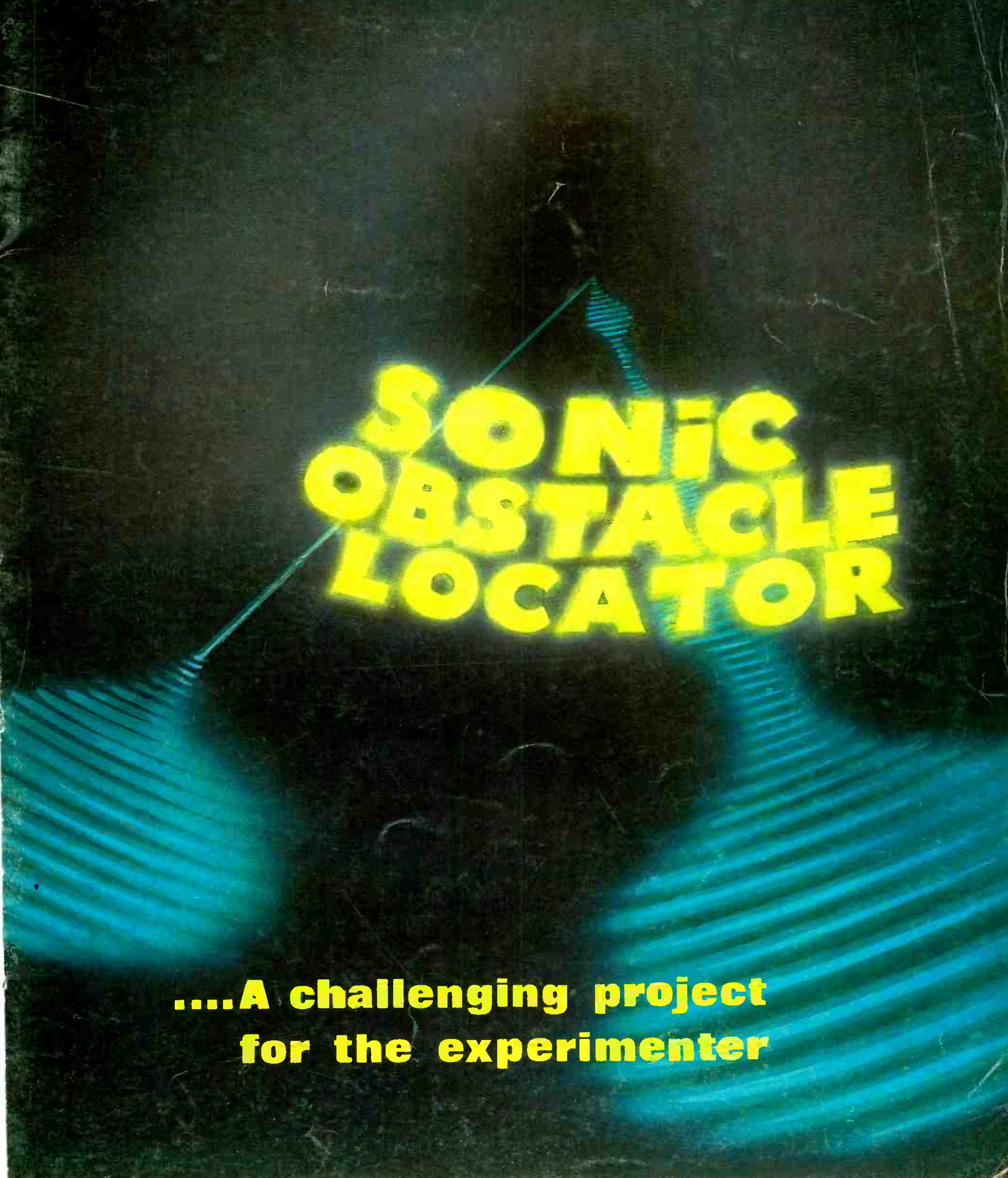
PRACTICAL

ELECTRONICS

JANUARY 1971

3/6 (17½ NEW PENCE)



SONIC OBSTACLE LOCATOR

....A challenging project for the experimenter

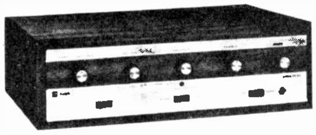
knight-kits FANTASTIC LOW PRICES!

Due to huge purchase these superb U.S.A. construction kits can be offered at 25%—50% off recommended list prices. Absolutely complete with most detailed construction and operating books. Available from all branches or by mail order for 7/6 CARRIAGE AND PACKING on each kit. Two kits or more carr. free.

KG-865 50 Watt Stereo Amplifier Kit

DELUXE FEATURES

All Silicon Transistors for Stability, Cleaner Sound ● Extremely Wide Power Bandwidth and Frequency Response ● 50W IHF Power Output ● Specially Selected Low-Noise Preamp Transistors ● Two Printed Circuit Boards for Fast Easy Assembly ● Convenient Front-Panel Stereo Headphone Jack ● Teak-finished Extruded Aluminium Front Panel ● Two a.c. Convenience Outlets.

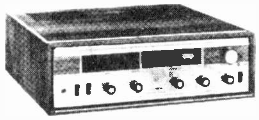


Output: *50W IHF. 25W per channel: 34W continuous sine wave* ● **Response:** *– 1dB, 18 to 30,000Hz* ● **Output Impedances:** *4 through 16 ohms, plus stereo headphones* ● **IM Distortion:** *under 1% at 60Hz and 7,000Hz mixed 4 : 1 at rated power* ● **Input Sensitivity:** *Magnetic Phono, 5mV; Tuner and Auxiliary, 500mV* ● **Power Requirement:** *230–250V, 50Hz a.c.*
Recommended List Price £34.19.6: **24 GNS.** Assembled **29 GNS.** Teak Case **£5** Extra

ALL SILICON TRANSISTORS

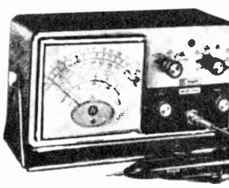
The NEW KG-980 Stereo FM Receiver Kit

Designed to Satisfy the Most Critical Listener



R.F. and I.F. Panels Assembled and Aligned ● Front Panel Stereo Headphone Jack and Speaker Muting Switch ● Full Controls including Tape Monitor ● 50W I.H.F. Output ● Usable I.H.F. Sensitivity: *3µV* ● **Frequency Response:** *±1dB, 30 to 15,000Hz* ● **Harmonic Distortion:** *less than 1·0%* ● **A.M. Suppression:** *more than 30dB* ● **Channel Separation:** *30dB* ● **Complementary Transformerless ● Power Output:** *50W I.H.F. (25W per channel); 34W continuous sine wave* ● **Frequency Response:** *— 1dB, 18 to 30,000Hz* ● **Power Bandwidth:** *20–20,000Hz at 1% harmonic distortion* ● **Two R.F. Stages ● Stereo indicator light.** Recommended List Price £62.19.6: **39 GNS.** Assembled **49 GNS.** Teak Case **5 GNS.** Extra

KG-625 Deluxe 6in Vacuum Tube Voltmeter Kit



Huge 6in Meter Scale ● Ranges: *d.c. 0–0·5–1·5–5–15–50–150–500–1,500V full scale.* ● **Accuracy:** *±3% of full scale reading* ● **Input Resistance:** *11MΩ to 1,500V* ● **Ranges:** *a.c. 0–1·5–5–15–50–150–500–1,500V full scale. 0–4·2–14–42–140–420–1,400–4,200V full scale* ● **Accuracy:** ±5% ● **Frequency Response:** *±1dB, 30Hz to 3MHz; ±3dB, 30Hz to 5MHz* ● **Ohm-meter Ranges:** *0–1,000–10,000 ohms; 0–1–10–100–1,000MΩ* ● **Battery:** *1½V U2.*
Recommended List Price £24.19.6: **12 GNS.** KG 620 as KG 625 (Same Ranges) but 4½in Scale: **9½ GNS.**

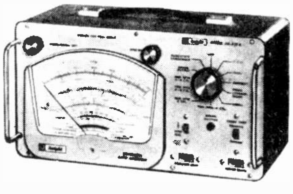
STAR ROAMER 5-Band Shortwave Receiver Kit

Bandspread: *electrical, calibrated 0–100* ● **Sensitivity:** *10µV for 10dB signal-to-noise ratio* ● **I.F. Bandwidth:** *8kHz at 6dB down* ● **Beat Frequency:** *variable, 0–5kHz* ● **Speaker:** *1in permanent magnet type* ● **Power Supply:** *fused, transformer operated* ● **Headphone Output:** *low impedance* ● **Valve Complements:** *1-6BE6, 1-6HR6, 1-12AX7, 1-6AK6 or 1-6AR5* ● **Power Requirements:** *230–250V, 50Hz a.c.; 15W* ● **Covers 200 to 400kHz and 550kHz to 30MHz in 5 Band-switched Ranges ● Superheterodyne Circuit includes controlled regenerative I.F. stage ● A.V.C. reduces fading and blasting; A.N.L. cuts noise to a minimum ● Aerial Trimmer effectively peaks incoming signals for best reception ● Illuminated "S" Meter; Large, Easy-to-Read 7½in Slide Rule Dial.**
Recommended List Price £21.19.0: **14 GNS.** Assembled Price **19 GNS.**

KG-375A Deluxe Solid-State Auto Analyzer Kit

Tune-up and trouble-shoot any car, perform actual road tests

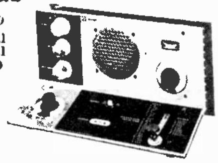
It's several testers in one . . . do all this



Set Engine Idle and Automatic Transmission Shift Points ● Detect Condition of Point Surfaces ● Detect Distributor Wear ● Check Voltage and Current Regulators ● Check Generators for both Current and Voltage Output ● Find Poor or Open Earth Circuits ● Detect Variation in Dwell Angle.
Recommended List Price £23.17.6: **16 GNS.** Assembled Price **21 GNS.**

100-in-1 Electronic Science Lab

LOOK AT THE PROJECTS YOU CAN BUILD

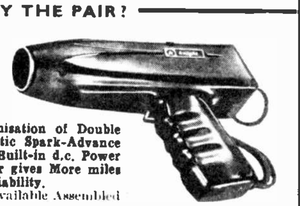


● Electronic Scale ● Electronic Timer ● Signal Generator ● Hybrid Light Meter ● Signal Injector ● Morse Code Buzzer ● Electronic Cat ● Metronome ● Code Flasher ● CW Monitor ● Ohmmeter ● Boat Horn ● Hybrid Radio ● Hybrid Voice Relay ● Air-powered Radio ● Polarity Checker ● Valve Checker.
Includes: ● Dual Headset ● Photocell ● Speaker ● Meter ● Aerial ● Transistors.
Recommended List Price £16.8.0: **9½ GNS.**

WHY NOT BUY THE PAIR?

KG-371 Deluxe Solid-State Timing Light

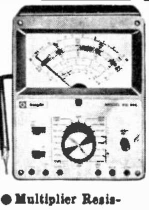
Performance surpasses assembled units costing much more



Helps Set Ignition Timing ● Checks Synchronisation of Double Breaker Arms ● Checks for Sticking Automatic Spark-Advance Mechanism ● Checks Distributor Cam Wear ● Built-in d.c. Power Supply ● Reliable Solid-State Circuit ● Your car gives More miles per gallon; Improved performance; Greater reliability.
Recommended List Price £12.10.0: **9 GNS.** Available Assembled Only.

