Thus $\bar{Q}2$ changes from "0" to "1" while Q2 changes from "1" to "0". The change in Q2 is positive-going so has no effect on binary 3.

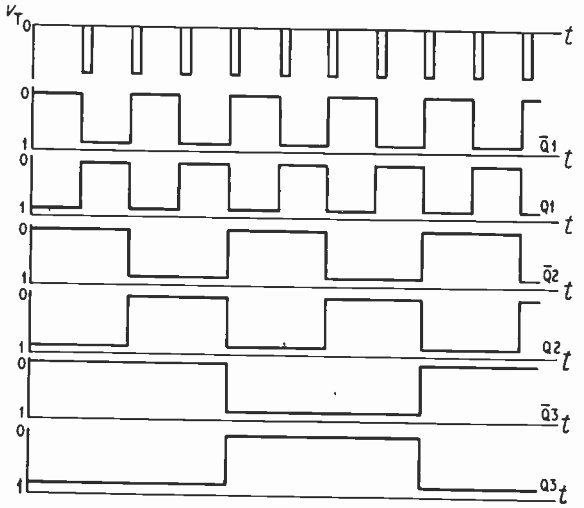


Fig. 6.6. Collector voltage waveforms of the binary counter

If we allow more and more input pulses to trigger binary 1, Q1 causes binary 2 to trigger whenever it changes from "0" to "1"; Q3 causes binary 3 to switch whenever it changes from "0" to "1", and so on. The successive states of the outputs are shown in Table 6.1 and also in Fig. 6.6 which shows the collector voltage waveforms.

DECIMAL TO BINARY

Now consider something quite different. Taking a decimal number such as 5, we can write this number as the sum of a succession of powers of 2 as follows: $5 = 1 \times 2^0 + 0 \times 2^1 + 1 \times 2^2 + 0 \times 2^3$. (Note that any number raised to the power zero equals 1.)

Similarly, the decimal number 6 can be written as:

$$6 = 0 \times 2^0 + 1 \times 2^1 + 1 \times 2^2 + 0 \times 2^3$$

For each row of "0"s and "1"s in Table 6.1, the decimal number is given in the left-hand column. They are read in the same way as the "0"s and "1"s which precede the multiplication signs in the two examples above.

Thus the states of the output terminals $\bar{Q}$ immediately tell us how many input trigger pulses have been applied, up to a maximum determined by the number of binaries in the cascade. The number appears however in binary notation rather than in decimal notation.

Part 7 next month is the final article in this series, in which the binary divider circuit is further expanded to make a decade divider.

CORRECTION

In the article on the "Monostable Multi" in the February issue, the following line should be inserted immediately after equation 1 (page 151): "which shows the change in voltage that takes place following triggering".

NEWS BRIEFS

Time Division Multiplex Slide Display

A TRI-PICTURE colour slide display, in which any combination of three adjacent screens can show one, two, or three pictures at once, is being used with an exhibition touring the designated area of new Milton Keynes city development in Buckinghamshire.

The fully automatic display, produced by Viscon Ltd., employs time division multiplex pulsed tape recordings, with sound track, and nine 35mm Kodak projectors. The electronic control equipment is being provided by Electrosonic Ltd. A similar type of display for the Irish Government will be used at the Osaka World Fair in Japan.

Post Office Progress

THE first few months of 1970 have seen more than one jump ahead, in technical methods, by the Post Office.

A fully automatic telephone service for every telephone customer in the United Kingdom came a step nearer recently when the Post Office's North-East Region became the first region in the country to have all its telephones working through automatic exchanges.

This milestone was reached with the opening of a new electronic telephone exchange at Corbridge, Northumberland. It was the last manually operated exchange in the region to be converted to automatic working.

The Post Office space aerial at Goonhilly in Cornwall recently handled the first television broadcasts between this country and the new Australian aerial at Ceduna in South Australia. This is the beginning of regularly available direct television service with Australia.

BI-PRE-PAK LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC170	3/-
AC126	2/6	OC171	4/-
AC127	3/6	OC200	3/6
AC128	2/6	OC201	7/-
AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF114	4/-	2N711	10/-
AF115	3/6	2N1302-3	4/-
AF116	3/6	2N1304-5	5/-
AF117	3/6	2N1306-7	6/-
AF239	12/6	2N1308-9	8/-
AF186	10/-	2N3844A	5/-
AF139	10/-	**Power Transistors**	
BFY50	4/-		
BSY25	7/6	OC20	10/-
BSY26	3/-	OC23	10/-
BSY27	3/-	OC25	8/-
BSY28	3/-	OC26	5/-
BSY29	3/-	OC28	7/6
BSY95A	3/-	OC35	5/-
OC41	2/6	OC36	7/6
OC44	2/6	AD149	10/-
OC45	2/6	AUY10	30/-
OC71	2/6	2S034	10/-
OC72	2/6	2N3055	15/-
OC73	3/6	**Diodes**	
OC81	2/6	AAY42	2/-
OC81D	2/6	OA95	2/-
OC83	4/-	OA79	1/9
OC139	2/6	OA81	1/9
OC140	3/6	IN914	1/6

FREE!

PACKS OF YOUR OWN CHOICE UP TO THE VALUE OF 10/- WITH ORDERS OVER £4

SURPLUS INTEGRATED CIRCUITS

These are brand new genuine surplus stocks, marked and guaranteed to full makers' specification and not re-marked rejects.

		Price
NE806A	Dual 4 I/P Expander TTL	7/-
NE808A	Single 8 I/P Nand Gate TTL	7/-
NE816A	Dual 4 I/P Nand Gate TTL	7/-
NE825A	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855A	Dual 4 Power Gate TTL	7/-
NE870A	Triple 3 I/P Nand TTL	7/-
NE880A	Quad 2 Nand TTL	7/-
SP616A	Dual 4 Nand Gate DTL	7/-
SP631A	Quad 2 I/P Gate Expander DTL	7/-
SP670A	Triple 3 Nand Gate DTL	7/-
SP806A	Dual I/P Expander TTL	7/-
SP808A	Single 8 I/P Nand Gate TTL	7/-
SP816A	Dual 4 I/P Nand Gate TTL	7/-
SP825A	D.C. Clocked J-K Flip-Flop TTL	17/6
SP840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
SP855A	Dual 4 Power Gate TTL	7/-
SP870A	Triple 3 I/P Nand TTL	7/-
SP880A	Quad 2 I/P Nand TTL	7/-
NE500K	Video Amplifier	40/-
NE501K	Video Amplifier 40MHz	40/-
NE806J	Dual 4 I/P Expander TTL	7/-
NE808J	Single 8 I/P Nand Gate TTL	7/-
NE816J	Dual 4 I/P Nand Gate TTL	7/-
NE825J	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840J	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855J	Dual 4 Power Driver TTL	7/-
NE870J	Triple 3 I/P Nand TTL	7/-
NE880J	Quad 2 I/P Nand TTL	7/-
ST620A	J-K Flip-Flop DTL	17/6
ST659A	Dual 4 Buffer/Driver DTL	7/-
ST680A	Quad 2 Nand DTL	7/-

Suffix A = DIP 14 lead; K = 10 lead TO5; J = Flat pack.

NEW TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries. 0·3 to 0·5V, 0·5 to 2mA.	10/-
B77	2	AD161–AD162 NPN/PNP Trans. Comp. Output. Pair	10/-
B81	10	Reed Switches, mixed types large and small	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1M Ω	10/-
B91	8	NKT163/164 PNP Germ. TO-5 equivalent to OC44, OC45	10/-
B92	4	NPN. Sil. Trans. AO6 = BSX20, 2N2369 500 MHz, 360mW	10/-
B93	5	GET113 Trans. equiv. to ACY17–21 PNP Germ.	10/-
B94	6	NPN Sil. Planar Epitaxial Trans. CS4 similar to BSY38 or BC108	10/-
B96	5	2N3136 PNP Sil. Trans. TO-18, HFE 100–300 I.C. 600mA. 200 MHz	10/-
B98	10	XB112 and XB102 equiv. to AC126, AC156, OC81/2, OC71/2, NKT271, etc.	10/-
B99	200	Capacitors, Electrolytics paper, silver mica, etc. Post and packing, this Pak 2/6	10/-
H4	250	Mixed Resistors. Post and Packing 2/-	10/-
H7	40	Wirewound Resistors. Mixed types and values. Postage 1/6	10/-

RETURN OF THE UNBEATABLE P.1 PAK.
NOW GREATER VALUE THAN EVER

FULL OF SHORT LEAD SEMICONDUCTORS AND ELECTRONIC COMPONENTS, APPROX. 170. WE GUARANTEE AT LEAST 30 REALLY HIGH QUALITY FACTORY MARKED TRANSISTORS PNP AND NPN, AND A HOST OF DIODES AND RECTIFIERS MOUNTED ON PRINTED CIRCUIT PANELS. IDENTIFICATION CHART SUPPLIED TO GIVE SOME INFORMATION ON THE TRANSISTORS.

PLEASE ASK FOR PAK **P.1** ONLY **10/-**
2/- P. & P. on this Pak.

LOOK ! TRANSISTORS ONLY 6d EACH

TYPE A
PNP SILICON ALLOY TO-5 CAN
SPEC:—
ICER AT VCE = 20v 1mA MAX.
HFE 15–100
THESE ARE OF THE 2S300 TYPE WHICH IS A DIRECT EQUIVALENT TO THE OC200/205 RANGE

TYPE B
PNP SILICON PLASTIC ENCAPSULATION
SPEC:—
ICER AT VCE = 10v 1mA MAX
HFE 10–200
THESE ARE OF THE 2N3702/3 AND 2N4059/62 RANGE

TYPE E
PNP GERMANIUM FULLY MARKED AND TESTED.
AF. or RF.
PLEASE STATE ON ORDER

Make a Rev. Counter for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car. **20/- each**

NEW UNMARKED UNTESTED PAKS

B78	12	Intergrated Circuits, Data and Circuits of types, supplied with orders	10/-
B80	8	Dual Trans. Matched O/P pairs NPN. Sil. in TO-5 can	10/-
B82	10	OC45, OC81D and OC81 Trans. Mullard glass type	10/-
B83	200	Trans. manufacturer's rejects all types NPN, PNP, Sil. and Germ.	10/-
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	10/-
B66	150	High quality Germ. Diodes. Min. glass type	10/-
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	10/-
B87	100	Germ. PNP Trans. equiv. to OC44, OC45, OC81, etc.	10/-
B88	50	Sil. Trans. NPN, PNP, equiv. to OC200/1, 2N706A, BSY95A, etc.	10/-
B60	10	7 Watt Zener Diodes Mixed Voltages	10/-
H5	16	1 Amp. Plastic Diodes 50-1000 Volts	10/-
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	10/-

FREE CATALOGUE AND LISTS for:—

ZENER DIODES
TRANSISTORS, RECTIFIERS
FULL PRE-PAK LISTS
& SUBSTITUTION CHART

MINIMUM ORDER 10/- CASH WITH ORDER PLEASE. Add 1/- post and packing per order. OVERSEAS ADD EXTRA FOR AIRMAIL.

P.O. RELAYS

Various Contacts and Coil Resistances. No individual selection. Post & Packing 5/-

8 FOR 20/-

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

BI-PRE-PAK LTD DEPT. A, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX
TELEPHONE: SOUTHEND (0702) 46344

SOUNDS INCREDIBLE - 1

By R. C. MILLS..... B.B.C. RADIOPHONIC WORKSHOP

TO THE man in the street, the "BBC Radiophonic Workshop" conjures up all sorts of pictures. The immediate association is with radio and television programmes like "Dr. Who", with its science fiction sound effects, which the Radiophonic Workshop provides, as well as the electronic signature tune. How are these sounds and music made?

THE BBC Radiophonic Workshop was formed in 1958, after experimental work in the field of radio drama had developed a need for special sound montages and sound treatments. A prime factor in the development of this form of creative art, was the increasing use of magnetic tape in the production studio itself, as opposed to the recording channel where the whole production was finally recorded.

Any sound effects used in programmes were usually from pre-recorded discs, played in at the right moment and mixed with the microphone output. The use of tape machines in the studio control cubicle meant that complete scenes could be pre-mixed; more complex sound backgrounds could be built up than would have been possible with a limited number of disc playing machines for live performances.

Most of the experimental work had to be done in spare time when studios and, more important, tape machines were freely available. These tape machines were normally used to record rehearsal work in drama studios, and were half track, $7\frac{1}{2}$ and 15in/second record/replay machines, no separate monitoring head being fitted.

Producers soon became aware of the new aspect that imaginative sound could give to radio productions, and many writers, including Louis MacNeice, Frederick Bradnum and Giles Cooper, were inspired to write with the idea of special creative sound treatment in mind.

Since its inauguration, the BBC Radiophonic Workshop has expanded both physically in size and in output, from the initial concept and demand for use in radio drama to the entire broadcasting spectrum. It now contributes material for television, the BBC World Service (sound), British sound radio programmes, including religious broadcasting, and political broadcasts.

All the sound pictures, no matter how simple or complicated, are made up using ordinary tape machines, signal generators, filters, sticky tape, razor blades and a lot of imagination.

BASIC EQUIPMENT

The tape machines used now are single track, $\frac{1}{4}$in, $7\frac{1}{2}$ and 15in/second, with separate record and replay heads. The majority are Philips EL 3566, three of these being in each of the three workshop areas. This uniformity is desirable so that flexibility and interchangeability can be maintained, and so that at least three tracks can be played simultaneously and stay in synchronisation with each other. This is the most important facility at the Workshop's disposal.

There is also another facility that is extremely useful: the ability to play tapes at speeds other than twice or half the recorded speed. This facility is provided by variable speed Leevers-Rich tape recorders, which are used to "tune" basic sounds. The tape speed can be continuously varied from 0–40in/second, or in fixed steps corresponding to musical intervals. These machines are capable of being used for stereo work, having stacked record and replay heads.

Two Ampex recorders, an EMI TR90 and a BTR/2 and a number of Ferrographs complete the tape machine line up.

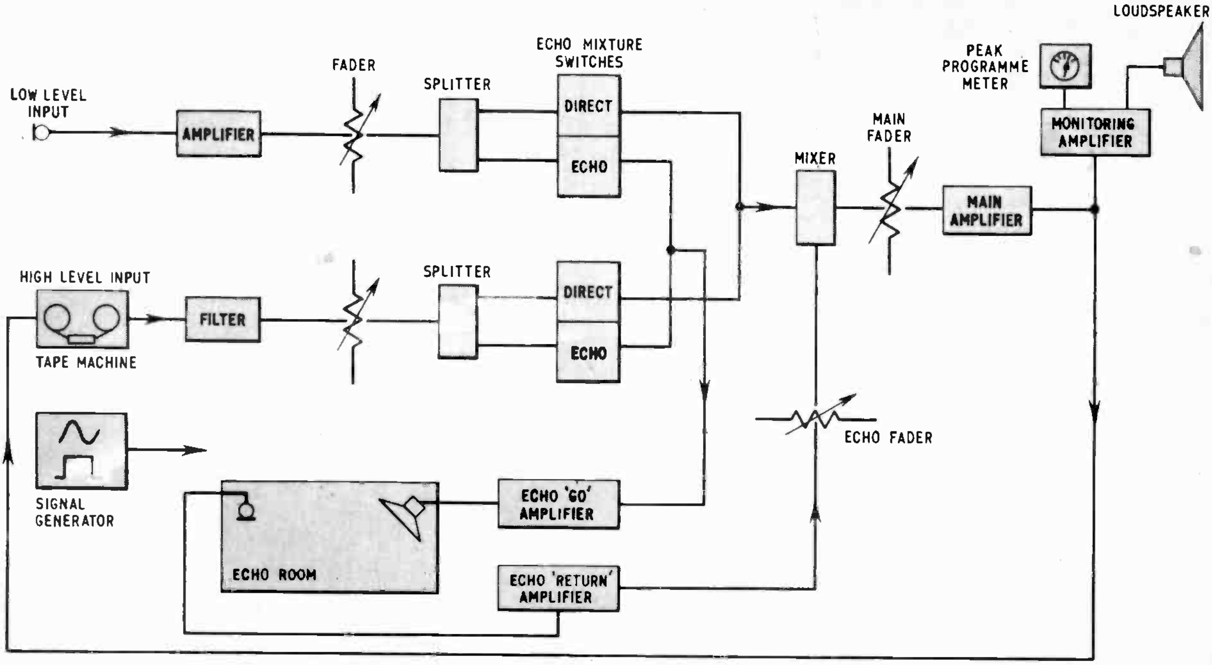


Fig. 1. Typical block diagram of a sound effects set-up for adding effects to a programme

SOUND SOURCES

The signal generators produce both sine and square waveforms over a frequency range 10Hz to 100Hz. Two other signal generators produce sine waves only, but with continuous frequency sweep. Modulated output is also available. These are used in conjunction with an accurate master oscillator that is used as a reference when tuning.

The electronic sound sources are completed with a "white noise" generator, which produces a sound like escaping steam. This can be filtered to give different "shades" of sound, "pink noise", "brown noise", and so on.

All electronic signal generators produce no noise in themselves, and the "note" is only heard when converted into sound energy by the loudspeaker. One virtue of this is that, as these sounds are recorded directly, they are not marred by extraneous noises, and can be treated "on the way" to the recording machine.

FILTERS

The filters used are of two types, passive and active. In the first type, the sound is attenuated at certain frequencies, i.e. 3,200, 1,600, 800, 400, 200Hz top cut, and 220, 440, 880, and 1,760Hz bass cut. Being passive filters, there is no compensating amplification and the sound level or volume is decreased with increasing filtering.

The active filters consist mainly of BBC designed equipment which give top cut and boost, bass cut and boost, and a peak at certain selectable frequencies around 1–5kHz, to give "presence" effect.

General view of the BBC Radiophonic Workshop. In the background is a bank of signal generators, keying unit and oscilloscope. The EMI BTR/2 tape recorder is in the centre. Behind this are the jackfields associated with the mixing desk (behind TR90 recorder on left)

Both types of filters have bypass switches fitted, which progressively insert or remove the effect of the filter, so that certain prerecorded sounds can be filtered if necessary without affecting adjacent passages. A new sound quality can also be created gradually for dramatic effect, and equally gradually removed, without any sudden audible step which might disturb and break continuity of mood.

Other filters available are octave and one third octave filters for more specialist work.

These are the tools of the trade, and with one other important item, the microphone, the scene is set for work. Every sound that can be recorded is our basic material, and anything that gives the required sound is pressed into service, including the human voice.

WORKSHOP LAYOUT

As each of the three "Workshop" areas is similarly equipped, a description of the basic pattern of equipment may not come amiss.

another for treatment such as "feedback", and the third for recording the final result.

It should be understood that in all references to sound treatment by means of tape machines, the machines are of the three head type, i.e. with separate record and replay heads.

A word about "feedback", a phenomenon quite common these days. If a tape machine is set to "record" and the machine's replay fader is left open on the desk, a "howl-round" or feedback path is established.

If this feedback is controlled, a repetitive echo is obtainable, the repetition rate of which is dependent upon the distance between the recording and replay heads and tape speed. Reference to Fig. 2 will clarify and also be useful in understanding an extension of this phenomenon.

If a second tape machine is used, and the tape laced up as shown, a longer delay will be obtained; this is

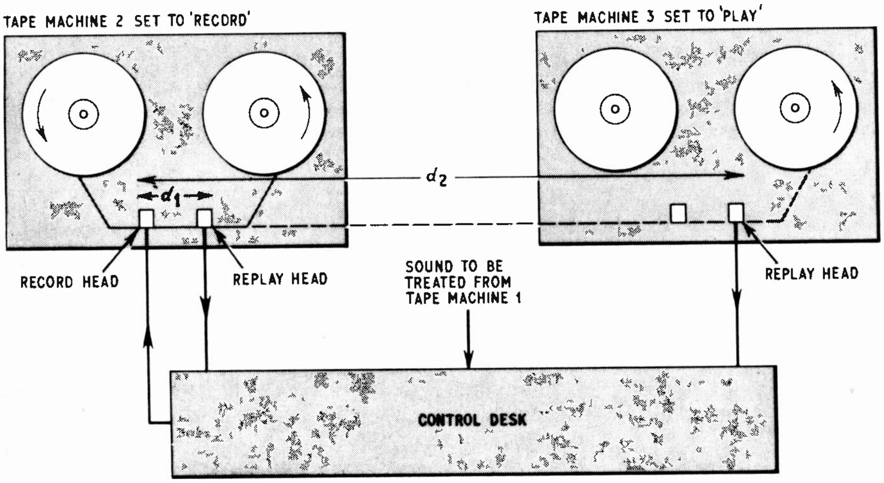


Fig. 2. Obtaining feedback effects with a sound repetition rate based on the distance between replay and record heads

Dominating the studio, is the control panel or mixing desk. This has a number of channels or faders (usually 12 or more); to each fader is connected a sound source which can be one of two types: high or low level. High level sources are tape machines, signal generators and disk players; low level sources, microphones and electronic pick-ups fitted to guitars and other instruments. See Fig. 1.

It is from the mixing panel that the recording chain is fed. This panel also houses the filters, echo mixture facilities and things like remote start circuits, cue lights, line-up reference tone and talkback circuits.

A minimum of three tape machines, a bank of signal generators, a disc playing desk, a jackfield (of terrifying appearance) and a loudspeaker complete the scene. Various other items of local development are available as "optional extras", but are not part of the basic equipment nor present in every studio.

SOUND TREATMENT

For sound treatment or manipulation, a basis of three tape machines is needed; unless a sound is to be treated "live", one machine is used for playback,

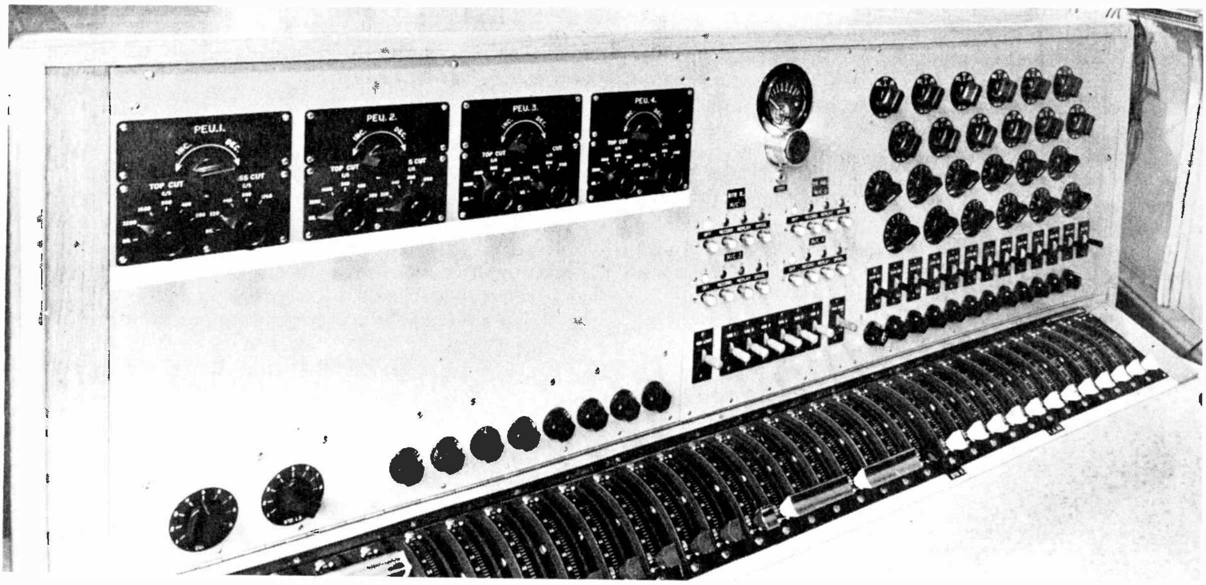
because the record head to replay head distance has increased to d_2 instead of d_1. By moving the machines apart according to the time required, a pattern can be created in sympathy with the original sound pattern.

This technique, with a pre-recorded track played from another machine, makes use of three identical machines, but the final recording is safely recorded on machine 2 and wound up on machine 3.

Exponents of the art will be quick to see many possibilities in this. Two delayed echoes (why not use both machines' outputs?) can be filtered on their respective channels, and reverberation can be added. In fact, the original sound can be removed altogether, and a new sound formed which contains a flavour of the original. If a mistake is made and a restart is necessary, all faders are closed down to let the system clear itself, otherwise the piece of sound on the tape between the machines will start the montage off on a wrong note.

ECHO

Echo, or reverberation, has been mentioned as a facility for treating sound. The Radiophonic Workshop has, over the past 12 years, used four types of



This photograph shows the mixing desk with quadrant type faders. Immediately above those on the right are preset level controls, echo select, echo mixture and group switches. Above those on the left are four passive filters. The centre section contains remote start facilities, cue light, talkback and line-up tone keys, and a peak programme meter

reverberation: the echo room, a magnetically coated revolving drum, a steel plate, and springs.

The echo room is a sound proof room, with bare walls to assist sound reflections. At one end is a loudspeaker fed from the echo mixture switches on the control panel, and at the other end a microphone picks up the reflected sounds.

The revolving drum system has a magnetic coating around the circumference, and erase, recording and up to eight replay heads are placed around the periphery. These heads are all set at about one "thou" away from the coating. The sound is fed to the record head, and picked off, by either a single replay head or all eight, to give "echo". This tends to be noisy and, because of the necessary gap between head and revolving drum, gives rather inferior quality compared with that of the input.

The plate system consists of a steel plate suspended on edge; a contact transducer feeds the sounds on to the plate while a contact microphone picks up the reflected sounds.

The echo spring technique is often found in electronic organs, and consists of a single or double row of springs fitted to a transducer, which converts the sounds fed to the device into mechanical vibrations. These are transmitted along the springs, re-converted into electrical energy by another transducer, and fed back to the control desk.

The reverberation times of the spring device and echo room are fixed, although variations can be achieved by moving the microphone nearer or further away from the loudspeaker in the echo room. The drum type echo time could be varied by choosing a replay head a different distance from the record head. The reverberation time of the plate is dependent upon the amount of damping applied.

Echo is derived from the sound source by splitting the sound into two separate paths, "direct" and "echo". The "direct" sound continues through the control desk to the output, where it is mixed with the echoed sound from the echo device. A proportional switch is used to feed the echo signal to the echo device. Up to the halfway position more direct sound is audible; past this point more echo is obtained.

Whilst on the subject of echo, tape can be used to modify the reverberation times, if only a fixed time is available on the device.

Echo added to a tape played at double speed will be twice as long when recorded at double speed and replayed at normal speed. Hence, a fixed reverberation time factor of $\times 2$ is applied. Conversely, adding echo to a tape played at half-speed and recording at half-speed, will result in the echo being sharper and brighter when played at normal speed again. This facility is one in which a two speed machine is essential.

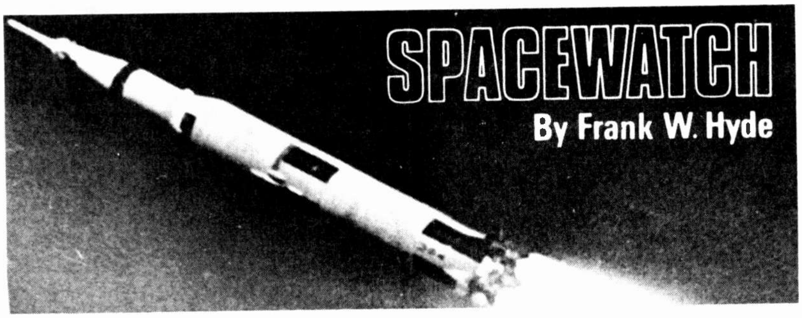
SPEED CHANGE

Speed change plays an important part in sound treatment, not only for comic effect. Whilst it is a useful tool, often a change in speed is required without a change in pitch, or conversely, a change in pitch is required without alteration in the time scale. At first sight these two seem inseparable, but by means of a special piece of equipment this paradoxical problem can be overcome.

This equipment makes use of a head that rotates either in the direction of the tape movement or against it, at different selectable speeds.

With constant tape speed, and the head stationary, it behaves as a normal replay head and no pitch change is evident. Rotation in the same direction as tape movement causes a lowering of pitch, and in the opposite direction, of higher pitch. The tape can be driven at higher or lower speeds to decrease or increase time scales. The rotating head is used to maintain original tape/head speed ratio, and keeps the pitch constant.

Next month, special techniques in editing and obtaining sound effects and electronic music effects will be described.



ORBITING OBSERVATORY

The second orbiting astronomical observatory, which is making its first survey of the sky in the ultra violet region, has discovered that there is a hydrogen cloud round the nucleous of the new comet designated *Tag-Sato-Kosaka*. The first signals in the ultra violet region were picked up on January 14, and the observatory spent about ten minutes a day till the end of February locked on to the comet.

The team from Wisconsin University under the leadership of Dr A. Code is responsible for this work and, as this is the first time that the ionised hydrogen has been detected, it represents an important "first". Previously it had not been possible to detect this phenomena from ground based detectors and it is an indication of the vastness of the field opened up by space observatories. In this particular experiment it is hoped that more will be learned about the mass loss from the comet.

Comets in their journey round the sun at perihelion are subject to solar heating which drives off dust and gases. The characteristic tail is produced which can stretch for over one hundred million miles and up to ten million miles wide. The hydrogen cloud is suspected to be as large as the sun itself.

MANNED ORBITING OBSERVATORY

In 1972 three men will be launched in the first of the manned observatories. The *Apollo* telescope mount will be one component of a vehicle which will consist of an *Apollo* command module and service module together with a *Saturn* workshop. The first flight will last 28 days and then the crew will return to earth to be replaced by another crew who will spend twice this period in orbit.

The vehicle, which will be the forerunner of the projected orbiting space station, will carry a number of instruments including a coronagraph designed by the staff of the high altitude laboratory at Boulder, Colorado. Two models have been made and delivered for testing; one will be tested in a 100ft vacuum tunnel with an artificial sun, and the other will be tested later at a height of 118,000 feet suspended from a helium balloon.

The coronagraph is an instrument designed by Lyot to produce artificial eclipses of the sun. The instrument is pointed at the sun and a disc in the tube adjusted to be equal to the image of the sun, allowing the corona to be studied.

When used as earth based instruments serious disadvantages are caused by the absorption and scattering of the sunlight by the earth's atmosphere. It is hoped that the spaceborne instruments will be able to photograph the corona out to a much greater distance from the sun. Dr G. Newkirk is hoping that it will be possible to study the corona out to a distance of six solar radii as compared to one to two solar radii with the best earth based instruments.