KG-640 20,000 ohms/Volt VOM Kit

BIG PROFESSIONAL SIZE 62 RANGE MULTIMETER



● A.C. Volts (12 Ranges): *0–2–4–8–16–40–80–200–400–800–1,600–2,000–4,000V* ● **D.C. Volts (12 Ranges):** *0–0·8–1·6–8–16–40–80–200–400–800–1,600–2,000–4,000V* ● **Output Volts (8 Ranges):** *0–2–4–8–16–40–80–200–400V* ● **Resistance (8 Ranges):** *0–1,000–100,000 ohms–10 megs. Centre scales at 12, 1,200 and 120KΩ* ● **D.C. Current (10 Ranges):** *0–80–160–400–800µA, 8–16–200–400mA, 8–16A* ● **Decibels (12 Ranges):** *—12 to +74* ● **D.C. Sensitivity:** *20,000 ohms per volt or 10,000 ohms per volt (function of scale multiplier switch)* ● **Frequency Response:** *20Hz to beyond 200kHz* ● **Accuracy:** *d.c. 3%, a.c. 5%* ● **Test Leads:** *one red, one black, each 48in long* ● **Multiplier Resistors:** *All 1% carbon film.*
Recommended List Price £16.19.6: **9½ GNS.** Assembled Price **12 GNS.**

JASON TAPE

We offer you fully tensilised polyester/mylar and P.V.C. tapes of identical quality hi-fi, wide range recording characteristics as top grade tapes. Quality control manufacture. They are truly worth a few more coppers than acetate, sub-standard, jointed or cheap imports. TRY ONE AND PROVE IT YOURSELF.

Standard		Long		Double		Triple	
3in. 150ft.	**2/3**	3in. 225ft.	**2/9**	3in. 300ft.	**4/-**	4in. 900ft.	**13/-**
4in. 300ft.	**4/6**	4in. 450ft.	**5/6**	4in. 600ft.	**8/-**	5in. 1,800ft.	**25/-**
5in. 600ft.	**7/6**	5in. 900ft.	**10/6**	5in. 1,200ft.	**15/-**	5¾in. 2,400ft.	**34/-**
5¾in. 900ft.	**10/6**	5¾in. 1,200ft.	**13/-**	5¾in. 1,800ft.	**19/-**	7in. 3,600ft.	**44/-**
7in. 1,200ft.	**12/6**	7in. 1,800ft.	**18/6**	7in. 2,400ft.	**27/-**	Quadruple	
						3in. 600ft.	**8/6**

Postage 1/- reel. Post free less 5% on three reels. **Quality and Trade enquiries invited.** NOTE. *Large tape stocks at all branches.*

Stockists of Leak, Quad, Chapman, Goodman, Armstrong, Tripletone, Linear, Rodgers, Truvox, Ferrograph, Wharfedale, etc., etc.

TECHNICAL TRADING

All Mail Orders:—

★ **ARUNDEL** 15-17 Queen Street Tel. 3280
★ **BRIGHTON** 6 Queen's Road Tel. 23975
★ **SOUTHSEA** 2 Clarendon Road
★ **PORTSMOUTH** 350-352 Fratton Road. Tel. 22034
★ **SOUTHAMPTON** 72 East Street Tel. 25851

PERSONAL CALLERS Welcomed at all Branches where there are large Hi-Fi and Component stocks at the keenest prices including:

GARRARD 1025 Autochangers complete with GARRARD STEREO CARTRIDGE 7½ GNS.

MAGNETIC CARTRIDGES Goldring 800H 7½ GNS.

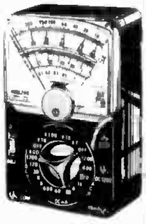
Shriro AT33 £7.10.0 (Both Listed over £10)

Laskys

TMK METER KITS

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

MODEL 200



20,000 O.P.V. Multimeter. Features 24 measurement ranges with mirror scale. Large 3 × 2in meter. Full scale accuracy: DCV and current: ±2%, ACV: ±3%, resistance ±3%. Special 0·6V DC range for transistor circuit measurements.

SPECIFICATION
● DCV: 0–0·6–6–30–120–600–1,200V at 20K/OPV. ● ACV: 0–6–30–120–600–1,200V at 10K/OPV. ● DC Current: 0–0·6–6–600mA. ● Resistance: 0–10K 100K–1M–10M/ohms (58–580–5·8K–58K at mid-scale). ● Capacitance: 0·002–0·2μF (AC 6V range). ● Decibels −20 to +63dB. ● Output: 0·05μF blocking capacitor. Uses two 1·5V (U7 type) batteries. Black bakelite cabinet—Size 5¼ × 3⅞ × 1⅞in. Complete with test leads.

KIT PRICE **ONLY 92/-** Post 3/6

MODEL 5025

50,000 O.P.V. FEATURING 57 MEASUREMENT RANGES

Uses an entirely new range selection mechanism which permits the use of a really large meter in a more compact cabinet. The range selected is indicated on the meter face. High speed rotary range selection knob; polarity reversal switch, shielded meter movement with overload protection circuit; Special μA and mA measurement ranges.

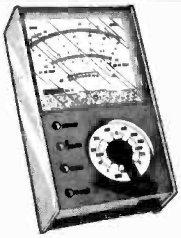
SPECIFICATION DCV: 0–0·25–2·5–10–50–250–1,000V at 25K/OPV. 0–0·125–1·25–5·0–25–125–500V at 50K/OPV. ACV: 0–3–10–50–250–1,000V at 2·5K/OPV. 0–1·5–5–25–125–500V at 5K/OPV. DCμA: 0–25μA at 125mA: 0–50μA at 250mA. DCmA: 0–2·5–25–250mA at 125mV; 0–5–50–500mA at 250mV. DC Amps: 0–5A at 125mV; 0–10A at 250mV. Resistance: 0–10M/ohms. Output: Capacitor (0·1μF, 400Vw) in series with ACV ranges. Decibels: −20 to +81·5dB. Operates on two 1·5V batts. Black bakelite cabinet, size 5¼ × 6¾ × 2⅞in. Complete with test leads.

KIT **£10.10.0** Post 5/

MODEL 5025 *ALSO AVAILABLE READY BUILT AND TESTED £12.10.0* POST 5/-

EXCLUSIVE

TM-5



5 K ohms/V POCKET MULTIMETER

Another new look pocket multi-meter from Lasky's providing top quality and value. The "slimline" impact resistant case—size 4⅞in × 2⅞in × 1¼in, fitted with extra large 2⅞in square meter. Readability is superior on all low ranges; making this an excellent instrument for servicing transistorised equipment. Recessed click stop selection switch. Ohms zero adjustment. Buff finish with crystal clear meter cover.

● DC/V: 3–15–150–300–1,200 at 5K/OPV.
● AC/V: 6–30–300–600 at 2·5K/OPV.
● DC Current 0–300μA, 0–300mA.
● Resistance: 0–10kΩ, 0–1MΩ.
● Decibels: −10dB to +16dB.
● Complete with test leads, battery and instructions.

LASKY'S PRICE **59/-** Post 2/6

TM-1 MINI-TESTER

1 K ohms/volt

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

Size Only 3¼in. × 2⅜in. × 1¼in

● DC/V: 0–10–50–250–1,000 at 1K/OPV.
● AC/V: 0–10–50–250–1,000 at 1K/OPV.
● DC CURRENT: 0–1mA, 100mA.
● Resistance: 0–150kΩ.
● Decibels: −10dB to +22dB.
● Complete with test leads, battery and instructions.

LASKY'S PRICE **39/-** Post 2/6

TMK 100,000 OPV

"LAB MODEL"

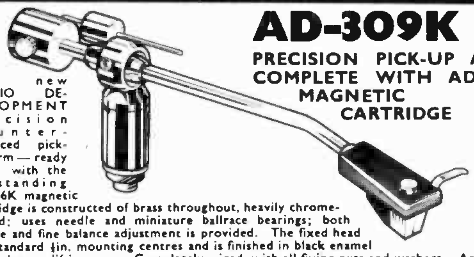
A highly accurate yet rugged Multitester using a 10μA meter hand calibrated to a D.C. accuracy of ±3% of full scale. Special features—ultra large meter scale 6¼ × 3¼in Incorporating an entirely new type of range selection panel which gives instant range identification without taking your eyes from the meter. An audible buzzer is provided for easy short testing. SPEC: D.C./V ranges: 0·5, 2·5, 10, 50, 250, 500, 1,000V at 100K/O.P.V. A.C./V. ranges: 3, 10, 50, 250, 500, 1,000V at 5K/O.P.V. D.C. current: 0–10, 100μA, 0–10, 100mA, 0–2·5, 10A. Resistance: 0–1K, 10K, 100K, 10M, 100M/ohms. Decibels: −10 to 49.4dB. Continuity test: Audible buzzer. Operates on × 11·5V U2 and 1 × 15V B. 154 type batteries. Cabinet size 7⅞ × 6¾ × 3¼in. Weight 4lb.

LASKY'S PRICE **£17.15.0** Post 5/-

AUDIO DEVELOPMENT

AD-309K

PRECISION PICK-UP ARM COMPLETE WITH AD-76K MAGNETIC CARTRIDGE



The new AUDIO DEVELOPMENT precision counter-balanced pick-up arm — ready fitted with the outstanding AD-76K magnetic cartridge is constructed of brass throughout, heavily chrome-plated; uses needle and miniature ballrace bearings; both coarse and fine balance adjustment is provided. The fixed head has standard ½in. mounting centres and is finished in black enamel with chrome lifting spur. Completely wired, with all fixing nuts and washers. Arm rest also supplied. Tech. details: Overall length 285mm; needle to pivot length 223mm; offset angle 24°; overhang 10mm. Requires single 7/16in. dia. mounting hole.

LASKY'S PRICE **£8.10.0** Post Free

AUDIO DEVELOPMENT AD-76K

Stereo Magnetic Cartridge. Frequency response: 20–20,000Hz. Output: 5mV. Stylus: Diamond LP. Tracking force: 2 gms ±0·5 gm. Replacement stylus type JS.P1 41/- post free. **90/-** Post Free

AUDIO DEVELOPMENT AD-96K

Stereo Magnetic Cartridge. Frequency response: 20–20,000Hz. Output: 5mV. Stylus: Diamond LP. Tracking force: 2 gms. Replacement stylus type Y.960S.51/6, post free. **£5.18.0** Post Free

SONICS AS-57

ELEGANT BUDGET PRICED BOOKSHELF SPEAKER SYSTEMS

The AS-57 is a real space saver. This fine miniature high-fidelity speaker system will provide good quality sound anywhere in your home at remarkably low cost. Designed for use where space is at a premium, the AS-57 system is ideal for the small apartment or isolated listening area. The special high efficiency 5 × 7in full range speaker has a frequency range of 70–18,000Hz with a peak handling capacity of 10 watts. Imp. 8 ohms. Finish: oiled walnut. Size 5⅞ × 15¾ × 8½in.

LASKY'S PRICE **£15** per PAIR POST 10/-

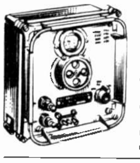
TYPE 13A DOUBLE BEAM OSCILLOSCOPES

An excellent general purpose D/B oscilloscope, T.B. 2 c/s-750KHz. Bandwidth 5·5 MHz. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V a.c. Supplied in excellent working condition. **£22.10.0.** Carriage 30/-.

AVO CT471A MULTIMETER

Battery operated, fully transistorised. Sensitivity 100mΩ/v. Measures AC/DC Voltages 12mV to 1,200v. AC/DC Current 12uA to 1.2 Amp. Resistance 12 ohm to 120 mΩ HF, VHF, UHF, Voltage with multiplier 4v to 400v up to 50 Mc/s, 40mV to 4V up to 1,000 Mc/s. Offered in perfect condition. **£55 each.** Carr. 10/-.

CRYSTAL CALIBRATORS No. 10

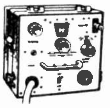


Small portable crystal controlled wavemeter. Size 7" 7½" :4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **89/6.** Carr. 7/6.

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.

CLASS D WAVEMETERS

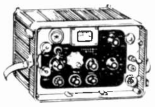


A crystal controlled heterodyne frequency meter covering 1-7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new. **£7.19.6.** Carr. 7/6.

B.C. 221 FREQUENCY METERS

latest release 125kHz to 20MHz. Excellent condition. Fully tested and checked and complete with calibrator charts. **£27.10.0.** each, Carr. 10/-.

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/-.

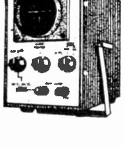
AVO CT.38 ELECTRONIC MULTIMETERS

High quality 97 range instrument which measures a.c. and d.c. Voltage, Current, Resistance and Power Output Ranges d.c. volts 250mV-10,000V (10 megΩ-110 megΩ input). D.c. current 10μA-25A. Ohms. 0-1,000 megΩ a.c. volt 100mV-250V (with R.F. measuring head up to 250MHz) a.c. current 10μA-25A. Power output 50 microwatts-5 watts. Operation 0/110/200/250V a.c. Supplied in perfect condition complete with circuit lead and R.F. probe. **£25.** Carr. 15/-.

ADMIRALTY 62B RECEIVERS

High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 150-300 Kc/s; 5½ Kc/s-1·5 Mc/s; 3·9-30·5 Kc/s. I.F. 500/KHz. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19½ :: 13½ : 16in. Weight 114lb. Offered in good working condition. **£22.10.0.** Carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15KHz-700KHz. **£17.10.0.** Carr. 30/-.

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/-.

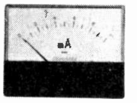
SEW PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.
● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS

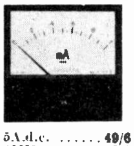
TYPE SW. 100
100 x 80 mm



50μA	69/6	1mA	59/6
100μA	67/6	20V d.c.	59/6
500μA	62/6	50V d.c.	59/6
		1A d.c.	59/6
		5A d.c.	59/6
		300V a.c.	59/6
		VU Meter	75/-

BAKELITE PANEL METERS

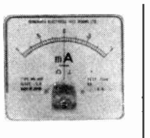
TYPE S-80
80 mm
square fronts



50μA	62/6	5A d.c.	49/6
100μA	59/6	300V a.c.	52/6
500μA	52/6	VU Meter	67/6
1mA	49/6		
20V d.c.	49/6		
50V d.c.	49/6		
1A d.c.	49/6		

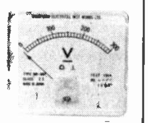
"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4¼in 4¼in fronts.



50μA	72/-	10mA	52/-
50-0-50μA	62/-	50mA	52/-
100μA	62/-	100mA	52/-
100-0-100μA	62/-	500mA	52/-
200μA	57/6	1A	52/-
500μA	55/-	5A	52/-
500-0-500μA	52/-	15A	52/-
1mA	52/-	30A	52/-
1-0-1mA	52/-	20V d.c.	52/-
5mA	52/-	50V d.c.	52/-
		150V d.c.	52/-
		300V d.c.	52/-
		15V a.c.	52/-
		300V a.c.	52/-
		8 Meter 1mA	57/6
		VU meter	72/-
		1A a.c.*	52/-
		5A a.c.*	52/-
		10A a.c.*	52/-
		20A a.c.*	52/-
		30A a.c.*	52/-

Type MR.38P. 1 21/32in square fronts.



50μA	40/-	150mA	27/6
50-0-50μA	37/6	200mA	27/6
100μA	37/6	300mA	27/6
100-0-100μA	35/-	500mA	27/6
200μA	35/-	750mA	27/6
500μA	30/-	1A	27/6
500-0-500μA	27/6	2A	27/6
1mA	27/6	5A	27/6
1-0-1mA	27/6	10A	27/6
2mA	27/6	3V d.c.	27/6
5mA	27/6	10V d.c.	27/6
10mA	27/6	15V d.c.	27/6
20mA	27/6	20V d.c.	27/6
50mA	27/6	100V d.c.	27/6
100mA	27/6	150V d.c.	27/6
		300V d.c.	27/6
		500V d.c.	27/6
		750V d.c.	27/6
		15V a.c.	27/6
		50V a.c.	27/6
		150V a.c.	27/6
		300V a.c.	27/6
		500V a.c.	27/6
		8 meter 1mA	32/-
		VU meter	42/-

Type MR.52P. 2½in square fronts.

50μA	62/-	10V d.c.	40/-
50-0-50μA	52/-	20V d.c.	40/-
100μA	52/-	50V d.c.	40/-
100-0-100μA	47/6	300V d.c.	40/-
500μA	45/-	15V a.c.	40/-
1mA	40/-	300V a.c.	40/-
5mA	40/-	8 Meter 1mA	42/-
10mA	40/-	VU Meter	62/-
50mA	40/-	1A a.c.*	40/-
100mA	40/-	5A a.c.*	40/-
500mA	40/-	10A a.c.*	40/-
1A	40/-	20A a.c.*	40/-
5A	40/-	30A a.c.*	40/-

Type MR.45P. 2in square fronts.

50μA	45/-	5A	30/-
50-0-50μA	42/-	10V d.c.	30/-
100μA	42/-	20V d.c.	30/-
100-0-100μA	37/6	50V d.c.	30/-
200μA	37/6	300V d.c.	30/-
500μA	32/-	15V a.c.	30/-
500-0-500μA	30/-	300V a.c.	30/-
1mA	30/-	8 meter 1mA	37/6
5mA	30/-	VU meter	45/-
10mA	30/-	1A a.c.*	30/-
50mA	30/-	5A a.c.*	30/-
100mA	30/-	10A a.c.*	30/-
500mA	30/-	20A a.c.*	30/-
1A	30/-	30A a.c.*	30/-

Type MR.65P. 3½in 3¼in fronts.

50μA	67/6	20V d.c.	42/-
50-0-50μA	55/-	50V d.c.	42/-
100μA	55/-	150V d.c.	42/-
100-0-100μA	52/-	300V d.c.	42/-
500μA	47/6	15V a.c.	42/-
500-0-500μA	42/-	50V a.c.	42/-
1mA	42/-	150V a.c.	42/-
5mA	42/-	300V a.c.	42/-
10mA	42/-	500V a.c.	42/-
50mA	42/-	8 meter 1mA	47/6
100mA	42/-	VU meter	67/6
500mA	42/-	50mA a.c.*	42/-
1A	42/-	100mA a.c.*	42/-
5A	42/-	200mA a.c.*	42/-
10A	42/-	500mA a.c.*	42/-
15A	42/-	1A a.c.*	42/-
20A	42/-	5A a.c.*	42/-
30A	42/-	10A a.c.*	42/-
50A	47/6	20A a.c.*	42/-
10V d.c.	42/-	30A a.c.*	42/-

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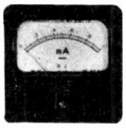
ALL OTHERS MOVING COIL

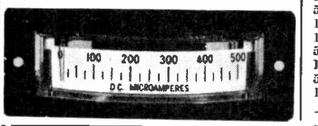
Please add postage

"SEW" BAKELITE PANEL METERS

Type MR 65. 3¼in square fronts.



25μA	70/-	500mA	35/-
50μA	47/6	1A	35/-
50-0-50μA	45/-	5A	35/-
100μA	45/-	15A	35/-
100-0-100μA	45/-	30A	35/-
500μA	42/-	50A	35/-
1mA	35/-	5V d.c.	35/-
1-0-1mA	35/-	10V d.c.	35/-
5mA	35/-	20V d.c.	35/-
10mA	35/-	50V d.c.	35/-
50mA	35/-	150V d.c.	35/-
100mA	35/-	300V d.c.	35/-
		30V a.c.*	35/-
		50V a.c.*	35/-
		150V a.c.*	35/-
		300V a.c.*	35/-
		500mA a.c.*	35/-
		1A a.c.*	35/-
		5A a.c.*	35/-
		10A a.c.*	35/-
		20A a.c.*	35/-
		30A a.c.*	35/-
		50A a.c.*	35/-
		VU meter	62/-



EDGWISE METERS

Type PE.70. 3 17/32in 1 15/32in 2½in deep.

50μA	60/-	500μA	52/-
50-0-50μA	57/6	1mA	47/6
100μA	57/6	300V a.c.	47/6
100-0-100μA	55/-	VU meter	65/-
200μA	55/-		

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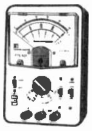
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

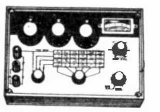
FTC-401 TRANSISTOR TESTER



Full capabilities for measuring A, B and ICO, *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. **£6.19.6.** P. & P. 3/-.

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

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



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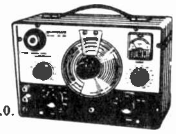
Frequency 0·20 Kc/s on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

TY75 AUDIO SIGNAL GENERATOR

Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 :: 120mm. Brand new with instructions. **£16.** Carr. 7/6.

MARCONI TF885 VIDEO OSCILLATORS. 0-5MHz. Sine Square Wave. **£45.** Carr. 20/-.

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.

270° 500 MICROAMP METER. Incorporated in Radio Altitude Indicator 1D-14APN. Ideal for rev. counter, etc. **15/6.** P. & P. 3/-.

ADVANCE TEST EQUIPMENT

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6U4	12/6	ECH83	8/6	U801	20/-
6V6G	5/-	ECL80	9/-	UABC80	6/9
6V6GT	6/6	ECL82	6/6	UAF42	10/6
6X4	5/-	ECL83	12/6	UBC41	9/6
6X5G	5/6	ECL86	8/6	UBC81	8/-
6X5GT	5/6	EF37A	8/-	UBF80	7/3
10C2	10/-	EF39	8/-		
10F1	18/-	EF40	10/-	UBF89	7/-
10P13	11/-	EF41	12/6	UCC84	9/9
10P14	20/-	EF42	14/-	UCC85	8/-
12AT6	5/-	EF80	5/-	UCF80	10/6
12AT7	4/-	EF85	7/-	UCH21	11/-
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12BA6	6/6	EF92	7/6	UCL83	12/-
12BE6	6/6	EF183	6/6	UF41	10/-
12BH7	6/3	EF184	7/-	UF80	7/6
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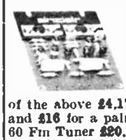

Project 60. Package offers. 2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply, £19.0.0. Carr. 7/6. Or with PZ6 power supply, £21, Carr. 7/6. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply, £21.10.0, Carr. 7/6. Transformer for PZ8, 59/6 extra. Add to any of the above £4.17.6. for active filter unit and £16 for a pair of Q16 speakers. Project 60 Fm Tuner £20.19.6, Carr. 7/6.
All other Sinclair products in stock. 2,000 amplifier, £23, Carr. 7/6. 3000 Amplifier £36. Carr. 7/6. Neoteric amplifier £46, Carr. 7/6.