X-RAY STAR

Centaurus XR4 appeared in an area of sky in 1969 where no object had been seen before, and it is predicted by a group at Los Alamos Scientific Laboratory, who have studied it during its lifetime, that it will flare up again in the near future. This prediction is based on the knowledge of the behaviour of a *DQ Hucilis* type of Nova which has a double peaked light curve, and the behaviour of *Cen XR-4* which appears by observation to be similar.

If this prediction should prove to be true the way to the better understanding of one type of nova will be open.

EARTH BULGE

The gravitational pull of the moon on the earth produces the ocean tides which are easily measured. Also, there is a corresponding tide of the earth's crust but this is very difficult to measure. The large errors which arise are because of wide changes in temperature and also the change of gravity brought about by the effects of the large bodies of water which are displaced by the tides.

A team from the Lamont-Doherty geological observatory have set up an array of 13 sensitive gravimeters on the 40th parallel and with the help of other colleges and universities have been able to continuously monitor changes for six months. The accuracy of the measurements are such that the changes in the radius of the earth can be assessed within one centimetre. The average change is about 30cm every 12 hours corresponding with the tidal changes due to the pull of the moon.

It has been noted that the effects of the oceanic movements acts much farther inland that was thought to be the case. There is also the possibility that the movements in the crust are a contributory factor in earthquake outbreaks.

INFRA-RED TELESCOPE READY

The 40in infra-red telescope built by the staff of Imperial College under the leadership of Prof. J. Ring, will shortly go into service at Silwood Park, Ascot, where the outstation of the group is situated.

The infra-red telescope is a flux collector and in technical jargon often referred to as a "light bucket". The 40in paraboloid is of novel design and the collector is a 60in flat which directs the infra-red light to the paraboloid.

Because there are difficulties in the production of a 60in flat in one piece it is made up of a circle of six hexagons with a hole in the middle where the seventh would be. It is through this that the rays are directed on to the detectors. Plans are already under way for a 60in paraboloid and the glass bank is being polished by Grubb Parsons.

Design studies are under way for an eventual 120in flux collector and the sites for the larger ones will need to be in areas where the water vapour problem is least. Two possible sites are one at Tenerife and another in the Sierra Mountains of Spain.

The improvement of the 60in over the 40in is considerable. While the 40in will have an image size of about thirty seconds of arc the 60in will be reduced to an image size one second of arc.

REDUCTION OF FIRE RISK

Another spin off benefit from the space programme is the development of a chemical which is so resistant to flame and so versatile in use that it can be applied in industry, the home and transport. The material can be sprayed onto surfaces which will then resist temperatures up to twice the level at which they would normally catch fire.

This development arises out of the investigations into the fire in the *Apollo* spacecraft in which Grissom, White and Chaffee lost their lives.

The new product has the trade name of Fluorel, is a copolymer containing two fluorides whose action is to increase in resistance to heat as the temperature rises. It can be used as a solid, paint or foam and will fireproof materials up to a temperature of 2,200 degrees Fahrenheit in an atmosphere of 100 per cent oxygen.

Some idea of this breakthrough can be gained by comparing the ignition point of paper 800 degrees Fahrenheit, plywood at 900 degrees Fahrenheit and canvas at 1,000 degrees Fahrenheit in an atmosphere of 20 per cent oxygen.

A NEW SERIES FOR THE BEGINNER

THIS

ALL MATTER is made up of atoms, which are bonded together by electrical forces. An atom consists of a positively charged central core or nucleus, with negatively charged electrons circling around it in fixed orbits. An atom of a particular element is characterised by a specific number of orbital electrons—copper has 29—and the total electron charge cancels out the positive charge of the nucleus.

In certain circumstances, atoms can be encouraged to release or capture electrons, as well as share them with neighbouring atoms, and these exchanges determine the basic operating principle of any electronic device.

We are concerned here with only three classes of matter, conductors, insulators, and semiconductors. When copper atoms are united to form, say, a wire conductor, the binding force between the outermost electrons and the parent nuclei is weakened, and some electrons are freed to wander at random among the atoms.

In the case of an insulator, the electrons remain tightly bound to the nuclei and are not available to act as carriers of an electric charge, except when released by high temperatures or high voltages.

Semiconductors can be explained, in a simplified way, by considering them as insulators which have been modified by the addition of impurity atoms to become a special type of conductor.

METALLIC CONDUCTORS

Atoms are arranged in a regular pattern or lattice in a solid metallic conductor, with free electrons distributed between the atoms. At absolute zero temperature, the atoms and free electrons are stationary, but room temperatures will cause the electrons to move about at random, and the atoms to vibrate within the confines of the lattice.

The most important consequence of thermal motion is that it increases the likelihood of collisions between free electrons and atoms. The resistance of a conductor depends on the number of free electrons available to act as carriers, and on the number of collisions. Thus, the resistance of an ordinary metallic conductor increases with temperature.

LIQUID CONDUCTORS

A liquid metallic conductor like mercury, or molten solder, behaves electrically in much the same way as a solid, but the term "conduction" is something of a misnomer when applied to chemical solutions.

Electrons are not, as is popularly supposed, transported through a solution by "ferryboat" atoms, but instead take part in a chemical reaction at the surface of electrodes which are dipped into the solution. Electrons are absorbed by one electrode and are given off by the other, but they do not pass through the solution.

When an acid is dissolved in water, to form a typical solution, a process called ionisation takes place.

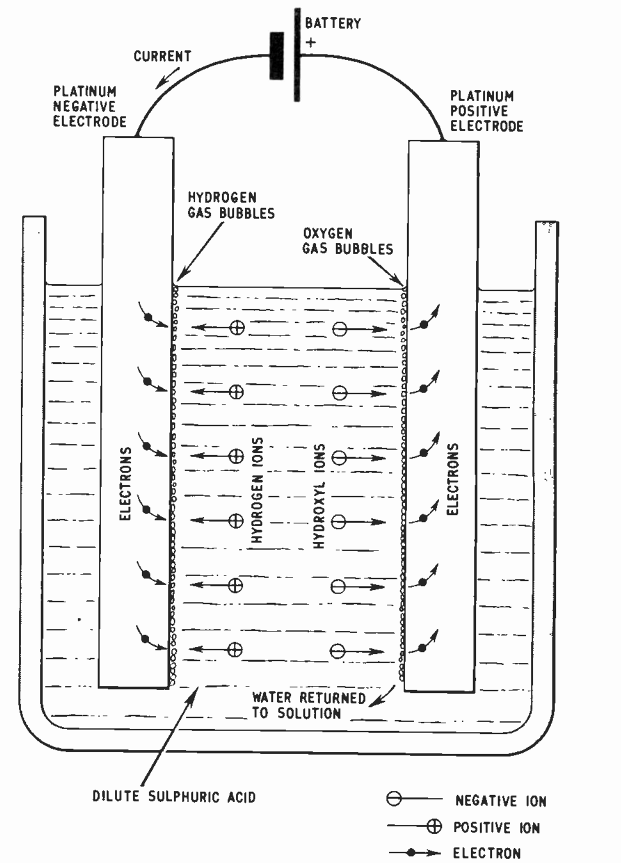


Fig. 2.1. Conduction in a liquid solution

Certain atoms or groups of atoms take on an excess of electrons, while others lose electrons. In other words, the atoms become electrically charged and are termed ions.

The ionisation is purely a result of the acid going into solution, and has nothing to do with any external or internal electric current. Ions in a solution move very slowly under the action of an electric current, just a few thousandths of a centimetre per second.

If a battery is connected to two platinum electrodes which are immersed in acidulated water to form a cell, as in Fig. 2.1, electrons will flow into the negative electrode and attract positively charged hydrogen ions from the solution.

The electrons combine with the hydrogen ions to create hydrogen atoms, which are then given off in the form of gas bubbles. At the same time, negatively charged hydroxyl ions are attracted from the solution to the positive electrode, where they liberate electrons and are converted into oxygen and water.

The oxygen bubbles off and the water is returned to the solution. The above description is simplified, but it does serve to show that so-called conduction in a solution really consists of an electro-chemical conversion process.

CONDUCTION IN GASES

Ionisation also occurs in gases. In the absence of an e.m.f. between two electrodes in a gas, a trace of naturally occurring radioactivity will cause a few electrons to be knocked out of gas atoms, thus giving rise to positive ions.

WAY TO ELECTRONICS 2

CONDUCTION

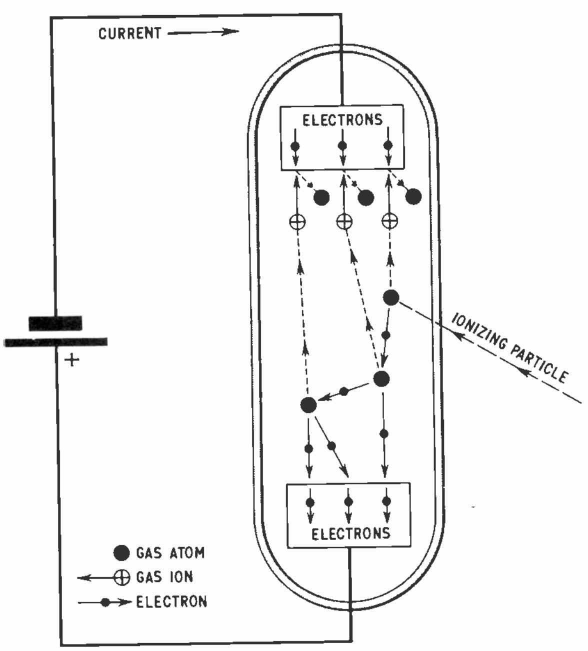


Fig. 2.2. Conduction in a gas

If a small voltage is applied to the electrodes, see Fig. 2.2, the positive ions will be attracted towards the negatively charged electrode, where they combine with electrons from the battery and are converted back into gas atoms. The few free electrons liberated by ionisation will move towards the positive electrode.

This very small migration of electrons and ions does form a minute current, but the gas can be regarded as a near perfect insulator.

Something happens when the voltage across the electrodes in a gas is increased to a threshold value. The few free electrons are accelerated to high velocities and they knock other electrons from gas atoms, thus causing further ionisation to occur. It is an avalanche effect, the more free electrons there are, the greater will be the number of electrons knocked out of gas atoms, and so on until a considerable number of electrons are arriving at the positive electrode.

INSULATORS

There are hardly any free electrons in an insulator to carry electrical charges through the material, so an insulator offers a very high resistance. When enough heat is applied to an insulator, however, the point will be reached where the vigorously vibrating atoms will "throw off" electrons, which then become free to drift and act as current carriers.

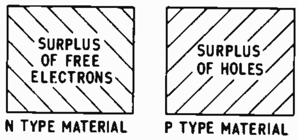
So, the resistance of an insulator tends to decrease with a rise in temperature. A good example is glass, which has a fairly low resistance when red hot.

SEMICONDUCTORS

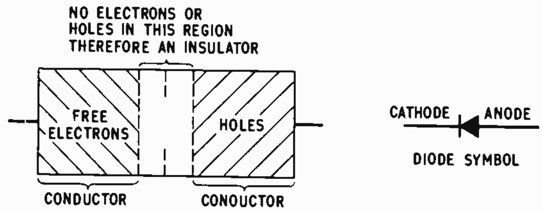
Semiconductors are certain solids which combine the properties of conductors and insulators. Examples are silicon and its carbide, germanium, copper oxide and sulphide, selenium, lead sulphide and telluride, cadmium sulphide, and zinc sulphide.

The resistance of a pure semiconductor decreases with a rise in temperature, like an insulator, but is low enough at room temperatures for the material to be classified as a conductor. The implications are that heat causes electrons to be "thrown off" by vibrating semiconductor atoms at a much lower temperature than

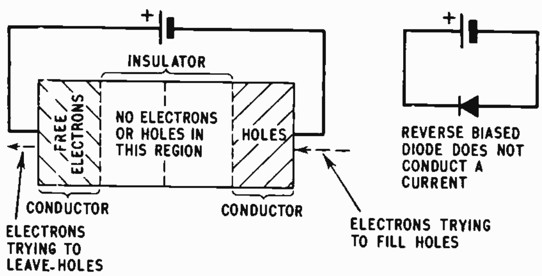
DIODE



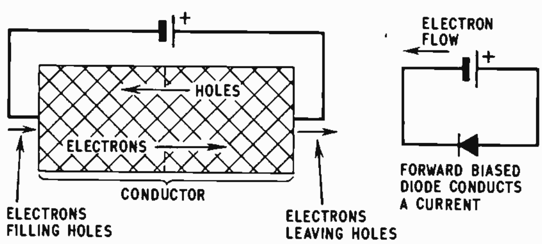
(a) N and P type material are joined together



(b) Narrow region of insulation between N and P materials



(c) Reverse bias applied to diode. Electrons try to move but are blocked by "insulator" region



(d) Free flow of electrons when forward biased

Fig. 2.3. Semiconductor diode principle

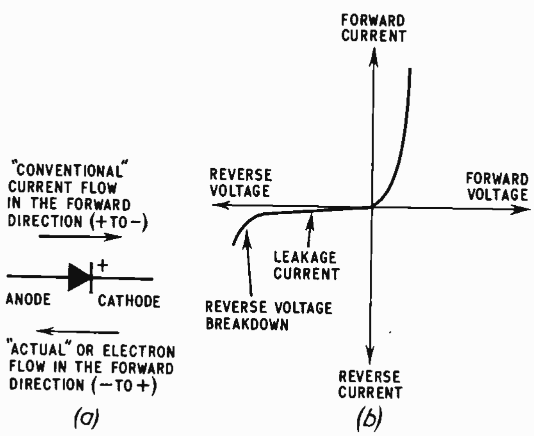


Fig. 2.4. Current flow and voltage/current characteristic of a diode

insulator atoms, thus providing a source of free electrons to carry a current.

An atom which has an abnormal number of electrons is an ion and, in solutions or gases, these ions are free to move around and carry charges to electrodes. The atoms of a semiconductor are fixed in position, so all they can do is to "trade" electrons.

When an electron breaks free from its parent atom it leaves behind a space or "hole" which can be filled by another electron. In a semiconductor there will be some thermally generated free electrons and the same number of holes.

Suppose now that atoms of an impurity such as phosphorus are added to a pure silicon semiconductor, this will result in the existing holes being filled by donated electrons from the phosphorus, but will leave the number of free electrons virtually unchanged.

Alternatively, if boron is added to silicon, the free electrons will be accepted by the impurity to leave only holes.

TWO DISTINCT TYPES

There are therefore two distinct types of modified semiconductor, the *n* or negative type with an excess of free electrons, and the *p* or positive type with an excess of holes. The addition of donor or acceptor impurity atoms does not cause a piece of semiconductor material to become electrically charged, as might be expected, because the charge on the impurity nuclei exactly cancels the charge, due to a surplus or deficiency of electrons in the material.

A *p* type semiconductor with a surplus of holes will conduct a current just as well as an *n* type, because holes like free electrons are a form of carrier.

If all free electrons and holes are removed from a semiconductor material, it would be transformed into a perfect insulator. One method of achieving this transformation is to encourage free electrons to combine with holes.

PN JUNCTION OR DIODE

If *p* and *n* type semiconductors are joined together, in such a way that both form part of one continuous crystal structure, electrons can only flow across the resulting junction in one direction; this forms the basis of an important device called a diode or rectifier.

To see how the *pn* combination works, refer to Fig. 2.3. When the two blocks of semiconductor material (Fig. 2.3a) are joined together in a special way, free electrons and holes will drift a short distance across the junction and will then disappear as they combine, shown in Fig. 2.3b.

There will exist on each side of the junction a narrow region without free electrons or holes, which is therefore an insulator. The interesting property of such a semiconductor insulator is that it can be varied by applying an e.m.f.

When a battery is connected to the diode as in Fig. 2.3c, free electrons will be attracted towards the positive battery terminal, and holes towards the negative terminal, and they will move away from the insulator region, thus increasing its effective width. As long as the insulator exists, a current cannot flow.

Now look at Fig. 2.3d. If the battery connections are reversed, free electrons and holes will be attracted towards the junction, thus tending to reduce the thickness of the insulator region. If the battery e.m.f. is more than, say, $\frac{1}{4}$ volt, the insulator region disappears altogether, and electrons begin to flow through the diode.

DIRECTION OF FLOW

Before J. J. Thompson discovered the electron in 1897, it was generally assumed that an electric current flowed from positive to negative. Even then it would have meant a major upheaval to correct all existing books, circuit diagrams, and graphs, so the problem was shelved.

At the present time, "conventional flow" from positive to negative is still applied to the majority of circuit diagrams and general descriptions of circuits, while "actual flow" from negative to positive is mainly used in discussions of basic electron theory.

The diode circuit symbol naturally suggests that the direction of flow is pointed by the arrowhead shape, but this is conventional flow from positive to negative. Confusion can be avoided if the following rule is memorised. A diode will conduct a current when the arrowhead (anode) is more positive than the bar (cathode), see Fig. 2.4a.

The graph in Fig. 2.4b shows that a diode has not got a perfect characteristic; it will offer some resistance to a forward current, and will "leak" a small current when a reverse e.m.f. is applied.

ALTERNATING CURRENT

All the circuits given thus far have made use of a unidirectional flow of electrons, or a direct current (d.c.) from batteries. But there are many applications in electronics where an oscillatory, or to and fro motion of electrons is encountered, called alternating current (a.c.).

If the value of an alternating current is plotted against time on a graph, it might look something like Fig. 2.5a, rising from zero to a maximum or peak positive value, then falling through zero to a similar but negative peak value. So, an alternating current is continuously changing and reversing, usually many times a second.

How then can a.c. be measured if it is never steady? One way is to feed the a.c. to a resistance and see how much heat it produces; then compare this with the heat generated by a direct current.

It is found that a direct current gives 1·4 times the heat output of an alternating current of the same peak value. Therefore, to achieve parity, and to allow Ohm's and Joule's Laws to be applied to a.c. calculations, it is necessary to divide peak values by 1·4, to give what is called the root mean square or r.m.s. value. An alternating current of 1 amp r.m.s. has the same heating effect as a direct current of 1 amp.

Most a.c. measuring instruments are already calibrated for r.m.s. values, thus eliminating the need for conversion. It is usually taken for granted that any quoted a.c. voltage or current (for example, the 240 volt mains supply) is an r.m.s. value, unless otherwise stated.

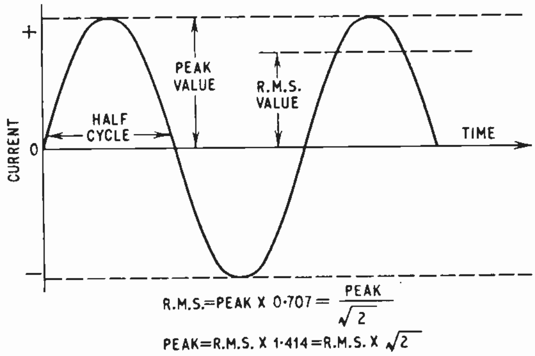
DIODE RECTIFYING CIRCUITS

Now let us see what effect a diode has on an alternating current.

Diodes are often used as rectifiers, to convert an alternating current into a direct current, by inverting or suppressing alternate half waves of a.c., see Fig. 2.5b.

The half-wave rectifier circuits in Fig. 2.6 work by charging the capacitor with unidirectional pulses of current, which are only allowed to pass during alternate half-cycles. The capacitor stores energy, and acts as an electrical reservoir when the alternating current input has fallen temporarily to zero. The full wave circuits of Fig. 2.6 make use of both half cycles of the alternating current, and are therefore more efficient.

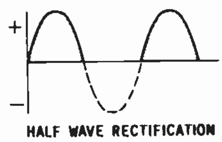
RECTIFICATION



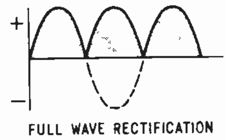
R.M.S.=PEAK X 0·707 = $\frac{\text{PEAK}}{\sqrt{2}}$

PEAK=R.M.S. X 1·414=R.M.S. X $\sqrt{2}$

(a) Peak and r.m.s. values of an a.c. sine wave. $1\frac{1}{2}$ cycles are shown

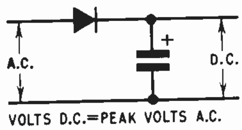


(b) Half-wave rectification suppresses alternate half-cycles

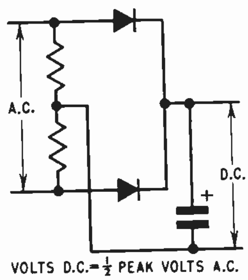


(c) Full-wave rectification inverts alternate half-cycles

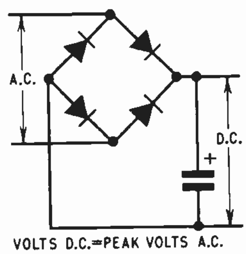
Fig. 2.5. Sine wave a.c. waveform and rectification



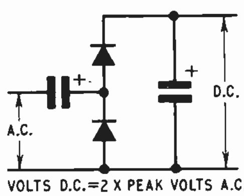
(a) Half-wave with one diode



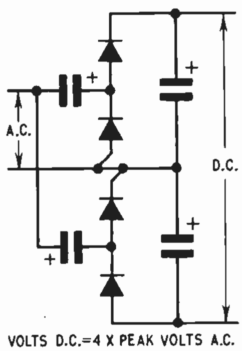
(b) Full-wave with two diodes



(c) Full-wave rectifier bridge with four diodes

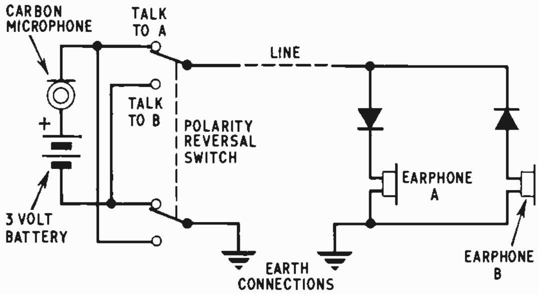


(d) Voltage doubler

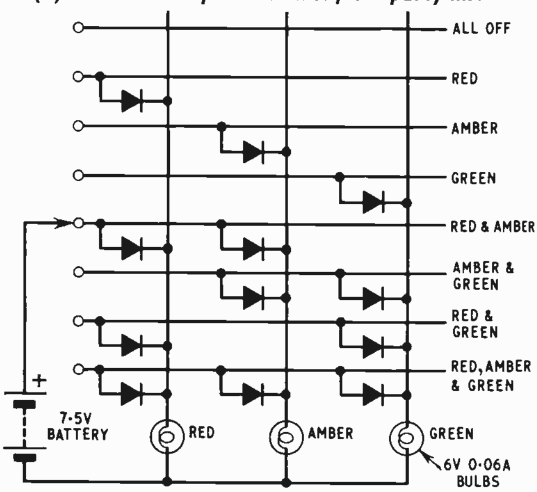


(e) Voltage quadrupler

Fig. 2.6. Various types of rectification



(a) Selective telephone circuit for a party line



(b) Diode matrix for lamp signalling

Fig. 2.7. Two examples of other uses of the diode

It is possible to obtain very large d.c. voltages from a.c. supplies by adding on or cascading extra rectifier circuits, rather like placing a number of batteries in series. The quadrupler circuit of Fig. 2.6 is really two voltage doublers placed end to end.

OTHER USES

There are many other uses for diodes, apart from rectification. The selective telephone circuit of Fig. 2.7 uses diodes to prevent speech signals from reaching both receiving stations (earphones) at the same time, even though the signals travel along a single line (shown dotted). When the switch is in the "talk to A" position, the diode in series with earphone A is forward connected, and introduces very little resistance into the circuit, but the diode of earphone B is reverse biased by the battery polarity, so that it acts as an insulator and prevents the passage of speech signals.

The diode matrix of Fig. 2.7 will give pre-selected combinations of three coloured lamps without the need for a complicated multi-way switch. The diodes serve to "route" currents from the battery to appropriate lamps, depending on where they are placed inside the matrix. The diode matrix principle can be extended to cover very complicated arrangements of lamps for giving alphabetical or numerical readouts and moving news message displays.

Next month we shall be looking at extensions of the diode principle, where two diodes formed on a single common semiconductor material can control currents.

CORRECTION

In Part I last month the drawings for Fig. 1.3c and Fig 1.4c should be transposed.

BOOK REVIEWS

USING SEMICONDUCTORS

By J. Hughes, B.Sc. and T. M. Johnston, B.Sc.
Published by Heinemann Educational Books Ltd.
124 pages, 9in × 6in. Price 25s.

SOME beginners in electronics tend to start construction of fairly simple (or even complex) projects without really knowing what each component is used for or how it functions. Simple do-it-yourself experiments are given in this book to illustrate the functions of semiconductor diodes and transistors, followed progressively by more complex circuits.

Whilst this is an excellent practical book, the authors admit in the Preface that any shortcomings are their own. Of these, explanations of certain terms used are lacking and, for the likes of teenage students, this may be a drawback.

Attempts have been made to over-simplify some descriptions, and yet the physics of semiconducting plunges the reader into the deep end as early as Chapter 3. Experimenters in elementary circuitry could pass over the Hall Effect for the time being and go on to rectification. However, this section fails to explain why the peak inverse voltage is 1·4 times the r.m.s. voltage and does not say what r.m.s. means.

Chapter 4 introduces transmitter theory and demonstrates amplification in d.c. terms. Calculus knowledge is assumed; the delta symbols are used with no explanation.

These are just examples of some shortcomings that are not confined to this book alone. On setting out to write for beginners, a distinction between theory and practice should be obvious; theory should be basic and in line with the purposes of the practical projects.

Since the practical parts of this book are highly commendable, it would be a pity for beginners to be deterred by the theoretical approach. Readers are recommended to browse through the pages before buying.

Chapters 1 and 2 deal with the apparatus, tools, and components required and describe the construction method suggested. Later chapters race on to amplifiers, oscillators, radio reception and specialised semiconductors, the latter in brief terms with no circuit applications.

Three appendices are included, giving lists of apparatus, components, suppliers, and construction templates.

M.A.C.

ITV 1970

Published by the Independent Television Authority
240 pages, 9in × 7¾in. Price 10s 6d.

1969 WAS probably the most important year for the Independent Television Authority since its birth fifteen years previous. On November 15, the confidence of the ITV companies, to convince Parliament of the need for colour on 625 lines along with BBC-1, burst into the realisation of a fully prepared colour service. By the beginning of 1970 almost half the population in the fourteen programme company areas were within reach of colour reception.

The I.T.A. further predict that almost four-fifths of the population would be covered by 1972.

The Authority also announces that ten million pounds is being spent on the change in line standards equipment to 625-lines. Programme Companies are equalling this expenditure on their studio needs. The first new u.h.f. transmitter for I.T.V. was switched on at Crystal Palace, London, on September 5, 1969. Standards converters were also installed to maintain the 405-line service.

What with all this innovation, plus the new Emley Moor tower and additional advertising levies in excess of £25 million, one cannot help asking what the financial status of the Authority is now in 1970. But, like all well organised companies, the I.T.A. and its subsidiary programme companies have a powerful conviction of their abilities; indeed they must have to compete with the equally mighty BBC.

The appropriation of revenue is a complicated affair which is briefly described, but one can assess that the public purse is well fed and still leaves the Authority with considerable assets of more than £18 million.

A word on programmes, which are adequately described and lavishly illustrated; the scope and quality of programmes continues to improve. Perhaps this is largely due to the tremendous efforts of JICTAR and TOP (Television Opinion Panel Ltd.), the latter being a newly set up audience research unit to complement JICTAR on programme reaction.

Particularly commendable are the documentaries and the ITN programmes, which consistently appear in the Top Ten ratings.

M.A.C.

DOCUMENTARY PROGRAMMES ON TAPE

By P. Bastin
Published by Print and Press Services Ltd.
47 pages, 7in × 4¾in. Price 5s.

A USEFUL pocket book describing how to get the best out of recording documentaries with full sound effects. Hints and tips are given on planning a programme, setting up equipment, narration, and adding other sound tracks. The style of writing is friendly but elementary.

TAPE RECORDERS A-Z

Published by A.P.A. Publishing (Catalogues) Ltd.
164 pages, 12in × 8¼in. Price 20s.

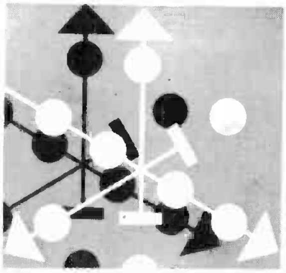
THIS is a detailed list of video, professional, domestic and high fidelity tape recorders currently available on the U.K. market. Photographs and manufacturers' specifications are given.

AUDIO ANNUAL 1970

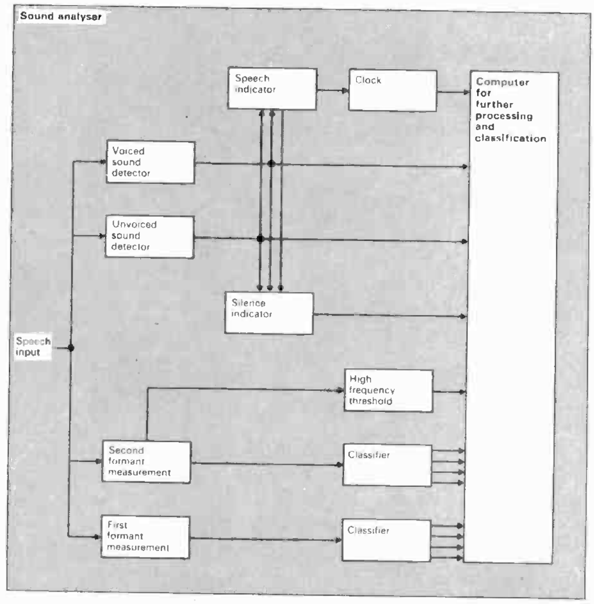
Published by Link House Publications Ltd.
138 pages, 11in × 8¼in. Price 7s 6d.

THIS is virtually an enlarged version of *Hi Fi News* containing 30 pages of feature articles and 52 pages of equipment reviews, taken from issues previously published.

ELECTRONORAMA



THE 1970 Physics Exhibition took place at Alexandra Palace from March 2 to 5. Some of the more interesting electronic systems and devices displayed are described and illustrated below.



Talking to a Computer

ONE of the current trends in the use of computers is the degree of interaction between the user and the computer. Since man uses speech to communicate, why shouldn't the computer do likewise. Work has been carried out to persuade the computer to talk, using synthetic speech, but if it is to understand man, it must learn to recognise forms of speech sound.

One way of doing this is to split the speech signal into several parallel signals that indicate the presence or absence of particular formants. Relative energy contents of voiced sounds and unvoiced sounds can be recognised by a computer.

The voiced sound is a vowel-like sound produced by vibrating vocal chords. Unvoiced sounds are those produced by air passing through shaped orifices in the mouth or throat.

There are other types of sound that are recognised; these are classified into four frequency levels determined by measurement of the lowest formant frequencies. Another circuit will detect high frequency sounds, such as "s".

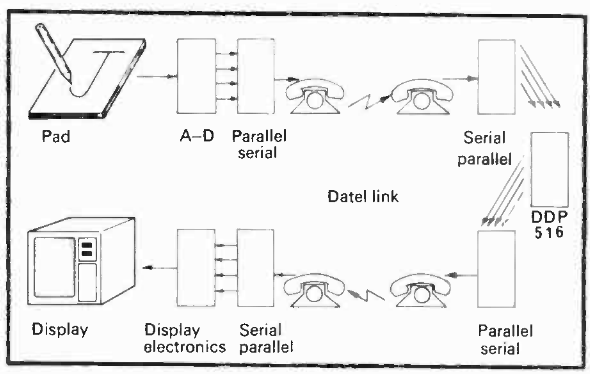
Thus, by using a simple language, the computer can be made to recognise certain words. In the demonstration, a sound analyser was coupled to a telephone and a computer. A pre-arranged programme of conversation and questions was "written" on a screen by the computer. The answers and interjections, based on the words "yes", "no", "stop", and "wrong" were spoken by the visitor into the telephone.

On receipt of an answer, the computer can comment or proceed to the next topic, depending on the answer received. The block diagram (top right) shows the system of speech analysis used with an ICL 4120 computer, similar to that shown below.

Writing Detection and Display

A NEW system of "writing" display using a pressure operated co-ordinate generator is based on the variable pressure applied to a pencil by the writer. No wires are attached to the pencil since the detector is under the pencil tip.

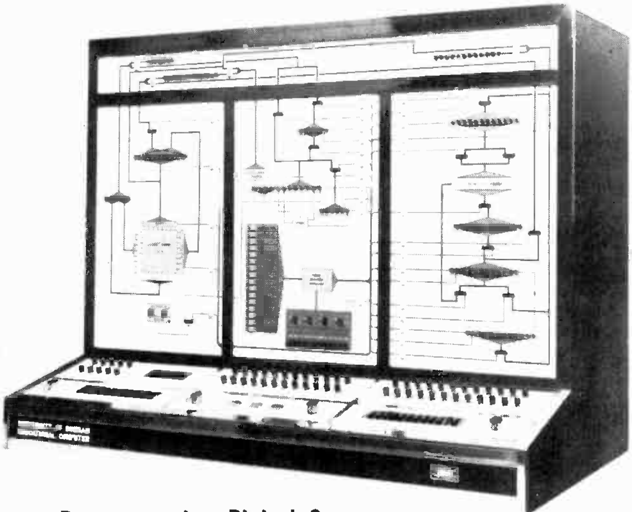
The device consists of two resistive strips separated by air. Writing pressure on the upper strip, which is flexible, deforms it into contact with the lower strip. Shorting electrodes are connected across the strip ends so that, when a current pulse is passed through one strip a uniform voltage gradient is developed along its length. The



voltage at the point of contact is proportional to the distance from the ends.

An electrical analogue is processed to a storage tube unit fed with X and Y signals derived from a pair of binary counters as shown in the block diagram above. The pad and display are shown in the photograph on the right.

VISITS PHYSICS EXHIBITION



Demonstration Digital Computer

THERE are several courses available to teach computer programming, but when it comes to demonstrating the functions and working of a digital computer in schools, colleges, and universities, commercial models tend to be too expensive or too fast, with no visual display of processing.

A new simplified computer, with a core storage capacity of 128 words (12 bits per word), has been designed and developed by two lecturers from the University of Durham and Darlington College of Technology. This development, which is being supported by N.R.D.C., has a visual display panel which indicates the flow of information and the contents of the registers. The panel layout is designed so that the functions of individual parts can be learnt before tackling the complete machine, shown above.

Five modes of operation are demonstrated: these are manual, one-shot, automatic instruction slow, automatic instruction fast and automatic programme.

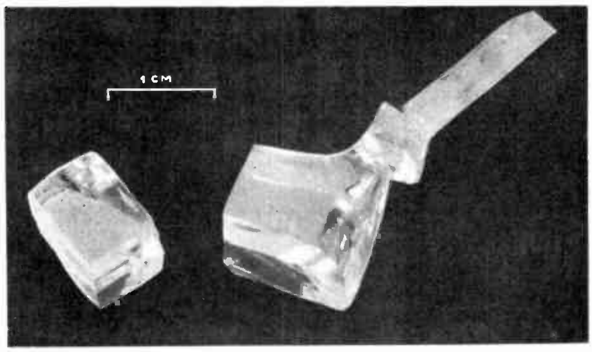
Although the output is in the visual display form it is expected that a tape punch or printer could be coupled to it. Other likely additions include magnetic tape store, tape or teleprinter input/output, enlarged core store.

Light Modulation Crystals

A METHOD of growing KTN Crystals has been developed at Mullard Research Laboratories by R. W. Whipps. KTN, a mixture of the ferro-electric compounds, potassium tantalate and potassium niobate, is a transparent solid having optical properties that can be changed by the application of a voltage; this effect can be used for the electrical deflection or modulation of a beam of light. KTN is much more sensitive than materials previously used and thus lower voltages can be used to achieve a useful electro-optic effect.

Crystals of KTN are, however, very difficult to prepare in useful sizes since the material decomposes below its melting point (approximately 1,300°C) and must be grown from solution.

KTN optical modulators and switching devices can be used for laser-beam communication systems and are of potential use for flat-screen televisions and in high-speed computers. A photograph of Mullard KTN crystals is shown below. A division equal to 1 centimetre is shown for size comparison.



British Equipment for German Police

THE police forces of three of the states of the Federal Republic of Germany have recently installed fingerprint facsimile transmission equipment manufactured by Muirhead Limited of Beckenham, Kent.

Fingerprint photographs can now be transmitted within minutes between the Bundeskriminalamt in Wiesbaden and the Landeskriminalaemter in Dusseldorf (Nordrhine/Westphalia), Stuttgart (Wuttenburg), and Hannover (Niedersachsen) over normal telephone lines.

With this equipment a fingerprint picture 8 inches square can be transmitted with extremely high definition in 14 minutes. The picture received is fully processed inside the receiver, so there is no need for dark-room facilities.

The picture below shows one of the fingerprint picture transmitters.

50 PLUS 50 HIGH POWER AMPLIFIER

PART THREE

By R. D. PALMER

IN THIS, the concluding article, modifications are provided to extend the input capability of the amplifier. A fault finding table is also given to assist those constructors who might experience difficulties in getting a satisfactory performance.

Whilst this table is not intended to be exhaustive it should provide enough information to locate the most likely faults and provide guidelines to their rectification.

The item of test gear required is a 50,000 ohm per volt multimeter.

EXTENDING THE INPUTS

If more than two inputs per channel are required the circuit terminating at pins N′7 and N′1 in Fig. 6 should be substituted with that given in Fig. 19. Here three inputs are given but in fact this can be extended to any number, the limiting factor being a reduced sensitivity with serial additions. For example, with five of the input circuits added the sensitivity of each one will be about 10mV with an input impedance of 1 megohm. As more circuits are added, this input figure for the rated output will have to be increased.

FAULT FINDING TABLE

Table 1 gives a number of common faults, and their diagnoses. To use it, take, for example, the overall symptom of no output from both channels when signals are applied to the inputs.

Since this is most likely to be a power supply fault we refer to the column under the heading of "Local Symptom" in the power supply block.

The first symptom "56V rail zero" points the way to our first voltage check with the multimeter. If in fact, the supply voltage does read zero then proceed on to the column listing the possible fault conditions.

Here are given a number of items of circuitry which are likely to be faulty. If the fuse FS1 has blown, the mains transformer should be checked for short-circuited windings. If this proves to be all right, next check the bridge rectifiers D7–D10 for short circuits.

By following through the fault list we narrow down the search for the offending component or components. To assist in this a number of static voltage check lists are included. Unless otherwise stated, all of these have been measured with respect to earth. It should be emphasised that when a fuse has blown, no attempt should be made to replace it until the fault has been located. With the exception of TR7 and TR8 all the transistors can be expected to have a V_{be} (base to emitter voltage) of approximately 0·65 volts. This can be measured with a 50,000 ohms per volt meter without greatly upsetting the biasing.

Finally, in the amplifier circuit (Fig. 6), TR6, TR9, and TR12 can be type BFY51. ★

COMPONENTS . . .

Resistors
R53–R55 10MΩ (3 off)
All 10%, ½ watt carbon

Potentiometers
VR8–VR10 1MΩ carbon log (3 off)

Capacitors
C23–C25 0·1μF polyester (3 off)

Sockets
JK3–JK5 Standard jack socket (3 off)

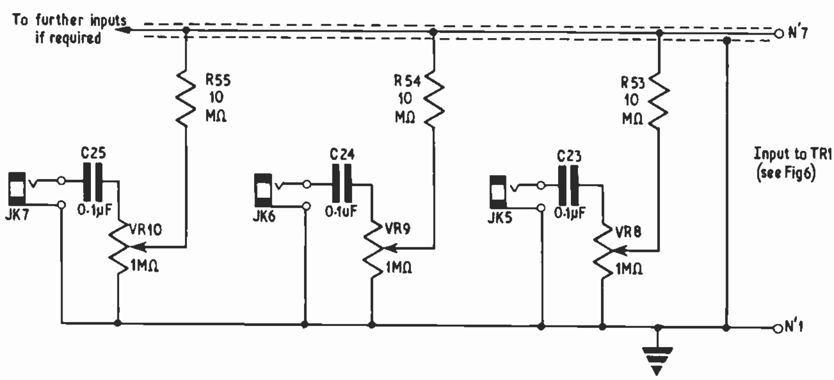


Fig. 19. Extension circuit for more than two inputs

POWER SUPPLY

NO OUTPUT FROM EITHER OR BOTH CHANNELS

LOCAL SYMPTOM	POSSIBLE FAULT CONDITIONS
56 Volt rail zero FS2 & FS3 Assumed O.K.	1. FS1 fused. Suspect short circuit (a) across T1 primary (b) across T1 secondary 2. S/C in bridge D7-D10. 3. C20 s/c (normal voltage 70V). 4. Heatsink of TR17/15 earthed. 5. S/C on line to FS2/3 (in which case TR17 will have been destroyed).

POWER SUPPLY VOLTAGES

POINT	MIN.	MAX.	CONDITION	S/C	O/C
TR16 Emitter	41V	47V	0V	D11 D12	R48
TR15 Base	53V	54·5V			
TR15 Emitter	54V	55·5V	O.K.		TR17
TR17 Emitter	56V	Nominal	0V		
22 volt rail	20V	24V	0V	D13 C21	R52

If short on 22V line	Disconnect each 22V line and check boards and lines for s/c
FS2 or FS3 Fused	S/C on line, Test Amplifiers
56 volt rail at ~70V	

POINT	MIN.	MAX.	CONDITION	S/C	O/C
TR16 emitter	41V	47V	high		D11, D12
TR16 base	41·6V	47·6V	low	TR16	R50, VR7

R50 may be too high

TR17 or/and TR15 c/e s/c disconnect and check.

OUTPUT OBTAINABLE BUT LACKS POWER

Output impedance of 56V rail high, voltage drops considerably with applied load	TR15 has b/e s/c or Zeners have poor regulation

POWER AMPLIFIER

NORMAL VOLTAGES WITH 56V RAIL O.K. AND CENTRE RAIL AT 28V

TR6 Collector	27·3V
Across C13	23V
Across C14	14V
From junction R38, R35, R41 to centre rail	0·6V
From junction R36, R39, R42 to centre rail	0·6V

LOCAL SYMPTOM	POSSIBLE FAULT CONDITIONS
TR13, TR14 case (collector) earthed, TR13 and TR14 both c/e s/c	Mica washer or insulating bushes damaged in this case protection circuit has probably failed
Excessive quiescent current	D3, D2 or VR6 o/c Check by shorting TR9 back to TR6 collector. This should reduce quiescent current.
Centre, rail voltage high (>45V)	TR13, TR11, TR9 or TR8 c/e s/c TR6 or R24, R25 (feedback), R45, TR14, TR12, TR10, o/c.
Centre rail voltage low (<10V)	TR7, TR6, TR10, TR12, TR14 c/e s/c D4, C16, C14, C13 or C15 s/c VR5, R44 o/c.
Protection circuits operating prematurely	Quiescent current, component values, resistances of R44 & R45 (suspect them being too high).
TR13 or TR14 b/e s/c	In which case V_{BE} of transistor will be zero.

PRE-AMP AND PRE-DRIVER

NORMAL VOLTAGES WITH 56V RAIL O.K. AND CENTRE RAIL AT 28V

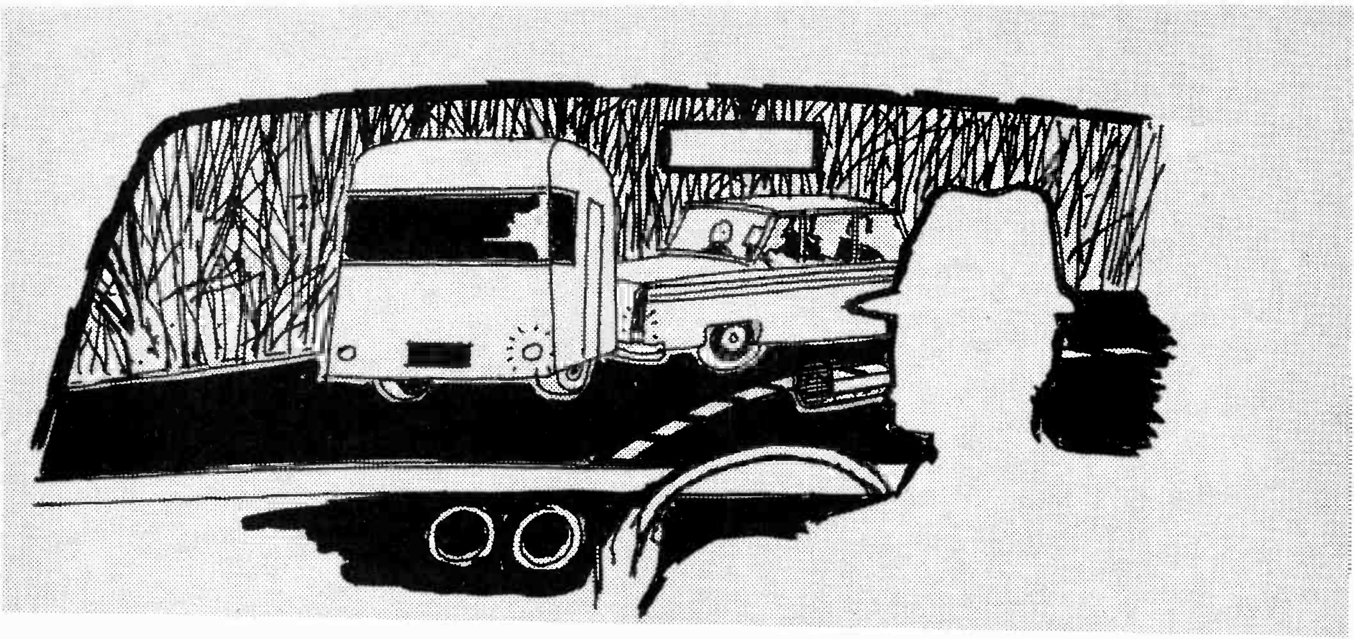
POINT	MIN.	MAX.
Across C5 (nominal)	10V	
TR1 Source	0·5V	5·0V
TR1 Source to drain (nominal)	2·0V	
TR2 Collector (nominal)	5·0V	
Across R8 (nominal)	1·5V	
TR3 Collector (nominal)	5·0V	
Across R15 (nominal)	3·0V	
TR5 Emitter	6·4V	13·4V
TR4 Collector	7·0V	14·0V
TR4 Emitter	0·5V	1·4V

LOCAL SYMPTOM		POSSIBLE FAULT CONDITIONS		
CONDITION		S/C	O/C	OTHERS
C5	Low			Faulty front end or C5 leaky
TR1 Source	Low	C2	R5, TR1	
TR1 Source	High	TR1	R6	TR1 out of spec.
TR1 Source to Drain	Low	TR1	R6	TR1 out of spec.
TR2 Collector	Low	C2, TR2	R8	C2 leaky
R8	Low	TR2 Base	TR2	TR2 gain low
TR3 Collector	Low	C4, C7	R15	C4, C7 leaky
R15	Low	TR3 Base	TR3	TR3 low gain
TR5 Emitter	Low	C14 s/c. Centre rail voltage will be low	TR5-R19	TR4, R19
TR4 Collector	High	TR5 c/e R20, C11		

If clipping due to incorrect biasing, check above

PLUS PLUS

NOTES: C/E = COLLECTOR TO EMITTER B/E = BASE TO EMITTER O/C = OPEN CIRCUIT S/C = SHORT CIRCUIT ALL VOLTAGES ARE WITH RESPECT TO EARTH (0 VOLTS) UNLESS OTHERWISE STATED



CAR CONVERSION FOR TOWING

By J.J.A.TENNANT

THOUSANDS of motorists today tow a boat, caravan or some form of trailer. In order to do this, their cars have been fitted with a towing bracket that strengthens the vehicle and takes the universal 50mm tow-ball.

The cars have also been converted to provide outputs for the rear brake and direction indicator lights of the towed vehicle. It is normal practice and legally necessary, for vehicles registered after 1965, to operate all direction indicator lamps—that is, front and back on the vehicle as well as the tow and this normally means the provision of a special heavy duty flasher unit.

This article describes a simple method of electrical conversion for tow indicators that can be completed in a few hours, using a minimum of components and giving warning lights.

WIRING OF TOWED VEHICLE

In general, the tow will be acquired with all lights and wiring fitted and, if modern, will be wired as Fig. 1 to the international standard with a seven pin plug (PL1). If the tow has no lights, approved patterns must be obtained from most garages and, although any wiring system could be adopted, it is strongly advised that the standard system is followed.

CAR CONVERSION

The standard seven pin socket (SK1) should be fitted to the car as close to the tow point as practicable and wired as Fig. 2, the main earth wire (white—pin 31) being taken to a good clean chassis connection. The car wiring cable form should be examined at the branch point to find the red wire to the side lights and a wire connected from this lead (preferably to the snap connectors at the lights themselves) to pins 58 and 58C. Also find the green/purple trace lead to the brake stop lights and connect this to pin 54.

DIRECTION INDICATOR WARNING LAMPS

Reference to the car wiring diagram will indicate a point at which a heavy duty connection can be made after the ignition switch (Fig. 3). A lead is taken from this point through fuse FS3 to pin 54G, SK1 (internal lighting auxiliary supply) and also to the warning lamp unit fitted to the dash or on a small panel.

AUXILIARY WARNING LAMP UNIT

The resistors R3 and R4 (Fig. 3) are chosen to drop approximately 1 volt when carrying the full indicator lamp current, i.e. $1\frac{1}{2}$ amps for 18W lamps on a 12 volt supply. The value of approximately $\frac{3}{4}$ ohm is made up of a 0·68 ohm 1 watt wire wound resistor. Transistors TR1 and TR2 are *npn* types capable of carrying the full switch on warning lamp current of 800mA and are bottomed by the voltage across R3, R4 and so operate the warning lamps LP1 and LP2 which are 12V 2·2W types. These are placed in series with resistors R1 and R2 to limit the lamp current to approx. $\frac{3}{4}$ normal rating to increase lamp life.

SWITCHING UNIT

The main tow indicator lamps are switched with transistors TR3 and TR4 which are *pnp* power types. Since the lamp switch on current is several times greater than the normal current, it is necessary to select a transistor of adequate current rating, i.e. 6 amps.

TR3 and TR4 are bottomed by a signal current taken from the standard wiring of the car and do not require large heat sinks: the base current is the lamp current, i.e. $1\frac{1}{2}$ amps, divided by the gain of the transistor; if this is of the order of 30, the additional load of 50 milliamps on the car flasher unit does not materially affect its performance.

If only low gain transistors are available then two Darlington pair configurations can be employed in place of TR3 and TR4. Transistors TR3 and TR4 should be totally insulated from the car chassis, mounted in a small box equipped with fuses and fitted close to SK1.

The base leads are taken to the car wiring cable form (at the rear indicator lamps), the left or nearside indicator being green/red trace and right or offside indicator being green/white trace.

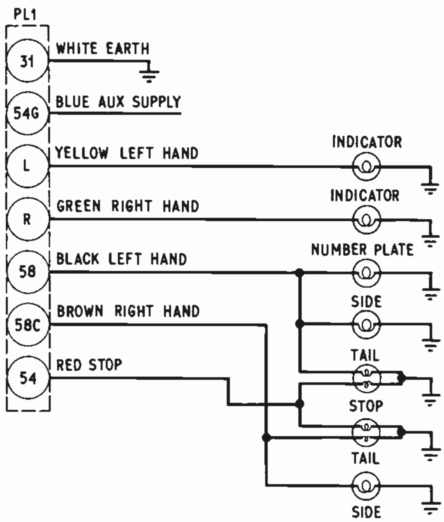


Fig. 1. Wiring diagram for the tow. All wiring should be carried out using heavy duty insulated connecting wire

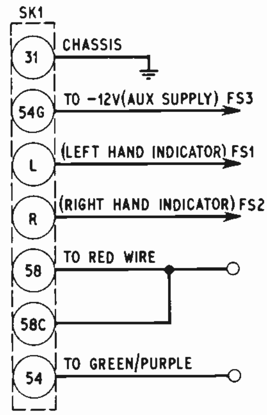


Fig. 2. Connections between SK1 and the car wiring loom. As in Fig. 1 heavy duty wire must be used

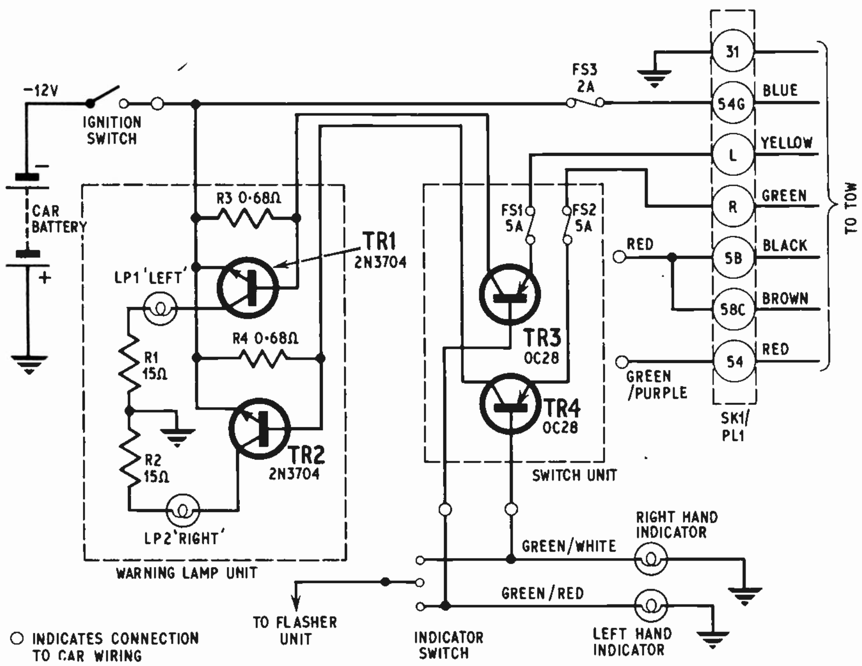
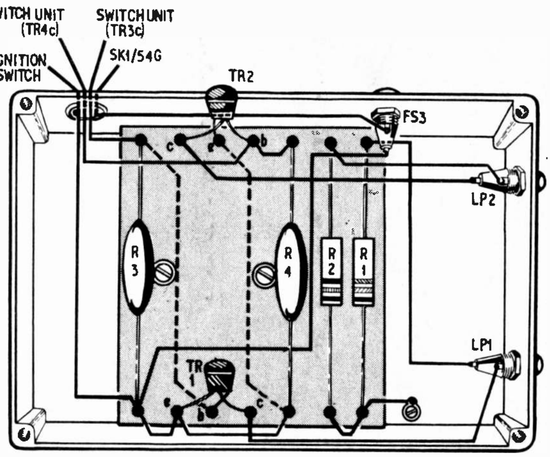


Fig. 3. Complete circuit diagram of the car conversion for towing. This circuit is for positive earth 12V car systems



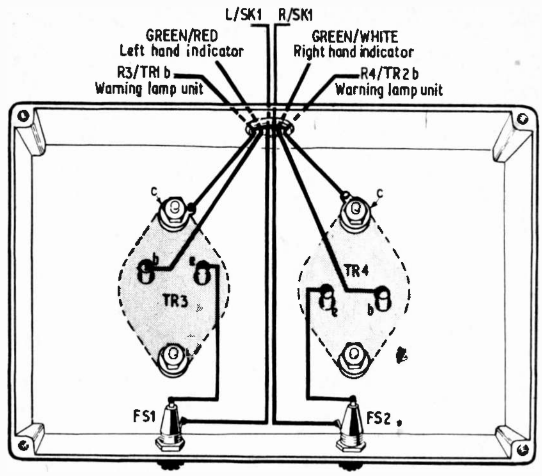


Fig. 4. Warning lamp circuit, layout and wiring diagram *Fig. 5. Switch unit circuit, layout and wiring diagram*

COMPONENTS . . .

Resistors
- R1 15Ω ¼W ±10%
- R2 15Ω ¼W ±10%
- R3 0·68Ω 1W
- R4 0·68Ω 1W

Transistors
- TR1 2N3704
- TR2 2N3704
- TR3 OC28 or equivalent
- TR4 OC28 or equivalent

Fuses
- FS1 Miniature fuse holder and 5A fuse
- FS2 Miniature fuse holder and 5A fuse
- FS3 Miniature fuse holder and 2A fuse

Miscellaneous
- LP1, 2 12V 2·2W bulbs and holders
- SK1/PL1 seven way plug and socket (standard tow connecting type)
- Seven way tagboard
- Transistor insulating kit for OC28 (2 off)
- Die cast case 4·25in × 2·25in × 1in (2 off)
- 4B.A. fixings
- Heavy duty insulated connecting wire
- ⅜in grommets (2 off)

CONSTRUCTION

Both the warning lamp unit and the switch unit can be housed in small die cast cases. It is important that the warning lamp unit is earthed to the car chassis and that TR3 and TR4 are completely insulated from the chassis and die cast case.

The warning lamp circuit is constructed on a seven way tagboard as shown in Fig. 4. The wiring between the ignition switch, the switch unit, FS3 and SK1 should be made with wire capable of carrying 7 amps.

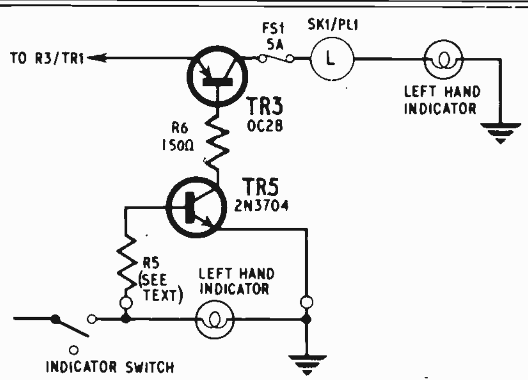


Fig. 6. Circuit for negative earth 12V car systems to be used when alternative transistors are not available

The tagboard is fixed inside the die cast case, by two 4B.A. fixings, on ¼in. spacers. The complete unit must be mounted in view of the driver so that LP1 and LP2 are visible.

The switch unit is also housed in a small die cast case to which TR3 and TR4 are mounted via insulating washers (Fig. 5). Wiring from TR3, TR4, FS1 and FS2 must be of heavy duty wire as indicated previously. When complete the case should be mounted near SK1 and the rear indicator lamps in a position such as that FS1 and FS2 can be easily replaced.

The cases (collectors) of TR3 and TR4 must never be shorted to earth and this should be remembered when siting the switch unit; stray tools inside the car boot could easily short the unit if TR3 and TR4 are exposed.

CARS WITH NEGATIVE EARTH

In general the wiring system for negative earth cars is identical with the above and if suitable inverse type transistors can be obtained (ACY19 for TR1 and TR2, 2N3055 for TR3 and TR4) the system can be copied. However, only *pnp* type power transistors may be available, in which case the wiring to the switch transistors must be as shown in Fig. 6. The base of TR3 is connected to earth (−ve) via R6 by the action of TR5 which is turned on by the voltage across the car direction indicator lamp when on. R5 is adjusted to allow TR3 to bottom. TR4 must be connected up in a similar manner. ★

SUPER BARGAIN STOCKTAKING SALE!!!

Use the form below for your order. **CONDENSERS MUST BE ORDERED BY STOCK NUMBER ONLY.** If any sale item is "sold-out" when order received we shall substitute items of equal value.

ELECTROLYTIC CAPACITORS

Stock No.	Capacity	Voltage	Price	No. Req'd	£ s. d.
1	1μF	6	4d		
2	4μF	25	4d		
3	4μF	4	4d		
4	6μF	6	4d		
6	64μF	9	4d		
7	20μF	6	4d		
11	8μF	6	4d		
16	32	150	9d		
17	64	2·5	3d		
18	100/200/200/50	275	7/6		
19	50/80	300	3/-		
21	24	275	1/-		
22	10	25	3d		
23	125	2·5	3d		
25	16/32	350	2/6		
26	32	275	1/6		
28	75/75/75/75	150	2/6		
30	12·5	40	9d		
32	3,000	35	7/6		
33	3,000	15	3/-		
34	3,000	30	7/-		
35	250	70	2/-		
36	2,500	9	2/-		
38	750	12	1/9		
39	100μF	275	2/6		
40	30μF	10	3d		
42	16μF	50REV	2/-		
43	16/16	275	2/-		
44	16	275	1/-		

Stock No.	Capacity	Voltage	Price	No. Req'd	£ s. d.
45	350	12	9d		
46	20/4	275	1/-		
47	250	50	2/-		
48	500	25	1/6		
49	400	15	1/-		
50	400	2·5	3d		
51	64	275	1/9		
52	32/32	350	2/6		
53	8/8/8	275	1/9		
54	500	6	6d		
55	64	275	1/3		
56	25	6	3d		
57	100	9	6d		
58	400	50	2/-		
59	400	30	1/6		
60	500	4	3d		
61	150	30	1/6		
62	64/32/8	275	2/6		
64	40	6·4	3d		
67	30	6	3d		
68	100/100/50	275	5/-		
69	50/50/50	350	4/-		
70	40/40/20	275	2/-		
71	400	6·4	3d		
72	320	10	3d		
73	32/32 +25	275 25	2/6		

Total:—

RESISTORS. EXCELLENT QUALITY. MAINLY 5%. 7/6 per 100 of any one value.
2/- per dozen of any one value. Smaller quantities 3d each.
Tick the values required.