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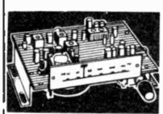

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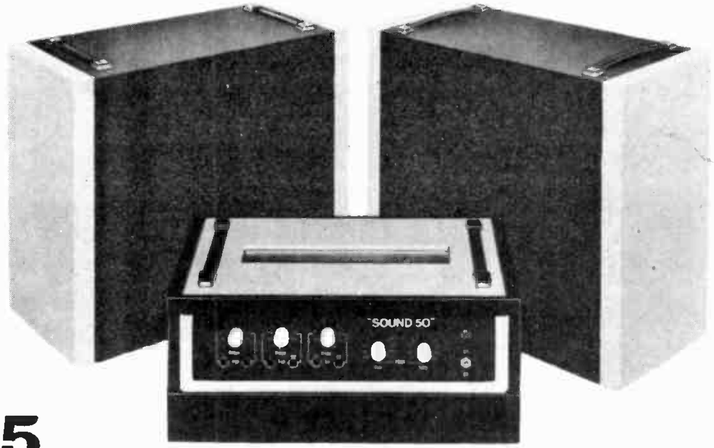

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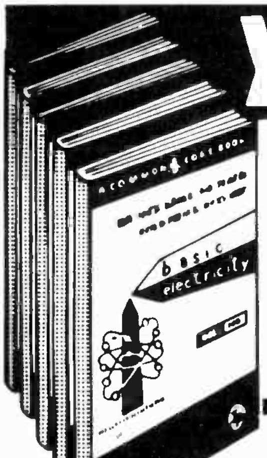

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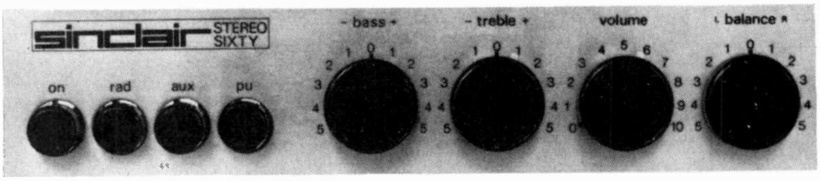
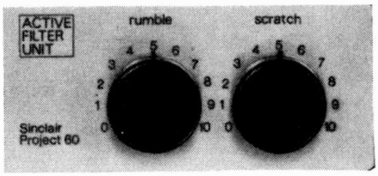
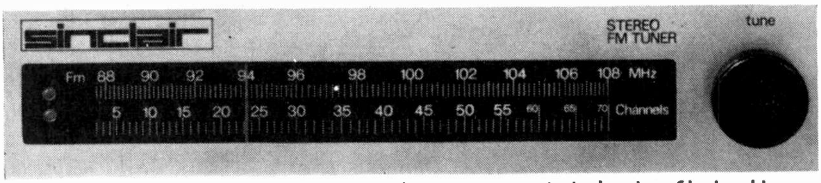
Project 60







the world's most advanced high fidelity modules

With the introduction of an entirely new and original high fidelity stereo F.M. tuner, the Project 60 range can be said at this stage to be complete. It offers the constructor a most attractive choice of modular arrangements whereby a high fidelity system can be selected to suit the user's personal requirements. Equally, it is possible to use any Project 60 modules separately or partially grouped and so benefit greatly from the flexibility in use these modules afford. The chart below shows some of the most popular applications for constructors to assemble. The Project 60 manual (free with the modules) suggests others as well and its 48 pages are packed with valuable information. The new tuner, for example can be used with any good high fidelity system as well as Project 60.

Project 60 now falls into four interdependent groups: – 1. The Z.30 and Z.50 amplifiers which have only 0.02% distortion at all output levels and are useful in a wide variety of other applications. 2. The control units comprising the Stereo 60 preamp and control unit and the Active Filter Unit (A.F.U.) with which both high pass and low pass filtering can be introduced between control unit and power amplifiers. 3. The Stereo F.M. tuner as described opposite; and 4. The power supply units PZ.5, PZ.6 and PZ.8. For most requirements when using Z.30 power amplifiers, the PZ.5 will be perfectly adequate; if low efficiency (high quality) loud speakers are used, the PZ.6 stabilised power supply unit will be used. The PZ.8 will be needed with Z.50s which can be used for any Project 60 system.

Project 60 modules incorporate some of the most advanced circuitry in the world to achieve unsurpassed standards of high fidelity and modern manufacturing techniques enable these modules to be sold at exceptionally attractive prices. Assembling the modules requires no skill or previous experience since the manual supplied with the modules explains clearly how everything can be done with nothing more than the simplest of domestic tools.

Project 60 manuals
How to assemble and use Project 60 modules to best advantage in the above and other applications will be found in the fully descriptive Project 60 manual included with Project 60 systems. This 48 page manual is available separately, price 2/6d including postage.

	System	The Units to use	In conjunction with	Cost of Units	+ Project 60 tuner
A	Car Radio	**Z.30**	Existing car radio, Sinclair Micromatic	**89/6**	
B	Simple battery powered record player	**Z.30**	Crystal pick-up, 12V or more battery supply and volume control	**89/6**	
C	Mains powered record player	**Z.30 and PZ.5**	Crystal or ceramic P.U. Volume control etc.	**£9.9.0**	**£34.9.0**
D	20+20 watts R.M.S. stereo amplifier for most needs	**Two Z.30s, Stereo 60 and PZ.5**	Crystal, ceramic or magnetic P.U., most dynamic speakers, F.M. tuner etc.	**£23.18.0**	**£48.18.0**
E	20+20 watts R.M.S. stereo amplifier for use with low efficiency (high performance) speakers	**Two Z.30s, Stereo 60 and PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc All dynamic speakers	**£26.18.0**	**£51.18.9**
F	40+40 watts R.M.S. de-luxe stereo amplifier	**Two Z.50s, Stereo 60 PZ.8 and mains transformer**	As for E	**£32.17.6**	**£57.17.6**
G	Outdoor public address system	**Z.50**	Microphone, up to 4 P.A. speakers, 12V car battery with converter, or 45V d.c., controls	**£5.9.6**	
H	Indoor P.A.	**One Z.50, PZ.8 and mains transformer**	Microphone, guitar, heavy duty speakers etc., controls	**£17.8.6.**	
J	High pass and low pass filters	**A.F.U.**	D, E or F as above	**£5.19.6**	

sinclair

Sinclair Radionics Limited, 22 Newmarket Road, Cambridge
Telephone (0223) 52731

Z.30 & Z.50 power amplifiers

The Z.30 together with the Z.50 are both of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use the Z.30 or Z.50 power amplifiers in your Project 60 system will depend on personal preference, but they are the same physical size and may be used with other units in the Project 60 range equally well. For operating from mains, for the Z.30 use PZ.5 for most domestic requirements, or PZ.6 if you have very low efficiency loudspeakers. For Z.50, use the PZ 8 described below.

Z.50

Z.30

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms, using 35V: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms from 40 volts: 30 watts R.M.S. into 8 ohms, using 50 volts.
Frequency response 30 to 300,000 Hz ± 1 dB
Distortion 0.02% into 8 ohms
Signal to noise ratio better than 70 dB unweighted
Input sensitivity 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ ins.

Z.30
Built, tested and guaranteed with circuits and instructions manual **89/6**

Z.50
Built, tested and guaranteed with circuits and instructions manual **109/6**

Stereo 60 pre amp/control unit

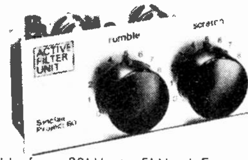
Designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate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

SPECIFICATIONS
- Input sensitivities – Radio – up to 3mV. Mag. p.u. – 3mV: correct to R.I.A.A. curve ± 1dB: 20 to 25,000Hz. Ceramic p.u. – up to 3mV: Aux. – up to 3mV.
- Output – 250mV.
- Signal-to-noise ratio – better than 70dB.
- Channel matching – within 1dB.
- Tone controls – TREBLE +15 to —15dB at 10kHz: BASS +15 to —15dB at 100Hz.
- Front panel – brushed aluminium with black knobs and controls.
- Size $8\frac{1}{4} \times 1\frac{1}{2} \times 4$ ins.

Built, tested and guaranteed **£9.19.6**

Active Filter Unit

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

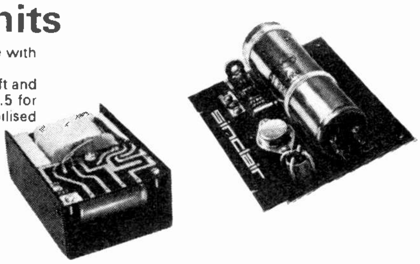


Built, tested and guaranteed **£5.19.6**

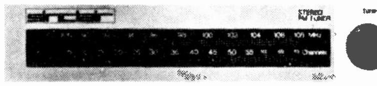
Power Supply Units

The units below are designed specially for use with the Project 60 system of your choice.
Illustration shows PZ.5 power supply unit to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

PZ-5 *30 volts unstabilised* **£4.19.6**
PZ-6 *35 volts stabilised* **£7.19.6**
PZ-8 *45 volts stabilised (less mains transformers)* **£5.19.6**
PZ-8 *mains transformer* **£5.19.6**



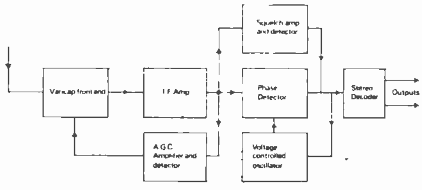
Stereo FM tuner



first in the world to use the phase lock loop principle

Before production of this tuner, the phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio over other systems. Now, for the first time the principle has been applied to an FM tuner with fantastically good results. By the inclusion of other original features such as varicap diode tuning, printed circuit coils and an I.C. in the specially designed stereo decoder, the tuner has an unsurpassed specification, which also incorporates a squelch circuit for silent tuning between stations, A.F.C. and A.G.C. Sensitivity is such that good reception becomes possible in difficult areas, foreign stations can be tuned in suitable conditions and often a few inches of wire are enough for an aerial. In terms of high fidelity, this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. Although the tuner is intended primarily for use with a Project 60 system, it can be used to advantage with any other high fidelity system. It is easily mounted into any cabinet as shown in the manual supplied with it.

Specifications
Number of transistors 16 plus 20 in I.C.
Tuning range 87.5 to 108 MHz
Capture ratio 1.5dB
Sensitivity 2µV for 30dB quieting
7µV for full limiting
Squelch level 20µV
A.F.C. range ± 200 KHz
Signal to noise ratio > 65dB
Audio frequency response 10Hz—15kHz (±1dB)
Total harmonic distortion 0.15% for 30% modulation
Stereo decoder operating level 2µV
Pilot tone suppression 30dB
Cross talk 40dB
I.F. frequency 10.7 MHz
Output voltage 2 x 150mV R.M.S.
Aerial Impedance 75 Ohms
Indicators Mains on; Stereo on; tuning indicator
Operating voltage 25-30 VDC
Size 3.6 x 1.6 x 8.15 inches: 91.5 x 40 x 207 mm



Price: **£25** built and tested. Post free.

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

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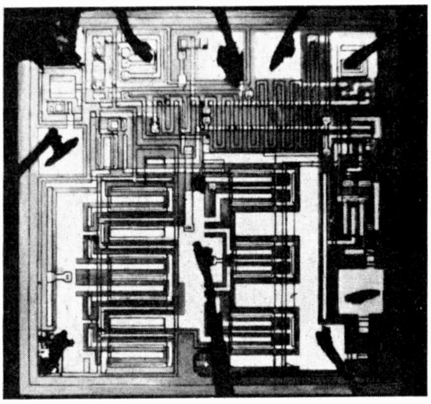
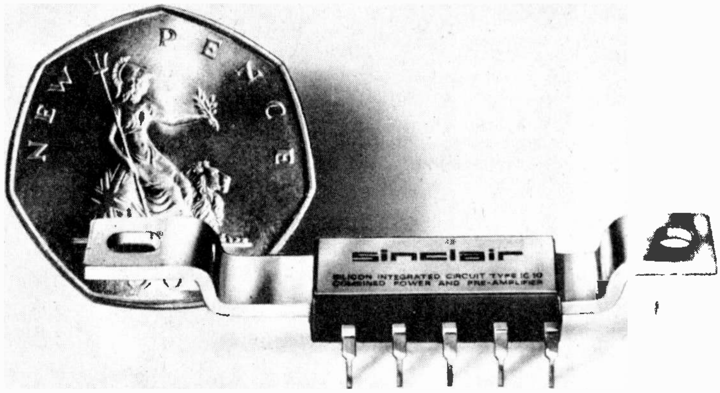
Sinclair IC-10





the world's most advanced high fidelity amplifier

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 x 0.4 x 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 feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

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.