13 ohms	220 ohms	1·5kΩ	3·6kΩ	7·5kΩ	22kΩ	39kΩ	62kΩ	130kΩ	560kΩ	1·8MΩ	7·5MΩ
22 ohms	470 ohms	1·8kΩ	4·3kΩ	10kΩ	24kΩ	43kΩ	75kΩ	360kΩ	620kΩ	3·6MΩ	8·2MΩ
36 ohms	560 ohms	2·2kΩ	4·7kΩ	16kΩ	27kΩ	47kΩ	82kΩ	430kΩ	1·2MΩ	5·1MΩ	9·1MΩ
47 ohms	750 ohms	2·4kΩ	5·6kΩ	18kΩ	30kΩ	51kΩ	91kΩ	470kΩ	1·5MΩ	6·2MΩ	10MΩ
91 ohms	1kΩ	3·3kΩ	6·8kΩ								

or our selection (mixed) 6/6 per 100

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS. 10/- per 100 of any one value. **3/-** per dozen of any one value. Smaller quantities **6d** each.
As available. In following values. Tick those required.

2pF	5pF	12pF	25pF	50pF	80pF	135pF	180pF	250pF	680pF	1,000pF	2,500pF
3·9pF	6pF	15pF	27pF	58pF	82pF	140pF	190pF	330pF	800pF	1,100pF	2,700pF
4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	500pF	820pF	1,500pF	3,000pF
4·7pF	10pF	22pF	39pF	72pF	125pF	170pF	240pF	600pF	900pF	2,200pF	6,200pF

Total:

COMPARE THESE PRICES!!

MULLARD POLYESTER CONDENSERS

	No.	Price
1,000 pF 3d ea. 400V		
1,500 pF 3d ea.		
1,800 pF 3d ea.		
2,200 pF 3d ea.		
0·15 μF 6d ea. 160V		
0·22 μF 6d ea. 160V		
0·27 μF 6d ea. 160V		
1 μF 1/- ea. 125V		

Total:

25% discount lots of 100 per type.
50% discount lots of 1,000 per type.

TRANSISTOR BARGAIN! THEY CAN'T GET ANY CHEAPER!!!
P.N.P. Audio, Untested, unmarked. MAINLY O.K., **10/-** per 100.
N.P.N. Silicon. R.F. types, unmarked. ALL USABLE, **10/-** per 50.
POWER OUTPUT (Similar OC35) ALL TESTED, **4/-** ea; **£2** doz.

SILICON PLANAR TRANSISTORS. ALL TESTED. NO LEAKS OR SHORTS
Gain of 20/50, **6d** ea.; 50/100, **9d** ea.; 100/200, **1/-** ea.

LIGHT SENSITIVE TRANSISTORS. 2/- each.

LIGHT SENSITIVE DIODES. Can be used to control any transistorised device. **1/-** each. **75/-** per 100. **£25** per 1,000.

THYRISTORS 5CR51 (10A), **£1** ea.

RECTIFIERS Latest type. All marked. 800V peak, 1A mean current type IN4006
2/6 ea., **24/-** doz, **£7/10/-** 100.
S.T.C. 3/4 (400V), **2/6** ea., **24/-** doz, **£7/10/-** 100.
BYZ 13 or 19 (6A), **2/6** ea., **24/-** doz, **£7/10/-** 100.
BY127, 2/6 each. **24/-** dozen. **£7/10/-** per 100. **£50** per 1,000

RECORDING TAPE GIVE-AWAY!
ALL BRITISH MADE, BEST QUALITY!
5in Standard **7/6**. 5¾in Standard **9/-**. 5¾in Long-play **12/-**. 7in Standard **12/-**. 7in Long-play **16/3**. 3in "Odd-ends" Minimum 150ft **2/3**.

MAINS DROPPER TYPE RESISTORS. Hundreds of types from 0·7 ohm upwards. 1W to 50W. A large percentage of these are Multi-tapped droppers for radio/television. Owing to the huge variety these can only be offered "assorted". **10/-** per dozen.

GIANT SELENIUM SOLAR CELLS. Last few to clear at half price! Circular, 67mm diameter **5/-** each. 50mm × 37mm. 3 for **10/-**.

SKELETON PRESETS. Mixed. **6/-** dozen.
VOLUME CONTROLS. ½MΩ, 1MΩ, with D.P. switch. 5k (no switch) all **2/-**.

RECORD PLAYER AMPLIFIERS. All transistor. Complete with screened input lead, volume control and speaker leads. This excellent unit also has built-in rectifier and smoothing components enabling same to be used direct on 6 to 9V a.c. supply. Small number only. Cannot be repeated at this price! **30/-** each.

TRANSISTOR RADIOS. Fantastic bargain! Tremendous value! Superb quality sound from large speaker! Excellent sensitivity! Complete with earpiece, battery and plastic carrying case, all packed in a colourful presentation box. You would expect to pay £5—but our price due to huge purchase is only **37/6!!!**

CO-AXIAL CABLE. Semi-air spaced. **8d** yd 60 yd rolls **30/-**, plus **4/6** postage.
CRYSTAL TAPE-RECORDER MIKES. 12/- each.
CRYSTAL EARPIECES WITH PLUG. 5/- each.
MAGNETIC EARPIECES. No Plug. **1/6** each.
THIN CONNECTING WIRE: 10 yds **1/-**. 100 yds **7/6**. 1,000 yds **50/-**.

RECORD PLAYER CARTRIDGES
ACOS GP67/2, **15/-** (Mono)
GP91/3, **20/-** (Compatible)
GP93/1, **25/-** (Stereo)
GP94/1, **30/-** (Stereo, ceramic)
GP93/1 with diamond needle, **32/6**
GP94/1 with diamond needle, **37/6**

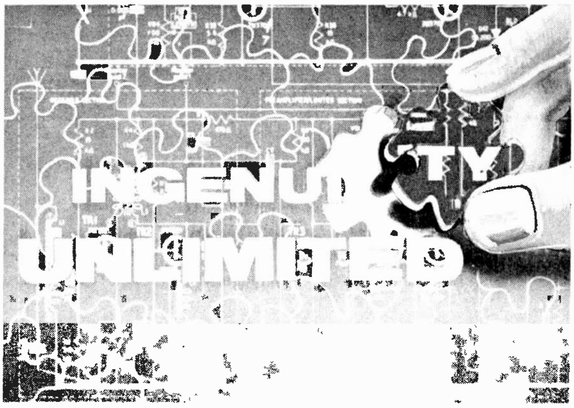
TRANSISTORISED FLUORESCENT LIGHTS. 12V.
8W 12in tube, Reflector type, **59/6**
15W 18 in tube, Batten type, **79/6**
Complete with tube. Postage **3/-**

TRANSISTORISED SIGNAL INJECTOR KIT 10/-
TRANSISTORISED SIGNAL TRACER KIT 10/-
TRANSISTORISED REV. COUNTER (CAR) 10/-
(State Positive or Negative earth)

VERO-BOARD
2½ × 1 × 0·15in, **1/3**
3¾ × 2½ × 0·15 in, **3/3**
3¾ × 3¾ × 0·15in, **3/11**
5 × 2½ × 0·15in, **3/11**
5 × 3¾ × 0·15in, **5/6**
17 × 2½ × 0·15in, **11/-**
17 × 3¾ × 0·15in, **14/8**
3¾ × 2½ × 0·1in, **4/2**
3¾ × 3¾ × 0·1in, **4/9**
5 × 2½ × 0·1in, **4/7**
5 × 3¾ × 0·1in, **5/6**
Spot Face Cutter **7/-**. Pin Insert Tool, **9/6**.
Terminal Pins, **3/6** for 36.
Spot Face Cutter and 5 2½ × 1in boards, **9/9**.

These prices cannot be repeated. Order now. Don't forget to add your name and address! Please include suitable amount to cover post and packing. Minimum 2/-.

G. F. MILWARD - DRAYTON BASSETT - Nr. TAMWORTH, STAFFS - Phone TAMWORTH 2321



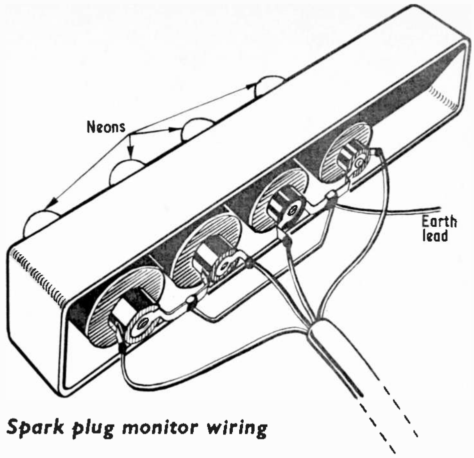


Fig. 1. Spark plug monitor wiring

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

SPARK PLUG MONITOR

ANYONE who has ever ventured out in a small craft with a two stroke outboard engine, will know that one of the most common annoyances occurs if the spark plugs oil up or break down, possibly leaving one "stranded" in an awkward location; it is, however, a simple matter to monitor the plugs whilst the engine is running and can save considerable time, as well as increasing safety to have such a device on board.

By using a spark plug monitor on any multi cylinder engine, considerable time can be saved if ignition troubles occur, the guilty cylinder showing itself immediately.

Let us assume that the engine to be monitored has four spark plugs (e.g. ordinary motor car). If we wish to monitor all four plugs we will require four low voltage neons (NT2's) and several feet of four-core cable. The neons are first soldered into standard type holders as shown in Fig. 1 and the four holders located on a suitable panel. The neons are marked 1 to 4 to correspond to the cylinder being monitored.

One side of each neon is grounded to the car chassis either via the mounting panel or directly (a good earth connection must be made). The other side of each neon is connected to one of the cores of the four-core cable. About 12in of the outer casing of the cable at the engine is stripped off and each individual wire is wound around one of the spark plug h.t. leads. About ten turns are required on each cylinder but this may vary with different cars and the exact number is best found by experiment.

When the engine is running the neons will glow steadily but in the event of failure to spark of one or more of the plugs the neon corresponding to the plug at fault will flicker erratically.

D. W. Nelson,
Merstham, Surrey.

TREMOLO UNIT

I ENCLOSE details of a tremolo unit which I have designed and which your readers may be interested in.

In the circuit, Fig. 1, transistors TR1 and TR2 form an astable multivibrator whose frequency can be varied by VR1, between approximately 5Hz and 0·2Hz. The resulting square wave appearing at the collector of TR2 is fed to VR2. The output from VR2 (depth control) is fed to TR3 base which switches the transistor on and off.

The collector emitter junction of TR3 acts as a variable resistor in the potential divider circuit between input and output thus varying the output, the output signal being proportional to the base emitter voltage of TR3. Capacitors C3 and C4 remove the harmonics from the square wave which would otherwise cause clicks in the output.

This circuit has three main advantages over other tremolo units. Firstly, the unpleasant "thump" often heard in tremolo units is supressed by C3 and C4 without the necessity for complex filtering circuits.

When the power supply is disconnected, the signal passes through the unit unaffected and hence if S1 is a foot switch operated by the instrumentalist, the tremolo can be switched in and out at will.

Finally, the power supply requirements are very modest, and at 9V the current drain is approximately 1mA. The unit works reliably down to about 4V.

Transistors TR1–TR3 were BC108's in the prototype, but any general purpose *npn* silicon transistors should work satisfactorily.

A. T. Barker,
Sheffield.

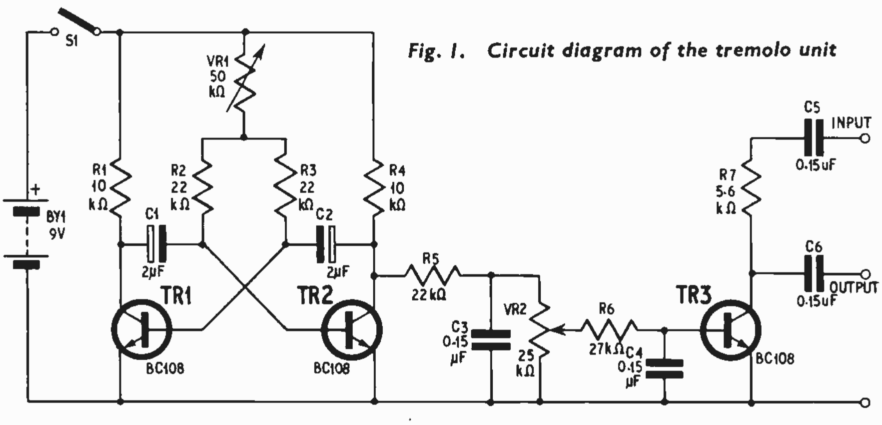


Fig. 1. Circuit diagram of the tremolo unit

20 SOLID STATE PROJECTS FOR THE HOME

by R. M. Marston

18/- Postage 1/-

POWER ENGINEERING USING THYRISTORS VOL. I, by Mullard. 30/-. Postage 1/-.

TRANSISTOR AUDIO AND RADIO CIRCUITS, by Mullard. 30/-. Postage 1/-.

DIGITAL COMPUTER BASICS, by Bureau of Naval Personnel. 19/-. Postage 1/-.

PAL-D COLOUR RECEIVER QUESTIONS & ANSWERS, by K. J. Bohlman. 13/6. Postage 1/-.

PRACTICAL INTEGRATED CIRCUITS, by A. J. McEvoy and McNamara. 18/-. Postage 1/-.

TRANSISTOR MANUAL, by General Electric Company. 21/-. Postage 1/6.

RADIO COMMUNICATION HANDBOOK, by R.S.G.B. 63/-. Postage 4/6.

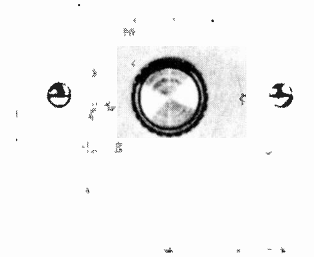
SOLID STATE HOBBY CIRCUITS MANUAL, by R.C.A. 17/6. Postage 1/-.

VHF-UHF MANUAL, by G. R. Jessop. 21/-. Postage 1/6.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST
of British and American Technical Books
19-21 PRAED STREET
LONDON, W.2
Phone: PADdington 4185
Closed Saturday 1 p.m.

DIMMASWITCH



This is an attractive dimmer unit which fits in place of the normal wall light switch. The mounting plate is ivory to match modern fittings and the control knob is in bright chrome. An ON/OFF switch is incorporated to control up to 500 watts at mains voltages from 200-250 volts, 50 Hz.

These are normally sold at £4 19s. 6d.—our price is £3 5s. We also offer at £2 15s. a complete kit of parts with simple instructions enabling you to build this dimmer yourself.

The circuit uses the latest miniature RCA triac and new diac triggering device to give complete reliability. Radio interference suppression is included.

DEXTER & COMPANY

ULVER HOUSE, 19 KING STREET
CHESTER CH1 2AH
Chester 25883

STEPHENS ELECTRONICS

P.O. BOX 26 AYLESBURY BUCKS.

Send S.A.E. for Lists
Terms of business cash with order

CATHODE RAY TUBES

Rebuilt: 17in. **£4**, 19in. **£4.10**, 21in. **£5.10**, 23in. **£6.**
Twin Panel: 19in. **£7.15**, 23in. **£10.19.6.**
New: 17in. **£5.19.6**, 19in. **£6.19.6**, 21in. **£7.19.6**, 23in. **£9.10.**
Twin panel: 19in. **£9.10**, 23in. **£12.**
Panorama: 19in. **£8.10**, 23in. **£11.10.**
All tubes covered by 2-year guarantee.
All types in stock. Carr. & ins., 15/-.

ACOS CARTRIDGES

GP91-1 **21/-.** GP91-3 equiv. types (TC8 H and M, BSR X3H, X3M, X5H) **21/-** inc. purchase tax.
GP93-1 Stereo Crystal **24/9**
GP94-1 Stereo Ceramic **31/-**
GP95-1—**24/9**, GP96-1—**31/6**, carr. inc.

SEMICONDUCTORS

AC127	2/6	BC108	5/6	AD149	7/6
AF117	3/-	BC109	5/6	OA79	1/6
AF181	5/6	AC126	3/-	OA81	1/6
BF181	5/6	OC45	2/6	OA91	1/6
BF200	5/6	OC71	2/6	OA95	1/6
AC107	3/-	OC81	2/6	OA200	1/6
AC128	2/6	OC81D	2/6	OA202	1/6
BC107	5/6	BY127	2/6		

Add 5d per item for P. & P. under 24 pieces.

HOME RADIO (Components) LTD., Dept. PE, 234-240 London Road, Mitcham, CR4 3HD. Phone 01-648 8422

Why live the HARD way?

We're making life EASY for you!

We've never seen the sense in wasting time and energy tramping round the shops trying to locate components for radio and electronic projects—especially when the British weather turns it into a battle worse than a lone journey across Antarctica! That's why we issue the Home Radio Components Catalogue which for many years has enabled thousands of enthusiasts to order by post. We've built up a mail-order service which for speed and efficiency is second to none. But recently we've gone a step further in making life easy for you. Now you need not even walk round to the post box. With our Credit Account Service you can just telephone—any time of day or night, week-ends included! If your call comes out of shop hours a recording machine takes your message for us to deal with when we open next day.

For full details just drop us a line or 'phone 01-648 8422. After you have availed yourself of the service for 12 months we regularly send an up-to-date catalogue—FREE.

If you've not already got a Home Radio Catalogue, send the coupon with cheque or P.O. for 12/6 (8/6 plus 4/- P. & P.). Even if you don't intend to use our Credit Account Service you certainly need the catalogue—it has 350 pages, lists over 8,000 components and has over 1,500 illustrations!
The price of 12/6 applies only to catalogues purchased by customers residing in the U.K.

Please write Name and Address in block capitals

NAME ....

ADDRESS ....

....

HOME RADIO (COMPONENTS) LTD., Dept. PE
234-240 London Road, Mitcham, Surrey, CR4 3HD

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 shpuld then be made direct to the firm concerned.

LOW-COST ULTRASONIC CLEANER

Virtually unknown only ten years ago, ultrasonic cleaning is now widely used in industry because of its effectiveness in removing even the most tenacious dirt from complex components in a matter of minutes.

Until recently ultrasonic cleaning equipment has only been a viable proposition to industry due to its prohibitive costs and involved filtration units required. But now **Dawe Instruments** have marketed a range of cleaning units which, at less than £100, are within the reach of some workshops, hobbyists, collectors of coins and antiques, jewellers or anyone wishing to clean delicate components.

Known as the Sonicleaner type 6442A it contains a transistorised generator, special transducers and a stainless steel tank of 5 pints (approx. 3 litres) capacity, all housed in a case measuring 7½in × 12in × 9in. The generator incorporates automatic tuning circuits and apart from the 240V mains on/off switch there are no other controls.

Ultrasonic frequencies are used for cleaning because, when applied to a liquid, they give rise to the continuous creation and collapse of millions of microscopic vapour bubbles. This so-called cavitation results in very intense although hardly visible agitation of the liquid, which "scrubs" all dirt off any object dipped into it. Because cavitation affects all surfaces which the liquid can wet, ultrasonics can clean components and assemblies too delicate even for the finest brush.

Ordinary water is adequate for many cleaning jobs and a little household detergent can cope with most stains or grease. Other types of unwanted particles can be removed with any appropriate liquid solvent.

Full details and cost of the Sonicleaner type 6442A can be obtained from Dawe Instruments Ltd., Concord Road, Western Avenue, London, W.3.

Sonicleaner type 6442A marketed by Dawe Instruments

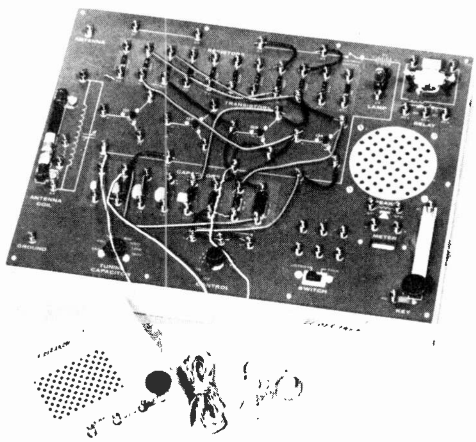
BEGINNERS' EXPERIMENTAL CONSTRUCTION KIT

A new experimentation course in basic electronics for beginners has just been introduced by Heathkit. Designated the Heathkit JK-18, it features 35 experiments using the "learn-by-doing" technique, ranging from a transistor tester to a simple electronic organ.

All parts are mounted on a "breadboard" and then various circuits are constructed according to instructions by connecting them with ordinary wire, provided in the kit. For speed and easy circuit assembly, solderless spring-clip connectors are used throughout.

Supplied with the kit is an illustrated manual which describes the operation of the circuit for each experiment. All parts used in any experiment are identified by both a pictorial diagram and the standard schematic symbol, so that the experimenter can learn how to read circuit diagrams. The manual also includes a dictionary of common electronic terms, and the international morse code.

The Heathkit JK-18 is available at most component shops or direct from **Daystrom Ltd.**, Heathkit Division, Gloucester, price £13 18s, plus 5s carriage charge.



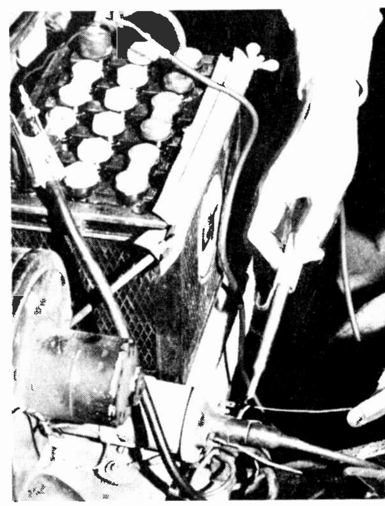
Heathkit JK-18 junior experimenter's constructional kit

LOW VOLTAGE IRON

Of particular interest to our seafaring and motoring readers is the new **Adcola** Model L107 low voltage soldering iron.

Ideal for temporary electrical repairs on the boat and when the car breaks down miles from anywhere, low voltage irons have in the past suffered from lack of sufficient power output. However, the model L107 is rated at 27 watts, which we found ideal when tested in our workshop.

The L107 iron is fitted with 12ft of cable with suitable large battery clips attached and operates from a 12V car battery. The recommended retail price is 49s 6d.



Miniature 12V 27W soldering iron from Adcola

If readers have any difficulty in obtaining the iron, details of local stockists can be obtained from Adcola Products Ltd., Adcola House, Gauden Road, London, S.W.4.

TAPE SPLICER

With the increasing popularity of cassette tape recorders **Multicore Solders** have introduced the Bib Model 24 tape splicing kit. The kit is contained in a plastics wallet; the block has a ⅛in channel and is fitted with chromium plated clamps for holding the tape when making diagonal or butt splices. Also included in the kit is a razor cutter,

Bib Model 24 cassette tape splicer kit by Multicore Solders

Selection of audio components marketed by Ré-An Products

Alarm equipment manufactured by Digitation

tape marker, a device for withdrawing the tape from the cassette and of course, a reel of splicing tape.

Believed to be the first marketed for ⅛in tape, the kit is intended for use in joining tape, editing, and is particularly useful when the recording has been made to be synchronised with cine films or slides. The playing time of pre-recorded cassettes can be extended.

The recommended retail price of the Bib Model 24 tape splicer kit is 29s.

Adding still further to their range of Bib tape accessories, Multicore have also introduced the Bib "Five" Tape Cassette Case, designed for easy storage of tape cassettes.

The case holds five cassettes and is a convenient size for keeping in the car, and for storing in the home. Made from p.v.c. it has a clear hinged top, through which cassette titles can easily be read.

Available from audio dealers and music shops the cassette case costs 5s 11d, including purchase tax.

AUDIO COMPONENTS

Readers who are building their own electric guitars and audio equipment may be interested in the range of miniature components available from **Ré-An Products.**

Among their range of components are special "off-set" switches, ideal for solid body guitars where the amount of depth is limited. Other products include miniature jack plugs and sockets, control knobs, trimmers and slide switches, etc.

Full particulars can be obtained from Ré-An Products Ltd., Burnham Road, Dartford, Kent.

BURGLAR ALARM

A new range of burglar alarms for the home has just been announced by **Digitation Ltd.** Three basic models are available and various other versions which operate from a "standby" battery supply, including a car alarm version.

The basic kits contain a control box housing a printed circuit board and associated circuitry, a 3in alarm bell and bell transformer, miniature magnetic detector switches, sufficient cable to connect all units and a comprehensive booklet covering the installation and operation of the system.

Kits are available for use with both magnetic switches (magnet and reed switch) and pressure pads, and for use with infra-red beam units. Extra magnetic switches, complete with mounting accessories, and a 6in alarm bell can be supplied at an additional cost.

The price of the basic kits vary from £19 10s to £30. Details can be obtained from Digitation Ltd., 117 Church Lane, Rickmansworth, Herts. Callers can view the alarms at Digitation's Installation Department, Page and Girling Works, 111 Midhurst Road, West Ealing, London, W.13.

LITERATURE

The new 464-page edition of the 1970 Electroniques Constructor's Catalogue is now available from **Electroniques,** Edinburgh Way, Harlow, Essex, price 10s plus 3s postage and packing, or from local components dealers.

Apart from the exhaustive range of S.T.C. components and numerous other manufacturers' items, the section on educational kits should be of interest to readers. These kits are known as Knight Mini-Kits, and range from a 2-pole motor kit to a telegraph key, buzzer and bell kit. Also available is a 100-in-1 Electronic Science Lab kit.

The fourth edition of the **Motorola** Semiconductor Data Book is now available through the **Modern Book Co.,** 19 Praed Street, London, W.2.

This latest 2,160-page edition has been re-designed and given a better layout, making it far easier to locate particular devices. Instead of a number of product categories, discrete device specifications are presented in alpha-numeric sequence in three major sections, namely: 1N, 2N and 3N prefixed devices; and Motorola's own numbered types. A short form specification is given with all devices listed.

To enable particular application requirements to be directly related to semiconductor device numbers, a 50-page selection guide is included.

The Motorola Semiconductor Data Book costs £3, plus 6s postage.

CHEAP TRANSISTORS

WEL Components Ltd. have recently reduced their price of 2N2926 transistors.

The device is colour coded to achieve tight gain spread with five gain selections:

h_{FE}:	35–70	55–110	90–180
Colour	Brown	Red	Orange
	150–300	235–470	
	Yellow	Green	

Further data and information is obtainable from WEL Components Ltd., 5 Lovelock Road, Reading, Berks.

P.E. ANALOGUE COMPUTER KIT

Readers and educational establishments who have begun or are contemplating the construction of the PEAC computer, and are having difficulty in obtaining components, might contact **Linstead Electronics,** who will be pleased to quote for complete kits. They emphasise that they will only undertake this service if there is sufficient demand. Enquiries should be made in writing, to Linstead Electronics at Roslyn Road, Braemar Road, London, N.15.

Complete stereo system – £29.10.0

These 5 items can be purchased together for £29.10 + P.&P. £1.10

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.

Type 1 SPECIFICATION:–
Impedance 3, 8 or 15 ohms (state requirement), high flux 6″ × 4″ speaker and 2½″ tweeter. Teak finish 12″ × 6¾″ × 5½″. **4 guineas** each. 7/6d. p. & p. **Type 2** as type 1. Size 17¼″ × 10¾″ × 6½″. Incorporating 10½″ × 6½″ bass unit and 2½″ tweeter. 3 ohms impedance **£6.6.0** plus 15/- p. & p.

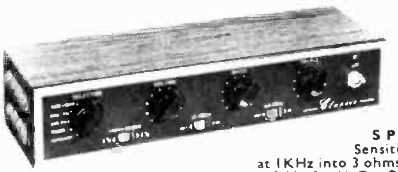
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto Integrated Transistor Stereo Amplifier **£9.10.0** plus 7/6d. p. & p.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.

SPECIFICATION:–
R.M.S. power output: 3 watts per channel into 10 ohms speakers.
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on/off switch. A preset balance control.

The Classic



Teak finished case

£9

Plus P. & P. 7/6

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2 mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range: Bass:* 13dB at 60Hz. *Treble:* ±14dB at 15KHz. *Total Distortion:* (for 10 watt output) < 1·5%. Signal Noise: < –60dB. A.C. Mains 200–250V. Size 12½in long, 4½in deep, 2¾in high. **Built and tested.**

The Viscount

INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFER

£14.5.0

Plus P. & P. 7/6

SPECIFICATION: *Output:* 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). *Input:* 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1·8M ohm. *Frequency Response:* 40Hz–20KHz ±2dB. *Tone Controls:* Separate bass and treble controls. *Treble* 13dB lift and cut [at 15KHz]. *Bass:* 15dB lift and 25dB cut [at 60Hz]. *Volume Controls:* Separate for each channel. *A.C. Mains Input:* 200–240V, 50–60Hz. *Size:* 12½ × 6in × 2¾in teak-finished case. Built and tested. P. & P. 7/6. **Viscount Mark II** for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum outputs of 4mV/cm/sec. at 1kc. Input Impedance 47k. **15 gns.** plus 7/6 P. & P.

THE RELIANT Mk. II

SOLID STATE GENERAL PURPOSE AMPLIFIER

£6.16.0 Plus P. & P. 7/6

In teak finished case

SPECIFICATION: *Output:* 10 watts into a 3 ohms speaker. *Inputs:* (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors:* 4 silicon and three germanium. *Moins input:* 220/250 volts. *Size:* 10¼ × 4¾ × 2¼in. Mk. I £5.15.0 plus 7/6 P. & P. Less teak finished case.

SPECIAL OFFER

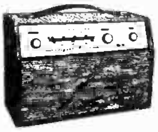
Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 DUO speaker systems size 12 × 6¾ × 5½in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

£25 Plus P. & P. £2

NEW COMPLETE HI-FI STEREO SYSTEM £41

Comprising SP 25 Garrard Mk. II with diamond stereo cartridge or 2025 TC, Viscount amplifier Mk. I, Two type 2 speakers, Plinth and cover. **£41** plus P. & P. £2.10

THE ELEGANT SEVEN Mk. III (350mW Output)

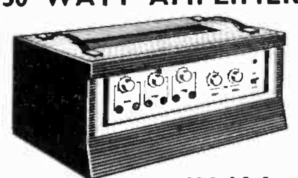


7-transistor fully tunable M.W.-L.W. Superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. **MAINS POWER PACK KIT: 9/6 extra.**

Price £5.5.0 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

50 WATT AMPLIFIER A.C. Mains 200-250V



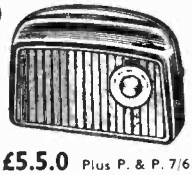
Price £28.10.0

Plus 20/- P. & P.

An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money. **TECHNICAL SPECIFICATIONS** 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES.** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300 mV at 1m. Suitable for most high output instruments (gram, tuner, organ etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost** +12dB at 60 Hz/s. **Bass Cut** –13dB at 60 Hz/s. **Treble Boost** +11dB at 15 KHz/s. **Treble Cut** –12dB at 15KHz/s. With bass and treble controls central –3dB points are 30Hz/s and 20 KHz/s. **POWER OUTPUT.** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sine wave 38·5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3·2% at 1KHz/s. Total distortion at 20 watts 0·15% at 1KHz/s. **NEGATIVE FEED BACK** 20dB at 1KHz/s. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES.** Adjustable from 200–250V. A.C. 50–60Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

THE DORSET (600mW Output)

7-transistor fully tunable M.W.-L.W. Superhet portable with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in.
MAINS POWER PACK KIT: 9/6 extra.



£5.5.0 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

RADIO & TV COMPONENTS
R+TV
(ACTON) LIMITED

RADIO & TV COMPONENTS (ACTON) LTD.

Post orders to:—**21d High Street, Acton, London, W.3**

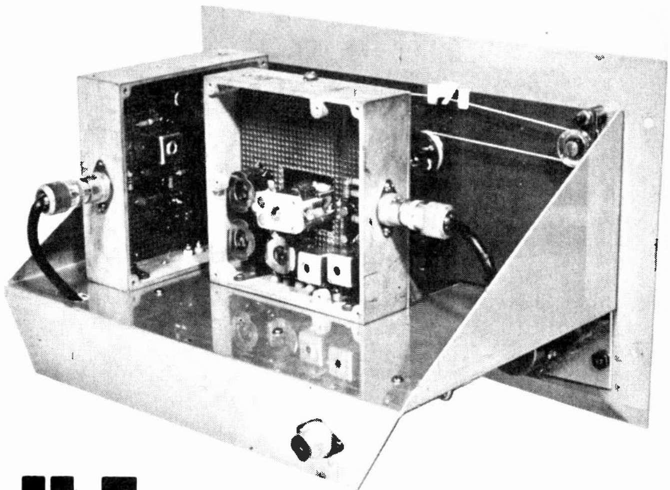
Also at 323 Edgware Road, London, W.2

Goods not despatched outside U.K. **Terms C.W.O.** **All Enquiries S.A.E.**

THE modules described in the following paragraphs form the Local Oscillator Unit for the Main Receiver. This unit is basically a stable signal generator tuning over the frequency range 36 to 64MHz; however, the tuning dial is calibrated from 2MHz to 30MHz indicating the aerial frequency at which the receiver is tuned. This can be readily appreciated by referring to the block schematic of Fig. 8.1. Some constructors may have a variable oscillator of the required frequency range and this can be used, instead of the local oscillator unit, to supply the main receiver.

The local oscillator unit comprises three modules and a main chassis. The modules are:

(a) Variable oscillator module, 2 to 30MHz, split into five ranges (A to E).
(b) Crystal oscillator, 34MHz.
(c) A combined mixer and high pass filter.



P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD. PART EIGHT LOCAL OSCILLATOR

VARIABLE OSCILLATOR MODULE

A two stage emitter coupled L.C. oscillator circuit forms the basis of the variable oscillator module (Fig. 8.2) using TR1 and TR2. The collector load comprises the tuning coils L1 to L5 and a variable capacitor, VC1. Each range is tuned in approximately a 1·6 to 1 ratio by VC1 but this ratio varies slightly due to the effect of stray capacity. The output tunes over the range 2 to 30MHz and is fed into the mixer module via SK1 to the base of TR7 (Fig. 8.4).

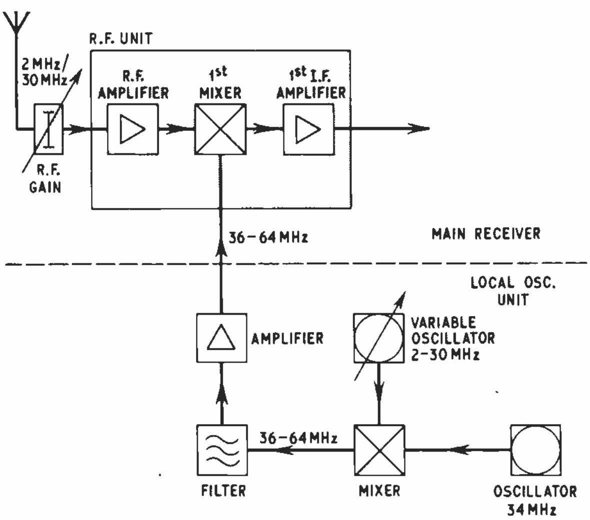
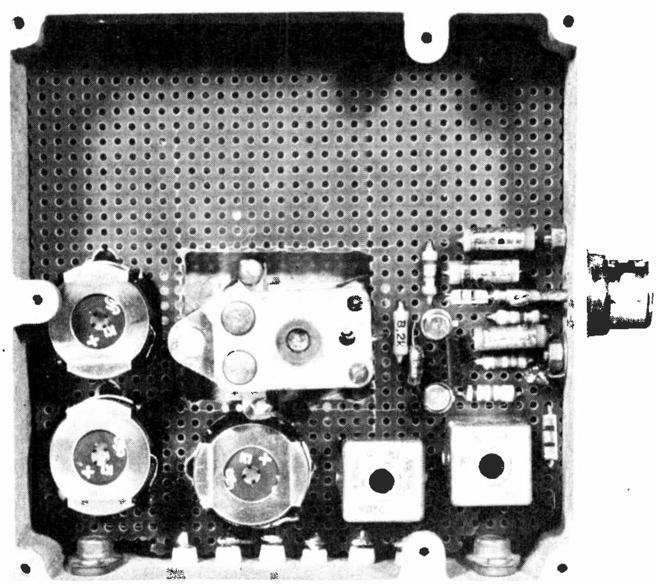


Fig. 8.1. Block schematic diagram of the local oscillator unit



Variable Oscillator Module

VARIABLE OSCILLATOR

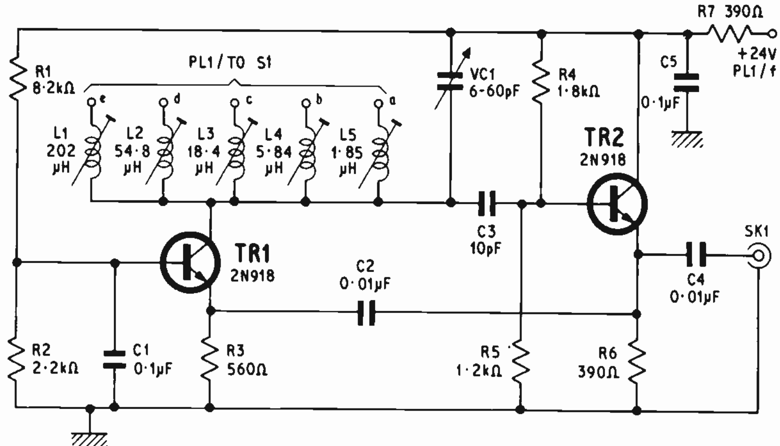


Fig. 8.2. Variable oscillator module circuit diagram

CRYSTAL OSCILLATOR

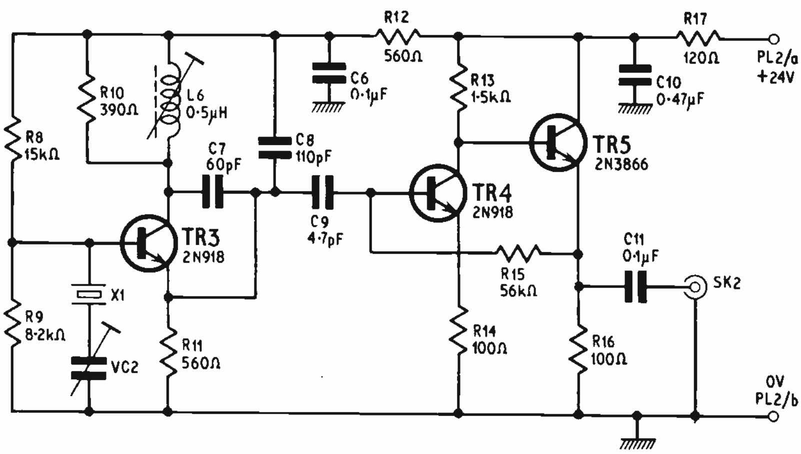


Fig. 8.3. Crystal oscillator module circuit diagram

MIXER AND FILTER

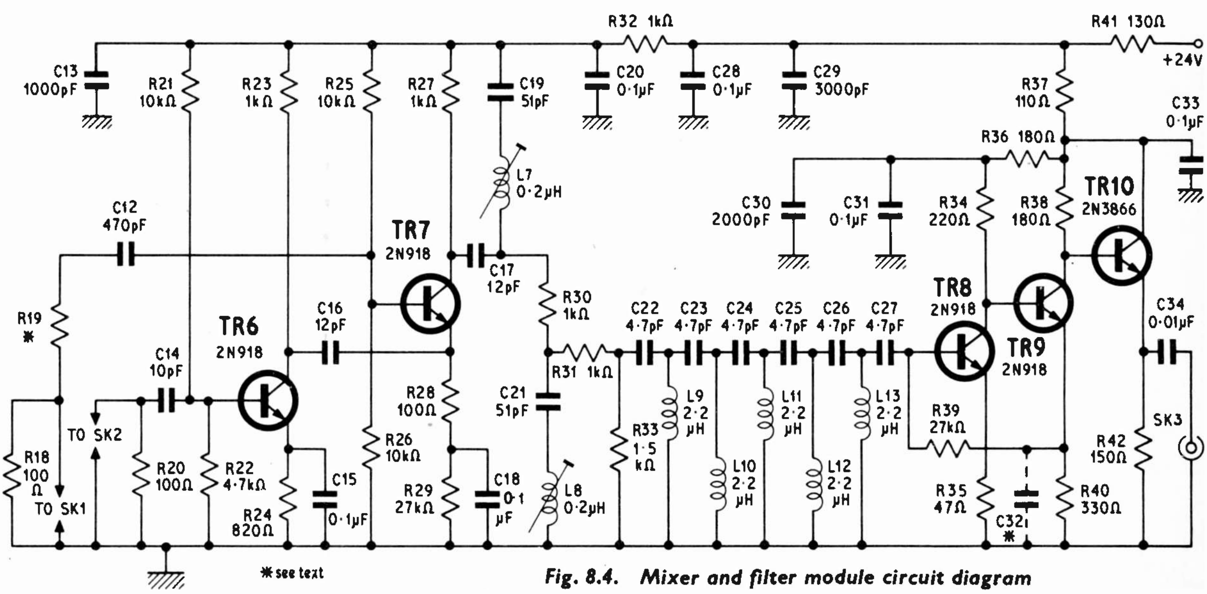
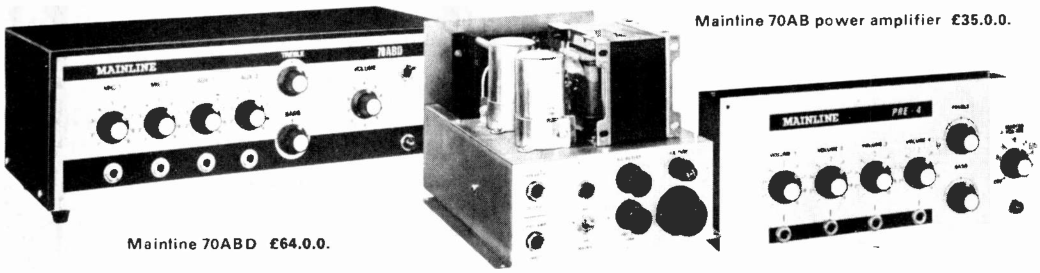


Fig. 8.4. Mixer and filter module circuit diagram

Mainline set the NEW standard in amplifiers



Mainline 70AB power amplifier £35.0.0.

Mainline 70ABD £64.0.0.

Mainline Pre-4 mixer pre-amp control unit £24.0.0.

Mainline 70ABD

The 70ABD is a fully integrated Preamplifier and Power Amplifier to the specifications of the Pre-4 and 70AB. Size $6\frac{3}{4}'' \times 15\frac{1}{2}'' \times 4\frac{3}{4}''$.

***Recommended Retail Price* £64.0.0.**

Mainline 70AB power amplifier

The MAINLINE 70AB is a high fidelity power amplifier, which is in every respect one of the finest units available on the market today, regardless of price. One of the main features of this remarkable amplifier is its elaborate protection against short and open circuit, and we can guarantee that it is virtually indestructible. Allied to this is the very high power output (70 watts RMS) a frequency range that is superb, and distortion well below 1% even at full output. The unit is suitable for use in discotheques, groups, P.A., etc., or anywhere that high quality, high output is required. Coupled to our Pre-4 Control Unit the results are quite remarkable. The Mainline 70AB main amplifier can be used with any other good quality control unit.

Specification

POWER OUTPUT 70 watts RMS ±1 db at 8 OHMS.
FREQUENCY RESPONSE 20–20,000 HZ ± 1 db.
SIGNAL/NOISE RATIO—70 db at full output.
HARMONIC DISTORTION less than 5% at full output.
INPUT SENSITIVITY 700 mV at 20–30 K OHMS.
SIZE $7'' \cdot 9'' \cdot 6\frac{1}{2}''$.
A.C. FUSE 1·5 amps (British Standard).

***Recommended Retail Price* £35.0.0.**

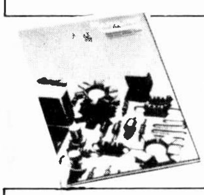
Mainline Pre-4 mixer pre-amp control unit

The MAINLINE Pre-4 is a high quality control unit, which has been designed specifically for use where mixing facilities are essential, and features many facilities not normally found on control units of this type.
The unit has four individual inputs each with its own gain control, plus separate bass, treble and master volume controls, for versatility in use. Inputs 3 and 4 are duplicated on the back panel so that if the unit is panel mounted the two auxiliary inputs (which are suitable for P.U. Tuners, Tape-recorders, etc.) may be connected from the rear. As the Pre-4 is self-powered it can be used with any other Power Amplifier, but has been designed basically as the control unit for our MAINLINE 70AB Amplifier Module.

Specification

INPUTS VOL. 1 8 mV at 50K OHMS (mic).
VOL. 2 8 mV at 50K OHMS (mic).
VOL. 3 50 mV at 500K OHMS (aux).
VOL. 4 50 mV at 500K OHMS (aux).
50 OHM and 600 OHM Mic inputs may be ordered at £2.0.0. extra per Input.
1 or 2 meg OHM aux inputs may be ordered at no extra cost.
FREQUENCY RESPONSE 30–20,000 HZ ± 3 db.
SIGNAL/NOISE RATIO Better than – 65 db.
HARMONIC DISTORTION Less than 5% at 1 volt.
BASS Continuously variable 20 db at 100 HZ.
TREBLE Continuously variable 30 db at 10 KHZ.
SIZE $12\frac{1}{4}'' \cdot 6'' \times 4\frac{1}{4}''$.
CUT OUT REQUIRED $11\frac{1}{4}'' \cdot 5''$.
FUSE 60 ma internally mounted.

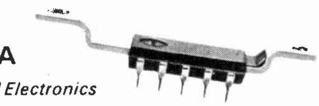
***Recommended Retail Price* £24.0.0.**



5/- stops you paying through the nose for your components

You could be paying too much for your semiconductors and electronic components. One *sure* way of saving money is to buy RCA, IR, SGS, Emihus, Semitron, Keyswitch, Plessey, Morganite, Litesold devices (together with manufacturers' application data) direct from us.

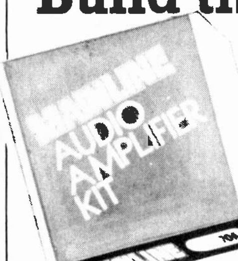
For example :- PLESSEY SL403A



As described in Practical Electronics

Integrated Circuit (Dual in Line Package) Audio Amplifier incorporating its own Pre-Amplifier. A Class A–B Power Amplifier stage capable of delivering up to 3·5 Watts RMS. The SL403A can be used to form the basis of a simple Audio Amplifier using a minimum of external components. Complete with Data Sheet. 44/– each.

Build the NEW Mainline Audio Amplifier Kits-up to 70 watts



The results of the combined resources of SGS and RCA, these Universal Quasi Complementary Symmetry Amplifier kits use rugged NPN Hometaxial base output transistors and provide full power to beyond 20 KHz.

The all silicon circuit with nine transistors and eleven diodes provides outstanding performance for the most stringent requirements of Hi-fi equipment manufacturers.

Each kit is supplied complete with all semiconductors, resistors, capacitors, P.C. board and heat sink.

12A	**£7. 0. 0.**
25A	**£8. 5. 0.**
40A	**£9. 0. 0.**
70A	**£10. 10. 0.**

Any two will make an outstanding stereo equipment.

To: **MAINLINE ELECTRONICS LIMITED, THAMES AVENUE, WINDSOR, BERKSHIRE.**

Please send me .... Mainline Pre-4 mixer pre-amps control unit(s) ☐
Please send me .... Mainline 70AB power amplifier(s) ☐
Please send me .... Mainline 70ABD integrated pre-amp and power amplifier(s) ☐
I am interested in .... Amp Mainline Audio Amplifier kits.
Please send me .... kits ☐ Please send further data ☐
Please send me your price-list guide. I enclose 5/– ☐
Cash or cheques with orders please.
I would like further data on pre-amplifier and power supply kits before I order. ☐

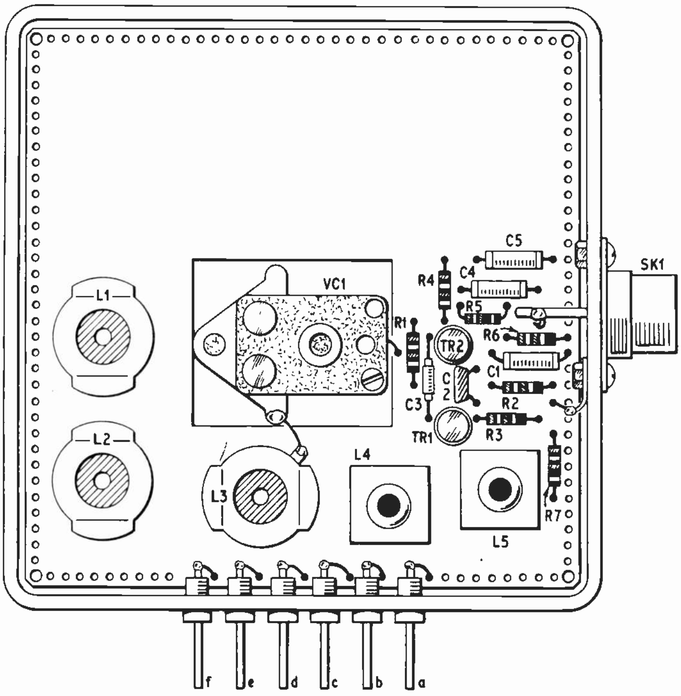
Name ____________________

Address ____________________

____

A member of the ECS Group of Companies P.E. 5/70

VARIABLE OSCILLATOR



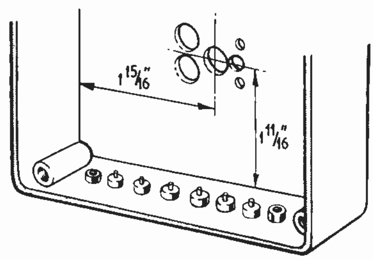


Fig. 8.6. Module case drilling details

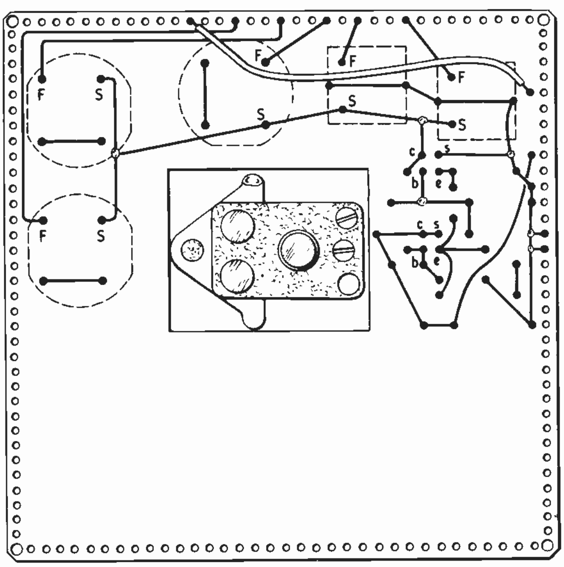


Fig. 8.5. Variable oscillator module layout and wiring

COMPONENTS . . .

Resistors

R1 8·2kΩ
R2 2·2kΩ
R3 560Ω
R4 1·8kΩ
R5 1·2kΩ
R6 390Ω
R7 390Ω
All $\frac{1}{3}$W, 5% high stability, carbon film

Capacitors

C1 0·1μF paper or foil
C2 0·01μF ceramic
C3 10pF mica ±2·5%
C4 0·01μF ceramic
C5 0·1μF paper or foil
VC1 6–60pF twin ganged 3–30pF variable capacitor (wired in parallel)

Transistors

TR1, 2 2N918 (2 off)

Miscellaneous

L1–5 inductors, see Fig. 8.11 (5 off)
SK1 coaxial output socket
PL1/*a-f* lead through connectors (6 off)
Veroboard $3\frac{1}{2}$in × $3\frac{1}{2}$in, 0·1in grid

CRYSTAL OSCILLATOR

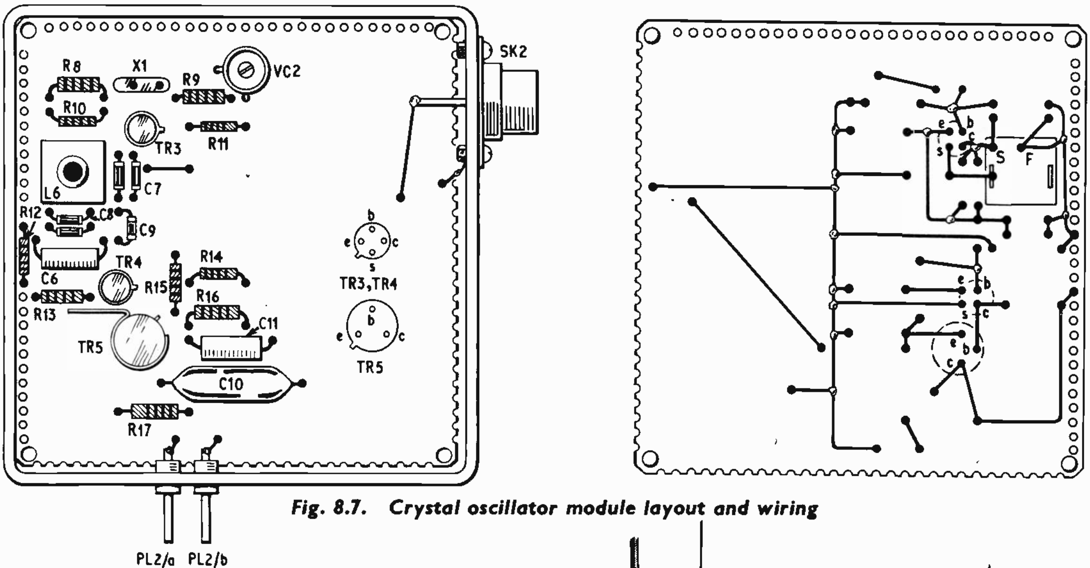


Fig. 8.7. Crystal oscillator module layout and wiring

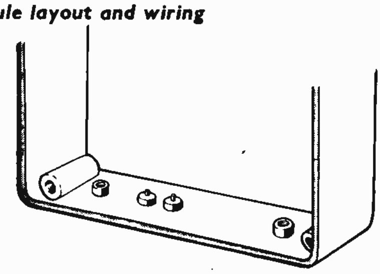


Fig. 8.8. Module case details

COMPONENTS . . .

Resistors

R8	15kΩ	R13	1·5kΩ
R9	8·2kΩ	R14	100Ω
R10	390Ω	R15	56kΩ
R11	560Ω	R16	100Ω
R12	560Ω	R17	120Ω

All $\frac{1}{3}$W, 5% high stability, carbon film

Capacitors

C6	0·1μF polyester or foil
C7	60pF polystyrene ±2·5% (39pF and 22pF in parallel)
C8	110pF polystyrene ±2·5% (100pF and 10pF in parallel)
C9	4·7pF polystyrene ±2·5%
C10	0·47μF polyester or foil
C11	0·1μF polyester or foil
VC2	6–24pF ceramic trimmer

Transistors

TR3, 4 2N918 (2 off)
TR5 2N3866

Miscellaneous

X1 overtone crystal 34MHz
SK2 coaxial output socket
TO5 heatsink
PL2/a, b lead through connectors (2 off)
Veroboard $3\frac{1}{2}$in × $3\frac{1}{2}$in, 0·1in grid

CRYSTAL OSCILLATOR MODULE

The crystal oscillator module is very similar to the second oscillator module described earlier in this series where the output frequency was 36MHz. However, in this instance the output frequency is 34MHz which is produced by the basic oscillator, TR3 and associated components (Fig. 8.3).

The following stage TR4 and TR5 forms a directly coupled amplifier giving an output of approximately 0·5 volts at 34MHz to switch the mixer module.

MIXER MODULE

The mixer module can be broken down into three separate circuit configurations, these are as follows:

(a) Mixer.
(b) High Pass Filter.
(c) Output Amplifier.

The mixer section comprises TR6 and TR7 (Fig. 8.4) functioning in the following manner. The 2 to 30MHz signal from the variable oscillator module is fed into the base of TR7 via C12 and is mixed, in TR7, with 34MHz from the crystal oscillator module which is injected into the emitter of TR7. Due to the very low impedance at the emitter of TR7, a further stage, TR6 is introduced which current feeds TR7 via C16. Capacitor C14 is adjusted so that the signal level across R20 is at the level stipulated in the setting-up instructions given later.

The output at the collector of TR7 is made up of a number of frequencies depending upon the output of the variable oscillator module. If the frequency of the variable oscillator module is 2MHz the following frequencies are present in the collector circuit:

(a) Direct signal (34MHz)
(b) 34MHz + 2MHz **(36MHz)**
(c) Direct signal (2MHz)
(d) 34MHz − 2MHz (32MHz)

If the output frequency of the variable oscillator module is changed to 30MHz the frequencies present in the collector circuit of TR7 will now be:

(a) Direct signal (34MHz)
(b) 34MHz + 30MHz **(64MHz)**

MIXER AND FILTER

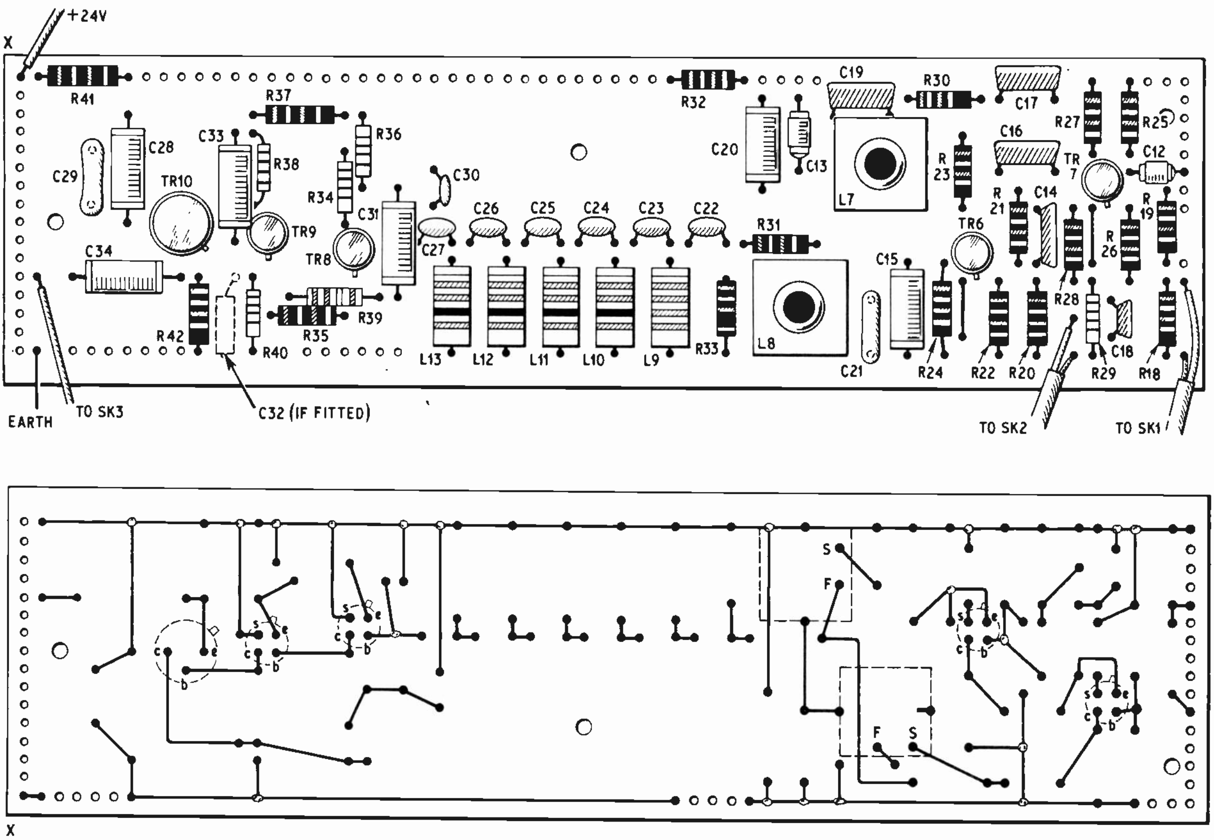


Fig. 8.9. Mixer and filter module layout and wiring

COMPONENTS . . .