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 one hundredth of an inch thick, has 5 watts R.M.S. output (10w. 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. Once proven, the circuits can be produced with complete uniformity which enables us to give a full guarantee on every IC-10, knowing that every unit will work as perfectly as the original and do so for a lifetime.

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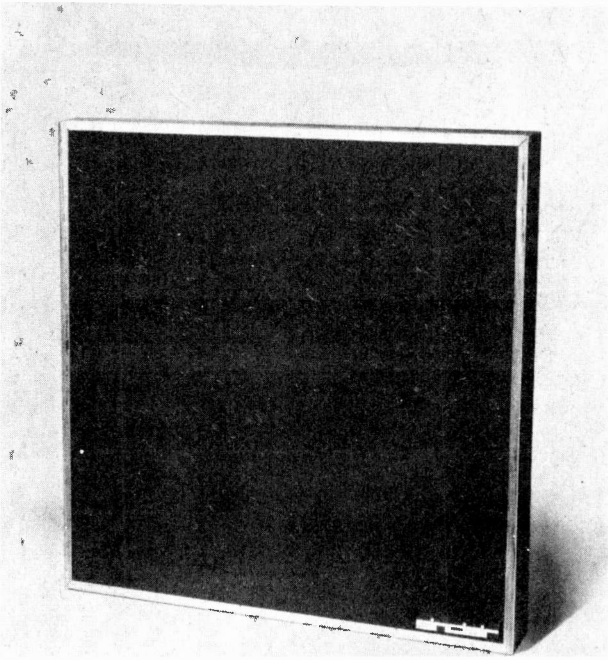
The Q.16 is compact and slim and is the ideal shelf-mounted speaker, and brings genuine high fidelity within reach of every music lover.



Specifications

Construction:	A sealed seamless sound or pressure chamber is used with internal baffle, all of materials carefully chosen to ensure freedom from spurious tone coloration.
Loading:	Up to 14 watts R.M.S.
Input impedance:	8 ohms.
Frequency response:	From 60 to 16,000Hz, as confirmed. by independently plotted B & K curve.
Driver unit:	Specially designed high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and special cone suspension. Excellent transient response is achieved.
Size and styling:	$9\frac{3}{4}$" square on face × $4\frac{3}{4}$" deep with neat pedestal base. Black all-over cellular foam front with natural solid teak surround.
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Specifications

Size:	$1\frac{13}{16}$" × $1\frac{7}{16}$" × $\frac{1}{2}$" (46 × 33 × 13mm).
Weight including batteries:	1 oz. (28.35gm) approx.
Tuning:	Medium wave band with bandspread at higher frequency end.
Earpiece:	High-fidelity magnetic type.
Battery requirements:	Two Mallory Mercury Cells, type R.M. 675, for long working life.
Case:	Black plastic with anodised aluminium front panel, spun aluminium dial.
Controls:	Tuning dial, and on/off switching by means of earpiece plug.
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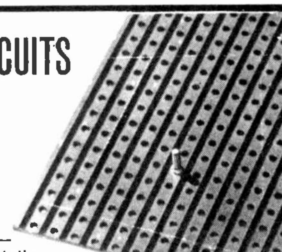

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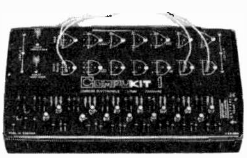

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VOL. 7 No. 1
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PRACTICAL ELECTRONICS

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SEEING WITH SOUND

ALMOST two whole years have passed since fog was last discussed on this page. More specifically, we then aired our hopes for an electronic system that would, to some degree, restore visibility to drivers of motor vehicles in bad weather conditions.

Two years is a long time in electronics, and one could quite reasonably expect important steps to have been taken by now toward the solution of this serious problem. But nothing concrete has emerged so far from industry or from government research establishments.

We do know that much effort has been put into the development of a radar system for vehicles operating inside airports. There is a vital need for emergency service vehicles to be able to move at speed to the scene of an aircraft mishap, no matter what state of visibility obtains. This particular radar system has not yet been put into production, presumably because the airport authorities have not yet been decided to buy.

By normal standards, a radar system is necessarily expensive and involves much sophisticated engineering. It is true that solid state devices such as Gunn-effect diodes are available for microwave operation, and these help to simplify the receiver and transmitter design and so reduce the overall bulk of the installation. But there still remains a major problem in the form of the display device. Until the c.r.t. is superceded by a solid state electro-luminescent panel, there is little likelihood that radar, even in an elementary form, can be seriously considered as a feasible proposition for installation on all types of road vehicles.

While waiting for further advances in technology to solve these engineering (and cost) problems, there is no reason why private individuals should not on their own account investigate other methods to combat the common enemy, fog.

Leaving aside electro-magnetic waves, why not explore the possibility of sound waves? The equipment needed for an acoustical system is not highly complicated, and the basic principles involved are familiar enough to most electronics enthusiasts. The Sonic Obstacle Locator described in this issue has proved itself to a marked degree. Admittedly, as a driving aid it is not infallible, and lacks, as yet, the ability to discriminate between tree, lamp post, or car. Serious limitations, in fact, for a car-borne device. But it is not offered as an instant solution to a formidable problem. It is offered as an idea worthy of further development by the experimentally inclined. And other uses may well become apparent.

We hope many will rise to the challenge. Amateurs have blazed the trail before. Most significantly, in proving the usefulness of the then neglected high frequency radio waves. Maybe private experimenters can achieve some noteworthy success in electro-acoustics. F.E.B.

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SONIC OBSTACLE

ATMOSPHERIC pollution and weather conditions often combine to produce thick fogs which reduce visibility to as little as 10–20 feet. Much the same applies where there is smoke or driving snow. In such conditions man's senses are virtually useless and there is a real need for technical aids to penetrate the murk.

Short range radar would seem to provide an answer to the problem, but the equipment is expensive and involves radio licensing complications. Fog is transparent to certain bands of infra-red, but infra-red emitters and sensors for use at such wavelengths are not, as yet, sufficiently developed. Another approach would be ultrasonics, but high frequency sound waves tend to be scattered by fog droplets, and have a short range.

AUDIBLE SOUND

The Oil-bird of South America points the way to a possible solution to the problem; it finds its way around dark caves by emitting audible clicking noises, like the sound of castanets. Audible sound is, of course, only slightly attenuated by fog and other atmospheric particles, hence the use of the fog horn, and the explosive cap on railways.

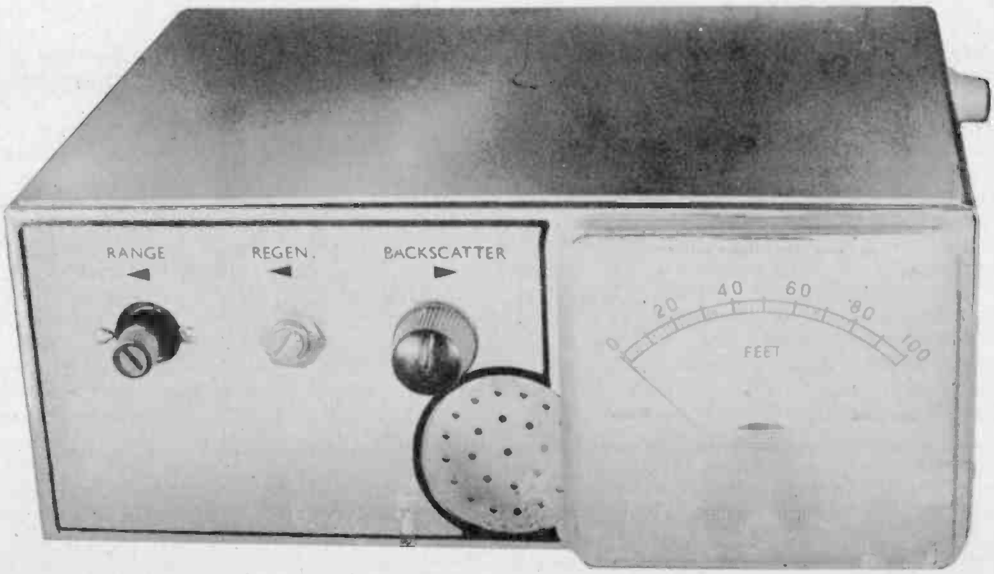
Sonar has long been employed for navigation and ranging purposes underwater, and there seems to be no reason why audible sound pulses in air should not be similarly used if the equipment can be made to operate against a background of day-to-day ambient noise.

The Sonic Obstacle Locator is the result of experiments to test the practicability of using audible sound to detect the presence of unseen objects in fog. With a range of 100 feet, the equipment could be used on board small boats for docking in conditions of poor visibility, or as an outdoor, all weather intruder alarm. There are many other possible applications, such as counting passing cars on a roadway, and educational demonstrations involving the speed, refraction, and reflection of sound waves.

SENSITIVITY

Although not recommended for use on cars in fog, the Sonic Obstacle Locator will work at low speeds, and was tested on a vehicle as this provided the most adverse conditions of high ambient noise.

To give an idea of sensitivity, a response is obtained from an adult pedestrian at up to 22 feet, a small parked car at 50 feet, or a stone wall perpendicular to



LOCATOR

By D. Bollen

the sound source axis at 100 feet. When an obstacle in the road ahead is detected, the unit inside the car emits a bleep warning note, of duration directly proportional to distance.

The note varies from a short click at 95 feet range, to an almost continuous tone at the minimum range of 5 feet. A meter linearly calibrated 0–100 feet is incorporated to show the actual distance of the obstacle.

Because of sonic interference from the exhaust noise of other vehicles, particularly diesel lorries, the equipment will only operate reliably at traffic speeds below 30 m.p.h., under typical fog driving conditions.

MEASURING DISTANCE THROUGH AIR WITH SOUND

High frequency sound is readily reflected from solid surfaces, and sound waves conform to the same general laws of reflection as light.

The time taken for a sound to travel to a reflecting surface and back again can be used as a measure of the intervening distance, with an accuracy dependent on slight changes in the speed of sound resulting mainly from variations of temperature and humidity.

Sound velocity is not significantly influenced by droplets or particles in the atmosphere, and is largely independent of air pressure and altitude when corrections are made for temperature.

The velocity of sound in dry air at 0 degrees centigrade is 1,087 feet per second; about 4½ times slower than sound in water. If the air temperature is raised to 20 degrees centigrade a velocity increase of about 3·7 per cent will be noted.

When the air is fully saturated with water vapour, this causes a velocity increase of about 0·5 per cent, because water vapour decreases the density of air.

From the above it can be estimated that, over a temperature range ±10 degrees centigrade, and in varying humidity, a sonic yardstick should offer a potential accuracy of about ±2·5 per cent.

OPERATING FREQUENCY AND TRANSDUCERS

The frequency of the transmitted sound should be high, to combat interference from man-made noise, the bulk of which lies in the lower part of the audio spectrum. However, sonic transducers operating above 15kHz are usually not sensitive enough for low power sound-through-air applications, although they may be suitable for service underwater where sound conduction

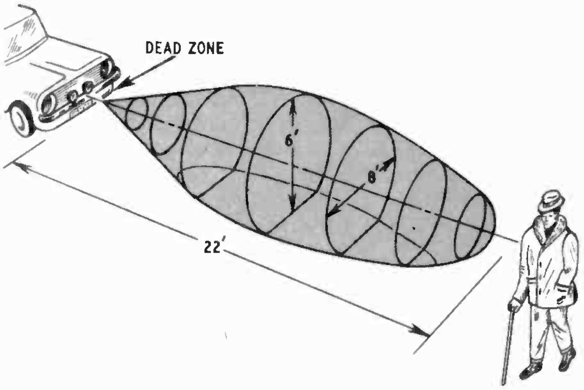


Fig. 1. Area of response of the Sonic Obstacle Locator when used for pedestrian detection

is good. In the interests of economy, it was decided that special transducers should be avoided.

Tests were made with several types of loudspeaker and microphone, to establish a suitable compromise between cost and noise rejection when choosing the operating frequency. Firstly, the upper limit was set by microphones offering a useful output above 15kHz, as they were too expensive to qualify.

It was discovered that good quality tweeters operating at 10–15kHz gave markedly inferior results when compared with small, cheap loudspeakers handling 10kHz. This somewhat surprising result was eventually attributed to sound reinforcement arising from resonances in the cheap loudspeakers, and further improvements at 10kHz were effected by cutting down the size of the loudspeaker cone, and stiffening it with cellulose dope. Obviously, if the sonic transmitter can be encouraged to provide a large acoustic output, this will tend to minimise noise, and compensate for the lower frequency.

When a loudspeaker is handling frequencies above a few kilohertz there will be only a small excursion of the voice coil and cone, and the limit to the amount of power the loudspeaker can handle is determined by voice coil overheating. If the high frequency input is pulsed on and off, with a relatively long pause between pulses, the loudspeaker can sustain very high levels of input without damage, and at the same time yield an output of high intensity.

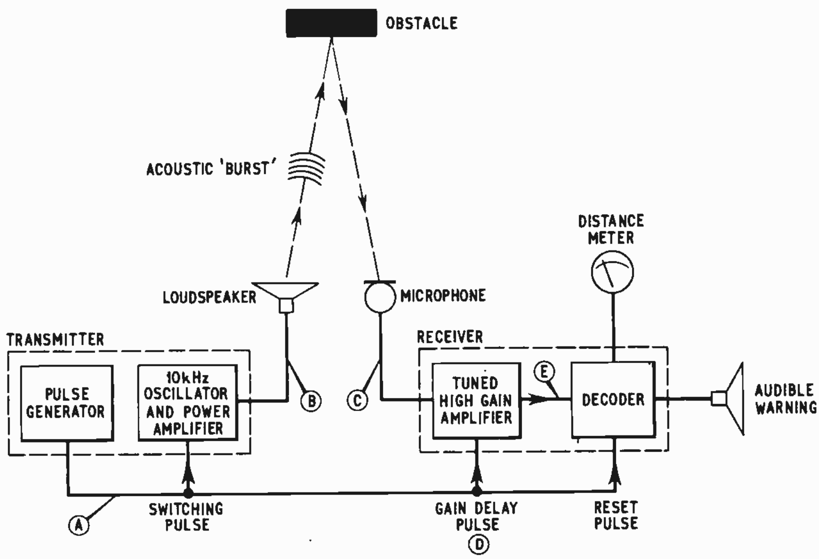


Fig. 2. Block diagram of the Sonic Obstacle Locator. 10kHz bursts of radiated acoustic energy are made to bounce off the obstacle. These are then amplified and the distance of the obstacle computed by the decoder for display by a meter. An audio bleep warning is also triggered at this final stage

DIRECTIONAL CHARACTERISTIC

In using a locator, echoes should only be obtained from obstacles in the road ahead, and not from objects which do not lie in the path of the vehicle.

A loudspeaker offers a polar response, at high frequencies, which is directional, but is not sufficiently narrow in shape for the present application; the requirement taking the form of a broad sphere slightly flattened along the sound source axis. However, a microphone can be made to see only a narrow angle by placing it at the focus of a parabolic reflector which looks along the source axis.

When loudspeaker and microphone polar responses are combined, the result is a thin, almost ideal cigar shape extending in front of the vehicle, as depicted in Fig. 1.

The plot upon which Fig. 1 is based was obtained from a 5 gallon oil drum which simulates a pedestrian wearing normal, soft clothing.

It can be seen that the area of response is roughly the width of the car and extends forwards to a distance of 22 feet. For larger obstacles, the area of detection will be wider and longer, though still of the same cigar shape.

SONIC TRANSMITTER

The basic features of the Sonic Obstacle Locator are outlined by the block diagram of Fig. 2, with associated waveforms in Fig. 3.

Dealing first with the transmitter, this consists of a pulse generator, a 10kHz square wave oscillator, and a tuned power amplifier. The pulse generator provides a master pulse of 2ms duration (Fig. 3A) at intervals of 178ms, the time taken for sound to travel to the obstacle and back at the maximum range of 100 feet.

On receipt of the pulse, the 10kHz oscillator provides an output of 2ms duration, consisting of 20 cycles of a 10kHz square wave, which is then passed to the power amplifier. Being tuned, the power amplifier converts the square wave into a sine wave, and the input to the loudspeaker is an envelope containing 20 cycles of a 10kHz sine wave as seen in Fig. 3B.

To detect echoes from obstacles very close to the transmitter, the radiated sound must be of short duration, so that it dies away completely before the echo arrives. A time of 2ms for the acoustic burst from the transmitter is well inside the period fixed by the minimum range of 5 feet, to allow for various circuit delays and loudspeaker lag.

In passing, it is of interest to note that the short burst of 10kHz sound from the transmitter is registered by the human ear merely as a loud click, with virtually no tone content.

RECEIVER

If an untuned amplifier was used with a microphone to pick up the minute reflected signals from the transmitter, the echo pulses would be completely swamped by

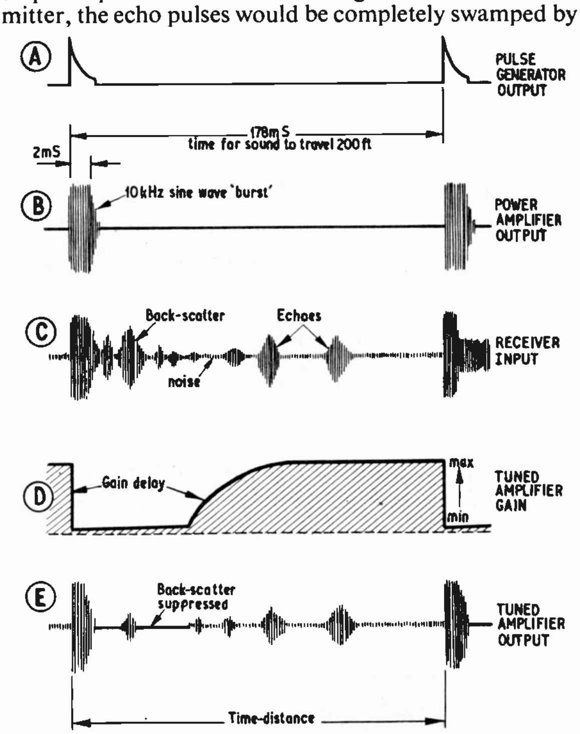


Fig. 3. Waveforms associated with Fig. 2 and identifiable by the letter. Fig. 3D is the tuned amplifier gain characteristic

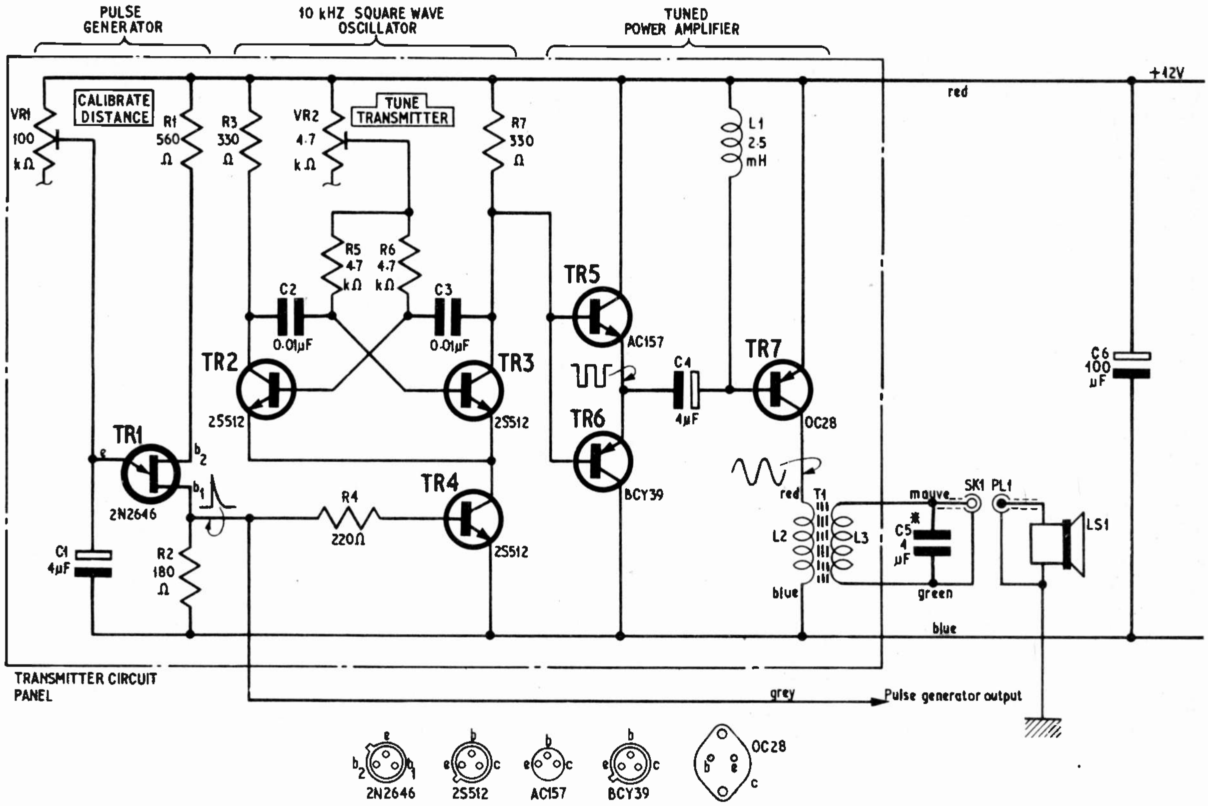


Fig. 4. Circuit diagram of the transmitter consisting of pulse generator, square wave oscillator and tuned power amplifier

broadband ambient noise, except in a very quiet environment. Therefore, the sonic receiver is tuned to the transmitter frequency. In the block diagram the receiver is seen to consist of a microphone, a tuned high gain amplifier, and an echo pulse decoder circuit.

A typical microphone response to the burst of sound from the transmitter is shown by waveform Fig. 3C. Note the presence of back-scatter, noise, and the echo pulses.

Because echoes from near objects are of greater amplitude than echoes from distant objects, rough surfaces and very small objects close to the loudspeaker and microphone tend to cause unwanted back-scattering of sound, and there is also direct pick-up of the unreflected burst from the loudspeaker.

Ideally, the receiver response should be proportional to distance; low for near objects and high for distant objects, so that an echo of the same amplitude is obtained from a given object at any distance with the range of the equipment. In practice, however, it is sufficient to ensure that the receiver is pulsed off while the acoustic burst is travelling over the first few feet of its journey, and then gain can be allowed to rise quickly to maximum for the reception of echoes.

ELIMINATING BACK-SCATTER

Controlled by the gain delay pulse derived from the pulse generator, the tuned amplifier gain characteristic takes the form shown, on an exaggerated time-distance scale, in Fig. 3D. Gain is almost zero at the time of the acoustic burst, and remains low over the region of back-scatter, then rises quickly to a stable level for the remainder of the period.

The effect of gain delay is demonstrated by comparing the resulting tuned amplifier output Fig. 3E with the amplifier input Fig. 3C. Back-scatter has been virtually eliminated from the waveform, without influencing the echo pulses. Although the tuned amplifier is switched off during the transmitter burst, it is almost impossible to remove evidence of the burst from the amplifier output (Fig. 3E) because of electrical interaction between transmitter and receiver circuits, despite careful screening. However, the decoder circuit takes this into account.

The function of the decoder, which will be examined in greater detail later, is to measure the time interval between the start of the control pulse and reception of the first significant echo, while ignoring as far as possible noise, and secondary echoes.