Resistors

R18 100Ω
R19 see text
R20 100Ω
R21 10kΩ
R22 4·7kΩ
R23 1kΩ
R24 820Ω
R25 10kΩ
R26 10kΩ
R27 1kΩ
R28 100Ω
R29 27kΩ
R30 1kΩ
R31 1kΩ
R32 1kΩ
R33 1·5kΩ
R34 220Ω
R35 47Ω
R36 180Ω
R37 110Ω
R38 180Ω
R39 27kΩ
R40 330Ω
R41 130Ω
R42 150Ω

All resistors ⅓W, 5% high stability, carbon film

Capacitors

C12 470pF polystyrene ±2·5%
C13 1,000pF polystyrene ±10%
C14 10pF polystyrene or mica ±2·5%
C15 0·01μF ceramic
C16 12pF mica ±2·5%
C17 12pF mica ±2·5%
C18 0·1μF paper or foil
C19 51pF mica ±2·5%
C20 0·1μF mica ±2·5%
C21 51pF mica ±2·5%
C22 4·7pF ceramic or mica
C23 4·7pF ceramic or mica
C24 4·7pF ceramic or mica
C25 4·7pF ceramic or mica
C26 4·7pF ceramic or mica
C27 4·7pF ceramic or mica
C28 0·1μF paper or foil
C29 3,000pF ceramic
C30 2,000pF ceramic
C31 0·1μF paper or foil
C32 see text
C33 0·1μF paper or foil
C34 0·01 ceramic

Transistors

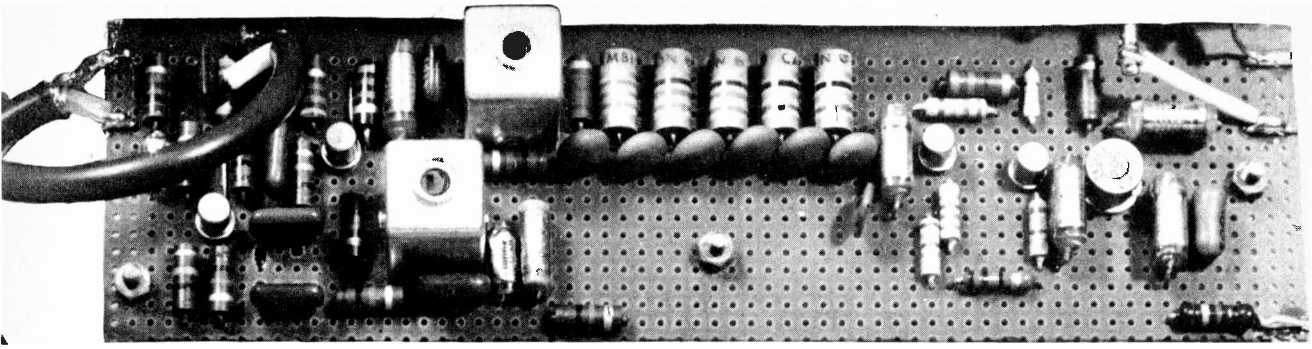
TR6–9 2N918 (4 off)
TR10 2N3866

Inductors

L7, 8 see Fig. 8.11 (2 off)
L9–13 2·2μH Cambion chokes (5 off)

Miscellaneous

SK3 coaxial output socket
Veroboard 6¾in × 1¾in, 0·1in matrix



Mixer and Filter Module

(c) Direct signal (30MHz)
(d) 34MHz – 30MHz (4MHz)
In both the instances the required frequency is shown in bold letters and is above all the other frequencies therefore, a high pass filter, set to the correct frequency range, will accept the required frequencies above 36MHz and reject those below. As the 34MHz signal is of a considerable level, required for switching, and is relatively close to the wanted frequency at the lower end of the band, the rejection at 34MHz achieved by the high pass filter is not sufficient. To reduce the level of the 34MHz signal, two rejector circuits, L7, C19 and L8, C21 are included, effectively, in the collector load of TR7. These two rejectors, when correctly tuned, give a rejection of approximately 46dB at 34MHz and coupled with the rejection of the high pass filter, the overall rejection is in the order of 54dB at 34MHz.

The high pass filter, L9 to L13 and C22 to C26, starts to cut off below 36MHz and takes the shape of the curve shown in Fig. 8.10.

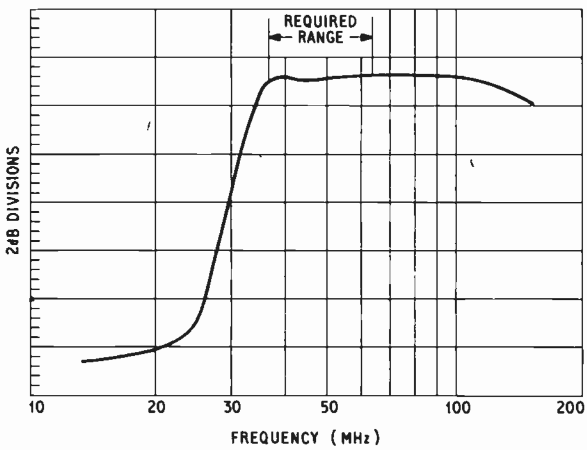


Fig. 8.10. High pass filter characteristic

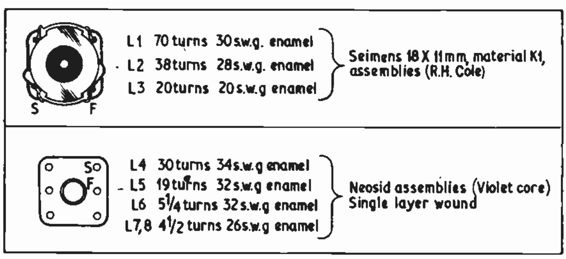


Fig. 8.11. Coil winding details

The output amplifier is directly coupled comprising three stages, TR8, TR9 and TR10, giving an output of 0·7 volts in the frequency range 34MHz to 64MHz. The input base of TR8 accepts the signal from the high pass filter via C27 and the signal is amplified in TR8 and TR9. The amplifier is terminated in an emitter follower TR10, to reduce the output impedance to something in the order of 10 ohms. The output at C34 is fed into the first mixer in the main receiver (via SK2), as shown in Fig. 8.1.

POWER SUPPLY

A separate 24 volt supply could be used to power the local oscillator unit; however the 24 volts already provided in the main receiver has sufficient current capacity to drive both the local oscillator unit and the main receiver and hence this can be used.

MECHANICAL AND WIRING DETAILS

It is essential that all the circuit wiring is kept as near to the layout diagrams as possible, as any extra capacity introduced due to lengthy leads will alter the tuning range of the overall unit. This is especially applicable to the variable oscillator module as the high frequency end of the band does include a certain percentage of stray capacity by necessity.

Both the variable oscillator unit and the crystal oscillator are built in module cases of the type detailed in Fig. 2.1. The only details that differ from the module cases described earlier are the number and spacing of the pin connectors and the drilling of mounting holes, in the variable oscillator module, for VC1; these details are shown in Figs. 8.6 and 8.8.

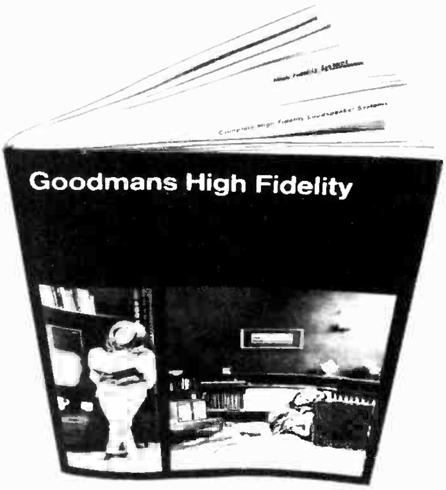
Before commencing construction of the variable oscillator module the five inductors should be wound to the details shown in Fig. 8.11 and the perforated board should be cut away to clear VC1 which is mounted on the back panel of the module. The components can then be positioned and wired up as shown in Fig. 8.5; note the use of six connecting pins—the pin letters *a* to *e* correspond to the ranges of the receiver.

As mentioned previously the crystal oscillator module is a copy of the 2nd oscillator module in every detail except the pin connectors and X1 (now 34MHz); construction details for this module are given in Fig. 8.7.

The mixer and filter unit is constructed on a piece of plain perforated Veroboard that is mounted on the chassis by three ½in mounting pillars. As before inductors L7 and L8 should be wound before commencing construction, to the details given in Fig. 8.11. The layout and wiring of the mixer and filter unit is straightforward and is shown in Fig. 8.9. Capacitor C32 and Resistor R19 may need to be fitted when the unit is set up; details will be given next month.

Next month: chassis and wiring details


McMurdo
make a new
connection
Full range of Connectors
now available ex-stock
Telephone: Harlow 26777
(STD code 02796)
ITT electronic services


Goodmans High Fidelity

New 1970 prices L.S.T. Electronic Components Ltd.

AC107	14/6	BD123	21/6	NKT141	7/-	OC84	5/-	2N386	12/-	2N3416	7/6	2S306	15/-
AC126	5/-	BD124	12/-	NKT142	6/-	OC123	7/-	2N385A/		2N3436	15/-	2S320	9/-
AC127	5/6	BF115	5/-	NKT143	5/6	OC139	5/-	2N388A	15/-	2N3525	21/9	2S321	6/-
AC127Z	9/6	BF152	13/6	NKT144	8/-	OC140	7/-	2N404	4/6	2N3528	19/-	2S323	10/-
AC128	4/-	BF154	9/-	NKT152	3/6	OC170	5/-	2N410	8/-	2N3606	5/6	2S701	8/6
AC176	5/-	BF159	15/-	NKT161	6/-	OC171	6/-	2N458A	25/-	2N3607	4/6	2S703	12/6
AC187	12/-	BF163	9/-	NKT162	6/-	OC200	6/3	2N511A	49/6	2N3702	3/3	2S720	25/-
AC188	12/-	BF167	5/-	NKT163	5/6	OC201	9/6	2N513A		2N3703	3/-	2S732	8/6
ACY17	5/-	BF173	6/-	NKT164	5/6	OC202	18/-		122/6	2N3704	3/3	2S1002	10/-
ACY18	3/6	BF178	10/6	NKT165	6/-	OC203	7/6	2N599	10/-	2N3705	3/-		
ACY19	4/5	BF179	12/6	NKT211	6/-	OC204	8/-	2N601	25/-	2N3706	2/9	DIODES &	
ACY20	3/7	BF180	6/-	NKT212	6/-	OC205	9/-	2N657	20/-	2N3707	3/-	RECTIFIERS	
ACY21	4/-	BF181	6/6	NKT213	4/-	OC206	10/6	2N696	4/-	2N3708	2/-	AA119	2/-
ACY22	2/9	BF184	7/-	NKT214	4/-	OC207	7/6	2N697	4/-	2N3709	3/-	AAY11	2/-
ACY40	3/-	BF185	8/-	NKT215	4/-	OC309	12/-	2N698	6/-	2N3710	3/-	AAZ12	6/-
ACY41	4/4	BF194	3/6	NKT216	10/-	OCP71	19/6	2N706	2/6	2N3711	3/-	AAZ13	2/6
ACY44	8/-	BF200	10/6	NKT217	13/-	ORP12	9/6	2N706A	2/6	2N3819	8/-	BA100	6/-
AD140	11/-	BFX13	5/-	NKT218	5/3	ORP60	8/-	2N708	4/-	2N3820	18/9	BA110	6/-
AD149	11/6	BFX29	8/-	NKT219	6/-	ORP61	8/-	2N711	7/6	2N3826	6/-	BA111	6/-
AD161	6/-	BFX44	8/-	NKT221	5/6	ORP63	9/-	2N711A	7/6	2N3854	5/6	BA112	18/-
AD162	6/-	BFX84	7/6	NKT222	4/-	P346A	5/-	2N715	7/6	2N3854A	5/6	BA115	1/6
ADT140	12/6	BFX85	9/-	NKT223	3/6	RAS310AF		2N716	7/6	2N3855	5/6	BA130	3/-
AF102	12/6	BFX86	6/6	NKT224	4/6		6/-	2N743	4/6	2N3855A	6/-	BAY31	2/6
AF106	7/6	BFX88	5/-	NKT225	3/6	RAS508AF		2N744	6/-	2N3856	6/-	BAY38	3/-
AF114	5/-	BFY50	4/6	NKT226	10/-		15/-	2N753	5/6	2N3856A	6/-	BY100	5/-
AF115	5/-	BFY51	3/9	NKT227	5/6	SIM	19/-	2N914	4/6	2N3858	5/-	BY125	3/6
AF116	5/-	BFY52	4/6	NKT228	6/-	S4M	33/6	2N918	7/6	2N3858A	6/-	BY127	4/-
AF117	5/-	BFY53	3/2	NKT261	4/3	ST140	3/-	2N929	5/6	2N3859	5/6	BY234	2/3
AF118	12/6	BFW57	6/-	NKT262	4/3	ST141	5/-	2N930	7/6	2N3859A	6/3	BYX10	3/-
AF121	6/-	BFW58	5/6	NKT264	4/3	ST2	9/9	2N1090	6/6	2N3860	6/-	BYX36/	
AF124	4/6	BFW59	5/-	NKT271	4/-	T1407	9/8	2N1091	6/6	2N3866	25/-	150	2/6
AF126	3/6	BFW60	4/6	NKT272	4/-	TIP31A	19/6	2N1131	6/6	2N3877	9/-	BYX36/	
AF127	3/6	BSX19	3/6	NKT273	4/-	TIP32A	22/6	2N1132	8/-	2N3877A	9/6	300	2/10
AF139	7/6	BSX20	3/4	NKT274	4/-	TIS34	17/6	2N1302	4/-	2N3900	10/6	BYX36/	
AF178	9/6	BSX21	7/6	NKT275	5/-	TIS44	1/9	2N1303	4/-	2N3900A		600	3/9
AF179	11/6	BSX76	4/-	NKT276	3/6	TIS45	3/3	2N1304	5/-		11/6	BYY21	25/-
AF180	12/6	BSX77	6/-	NKT279A	2/6	TIS46	3/3	2N1305	5/-	2N3903	7/-	BYY23	26/3
AF181	8/6	BSX78	6/6	NKT281	5/-	TIS47	3/3	2N1306	5/-	2N3904	7/-	BYY25	31/9
AF186W	9/-	BSY27	4/-	NKT301	16/-	TIS48	3/3	2N1307	5/-	2N3905	7/6	BYY142	3/9
AF186G	9/-	BSY29	5/-	NKT302	11/-	TIS49	3/6	2N1308	7/-	2N3906	7/6	BYZ10	9/-
AF239	7/6	BSY32	5/-	NKT303	10/-	TIS50	5/6	2N1309	7/-	2N4037	15/-	BYZ12	6/-
AFY19	22/6	BSY36	5/-	NKT304	9/6	TIS51	4/-	2N1496	34/-	2N4058	4/6	BYZ13	5/-
AFZ11	8/-	BSY37	5/-	NKT351	8/-	TIS52	4/-	2N1507	4/8	2N4059	5/-	CG6E	4/-
AFZ12	10/-	BSY38	4/-	NKT352	7/6	TIS53	6/6	2N1613	5/6	2N4060	5/-	CG63	2/-
ASY26	5/-	BSY95A	3/6	NKT401	17/6	TIS60	6/6	2N1671A		2N4061	4/-	CG64	2/6
ASY27	6/-	BSW41	8/6	NKT402	24/-	TIS61	7/-		29/6	2N4062	4/6	CG61	2/6
ASY28	5/-	BSW70	5/6	NKT403	15/-	TSW30C	18/-	2N1711	6/6	2N4284	3/-	CG62	2/6
ASY29	6/-	BTX39/600		NKT404	12/6	U23AAA	5/-	2N1893	10/-	2N4285	3/-	EA403	3/6
ASZ21	7/6		120/-	NKT405	15/-			2N2147	17/-	2N4286	3/-	EC401	5/-
AUY10	30/-	BTX40/600		NKT406	15/-	V205	20/-	2N2152	27/6	2N4287	3/-	EC402	4/8
ATZ10	40/-		120/-	NKT451	12/6	V405A	9/3	2N2148	12/6	2N4288	3/-	EB383	3/6
B2M	12/6	BTY87/150R		NKT452	12/6	XA102	6/-	2N2160	14/9	2N4289	3/-	GEX45/1	4/-
B3M	15/-		31/-	NKT453	10/-	XA702	15/-	2N2243	26/-	2N4290	3/-	GJ3M	4/-
BC107	2/9	C106F1	9/-	NKT613F	5/-	ZE12V7	3/6	2N2368	5/-	2N4291	3/-	OA5	3/8
BC108	2/9	C111	18/-	NKT674F		ZT22	19/-	2N2369	5/-	2N4292	3/-	OA10	6/-
BC109	2/9	C111E	12/-	NKT675	5/-	ZT86	27/6	2N2369A	5/6	2N4871	6/9	OA47	1/6
BC113	5/-	C400	9/-	NKT676	5/-	ZT2270	19/6	2N2432	67/-	2N5027	10/6	OA70	1/6
BC115	6/6	C426	8/3	NKT677F	5/-	40250	12/6	2N2484	8/-	2N5028	11/6	OA73	1/6
BC116	8/-	C444	9/8	NKT703	8/-	40309	9/6	2N2613	7/6	2N5029	9/6	OA79	1/6
BC118	5/-	D13T1	10/-	NKT713	7/6	40310	13/-	2N2614	4/-	2N5030	8/6	OA81	1/6
BC125	11/-	GET102	6/-	NKT773	5/-	40311	10/6	2N2646	10/-	2N5172	3/-	OA85	1/6
BC126	11/-	GET113	4/-	NKT10339		40312	13/6	2N2711	6/-	2N5174	10/6	OA90	1/6
BC134	5/-	GET114	4/-		6/6	40314	10/6	2N2712	6/-	2N5175	10/6	OA91	1/6
BC135	6/-	GET120	6/6	NKT10419		40315	10/6	2N2713	5/6	2N5176	9/-	OA95	1/6
BC136	8/-	GET880	9/-		6/-	40316	13/-	2N2904	8/6	2N5232	5/6	OA200	2/-
BC137	8/6	GET887	4/-	NKT10429		40317	11/-	2N2904A	8/-	2N5249	13/6	OA202	2/-
BC138	12/-	GET889	6/-		11/-	40319	15/-	2N2905	10/-	2N5249A		SD19	7d
BC140	3/3	GET890	6/6	NKT10519		40320	10/6	2N2905A	8/-		13/6	TD716	12/-
BC147	2/9	GET896	4/6		6/6	40323	10/6	2N2923	4/-	2N5305	7/6	IN34A	4/-
BC148	3/3	GET897	4/6	NKT16229		40324	12/6	2N2924	4/-	2N5306	8/-	IN60	4/-
BC149	3/-	GET898	6/-		11/-	40326	10/6	2N2925	3/6	2N5309	12/6	IN64	4/-
BC154	12/-	GEX 45/1	3/-	NKT20329		40329	7/6	2N2926		2N5354	5/6	IN82A	9/6
BC167	3/6	MAT100	5/-		11/-	40344	8/-	Green	2/-	2N5355	5/6	IN87A	4/6
BC168	3/9	MAT101	5/6	OC20	19/6	40347	9/6	2N2926		2N5356	10/6	IN191	5/-
BC169	3/9	MAT120	5/-	OC22	8/-	40348	14/6	Yellow	2/-	3N84	26/-	IN914	1/9
BC182L	3/-	MAT121	5/6	OC23	8/-	40360	11/6	2N2926		3N128	18/6	IN4001	2/-
BC183L	2/6	MJ400	21/6	OC24	8/-	40361	12/-	Orange	2/-	3N140	19/6	IN4005	4/-
BC184L	3/-	MJ420	22/6	OC25	7/6	40362	14/-	2N2926		3N141	21/6	IN4007	5/-
BC212L	3/9	MJ421	22/6	OC26	6/6	40370	8/6	Brown	2/-	3N142	16/6	IN4148	1/9
BCY10	10/-	MJ430	20/6	OC28	12/-	40406	16/-	2N3011	12/6	3N143	19/6	IS113	4/6
BCY12	12/-	MJ440	19/6	OC35	9/-	40408	14/-	2N3036	39/-	3N152	24/-	IS44	1/9
BCY30	5/-	MJ480	20/6	OC36	12/6	40467	16/6	2N3053	5/-	2S001	10/-	IS130	2/-
BCY31	5/6	MJ481	27/-	OC41	4/6	40468A	16/6	2N3054	12/6	2S002	12/6	IS131	2/6
BCY32	10/-	MJ490	22/6	OC42	4/6	40602	9/9	2N3055	15/-	2S003	12/6	IS132	3/-
BCY33	4/-	MJ491	29/6	OC43	4/6	2G301	3/6	2N3133	6/-	2S004	15/-		
BCY34	5/-	MPF102	8/6	OC44	3/-	2G302	3/-	2N3135	6/-	2S005	15/-		
BCY38	6/-	MPF103	7/6	OC45	3/-	2G306	8/6	2N3136	6/-	2S006	15/-		
BCY40	10/-	MPF104	7/6	OC70	2/6	2G339A	5/-	2N3235	28/6	2S012	25/-		
BCY42	4/-	MPF105	8/-	OC71	3/-	2G371	3/-	2N3234	27/6	2S012A	22/6		
BCY43	4/-	MPS3638	6/6	OC72	4/6	2G371B	3/-	2N3391A	6/-	2S017	15/-		
BCY54	7/6	NKT0013	9/6	OC75	4/6	2G374	5/-	2N3392	5/-	2S018	17/6		
BCY70	4/6	NKT121	11/-	OC76	2/6	2G378	7/-	2N3393	5/-	2S019	19/6		
BCY71	8/-	NKT122	8/-	OC77	5/6	2G381	5/-	2N3394	4/9	2S024	25/-		
BCY72	4/-	NKT123	6/-	OC81	4/6	2N109	11/-	2N3402	5/6	2S104	12/6		
BCY87	86/9	NKT125	5/6	OC81D	3/-	2N174	16/-	2N3403	5/6	2S301	8/6		
BCZ11	7/6	NKT127	5/6	OC82	5/-	N2217	7/6	2N3404	7/6	2S302	7/6		
BD119	15/-	NKT128	5/6	OC82D	3/-	2N370	15/-	2N3414	5/6	2S303	10/-		
BD121	18/-	NKT129	6/-	OC83	4/6	2N384	17/-	2N3415	6/-	2S304	12/6		

Prices quoted are current at time of going to press and may be subject to variation without notice.
Semiconductors offered in this advertisement bear the relevant manufacturers' original markings and are subject to our full replacement guarantee if not to published specifications.
We do not offer "re-marked" makers' rejects or similar out of specification devices.
Please enclose a stamped self-addressed envelope with any query.
Quantity prices on application: many more types in stock and expected daily. If you buy in bulk we can save you money!
Export enquiries particularly welcome, cable address: Lestroco Brentwood.
Terms of Business: Retail orders—cash with order please; Trade—please furnish references if credit account required.
Postage: 1/- per order inland; 4/- Europe; 12/- Commonwealth.

ADDRESS YOUR ORDERS TO:
L.S.T. LTD., 7 COPTFOLD ROAD, BRENTWOOD, ESSEX

LOWEST I.C. PRICES YET!

IC10	59/6	Sinclair IC amp.
PA230	20/-	IC Preamplifier
PA234	20/-	1 watt audio amp.
PA237	32/6	2 watt audio amp.
PA246	52/6	5 watt audio amp.
PA424	43/-	Zero voltage switch
SL403A	49/6	3 watt Plessey amp.
TAA263	15/-	Mullard linear amp.
TAD100	45/-	IC receiver
TAA293	20/-	Mullard gen. purp. amp.
TAA310	30/-	Record/Playback preamp.
TAA320	13/-	MOS LF amplifier
UL702C	29/6	Plessey linear amplifier
3N84	26/-	Silicon controlled switch

Data sheets available on request—1/- per copy.

PLEASE NOTE: Only new—full specification integrated circuits, no below-specification types.

FAIRCHILD MICRO-LOGIC

	1–6	7–11	12+
ul 900	9/9	9/-	8/-
ul 914	9/9	9/-	8/-
ul 923	12/6	11/9	11/-

Prices for 100+ and 1000+ on application

5 page data and circuits article—2/6
Plastic spreaders—1/6 each

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 trans-ducers can transmit and receive.

FREE: With each pair our complete transmitter and receiver circuit.
PRICE
£5.18.0 Pair
(Sold only in pairs)

ZENER DIODES

400mW 10% GLASS CASE. TEXAS Mfr.

1S2036	3·6 volt
1S2039	3·9 volt
1S2043	4·3 volt
1S2047	4·7 volt
1S2056	5·6 volt
1S2062	6·2 volt
1S2068	6·8 volt
1S2075	7·5 volt
1S2082	8·2 volt
1S2100	10 volt
1S2110	11 volt
1S2120	12 volt
1S2160	16 volt
1S2180	18 volt
1S2270	27 volt
1S2300	30 volt

PRICES: 1–24 3/6
25–99 2/9
100+ 2/3

2N3819 8/-
Texas FET
25 + 6/9 100 + 5/9

2N4871 6/9
Motorola unijunction
25 + 5/9 100 + 4/9

2N3055 15/-
115 watt silicon power transistor
25 + 13/- 100 + 11/-

BC107/8/9 2/9
NPN Planar transistors
BC107 & 9
25 + 2/5 100 + 2/2
BC108 25 + 2/3 100 + 2/-

BY 127 4/-
Mullard Plastic HV rectifier 800 piv. 1 amp. (similar BY100, etc.)
25 + 3/3 100 + 3/-

2N2926 2/-
NPN Planar transistors
25 + 1/8 100 + 1/6

INFRA-RED DEVICES

56 CAY 29/6
Gallium arsenide emitter

MGA 100 35/-
Gallium arsenide emitter

31F2 28/6
Infra-red detector diode

AD161/2 10/-
Siemens/Telefunken NPN/PNP output pair
25 + 9/- 100 + 8/-

OCP 71 19/6
Mullard phototransistor
25 + 17/3 100 + 14/9

VALUE ALL THE WAY

QUALITY-TESTED PAKS

6	Matched Trans. OC44/45/81/81D	10/-
20	Red Spot AF Trans. PNP	10/-
16	White Spot RF Trans. PNP	10/-
5	Silicon Rects. 3 A 100-400 PIV	10/-
2	10 A Silicon Rects. 100 PIV	10/-
2	OC1 140 Trans. NPN Switching	10/-
1	12 A SCR 100 PIV	10/-
3	Sil. Trans. 2S303 PNP	10/-
3	200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3	Zener Diodes 1W 33V 5% Tol.	10/-
4	High Current Trans. OC42 Eqvt.	10/-
2	Power Transistors 1 OC26 1 OC35	10/-
5	Silicon Rects. 400 PIV 250mA	10/-
4	OC75 Transistors	10/-
1	Power Trans. OC20 100V	10/-
10	OA202 Sil. Diodes Sub-min.	10/-
2	Low Noise Trans. NPN 2N929/30	10/-
1	Sil. Trans. NPN VCB 100 ZT86	10/-
8	OA81 Diodes	10/-
4	OC72 Transistors	10/-
4	OC77 Transistors	10/-
4	Sil. Rects. 400 PIV 500mA	10/-
5	GET884 Trans. Eqvt. OC44	10/-
5	GET883 Trans. Eqvt. OC45	10/-
2	2N708 Sil. Trans. 300Mc/s NPN	10/-
3	GT31 LF Low Noise Germ Trans.	10/-
6	IN914 Sil. Diodes 75 PIV 75mA	10/-
8	OA95 Germ. Diodes Sub-min. IN69	10/-
3	NPN Germ. Trans. NKT773 Eqvt.	10/-
2	OC22 Power Trans. Germ.	10/-
2	OC25 Power Trans. Germ.	10/-
4	AC128 Trans. PNP High Gain	10/-
4	AC127/128 Comp. pair PNP/NPN	10/-
3	2N1307 PNP Switching Trans.	10/-
7	CG62H Germ. Diodes Eqvt. OA71	10/-
3	AF116 Type Trans.	10/-
12	Assorted Germ. Diodes Marked	10/-
4	AC126 Germ. PNP Trans.	10/-
4	Silicon Rects. 100 PIV 750mA	10/-
3	AF117 Trans.	10/-
7	OC81 Type Trans.	10/-
3	OC171 Trans.	10/-
5	2N2926 Sil. Epoxy Trans.	10/-
7	OC71 Type Trans.	10/-
2	2S701 Sil. Trans. Texas	10/-
2	10 A 600 PIV Sil. Rects. 1S45R	10/-
3	BC108 Sil. NPN High Gain Trans.	10/-
1	2N910 NPN Sil. Trans. VCB 100	10/-
2	1000 PIV Sil. Rect. 1·5 A R53310 AF	10/-
3	BSY95A Sil. Trans. NPN 200Mc/s	10/-
3	OC200 Sil. Trans.	10/-
2	GET880 Low Noise Germ. Trans.	10/-
1	AF139 PNP High Freq. Trans.	10/-
3	NPN Trans. 1 ST141 & 2ST140	10/-
4	Madt's 2 MAT100 & 2MAT120	10/-
3	Madt's 2 MAT101 & 1 MAT121	10/-
4	OC44 Germ. Trans. AF	10/-
3	AC127 NPN Germ. Trans.	10/-
1	2N3906 Sil. PNP Trans. Motorola	10/-
2	Sil. Power Rects. BYZ13	15/-
1	Sil. Power Trans. NPN 100Mc/s. TK201A	15/-
2	2N1132 PNP Epitaxial Planar Sil.	10/-
3	2N697 Epitaxial Planar Trans. Sil.	15/-
4	Germ. Power Trans. Eqvt. OC16	15/-
1	Unijunction Trans. 2N2646	15/-
2	Sil. Trans. 200Mc/s 60Vcb ZT83/84	15/-
20	NKT Trans. AF, RF, VHF, Coded + Eqvt. List	10/-
2	2N2712 Sil. Epoxy Planar HFE225	15/-
8	BY100 Type Sil. Rects.	20/-
25	Sil. and Germ. Trans. Mixed, all marked, New	30/-

SEMICONDUCTORS FOR "P.E." 50+50AMP.