Distance is computed by the decoder for display by a meter, and an audio bleep warning oscillator is also triggered to give an output from a crystal insert loudspeaker.

TRANSMITTER CIRCUIT

The transmitter circuit of Fig. 4 was designed to feed a peak pulsed power of more than 20 watts, at 10kHz, into a 3 ohms nominal impedance loudspeaker (12 ohms at 10kHz), using as few components as possible.

Looking first at the pulse generator of Fig. 4, C1 is positively charged through VR1, the unijunction transistor TR1 triggers into conduction, whereupon C1 discharges rapidly through R2 to produce a steep-sided positive pulse. The interval between pulses is set by adjustment of VR1, and the duration of the pulse is determined by the fixed values of C1 and R2.

COMPONENTS . . .

SONIC TRANSMITTER

Resistors

R1	560Ω	R5	4·7kΩ
R2	180Ω	R6	4·7kΩ
R3	330Ω	R7	330Ω
R4	220Ω		

All 10%, ½ watt carbon

Capacitors

C1 4μF electrolytic 50V
C2 0·01μF miniature polyester 250V
C3 0·01μF miniature polyester 250V
C4 4μF electrolytic 50V
C5* 4μF metallised 150V (see text)
C6 1,000μF electrolytic 50V

Transistors

TR1 2N2646
TR2, TR3, TR4 2S512 or BSY27 (3 off)
TR5 AC157 or AC127
TR6 BCY39 or 2N2904
TR7 OC28

Potentiometers

VR1 100kΩ horizontal preset
VR2 4·7kΩ horizontal preset

Inductor

L1 2·5mH RF choke

Transformer

T1 LA5 pot core (see text)

Loudspeaker

LS1 3 ohm 5in dia. (see text)

Socket

SK1 Coaxial socket

Plug

PL1 Coaxial plug

Miscellaneous

0·1in matrix Veroboard 4·1in × 1·7in
3in × 1·8in 16 s.w.g. sheet aluminium
TO3 transistor mica washer and spacers
20 s.w.g. enamelled copper wire

Timing components R5, R6, C2 and C3, in Fig. 4, will cause the multivibrator circuit TR2 and TR3 to oscillate close to 10kHz, but a fine frequency adjustment is provided by VR2 (tune transmitter).

The multivibrator will only oscillate when the emitters of TR2 and TR3 are connected to the negative rail by transistor switch TR4. In turn, TR4 is only switched on for a period of 2ms when it receives the pulse from TR1, via R4.

Driven by the multivibrator output, the complementary pair TR5 and TR6 alternately clamp C4 to positive and negative supply rails, and owing to the presence of tuned circuits L1, C4, and L3, C5, the switching waveform is converted into a sine wave by output transistor TR7.

Approximately 15V r.m.s. is developed across the 12 ohm speaker load during the 2ms pulse period.

Transformer T1 is hand wound on a Vinkor assembly, and one end of the secondary winding L3 is taken to a separate earth connection to accommodate positive or negative earth battery supplies.

REGENERATIVE RECEIVER

Receiver tuned amplifier and decoder circuits will be considered separately. Fig. 5 shows the tuned amplifier circuit.

Looking first at the very important stage TR9 in Fig. 5, it can be seen that this closely resembles a regenerative tuned stage in a t.r.f. radio receiver. Regeneration does away with the need for multiple tuned stages and simplifies tuning adjustments, while still giving reasonable selectivity.

Winding L6 is phased with L7 to give positive feedback between collector and base of TR9, and thus multiplies the Q value of tuned circuit L7, C12, and TC1. Regeneration is smoothly controlled by the VR5 setting.

TR9 is operated at a low collector current, near the point where gain falls off as collector current is decreased. VR4 sets the working point by establishing the amount of positive bias on the base of TR9.

A positive going pulse from the pulse generator is converted by C9, D1, and D2 into a negative pulse which counteracts the bias on the base of TR9, thus reducing gain. Owing to the slow discharge of C9 through VR4, R11, and R12 at the termination of the pulse, TR9 remains off for a period much longer than the time of the control pulse. The gain delay period is adjustable by VR4, and back-scatter control VR3.

Transformer T3 is hand-wound on an LA2107 pot core assembly.

EMITTER FOLLOWER

The signal from the microphone could be fed straight to the base of TR9, but this would demand a microphone transformer of non-standard impedance. Also, a long run of microphone cable could cause detuning. Therefore, emitter follower TR8 is included to serve as an impedance converter and buffer stage. Transformer T2 is of the type found in hand-held, moving coil stick microphones, and has an output impedance of 50 kilohms.

As the collector load of TR9 is a high Q tuned circuit; it will present a high impedance, with large voltage amplification, to a signal of 10kHz, but side frequencies will see a low impedance and are hardly amplified at all. Overall rejection of the Fig. 5 circuit is better than 30dB for signals 1kHz above and below the centre frequency.

TUNED AMPLIFIER

Triple stage amplifier TR10, TR11, and TR12, is designed to offer some selectivity, but not enough to cause problems with instability. Emitter and coupling capacitors cause some attenuation of frequencies below 10kHz, and the response is sharpened still further by tuned collector load C16, and L8.

When viewed on an oscilloscope, the tuned amplifier output will appear similar to Fig. 3E when echo signals are present. If the oscilloscope is d.c. coupled, and can offer linear timebase sweeps at around 0·2s, then distance can be read off the X axis to give the precise location of all echoes.

DECODER

Having obtained satisfactory echo signals from the receiver tuned amplifier, these must be converted into regular shaped pulses for timing purposes.

In the decoder circuit of Fig. 6, the monostable (TR13 and TR14), responds only to signals above a certain amplitude, determined by the VR7 setting, and thus rejects noise and small, spurious echoes.

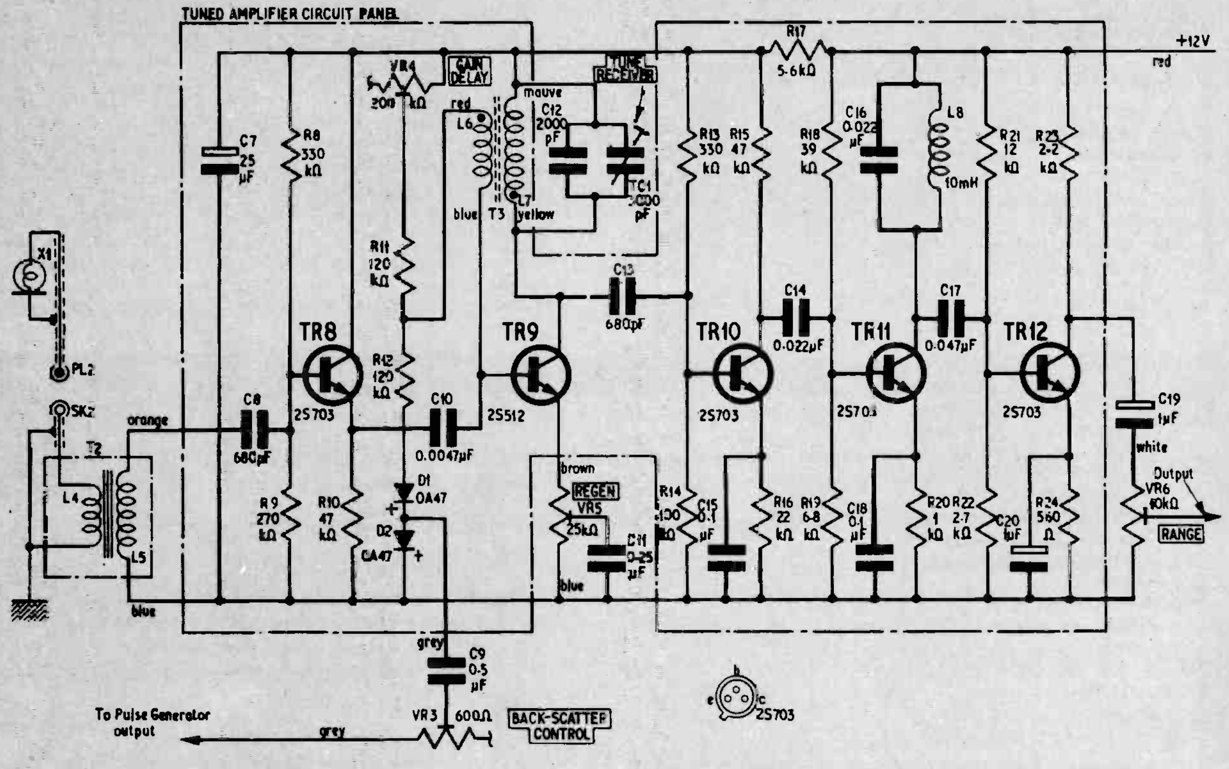


Fig. 5. Circuit diagram of the receiver tuned amplifier

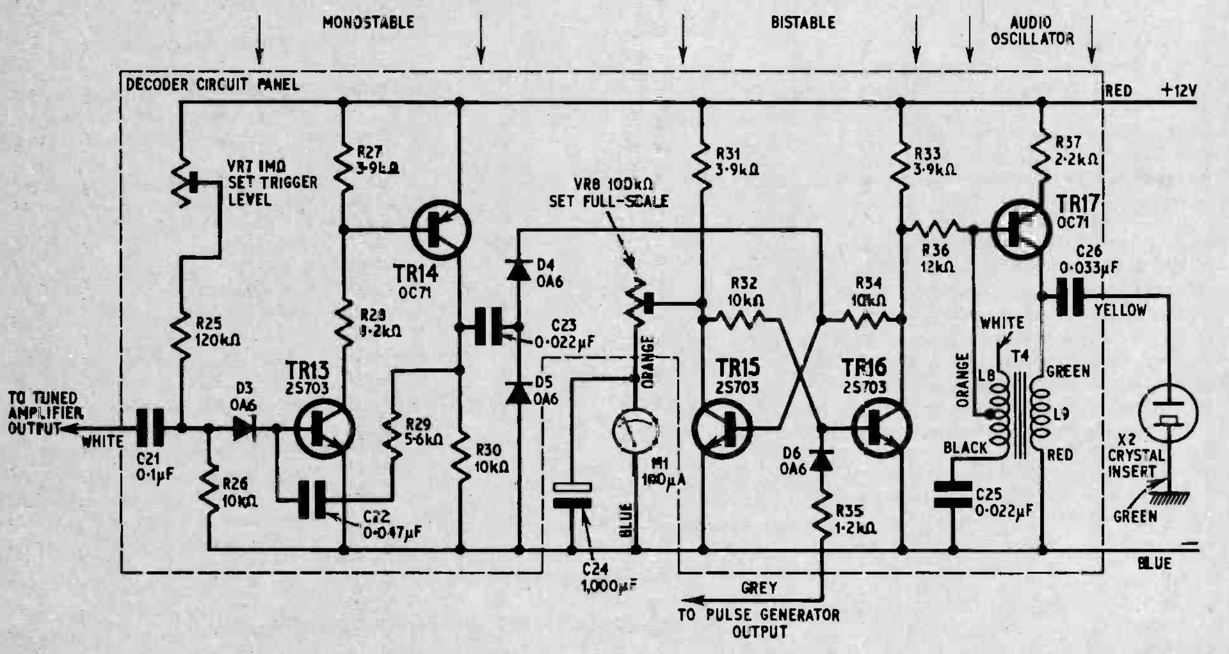


Fig. 6. Circuit diagram of decoder which converts the output from the tuned amplifier into regular shaped pulses for timing purposes

COMPONENTS . . .