TYPE	EACH	TYPE	EACH
2N1613	4/6	1N914	1/-
2N3055	12/6	OA200	1/-
2N3703	3/-	BFY51	3/6
2N3704	3/6	BYZ13	4/6
2N3707	3/9	40362	14/-
2N3819	8/-	22V 1½W Zener	3/6

GIRO No. 338-7006

BI-PAK

500 CHESHAM HOUSE
150 REGENT STREET
LONDON, W.1

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.		
U1	120 Glass Sub-min. General Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/RF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10/-
U4	40 Germanium Transistors like OC81, AC128	10/-
U5	60 200mA Sub-min. Sil. Diodes	10/-
U6	40 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	10/-
U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/-
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/-
U25	25 300Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U26	30 Fast Switching Silicon Diodes like 1N914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/-
U29	10 1 amp SCR's TO-5 can up to 600 PIV CRS1/25-600	20/-
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/-
U32	25 Zener diodes 400mW D07 case mixed Volts, 3–18	10/-
U33	15 Plastic case 1 amp Silicon rectifiers 1N4000 series	10/-
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	10/-
U35	25 Sil. Planar trans. PNP TO-18 2N2906	10/-
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10/-
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	10/-
U38	20 Fast Switching Sil. trans. NPN, 400Mc/s 2N3011	10/-
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	10/-
U40	10 Dual trans. 6 lead TO-5 2N2060	10/-
U41	30 RF Germ. trans. TO-1 OC45 NKT72	10/-
U42	10 VHF Germ. PNP trans. TO-1 NKT667 AF117	10/-

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

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

	1A (TO-5 case)	3A (TO-66 case)	7A (TO-48 case)	16A (TO-48 case)		30A
PIV	each	each	each	each	PIV	each
50	4/6	5/-	9/6	10/6	25	20/-
100	5/-	6/6	10/6	12/6	50	23/-
200	7/-	7/6	11/6	15/-	100	28/-
400	8/6	9/6	13/6	18/6	200	32/-
600	10/6	11/6	15/6	25/-	400	35/-
800	12/6	14/-	18/-	30/-	600	80/-

2A POTTED BRIDGE RECTIFIERS. 200V 10/-, 600V 15/-, 800V 20/-.

TRANSISTOR EQVT. AND SPECIFICATION BOOK. (German Publication.) A complete cross reference and equivalent book for European, American and Japanese Transistors. Exclusive to BI-PAK. 15/- each.

PRINTED CIRCUITS EX-COMPUTER
Packed with semiconductors and components, 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards 10/-. Plus 2/- P. & P.

PLEASE NOTE. To avoid any further Increased Postal Charges to our Customers and enable us to keep our "By Return Postal service" which is second to none, we have re-organised and streamlined our Despatch Order Department and we now request you to send all your orders together with your remittance, direct to our Warehouse and Despatch Department, postal address: **BI-PAK SEMICONDUCTORS, Despatch Dept., P.O. BOX 6, WARE, HERTS.** Postage and packing still 1/- per order. Minimum order 10/-.

SIL. RECTS. TESTED

PIV	750mA	3A	10A	30A
50	1/-	2/9	4/3	9/6
100	1/3	3/3	4/6	15/-
200	1/9	4/-	4/9	20/-
300	2/3	4/6	6/6	22/-
400	2/6	5/6	7/6	25/-
500	3/-	6/-	8/6	30/-
600	3/3	6/9	9/-	37/-
800	3/6	7/6	11/-	40/-
1000	5/-	9/3	12/6	50/-
1200	6/6	11/6	15/-	

TRIACS

VBOM	2A (TO-1)	6A (TO-66)	10A (TO-48)
100	14/-	15/-	22/6
200	17/6	20/-	28/-
400	20/-	24/-	35/-

VBOM — Blocking voltage in either direction.

LUCAS 35A SIL. RECTS. Branded. 400 PIV. Special Price, stud type, flying lead, 22/6 each.

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TIS43. BEN3000 5/6 each, 25-99 5/-. 100 UP 4/-.

NPN SILICON PLANAR BC107/8/9, 2/- each; 50-99, 1/10; 100 up, 1/8 each; 1,000 off, 1/6 each. Fully tested and coded TO-18 case.

SILICON HIGH VOLTAGE RECTIFIERS 10-Amp 3-K.V. (3000 P.I.V.) Stud Type with Flying Leads, 16/- each.

INTEGRATED CIRCUITS

BI-PAK MONOLITHIC AMPLIFIERS (TO-5 8 lead)

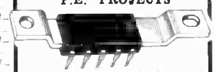
BP709C, Operational amplifier, 15/- each.
BP701C, Operational amplifier (with Zener output), 12/6 each.
BP702C, Operational amplifier (with direct output), 12/6 each.
BP501, Wide band amplifier, 18/- each.
BP521, Logarithmic wide band amp., 14/- each.
BP20/C, General purpose amplifier (TO-5 8 lead). (voltage or current amp.), 12/6 each.

I.C. Operational Amplifier with Zener output. **Type 701C.** Ideal for P.E. Projects. 8 Lead TO-5 case. Full data.

Our price **12/6** each

5 off 11/- each. Large Qty. Prices quoted for.

AMPLIFIER FOR USE IN 'P.E.' PROJECTS



Identical encapsulation and pin configuration to the following: SL402-3, IC10 and IC403. Each circuit incorporates a pre-amp and class A.B. Power amp stage capable of delivering up to 3 watts RMS. Fully tested and guaranteed. Supplied complete with circuit details and data. CODED BP.1010. OUR LOWEST PRICE 30/- each. 10 up 25/- each.

OTHER MONOLITHIC DEVICES

BP424, Zero voltage switch, 8/6 each.
This device is a monolithic I.C. that acts as combined threshold detector and trigger circuit for controlling a triac. It is designed to pulse the gate of a thyristor at the point of zero supply voltage, and therefore eliminate radio frequency interference when used with resistive loads.
D13D1 Silicon Unilateral switch 10/- 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.

FAIRCHILD (U.S.A.) RTUL MICROLOGIC INTEGRATED CIRCUITS

Epoxy case T8-5 lead temp. range 15°C. to 55°C.
UL900, Buffer, 9/9 each.
UL914, Dual two-input gate, 9/9 each.
UL923 J-K-flip-flop, 13/- each.
Complete data and circuits for the Fairchild I.C.'s available in booklet form priced 1/6.

MULLARD I.C. AMPLIFIERS

TAA243, Operational amplifier, 70/- each.
TAA263, Linear AF amplifier, 15/9 each.
TAA293, General purpose amplifier, 21/- each.

CA3020 RCA (U.S.A.) LINEAR INTEGRATED CIRCUITS

Audio Power Amplifier, 30/- each.

CADMIUM CELLS

ORP12 8/6
ORP60, ORP61 8/- each

PHOTO TRANS.

OCP71 Type. 8/6

AD161 *NPN*
AD162 *PNP*

MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.

For mains driven output stages of Amplifiers and Radio receivers.

OUR LOWEST PRICE OF 12/6 *PER PAIR*

HIGH POWER SILICON PLANAR TRANSISTORS. TO-3. FERRANTI ZT1487 NPN

VCB60	Ic 6A
	fT. 1M/cs
VCE40	Ptot. 75W
VEB8	hFE15-45

PRICE 15/- EACH

2N3055 115 WATT SIL POWER NPN
OUR PRICE 12/6 EACH

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-16V. 400mV (DO-7 Case) 2/6 ea. 1½W (Top-Hat) 3/6 ea. 10W (SO-10 Stud) 5/- ea. All fully tested 5% tol. and marked. State voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT
T1	8	2G371A	OC71
T2	8	2G374	OC75
T3	8	2G3744A	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 10/- each pack

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. **Our price 5/- each.**

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND120. 1-24 3/6 each. To-5 N.P.N. 25 up 3/- each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 1/- each. Any Qty.

FREE

One 10/- Pack of your own choice free with orders valued £4 or over.

NPN DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indicators, 50V, 250mW. OUR PRICE 10/- EACH, 50 OR OVER 8/6 EACH, FULL DETAILS.

FET'S

2N 3819	10/-
2N 3820	25/-
MPF105	8/-

LOW COST F.E.T.s

Fully Tested, Guaranteed Perameters equit. to 2N3819, MPF102, 2N-5459. 1–24 7/6 each; 25–99 6/3 each; 100 up 5/6 each. Coded FE19. Full data sent. TO-72 case.

BI-PAK MONOLITHIC DIGITAL CIRCUITS (10 lead TO-5)

BP305A, 6-Input AND gate, 9/6 each.
BP314A, 7-Input NOR gate, 9/6 each.

KING OF THE PAKS BI-PAK GUARANTEE SATISFACTION OR MONEY BACK

Practical Electronics Classified Advertisements

RATES: 1/6 per word (minimum 12 words). Box No. 1/6 extra. Advertisements must be prepaid and addressed to Classified Advertisement Manager, "Practical Electronics" IPC MAGAZINES LTD., Fleetway House, Farringdon Street, London, E.C.4

MISCELLANEOUS

MORE ROBOTS

Synthetic Animals with "BRAINS" of their own. The LATEST range of projects include: an electronic 'animal' which "LEARNS", and an Electro Chemical device capable of "REPRODUCING" itself! Other projects SURE TO INTRIGUE YOU are a transmitter/receiver which has quite a useful range and RADIATES WITHOUT USING R.F. also TEN new projects, one of which is an electronic dice machine. HOSTS OF EASY-TO-CONSTRUCT projects, for anyone with a basic knowledge of Electronics. DON'T WAIT. SEND 3/- for your list—NOW!

To: 'BOFFIN PROJECTS'
4 CUNLIFFE ROAD
STONELEIGH, EWELL, SURREY
Designed by GERRY BROWN and JOHN SALMON and presented on T.V.

BUILD IT in a DEWBOX quality cabinet 2in × 2½in × any length. DEW LTD., Ringwood Road, Ferndown, Dorset. S.A.E. for leaflet. Write now—right now.

6 OR 12 VOLT FLUORESCENT LIGHTS

12 ins. 8 Watt tube ample light for caravan, tent, etc. Fully transistorised, low battery drain
Unbeatable at 65/6 post paid.
or in kitform 57/6

4 WATT GRAM AMPS.

Volume and tone controls, mains operation, 3Ω output, new and boxed 72/6 POST PAID

SALOP ELECTRONICS Callers welcome
23 Wyle Cop
Shrewsbury, Shropshire S.A.E. for lists

LIGHT GUIDES

0.031" AND 0·063" DIA. TOTAL GLASS FIBRE OPTIC LIGHT GUIDES WITHIN A PVC SLEEVE

5'	10'	15'	25'	50'	
19/6	34/6	47/6	72/3	132/3	0·031" dia.
£3.2	£5.16	£8.2	£12.8.6	£23	0·063" dia.

STRICTLY C.W.O.
FIBRE LIGHT, Dept. P.E.E.
31 STOKE ROAD, GUILDFORD, SURREY

SOUND SWITCH (Feb.) printed circuit with data sheet, **12/-**. Rhythm Generator (Nov/Dec. 68) printed circuit with full data, **29/6**. Both inc. P.P. Send C.W.O. to ALMARY DESIGNS, 12 Lattimore Road, Wheathampstead, Herts.

IMPORTANT ANNOUNCEMENT to home constructors in the South. E.M.C. Components have just opened a components shop where a wide range of organ, amplification, etc., parts are available at a fraction of normal cost. Example—generators 6 octave at **£3** each plus other wonderful bargains for the Home Constructor., Callers welcome. 734A Christchurch Road, Boscombe, Bournemouth. Tel. Bournemouth 37451.

CASTLE LABORATORIES bargains in Veroboard at rock bottom prices; 2½in × 5in 0·1in matrix **4/2**; 0·15in matrix **3/9**. All sizes available. We cut to your sizes. For semiconductors see April issue. A stamp brings our full lists. CASTLE LABORATORIES, Stapleton Close, Highworth, Wilts.

MISCELLANEOUS *(continued)*

MUSICAL MIRACLES. Send S.A.E. for details of Rhythm Modules, Versatile Bass-pedal unit, self-contained with unique effects, kits for waa-waa pedals. Also new 50μA meters **25/-** post paid. HURRY! D.E.W. LTD. 254 Ringwood Road, Ferndown, Dorset.

SILICON PLANAR N.P.N. AMPLIFYING TRANSISTORS, 20 for **£1**. VEB30. HFE20–60. 350mW. Guaranteed all good or Money Back. P & P 1/-. J. M. KING (D), 17 Buckridge, Portpool Lane, London, E.C.1.

SERVICE FOR THE AMATEUR ELECTRONIC ENTHUSIAST. Are you building equipment requiring a transformer? If so send for an immediate quotation, or s.a.e. for our comprehensive price list. Also available on request enamelled copper wire price list. BANNER TRANSFORMERS, 84 Old Lansdowne Rd., West Didsbury, Manchester, 20.

SERVICE SHEETS

LARGE SUPPLIER OF SERVICE SHEETS

T.V., RADIO, TRANSISTORS, TAPES, CAR RADIOS
Only 10/- each, plus LARGE S.A.E.
(Uncrossed P.O.'s please, original returned if service sheets not available.)
FREE TV FAULT TRACING CHART OR TV LIST ON REQUEST WITH ORDER
C. CARANNA
71 BEAUFORT PARK, LONDON, N.W.11
MAIL ORDER ONLY

SERVICE SHEETS. Radio, TV, etc., 8,000 models. List **2/-**. S.A.E. enquiries. TELRAY. 11 Maudland Bank, Preston.

SERVICE SHEETS (1925–1970) for Televisions, Radios, Transistors, Tape Recorders, Record Players, etc., by return post, with free Fault-Finding Guide. Prices from **1/-**. Over 8,000 models available. Catalogue **2/6**. Please send S.A.E. with all orders/enquiries. HAMILTON RADIO, 54 London Road, Bexhill, Sussex.

RADIO TELEVISION, over 8,000 Models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Rd., London, W.6. SHE 8441.

WANTED

CASH PAID for New Valves. Payment by return. WILLOW VALE ELECTRONICS, 4 The Broadway, Hanwell, London, W.7. 01-567 5400/2971.

FOR SALE

SEEN MY CAT? 5,000 items. Mechanical and Electrical Gear, and materials. S.A.E. K. R. WHISTON, Dept. PE, New Mills, Stockport.

MORSE MADE EASY !!

FACT NOT FICTION. If you start **RIGHT** you will be reading amateur and commercial Morse within a month (normal progress to be expected).
Using scientifically prepared 3-speed records you automatically learn to recognise the code RHYTHM without translating. You can't help it, it's as easy as learning a tune. 18 W.P.M. in 4 weeks guaranteed.
For details and course C.O.D. ring S.T.D. 01-660 2896 or send 8d. stamp for explanatory booklet to:
G3HSC (Box 19), 45 GREEN LANE, PURLEY, SURREY

FOR SALE *(continued)*

NEW CATALOGUE No. 18, containing credit vouchers value 10/-, now available. Manufacturers' new and surplus electronic and mechanical components, price **4/6**, post free. ARTHUR SALLIS RADIO CONTROL LTD., 28 Gardner Street, Brighton, Sussex.

FOR SALE. Practical Electronics Analog Computer Units "A", "B", "C"; components for "D", perfect. Custom built Amplifiers and Power Supply. Many extras. Total cost of materials £273. Offers, Box No. 28.

BOOKS AND PUBLICATIONS

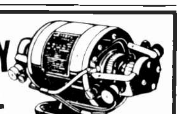
SURPLUS HANDBOOKS

19 set Circuit and Notes	7/- P.P. 9d
1155 set Circuit and Notes	7/- P.P. 9d
H.R.O. Technical Instructions ..	6/- P.P. 9d
38 set Technical Instructions....	6/- P.P. 9d
46 set Working Instructions....	6/- P.P. 9d
88 set Technical Instructions....	7/6 P.P. 9d
BC. 221 Circuit and Notes	6/- P.P. 9d
Wavemeter Class D Tech. Instr	6/- P.P. 9d
18 set Circuit and Notes	6/- P.P. 9d
BC.1000 (31 set) Circuit & Notes	6/- P.P. 9d
CR.100/B.28 Circuit and Notes	10/6 P.P. 1/-
R.107 Circuit and Notes........	7/6 P.P. 9d
A.R.88D. Instruction Manual....	18/6 P.P. 9d
62 set Circuit and Notes	7/- P.P. 9d

52 set Sender & Receiver Circuits 8/- post free
Circuit Diagrams 5/6 each post free. R.1116/A, R.1224/A, R.1355, R.F. 24, 25, & 26. A.1134, T.1154, CR.300, BC.342, BC.312, BC.348.J.E.M.P. BC.624. 22 set.
Colour Code Indicator .... 2/6 P.P. 6d
S.A.E. with all enquiries please.
Postage rates apply to U.K. only.
Mail order only to:
Instructional Handbook Supplies
Dept. P.E., Talbot House, 28 Talbot Gardens
Leeds 8

ELECTRICAL

240 VOLT ELECTRICITY ANYWHERE



BEST EVER 200/240 VOLT "MAINS" SUPPLY FROM 12 VOLT CAR BATTERY
Exclusive World Scoop Purchase. The fabulous **Mk.2D American Heavy Duty Dynamotor Unit** with a **Massive** 220 watt output and giving the most **Brilliant** 200/240 volt performance of all time. Marvellous for **Television, Drills, Power Tools, Mains Lighting, AC Fluorescent Lighting** and all 200/240 volt Universal AC/DC mains equipment. Made at tremendous cost for U.S.A. Govt. by Delco-Remy. This magnificent machine is unobtainable elsewhere. **Brand New** and **Fully Tested. Only £4.19.6 + 10/6** postage. C.O.D. with pleasure, refund guarantee. Please send S.A.E. for illustrated details.
Dept. PE, STANFORD ELECTRONICS
Rear Derby Road, North Promenade
BLACKPOOL, Lancashire

HI-FI EQUIPMENT

RELIABLE GUIDE to best value in Hi-Fi. Audio Supply's seventy-five-page illustrated catalogue **(6/6)**, 18 Blenheim Road, London, W.4.

GARRARD SP. 25 **£10/17/6.** AP 75 **£16/17/6.** 401 **£25.** Philips 202, **£49/17/6.** Goldring G 800, **£7/17/6.** Shure M44E, **£8/17/6.** Teleton 203QE, **£19/10/-.** MAYWARE & CO. Msil Order Specialists, 17 Heronsgate, Edgware, Middx.

APPOINTMENTS

CAREERS IN SCIENCE AND ENGINEERING

Exciting and rewarding opportunities in these fields are almost unlimited

Write now for details of the following courses offered by:—

BOURNEMOUTH COLLEGE OF TECHNOLOGY

UNIVERSITY OF LONDON EXTERNAL DEGREES

B.Sc. General (Hons.)—Mathematics, Physics, Chemistry, Botany, Zoology, Statistics

B.Sc. (Eng.) (Hons.)—Electrical (including Electronics)

These courses are suitable for both men and women.

Study by the Sea in Britain's foremost international and cultural resort.

For prospectus apply to:
The Principal, Room 47
College of Technology, Lansdowne
Bournemouth, BH1 3JJ
Tel. B.20844

EDUCATIONAL

TELEVISION

LEC

This private College provides efficient theoretical and practical training in Radio and TV Servicing. One-year day courses, commencing in Sept., January and April, are available for beginners, and shortened courses for men who have had previous training. Write for free prospectus to:— **London Electronics College, Dept. LX/3. 20 Penywern Road, Earls Court, London, S.W.5 Tel. 01-373 8721**

HOLIDAYS

HOLIDAY FOR BOYS. 14/16 years, August 1970, specialising in engineering, electronics, photography. Tuition and practical work including karting. 11 days—**£14 10s.** Write for free brochure: INTER-SCHOOL CHRISTIAN FELLOWSHIP, 47 Marylebone Lane, London, W1M 6AX.

SITUATIONS VACANT

A.M.I.E.R.E., A.M.S.E. (Elec.), City & Guilds, G.C.E., etc., on "Satisfaction or Refund of Fee" terms. Wide range of Home Study Courses in Electronics, Computers, Radio, T.V., etc. 132-page Guide—FREE. Please state subject of interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 124K), Aldermaston Court, Aldermaston Berks.

JUNIOR ELECTRONICS TECHNICIAN required for construction and repair of electronic instruments and maintenance of a Linear Accelerator. G.C.E. "O" level in Physics and Maths required; "A" levels or O.N.C. an advantage. Day release for further study is possible. Salary according to age and experience. Apply with full details to the Director, MEDICAL RESEARCH COUNCIL CYCLOTRON UNIT, Hammersmith Hospital, London, W.12.

ENGINEERS. A technical certificate or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C.Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B. and G.C.E. exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts., Building, etc. For full details write for FREE 132-page guide. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 125K), Aldermaston Court, Aldermaston, Berks.

GET INTO ELECTRONICS—big opportunities for trained men. Learn the practical way with low-cost Postal Training, complete with equipment. A.M.I.E.R.E., R.T.E.B., City & Guilds, Radio, T/V, Telecoms., etc. For FREE 100-page book, write Dept. 856K, CHAMBERS COLLEGE, College House, 29-31 Wrights Lane, Kensington, London, W.8.

FULL TIME COURSES in (*a*) Basic Electronics, and (*b*) Television Servicing. Nine-month courses starting September 21, 1970, leading to City and Guilds certificates. Details from: Section 47/48, Southall College of Technology, Beaconsfield Road, Southall, Middx.

ICS — Established 1891

TECHNICAL TRAINING IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the **I C S trained man.** Let I C S train YOU for a well-paid post in this expanding field.

I C S courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

* **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
* **C. & G. ELECTRONIC SERVICING.**
* **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
* **RADIO AMATEURS' EXAMINATION.**
* **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students coached until successful.

NEW SELF-BUILD RADIO AND ELECTRONIC COURSES
Build your own 5-valve receiver, transistor portable, signal generator, multi-meter and valve volt meter—**all under expert guidance.**

POST THIS COUPON TODAY and find out how I C S can help YOU in your career. Full details of I C S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES

INTERNATIONAL CORRESPONDENCE SCHOOLS

A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!

International Correspondence Schools
(Dept. 152), Intertext House, Stewarts Road,
London, S.W.8.

NAME ....
Block Capitals Please

ADDRESS ....

....

.... 5.70

RECEIVERS AND COMPONENTS

TRANSISTOR PANELS

INTEGRATED CCT'S TAKEN FROM PANELS
A — Quad 2 I/P Gate
B — Dual 4 I/P Gate
C — Dual 2 Level Gate
F — Single I/P Gate
All **3/-** each or 8 for **20/-** With Pin Connections Post Paid

EX GOVMT. RECEIVER R.209 covering 1—20 mc/s 12V D.C. Input **£12.10.0** Post Paid (Tested).

VENT AXIA 12V D.C. FANS. New boxed 6in blade. **£4.10.0** carriage paid.

PANEL WITH 5 BC108 AND DIODES. 4 for **10/-** Post Paid.

GPO TYPE UNI-SELECTORS. 5 bank 25-way 37 Ω plus 37 Ω coil. **£1** and **25/-**.

RECTIFIER UNIT EX GOVMT. New boxed 17 volts at approx. 15 amps. No instruments. A good heavy duty charger. Size 14 · 16 10in. **£8.10.0** carriage 10/-.

MIXED TRANSISTORS on panels 100 for **£1** carriage 2/-.

PANEL with 48 OA81 **5/-**.

COMPUTER PANELS WITH SEMICONDUCTORS. Postage 6d per panel: 8—OC43 or GET875 + 24—OA81, **7/6**; 24—A1678 (V405A) 550 mc/s PNP + 24 Diodes, **10/-**; 4—OC170 + 2—OC139 + 2—OC42, **7/6**; 4—OC42 + 6—GET875 + Diodes, **7/6**; 2—OC170 + 1—2G306 + OC42, **4/-**; 5—OC23 + 15—OA10, **20/-**; 6—ASZ21 + 15—OA91, **6/-**; 9—SB240 + 18—OA47, **10/-**; 12—2G106 + 24 Diodes, **9/6**; 8—OC76 + 8—OA10, **7/6**; 12—A1678 (V405A) 550 mc/s PNP + 22 Diodes, **10/-**; 6—GET872 + 8—OA10, **5/-**; 4—OC42, **3/-**; 12—ASZ20 + 80 Diodes, **9/6**; 4—GET872 + 8—OA10, 3 for **12/-**; 4—2G106 + 1—2N2410, **4/-**, 2—OC42 + 8—OA47, **3/-**; 2—GET872 + 4—OA10 + RF Chokes, 3 for **10/-**; 3—GET872 + 3—GEX541, ETC., **15/-**; 3—OC23 + 6—OA10 + 2—OA5, **10/-**.

ELECTROLYTICS 25,000 @ 12V, 16,000 @ 12V, 15,000 @ 10V, 4,000 @ 60V, 2,000 @ 50V, 1,200 @ 180V, **8/6** Post Paid.

ZENER DIODES—2·4, 2·7, 3·6, 4·75, 6·2, 6·8, 7·5, 13, 15, 16, 18, 20, 27, 30, 33 volts. **3/6** each, mostly 1 watt.

POLYSTYRENE CAPACITORS. 125V, 18, 22, 120, 220, 270, 330, 390, 560, 820, 1,000, 1,200, 1,800, 2,200, 2, 700, 3,300, 3,900, 5,600, 6,800, 8,200, 0·01, 0·012, 0·015, **2/6** doz. Post/Packing, 1/-.

BRAND NEW BOXED CHASSIS containing 2—OC35, 2—OC29 12 WW resistors **25/-**. Postage 1/6.

NEW CROSS RADIO
6 OLDHAM ROAD, MANCHESTER 4

EX COMPUTER PRINTED CIRCUIT PANELS 2″ × 4″ packed with semi-conductors and top quality resistors, capacitors, diodes, etc. Our price, 10 boards **10/-**. P. & P. 1/6. With a guaranteed minimum of 35 transistors. Transistor Data included.

SPECIAL BARGAIN PACK. 25 boards for **£1**. P. & P. 3/6. With a guaranteed minimum of 85 transistors. Transistor Data included.

PANELS with 2 power transistors sim. to OC28 on each board plus components. 2 boards (4 × OC28) **10/-**. P. & P. 1/6d.

9 OA5, 3 OA10, 3 Pot Cores, 26 Resistors, 14 Capacitors, 3 GET872, 3 GET 872B, 1 GET875. All long leaded on panels 13″ × 4″.
4 for **20/-**. P. & P. 5/-.

LT/STEP DOWN TRANSFORMER

Pri. 0-200-215-245V, Sec. 1 0-10-25V 4A, Sec. 2 0-115V 2A, **30/-**. P. & P. 6/-.

Quantity available.

EX COMPUTER "MEMORY" CORE STORE PLANES

160 BITS	£1	P. & P. 2/-
4000 BITS	£4	P. & P. 4/-
10000 BITS	£8	P. & P. 8/-

12V 4A POWER SUPPLY

Extremely well made by Frako GmbH in West Germany, with constant voltage mains transformer, tapped input from 115V to 240V. Full wave rectification and capacitor smoothing. Size 9″ × 6″ × 5″. Weight 11 lbs. These units are brand new, unused and fully guaranteed. Makers' price believed to be around £80.

OUR PRICE £9.10.0 Carr. 10/-

250 MIXED RESISTORS ¼ & ½ Watt **12/6**

150 High Stabs ¼, ½ and 1 Watt, 5% and Better **12/6**

DIODES EX EQPT. SILICON

10 Amp	150 PIV	4 for **10/-**
20 Amp	150 PIV	4 for **£1**
35 Amp	150 PIV	4 for **45/-**

P. & P. 1/-

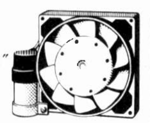
LARGE CAPACITY ELECTROLYTICS

1,500 mfd 150V.
4,000 mfd 72V
5,000 mfd 36V
16,000 mfd 12V

7/6 each P. & P. 1/6d

£3.10.0 doz. P. & P. 10/-

EXTRACTOR/BLOWER FANS (Papst)



100 c.f.m. 4½″ × 4½″ × 2″
2800 r.p.m.
50/- ea. P. & P. 5/-

EXTENSION TELEPHONES

19/6 ea. P. & P. 5/-

35/- for 2 P. & P. 10/-

These phones are extensions and do not contain bells.

RELAY OFFER

Single Pole Changeover Silver Contacts 2″ × 6″ × 7″. 2·5KΩ Coil Operates on 25 to 50V, **8 for 10/-** P. & P. 1/6.

KEYTRONICS
MAILING ADDRESS:
52 EARLS COURT ROAD, LONDON, W.8
WAREHOUSE AND DISPATCH
01-478 8499

SILICON TRANSISTORS 1,000,000 FOR SALE

Clearance of *pnp* Silicon Alloy Transistors from the 2S300 (TO-5) and 2S320 (SO-2) range and similar to the OC200-205 and BCY30-34 series. Available only from us at a fraction of the manufacturing cost. All these devices would normally be subject to re-selection for industrial use but owing to company policy change have been made available to us surplus to requirements. Offering these transistors in varied quantities make them ideal for *Amateur Electronics, Radio Hams and for experimental use in Schools, Colleges and Industry.*

Supplied uncoded (no warranty by the manufacturers). But our assurance given that a minimum of 80% will be found to be good usable Silicon Alloy Transistors. Please state preference of type, i.e., TO-5 2S300 or SO-2 2S320.

Approximate count by weight:
100 off—**15s.** (plus p. & p. 2s.)
300 off—**£1 15s.** (plus p. & p. 3s.)
500 off—**£2 10s.** (plus p. & p. 3s. 6d.)
1,000 off—**£4** (plus p. & p. 5s.)
10,000 off—**£35** (plus p. & p. 11s.)

Large quantities quoted for on request.

EXPORT ENQUIRIES WELCOME

All correspondence, cheques, postal orders, etc., to:

DIOTRAN SALES
P.O. BOX 5
63a High Street, Ware, Herts.
Tel.: WARE 3442

P.C. RECEIVER BOARDS:—PCR 1, 6 transistor type with OC44, two OC45s, but less the audio transistors, i.e. OC81D, and two OC81s. 8¾in. × 3in. as previously advertised, transformerless output ½ watt to 8 ohm speaker, ¼ watt to 20 ohm, with connecting data to clear at **25/-** each.
PCR 2, 7 transistors, 3 AF117s, 2 AC127s, 2 AC128s, complementary output pair giving ½ watt to 5 ohm speaker, no oscillator coil but I.F. amp and audio amp complete, size 3¼in. × 7½in. supplied with circuit diagram for 9 volt operation, **35/6** each.
PCR 3, 6 transistors, OC44, 2 OC45s, OC81D, 2 OC81s, transformerless output approx. 400 milliwatts, overall size 3in × 5in. with osc. coil and edgewise volume control on board, for 6 volt operation, no data or circuit, only **22/6** each.
NOTE. All boards require ferrite aerial, tuning capacitor, wavechange switch, etc. and are all as new and unused.
Push-pull output transformers to match 2 EL84s, approx. 8 watt rating with negative feedback winding brand, new only **10/-** post paid.
250 pF postage stamp type trimmers (new) ceramic insulation, **6d** each, **4/6** doz. Ferrite slab aerials 5in. long, M.W. and L.W., requires 250pF tuning capacitor, **3/6** each (despatched only with the above boards).
P.C. Board with 7 transistors, miniature resistors, capacitors, etc. was used as squelch switch but can be used as electronic switch or light sensitive switch, with circuit of board, no details of mods. brand new only **12/-**.
Mail Order Only — All Items plus 1/6 post.

A. J. H. ELECTRONICS
59 WAVERLEY ROAD, THE KENT
RUGBY, WARWICKSHIRE
RUGBY 71066

TO HELP THE HOME CONSTRUCTOR. Heathkit now make available our surplus Resistors, Capacitors, etc. at Bargain Prices. Send for lists. E. MOYLE, Daystrom Ltd., Gloucester.

JEF ELECTRONICS

NEW FULL SPECIFICATION DEVICES

Integrated Circuits complete with data:
GE PA230 Audio Preamplifier **18/6**
GE PA234 1W Audio Amplifier **17/6**
GE PA237 2W Audio Amplifier **32/6**
Plessey SL402A Preamp and 2W Amp **42/-**
MEL 11 Photo Darlington Amp **9/6**

High quality low cost transistors:
GE 2N5172 NPN 200mW **1/9**
ME 0412 PNP 200mW **3/9**
TI 2N4059 PNP 250mW **3/6**
MUL BFX86 NPN 800mW **6/-**
MUL BD124 NPN 15W **12/-**
S 2N3055 NPN 115W **14/6**

Triacs for full wave power control:
RCA 40669 8A 400V **24/-**
RCA 40583 Trigger Diode **5/3.**

Plastic rectifiers for power supplies:
IN 4820 1·5A 400V Si Rectifier **2/6**
W005 1A 50V full wave bridge Si **7/6**
PD40 2A 400V full wave bridge Si **15/-**

C.W.O. P. & P. 1/- per order. YORK HOUSE, 12 YORK DRIVE GRAPPENHALL, WARRINGTON, LANCS. Mail Order Only

BRAND NEW ELECTROLYTICS 15/16V: 0·5, 1, 2, 5, 8, 10, 20, 30, 40, 50, 100 mF., **8·5d;** 200 mF. **10d.** Carbon Film Resistors, ½W 5%, E. 12 series, 10 ohms to 1 Megohm, **1·5d.** Wirewound, 5W 5%, E. 12 series, 15 ohms to 15,000 ohms, **10d.** Mullard RPY58 Photo-cells, **6/6.** Postage 1/-. THE C.R. SUPPLY CO., 127 Chesterfield Road, Sheffield, S8 ORN.

TOP PRICES PAID
for new valves and components
Write:
KENSINGTON SUPPLIES
(B) 367 Kensington Street
Bradford 8, Yorks.

AUDIOSCAN-HI-FI loudspeaker systems for the home constructor, cabinet kits, new range of Peerless speakers, speaker kit systems and cross-over networks. BAF wadding and all necessary components. Free speaker fabric samples on request. Send **9d** in stamps to: AUDIOSCAN, Dept. PE, 4 Princes Square, Harrogate, Yorks.

PRINTED CIRCUIT BOARDS for P.E. PROJECTS
All boards drilled and roller tinned complete with layout drawing.
EXAMPLES
Waa-Waa pedal Vol 4 No. 7 **2/9d.** ea. Audio Sig. Gen. (Sine and Square on one board) Vol 5 No. 10 **8/6d.** ea. Mic. Mixer (3 Boards) Vol 5 No. 4 **12.-d.** Set. Stockmarket Vol 4 No. 12.
Central S.E. **6/-d.** ea. — Players **3/-d.** ea.
S.A.E. For List. Trade enquiries welcomed.
P.H. ELECTRONICS, Industrial Estate, Sandwich, Kent. Tel. 2517.

Free and illustrated lists of all types of Hi-Fi equipment; Tuners, Amps, etc. Electronic equipment, components and gadgets at lowest prices, from: Albion Electronics Supplies, D/4, 16 Albion Road, Birchington, Kent.

RECEIVERS AND COMPONENTS
(continued)

REVERBERATION UNITS, genuine GIBBS Hammond type with circuit and plugs **£7.12.6;** with printed circuit amplifier **£10.12.6.** THORNHITHE LTD., 15 Mill Crescent, North Kessock, Inverness.

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

VALVES BOXED, TESTED & GUARANTEED

EBF80	3/-	PCC84	3/-	PY81	3/6
EBF89	3/6	PCF80	3/-	PY82	3/-
ECC82	3/-	PCF82	3/6	U191	4/6
ECL80	3/-	PCL82	4/-	6F23	5/-
EF80	1/6	PCL83	4/-	30F5	2/6
EF85	3/-	PL36	5/-	30L15	5/-
EY86	4/-	PL81	4/-	30P12	4/6
EZ40	4/6	PL83	4/-	30C15	5/-
EBC41	4/6	PY33	5/-	50CD6G	7/6

POST, ONE VALVE **9d.** TWO TO SIX **6d.**
OVER SIX POST PAID.

BATTERY ELIMINATORS

The ideal way of running your TRANSISTOR RADIO, RECORD PLAYER, TAPE RECORDER, AMPLIFIER, etc. Types available: 6v, 9v, 12v, 18v (single output) 39/6 each. P. & P. 2/9. 9v + 9v; 6v + 6v; or 4½v + 4½v (two separate outputs) 42/6 each. P. & P. 2/9. Please state output required. All the above units are completely isolated from mains by double wound transformer ensuring 100% safety.

R.C.S. PRODUCTS (RADIO) LTD.
(Dept. P.E.), 31 Oliver Road, London, E.17

AUDIO EFFECTS

5 SHAW LANE, HALIFAX, YORKS.

Buy with confidence and obtain the right results. Refunds without question if any of our products fail to give 100% satisfaction.

AMATEUR BANDS ALL TRANSISTOR SUPERHET RECEIVER KIT. No fuss, no drilling. Just fit the components on our printed circuit. Slow Motion tuning. Simple IF alignment. Perspex front panel. Push pull AF amp drives your 8–15 ohm speaker. Amp can be used separately. Designed to accept a BFO signal. Uses Denco plug in coils 2T. 0·5 to 1·54 Mhz 3T. 1·67 to 5·3 Mhz 4T. 5·0 to 15 Mhz 5T. 10·5 to 31·5 Mhz Range 3T normally supplied with kit. Uses 9 Volt battery. Easy step by step instructions. Complete Kit. **£8.19.6** plus 5/6 P.P. & Ins. Extra ranges **12/-** per range.

POWER CONTROLLER. Power at your finger tips. Not merely half wave control but full wave. A single variable control gives zero to full power. Uses latest 15 amp 3kW triac and special triggering device. Ideal for all types of lighting, fires, motors, drills, etc. Complete with box, power socket, cables, etc. In kit form with easy to follow instructions **£6.9.6.** Ready built **£9.4.6** plus 5/6 P. P. & Ins.

REVERBERATION AMPLIFIER. Self contained transistorised, battery operated. An entirely different approach to sound reproduction. Normally, sound reproduction from a single source, has a flat one dimensional effect. With this unit, proper sound delay through reverberation, tones, are created with a truly third dimension for concert hall originality. Two controls adjust volume and reverberation. Simply plug microphone, guitar, etc., in, and the output into your amplifier. Supplied in a beautiful walnut cabinet 7¼in × 3in × 4¼in. **£10.4.0.** P. P. & Ins. 6/-.

VOX SWITCH. This sound operated switch is ideal for mobile TX work, tape recorder switching, etc. You speak, it switches. High and medium imp. inputs. AF take off point. Drives your 12 volt relay. In kit form with full instructions **42/6.** Ready built, tested and guaranteed. **62/6,** plus 2/6 P. P.

METRONOME UNIT. Variable beat. Listen while you play and keep in time. Easily built, pocket size with personal mini earphone. In kit form **27/6,** post paid. Ready built in an attractive black and white polythene case, **37/6** post paid.

MORSE OSCILLATOR. PC board, transistors, high stab. components, battery carrier, ear piece. Adjustable tone. Just attach your key. Drives phones or speaker. In kit form **17/6** post paid. Ready built in similar case as above **25/-** post paid.

STRAIGHT FROM THE PRESS. Latest Mullard manual: Audio Amps, FM tuners, Stereo decoder, Receiver circuits, Hi Fi, Tape, etc., etc. **32/6** post paid.

JUST ARRIVED IN STOCK. Texas transistors. Complementary symmetry. Driver, NPN, PNP output. The set of three ONLY **6/6** post paid.

Free lists with every order. For lists only send 1/6 *(deductible from first order).*

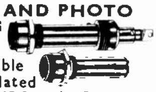
VARIABLE VOLTAGE TRANSFORMERS

LIGHT SENSITIVE SWITCH

Kit of parts, including ORP12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price **25/-** plus 2/6 P. & P. ORP 12 including circuit, **12/6** each, Post Paid.

A.C. MAINS MODEL. Incorporates Mains Transformer, Rectifier and special relay with 2 5 amp mains c/o contacts. Price inc. circuit **47/6** plus 2/6 P. & P.

LIGHT SOURCE AND PHOTO CELL MOUNTING



Precision engineered light source with focusible lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair **£2.15.0.** P. & P. 3/6.

UNISELECTOR SWITCHES NEW

4 Bank 25 Way 24V d.c. operation **£5.17.6,** P. & P. 2/6.
6 Bank 25 Way 24V d.c. **£6.10.0,** p.p. 2/6.

RELAYS

New SIEMENS, PLESSEY, etc. miniature relays at COMPETITIVE PRICES

Coil Ω	Working d.c. Volts	Contacts		Price
170	9-12	4 c/o H.D.		14/6
170	9-12	3 c/o + 1 H.D. c/o		12/6
230	6-12	2 c/o		12/6
280	6-12	2 c/o	I.B	14/6
700	12-24	2 c/o	I.B	12/6
700	16-24	4 c/o	I.B	15/6
700	16-24	4M 2B	I.B	12/6
2500	30-50	2 c/o H.D.	I.B	12/6
9000	40-70	2 c/o	I.B	10/-

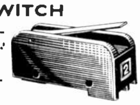
H.D. Heavy Duty. POST PAID
I.B. = Including Base

MINIATURE RELAYS

9–12 volt d.c. 2 c/o 500 M.A. contacts. Size 1 × ⅞ × ½in. Price **11/6** post paid.
30-36 v d.c. 2 c/o 500 M.A. contacts. 3,200 ohm coil. Size 1 × $\frac{9}{16}$ × $\frac{15}{16}$in. **8/6.** Post paid.

230 VOLT AC RELAY LONDEX 4 c/o 3 amp contacts. **18/6** inc. base, post paid.

BURGESS MICRO SWITCH



Lever operated c/o contacts. Price **4/-** plus **9d.** P. & P.

10 in makers' carton **35/-** post paid.

FOOT SWITCH

Suitable for Motors, Drills, etc.
5 amp 250V
Price **17/6** plus 2/6 P. & P.

36V 30 amp. a.c. or d.c. VARIABLE L.T. SUPPLY UNIT

INPUT
220/240V a.c.
OUTPUT
CONTINUOUSLY VARIABLE 0–36V.

Fully isolated. Fitted in robust metal case with Voltmeter, Ammeter, Panel Indicator and handles. Input and output fully fused. Ideally suited for Lab. or Industrial use. **£58** plus 40/– P. & P.

DOUBLE WOUND VARIABLE TRANSFORMER

Fully isolated, low tension Secondary winding. Input 230V a.c. OUTPUT CONTINUOUSLY VARIABLE 0–36V a.c.

0–36V at 5 amp. £9.12.6. P. & P. 8/6.
0–36V at 20 amp. £21.0.0. P. & P. 15/–.

These fully shrouded Transformers, are ideally suited for Educational, Industrial and Laboratory use.

INPUT 230/240v. A.C. 50/60— OUTPUT VARIABLE 0-260v.

BRAND NEW
Keenest prices in the country. All Types (and Spares) from ½ to 50 amp. from stock.

SHROUDED TYPE

1 amp, £5. 10. 0. **2.5 amps,** £6. 15. 0. **5 amps,** £9. 15. 0. **8 amps,** £14. 10. 0. **10 amps,** £18. 10. 0. **12 amps,** £21. 0. 0. **15 amps,** £25. 0. 0. **20 amps,** £37. 0. 0. **37.5 amps,** £72. 0. 0. **50 amps,** £92. 0. 0.

OPEN TYPE (Panel Mounting)
½ amp, **£3.18.6.** 1 amp, **£5.10.0.** 2½ amps, **£6.12.6.**
Carriage extra on open types.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250v. A.C. operation.

EXPERIMENTERS' ECONOMY KIT
1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions **£5.5.0** plus 5/- P. & P.

NEW INDUSTRIAL KIT
Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor 1-80 f.p.s. Price **9 gns.** 7/6 P. & P.

HY-LYGHT STROBE
This strobe has been designed and produced in response to wide public demand, for use in large rooms, halls and the photographic field. It has four times the light output at 30 f.p.s. and utilizes a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Light output approx. 4 joules. Price **£10.17.6.** P. & P. 7/6.

7-inch **POLISHED REFLECTOR**
Ideally suited for above Strobe kits. Price **10/6.** P. & P. 2/6 or Post Paid with kits.

100 WATT POWER RHEOSTATS (NEW)

AVAILABLE IN THE FOLLOWING VALUES:

1 ohm, 10 a.; **5 ohm,** 4.7 a.; **10 ohm,** 3 a.; **25 ohm,** 2 a.; **50 ohm,** 1.4 a; **100 ohm,** 1 a.; **250 ohm,** .7 a.; **500 ohm,** .45 a.; **1 Kohm,** 280 mA; **1·5 Kohm,** 230 mA; **2·5 Kohm,** .2 a.; **5 Kohm,** 140 mA. Diameter 3¼in. Shaft length ⅞in., dia. $\frac{13}{32}$in. All at **27/6** each. P. & P. 1/6.

50 WATT. 1/5/10/25/50/100/250/500/1/1·5/2·5/5 Kohm **All at 21/- each.** P. & P. 1/6.

25 WATT. 10/25/50/100/250/500/1/1·5/2·5 Kohm. **All at 14/6 each.** P. & P. 1/6.

VEEDER ROOT, 230V a.c. 50 cycle, 5-figure counter (non-resettable). **18/6,** P. & P. 1/6.

MOTORIZED SWITCHING UNIT (EX-W.D.)

Powerful precision made Ex-.W.D. 12V D.C. reversible motor, drives multiple gear train with output approx. 4 r.p.m. and 5 r.p.m. Price **25/-.** Plus 4/6 P. & P.

LATEST TYPE SOLID STATE DEVICES

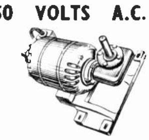
NEW PLASTIC THYRISTOR. 400 PIV 8 amp. **19/6.** Including Data Sheet.

R.C.A. 40432 Triac and Diac in TO5 can, 6 amp **35/-.**

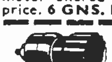
G.E. P.U.T. D13 T1, **12/-.** **TEXAS F.E.T.** 2N3819 **7/6.**

All above prices plus 1/6 P. & P

PARVALUX TYPE SD19 230/250 VOLTS A.C. REVERSIBLE GEARED MOTOR



30 r.p.m. 40lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first class running order. A really powerful motor offered at a fraction of makers' price. **6 GNS.** P. & P. 10/–.



INSULATED TERMINALS

Available in red, white, yellow, black, blue and green. New Price **2/–** each

PANEL METERS AT BARGAIN PRICES

A.C. AMMETERS 0–1, 0–5, 0–10, 0–15, 0–20 amp. F.R. 2½ in. dia. **ALL AT 21/– EACH.**
A.C. VOLTMETERS 0–24V, 0–50V, 0–150 M.I. 2½ in. Flush round. **ALL AT 21/– EACH.** P. & P. extra.
0–300V a.c. Rect. M-Coil 2½ in. **29/–**
0–300V a.c. Rect. M-Coil 3½ in. Type W23 **45/–**

SERVICE TRADING CO

All Mail Orders—Also Callers—Ample Parking Space
Dept. P.E. 57 BRIDGMAN ROAD, LONDON, W.4
Phone 995 1560 SHOWROOM NOW OPEN CLOSED SATURDAY

Personal callers only
9 LITTLE NEWPORT ST. LONDON, W.C.2. Tel. GER 0576

VALUABLE NEW HANDBOOK

FREE TO AMBITIOUS ENGINEERS

Have you had *your* copy of "Engineering Opportunities"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

On 'SATISFACTION OR REFUND OF FEE' terms

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

WHICH OF THESE IS YOUR PET SUBJECT?

ELECTRONIC ENG.
Advanced Electronic Eng.—Gen. Electronic Eng.—Applied Electronics—Practical Electronics—Radar Tech.—Frequency Modulation—Transistors.

ELECTRICAL ENG.
Advanced Electrical Eng.—General Electrical Eng.—Installations—Draughtsmanship—Illuminating Eng.—Refrigeration—Elem. Elec. Science—Elec. Supply—Mining Elec. Eng.

CIVIL ENG.
Advanced Civil Eng.—General Civil Eng.—Municipal Eng.—Structural Eng.—Sanitary Eng.—Road Eng.—Hydraulics—Mining—Water Supply—Petrol Tech.

RADIO & T.V. ENG.
Advanced Radio—General Radio—Radio & TV Servicing—TV Engineering—Telecommunications—Sound Recording—Automation—Practical Radio—Radio Amateurs' Examination.

MECHANICAL ENG.
Advanced Mechanical Eng.—Gen. Mech. Eng.—Maintenance Eng.—Diesel Eng.—Press Tool Design—Sheet Metal Work—Welding—Eng. Pattern Making—Inspection-Draughtsmanship—Metallurgy—Production Eng.

AUTOMOBILE ENG.
Advanced Automobile Eng.—General Auto. Eng.—Auto. Maintenance—Repair—Auto. Diesel Maintenance—Auto. Electrical Equipment—Garage Management.

WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT, INSTRUMENT TECHNOLOGY, WORKS STUDY, MATHEMATICS, ETC.

Which qualification would increase your earning power?
A.M.I.E.R.E., B.Sc.(Eng.), A.M.S.E., A.M.I.P.E., A.M.I.M.I., A.R.I.B.A., A.I.O.B., A.M.I.Ex., A.R.I.C.S., M.R.S.H., A.M.I.E.D., A.M.I.Mun.E., C.ENG., CITY & GUILDS, GEN. CERT. OF EDUCATION, ETC.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
316A, ALDERMASTON COURT, ALDERMASTON, BERKSHIRE

THIS BOOK TELLS YOU

- ★ *HOW to get a better paid, more interesting job.*
- ★ *HOW to qualify for rapid promotion.*
- ★ *HOW to put some letters after your name and become a key man . . . quickly and easily.*
- ★ *HOW to benefit from our free Advisory and Appointments Depts.*
- ★ *HOW you can take advantage of the chances you are now missing.*
- ★ *HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.*

164 PAGES OF EXPERT CAREER - GUIDANCE

PRACTICAL EQUIPMENT
Basic Practical and Theoretic Courses for beginners in Electronics, Radio, T.V., Etc., A.M.I.E.R.E. City & Guilds Radio Amateurs' Exam. R.T.E.B. Certificate P.M.G. Certificate Practical Electronics Electronics Engineering Practical Radio Radio & Television Servicing Automation

INCLUDING TOOLS
The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.

B.I.E.T.

You are bound to benefit from reading "ENGINEERING OPPORTUNITIES"—send for your copy *now*—FREE and without obligation.

POST COUPON NOW!

TO B.I.E.T. 316A, ALDERMASTON COURT, ALDERMASTON, BERKSHIRE.

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).

....

NAME ....

ADDRESS ....

....

....

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD

Published approximately on the 15th of each month by IPC Magazines Ltd., Fleetway House, Farringdon Street, London, E.C.4. Printed in England by The Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon & Gotch (A/sia) Ltd.: South Africa—Central News Agency Ltd.: Rhodesia and Zambia—Kingstons Ltd.: East Africa—Stationery and Office Supplies Ltd. Subscription Rate (including postage): For one year to any part of the world £2 5s. 0d.

HENRY'S RADIO LTD. ENGLAND'S LEADING COMPONENT AND EQUIPMENT CENTRES

HENRY'S RADIO *Fully Illustrated* CATALOGUES

ALL TYPES OF ELECTRONIC COMPONENTS TEST EQUIPMENT KITS BUILT UNITS

HIGH FIDELITY & GENERAL AUDIO EQUIPMENT CATALOGUE

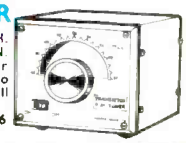
COMPREHENSIVE CLEAR CONCISE CATALOGUES

A Over 350 pages fully detailed and illustrated with more than 6,000 stock items. Everything for amateur and professional use. Complete with 5 vouchers. 10/- value, for use with purchases. New 6th impression now ready.
ORDER AS CATALOGUE A PRICE 7/6. p.p. 2/-.

B New audio and high fidelity catalogue. 120 pages containing ideas and equipment for every application. Special low prices for all leading makes. Plus 12/6 extra discount voucher. Over 40 recomm'd Stereo Systems.
ORDER AS CATALOGUE B PRICE 5/-. p.p. 1/-.
CONTINUALLY IMPROVED AND REVISED

WHY NOT SEND AWAY TODAY!

BUILD THIS VHF FM TUNER



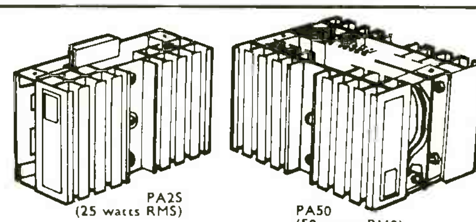
5 MULLARD TRANSISTORS 300 kc/s BANDWIDTH. PRINTED CIRCUIT, HIGH FIDELITY REPRODUCTION. MONO AND STEREO. A popular VHF FM Tuner for quality and reception of mono and stereo. There is no doubt about it—VHF FM gives the REAL sound. All parts sold separately.
PARTS TOTAL COST **£6.19.6.** DECODER **£5.19.6** (FOR STEREO)
ASK FOR BROCHURE No. 3.

HENELEC 5-5 STEREO AMPLIFIER

Excellent low priced British designed Stereo Amplifier for use with Record Decks, Tuners. 16 transistor mains operated. Output 5 + 5 watts for 8–15 ohm speakers. Black, silver and wood finish, size 13in. × 3in. × 6in. PRICE **£13.10.0.** p.p. 7/6. Complete Stereo System 5-5. Garrard 2025TC or 3000LM with 97AHC dia. Ceramic Cartridge 5-5 Amplifier. Plinth/Cover. Two 10 watt speakers with tweeters in polished cabinets. Size 18in. × 11in. × 7in. Usual price **£50.** Our price **£39.10.0.** p.p. 20/-. ASK FOR BROCHURE No. 13.

BUILD A QUALITY 4 TRACK TAPE RECORDER

To get the best out of your MAGNAVOX DECK, you need a MARTIN RECORDAKIT. This comprises a special high quality 6 valve amplifier and pre-amplifier which comes to you assembled on its printed circuit board—in fact everything for making a superb Tape Recorder. You need no experience or technical skill to bring this about. THE INSTRUCTIONS MANUAL MAKES BUILDING EASY AND SUCCESS IS ASSURED. Kit comprises Deck, Amplifier, Cabinet and speaker, with microphone, 7in. 1,200ft tape and spare spool.
ASK FOR BROCHURE No. 6. TODAY'S VALUE £60.
PRICE 39 gns. p.p. 22/6. NOTHING ELSE TO BUY.



PA25 (25 watts RMS)

PA50 (50 watts RMS)

SILICON POWER AMPLIFIERS

WITH DIRECT COUPLED, SYMMETRICAL OUTPUT

★HENELEC "PA25" POWER AMPLIFIER
This silicon design from Henry's Radio uses complementary transistors in the symmetrical output stage direct coupled to a loudspeaker of 8 ohms impedance or higher. Power output is 25 watts RMS with an 8 ohm load, or 12 watts for 15 ohms, over a frequency range of 15Hz–25kHz 3db. Cool running is assured by the use of generously dimensioned black anodised heatsinks. Input 700mV 15Kohms.

Price £7.10.0

★HENELEC "PA50" POWER AMPLIFIER
Basically similar to the "PA25" the "PA50" will deliver 50 watts RMS to a 3–4 ohm load. Extra power is handled by complementary triplet circuits using the latest PNP and NPN silicon power transistors. As a result of extra heatsinking, the "PA50" runs as cool as the "PA25".

Price £9.10.0

★HENELEC MU442 POWER SUPPLY
Designed to run one or two "PA25's" or one "PA50" the MU442 connects to the amplifiers by means of plug-on harnesses. No soldering is required to connect up the system. Audio input plug and speaker plug go to the panel of the MU442.

Price £6.0.0

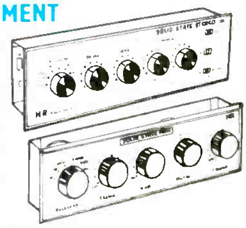
★SEND FOR FREE BROCHURES Nos. 24/25.

AMPLIFIERS IN STOCK

*1 watt Mullard	£2.5.0	*PA25 25 watt	£7.10.0
*PA7 7 watt	£3.12.6	*PA50 50 watt	£9.10.0
*MPA12/3 12 watt	£4.10.0	*100 watt PA	£49.10.0
*MPA12/15 12 watt	£5.5.0	Z30 Sinclair	75/-
*MA7 7 watt Amp/Preamp		Stereo 60	£8.10.0
Mono	£8.10.0	PZ5	79/6
*MA66 Stereo Amp/Preamp	£16.10.0	Also 20 types of integrated circuit.	

*Leaflets available on request.

MONO-STEREO UNIT EQUIPMENT



Mono or Stereo Audio equipment developed from Dinsdale Mk. II—each unit or system will compare favourably with other professional equipment selling at much higher prices. Complete systems and mixers from **£11.12.6.** to **£38.17.6.** (all units available separately). The finest value in low cost high fidelity —Choose a system to suit your needs and save yourself pounds. 7, 12 and 25 watt amplifiers, stereo and mono preamplifiers and modules.
★Send for brochures Nos. 12/14 and 21 today!

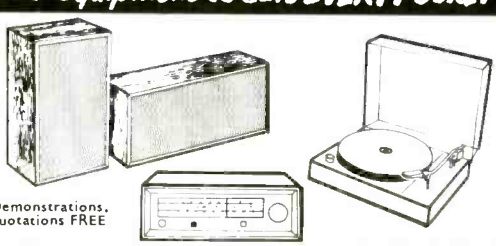
HENRY'S STOCK EVERY TYPE OF COMPONENT YOU NEED — A CATALOGUE IS A MUST!
ALSO SEE EARLIER PAGES FOR MORE ADVERTS.

TRANSISTORS, INTEGRATED CIRCUITS, TEST EQUIPMENT, GARRARD AND GOLDRING TURNTABLES, ALL AT SPECIAL SAVE MONEY PRICES—SEE OUR ADVERTS ON EARLIER PAGES OF THIS MAGAZINE.

FREE
16-PAGE TEST GEAR CATALOGUE—REF. T
10-PAGE RECORD PLAYER DECKS LIST—REF. 16/17
SEMICONDUCTOR PRICE LIST—REF. 36

SEND NOW

HI-FI equipment to suit EVERY POCKET



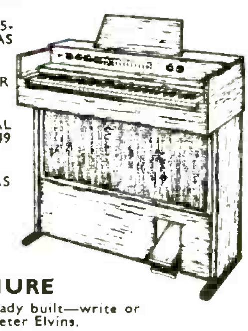
Demonstrations, quotations FREE

★ **CREDIT TERMS** (CALLERS ONLY) FOR PURCHASES AT 309 BRANCH ONLY. FROM **£30**

VISIT OUR HI-FI CENTRE AT 309 EDGWARE ROAD, for all leading makes of—AMPLIFIERS, TUNERS, DECKS, SPEAKERS, MICROPHONES, TEST EQUIPMENT. ALL WITH DISCOUNTS—IT WILL PAY YOU TO PAY US A VISIT. AUDIO SYSTEMS £40–£300 TO SUIT. SEND FOR STOCK LIST 16/17

ELECTRONIC ORGANS

CALL IN AND SEE THE NEW MODELS!



- ★ MODERN ALL BRITISH TRANSISTORISED DESIGNS AVAILABLE AS KITS OR READY BUILT
- ★ TEAK VENEERED CABINETS FOR ALL MODELS
- ★ 49 NOTE, 61 NOTE SINGLE MANUAL DESIGNS ALSO TWO MANUAL 49 NOTE
- ★ KITS AVAILABLE IN SECTIONS AS REQUIRED
- ★ HP and CREDIT SALE FACILITIES
- ★ **FREE 16-PAGE BROCHURE**

Covering organs in kit form and ready built—write or phone to ORGAN DEPT. Ask for Peter Elvins.

HENRY'S RADIO LTD.

Mail Order Dept. Electronic Components and Equipment, and Electronic Organ Dept.
303 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 1008/9
Open Mon-Sat. 9am–6pm. Thurs. 9am-1pm

High Fidelity and Audio Centre
309 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 6963
Open all day Saturday.