RECEIVER DECODER

Resistors

R25	120kΩ	R32	10kΩ
R26	10kΩ	R33	3·9kΩ
R27	3·9kΩ	R34	10kΩ
R28	8·2kΩ	R35	1·2kΩ
R29	5·6kΩ	R36	12kΩ
R30	10kΩ	R37	2·2kΩ
R31	3·9kΩ		

All 10%, ½ watt carbon

Capacitors

C21 0·1μF moulded polyester 250V
C22 0·047μF moulded polyester 250V
C23 0·022μF miniature polyester 250V
C24 1,000μF electrolytic 12V
C25 0·022μF miniature polyester 250V
C26 0·033μF miniature polyester 250V

Transformer

T4 LT44 transistor driver transformer (Henry's Radio)

Meter

M1 0–100μA MR-65P

Loudspeaker

X2 1in–1½in diameter crystal microphone insert

Transistors

TR13, TR15, TR16 2S703 *or* 2N929
TR14, TR17 OC71

Diodes

D3, D4, D5, D6 OA6

Miscellaneous

0·1in matrix Veroboard 3·9in × 1·7in

COMPONENTS . . .

RECEIVER TUNED AMPLIFIER

Resistors

R8	330kΩ	R17	5·6kΩ
R9	270kΩ	R18	39kΩ
R10	47kΩ	R19	6·8kΩ
R11	120kΩ	R20	1kΩ
R12	120kΩ	R21	12kΩ
R13	330kΩ	R22	2·7kΩ
R14	100kΩ	R23	2·2kΩ
R15	47kΩ	R24	560Ω
R16	22kΩ		

All 10%, ½ watt carbon

Potentiometers

VR3 600Ω panel mounting
VR4 200kΩ sub-min horizontal mounting
VR5 25kΩ panel mounting
VR6 10kΩ panel mounting
All presets

Capacitors

C7 25μF electrolytic 50V
C8 680pF polystyrene 125V
C9 0·5μF metallised 250V
C10 0·0047μF miniature polyester 500V
C11 0·25μF metallised 250V
C12 2,000pF polystyrene 125V
C13 680pF polystyrene 125V
C14 0·022μF miniature polyester 250V
C15 0·1μF moulded polyester 250V
C16 0·022μF miniature polyester 250V
C17 0·047μF miniature polyester 250V
C18 0·1μF moulded polyester 250V
C19 1μF miniature electrolytic 15V
C20 1μF miniature electrolytic 15V

Trimmer Capacitor

TC1 3,000pF Bulgin C.P.7

Inductor

L8 10mH RF choke

Transformers

T2 50kΩ moving coil microphone, matching transformer
T3 LA5 pot core (see text)

Transistors

TR8, TR10, TR11, TR12 2S703 *or* 2N929
TR9 2S512 *or* BSY27

Diodes

D1, D2 OA47

Plug

PL1 Coaxial plug

Socket

SK2 Coaxial socket

Microphone

X1 DM107 *or* similar

Miscellaneous

0·1in matrix Veroboard 6·9in × 1·6in
40 s.w.g. enamelled copper wire

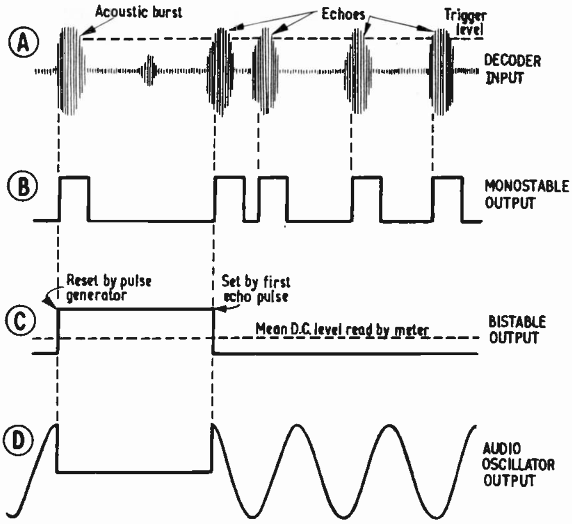


Fig. 7. Waveform sequence appearing at decoder. (A) Typical input signal. (B) Response of monostable. (C) Output of bistable. (D) Audio oscillator output

Demodulated by D3, the leading edge of a signal envelope triggers TR13 on, which in turn switches TR14 on. With the collector of TR14 now close to the positive rail, TR13 remains biased on by the slow charge of C22 through R29, giving a rectangular pulse output from the collector of TR14, of length dependent on C22 and R29 values.

Owing to the positive voltage present on the base of TR13, D3 is reversed biased, and blocks further signals until the monostable switches back into its stable state. The duration of the monostable output pulse determines the minimum distance which can be measured. If C22 is made smaller in value, a point will be reached where the monostable begins to deliver two pulses from each input signal.

BISTABLE

Looking next at the bistable in Fig. 6; a pulse via R35 and D6 from the pulse generator, at the commencement of each acoustic burst, will switch TR15 off and TR16 on. With the collector of TR15 almost at positive rail voltage, C24 will begin to charge via R31 and VR8. If no echo signals are present, C24 is allowed to become fully charged and the meter M1 will read full scale.

In the event of an echo being repeatedly received some time after each transmitter burst, however, the leading edge of a pulse from the monostable will switch TR15 on and TR16 off, thus interrupting the slow charge of C24, and giving a meter reading which is directly proportional to the distance of the nearest echo producing obstacle.

DECODER WAVEFORMS

The decoder waveforms of Fig. 7 show clearly the sequence of events. Fig. 7A is a typical input signal to the decoder, consisting of an acoustic burst waveform followed by four sizeable echo waveforms spaced in time. Fig. 7B gives the response of the monostable to the Fig. 7A signals, with a pulse for each signal envelope.

As the acoustic burst from the monostable, and the reset pulse from the pulse generator occur simultaneously, the bistable ignores the former, but will be set by the leading edge of the first echo pulse to be received, see Fig. 7C. The bistable can only respond again after it has been reset, and gives an output of duration exactly corresponding to the time taken for the sound to complete its journey.

The inverse occurs with the audio oscillator waveform Fig. 7C; in the event of no echo there is no output from TR17 but an echo from a close obstacle gives an audio oscillator output of long duration.

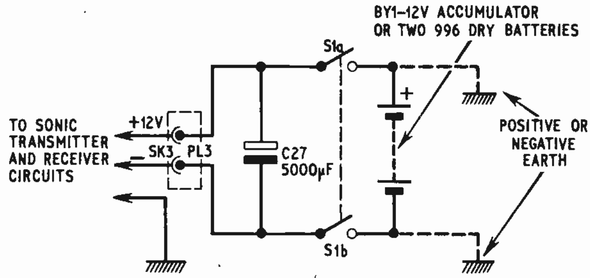


Fig. 8. Power supply circuit suitable for car battery or dry battery working. Battery impedance is minimised by large electrolytic

COMPONENTS . . .

POWER SUPPLY AND BOX

Capacitor
C27 5,000μF 15V

Battery
BY1 12V accumulator or two 996 dry batteries

Plug
PL3 Non-reversible 2 way

Switch
S1 Toggle d.p.s.t.

Socket
SK3 Non-reversible 2 way

Miscellaneous
Universal chassis 6in × 8in × 3in with extra 6in × 8in top plate and 8in × 3in side (Home Radio)

POWER SUPPLY

There are two possible snags when the Obstacle Locator is powered from a car battery; interference and voltage fluctuations.

Charging circuit contacts, dynamo brushes, and ignition spark gaps generate quite a lot of interference, which could increase the sonic receiver noise input to the point where maximum range suffers.

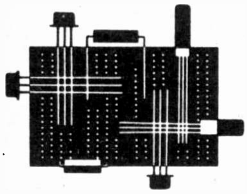
Although the situation could be improved by incorporating filters and some form of voltage stabilisation, the easiest and cheapest solution is to run the equipment from suitable dry batteries.

Average current consumption of the Obstacle Locator is in the region of 50mA, so two 996 batteries coupled in series will give 100 hours operation.

A power supply circuit suitable for car battery or dry battery working is shown in Fig. 8. The large electrolytic C27 helps to minimise battery impedance.

Part two next month will cover the construction, testing, and calibration of the Sonic Obstacle Locator.

SIREN



A SPECIAL PROJECT FOR BEGINNERS

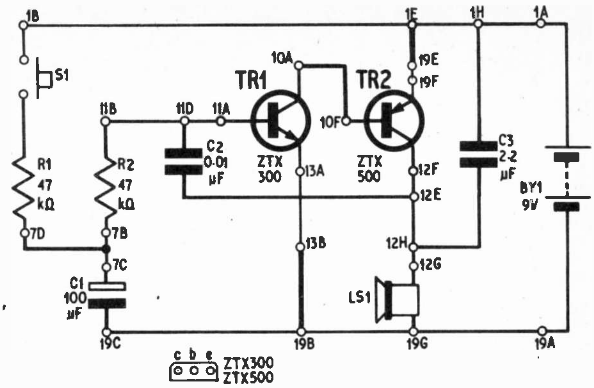


Fig. 1. Circuit diagram of the Siren; link wires are shown as thick lines. Note that an electrolytic capacitor should not be substituted for C3

MOST readers are probably familiar with the banshee wail of a siren. Rising from a low frequency beginning, the sound rises up in a smooth glissando through baritone to soprano, hovers, then falls, this being maintained through a series of undulating peaks.

For novelty appeal, this particular offering is pitched approximately to those sounds made by American police cars, albeit very much attenuated in decibels. For this reason alone it should prove an attractive project for youngsters.

PULSE GENERATOR

The active ingredients in this design are an *npn* and *pnp* complementary transistor pair arranged to form an astable multivibrator, which would be free running if R2 was connected directly to the positive rail of Fig. 1.

With such a connection the frequency would stabilise around 4kHz, this rate being determined by the time constant, or CR product, of R2 and C2. Mathematically, the pulse frequency is said to vary inversely as this product, which simply means that an increase in value of either R2 or C2 means a decrease in frequency, or alternatively with the values decreased the frequency rises.

The conduction cycle commences with the charging of C2 via R2. As discussed last month, the charging process takes the form of an exponential growth curve of voltage. No conduction takes place in the transistor pair until C2 reaches about 0·7V.

CUMULATIVE ACTION

At this voltage TR1 moves into action, passing current to its load TR2. Up to this point the collector of this transistor is at −9V relative to the emitter and with conduction this goes positive. This is immediately reflected to the base of TR1 which accelerates the overall switching of the transistor pair.

This self-regenerative feedback process, or cumulative action, results in a very sharp pulse at the speaker.

RISE AND FALL

In describing the action of the constant frequency generator it was arranged that R2 was fed from the positive line.

To produce the frequency variations necessary for the siren sound, R2 is in fact connected to the mid-point of a timing circuit C1, R1. S1 is introduced into this net so that rise and fall periods are arbitrary.

COMPONENTS . . .

Resistors
R1 47kΩ
R2 47kΩ
½ watt, 10% carbon

Capacitors
C1 100μF elect 15V
C2 0·01μF
C3 2·2μF polyester

Transistors
TR1 ZTX 300
TR2 ZTX 500

Switch
S1 On/off press switch

Loudspeaker
LS1 3Ω 5 inch

Miscellaneous
T-Dec, connecting wire

With S1 closed, C1 charges on a relatively long time constant to a maximum of 4V. A rising voltage across R2 and C2 means, in effect, a diminishing time constant, so the overall frequency starts to rise.

Just as the charge transition is smooth on C2, so is the frequency change which starts at zero and glides up to about 2kHz. The output at LS1 remains constant at 4V during this period, the waveshape produced being shown in Fig. 2.

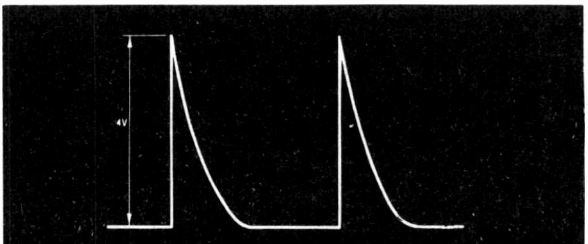
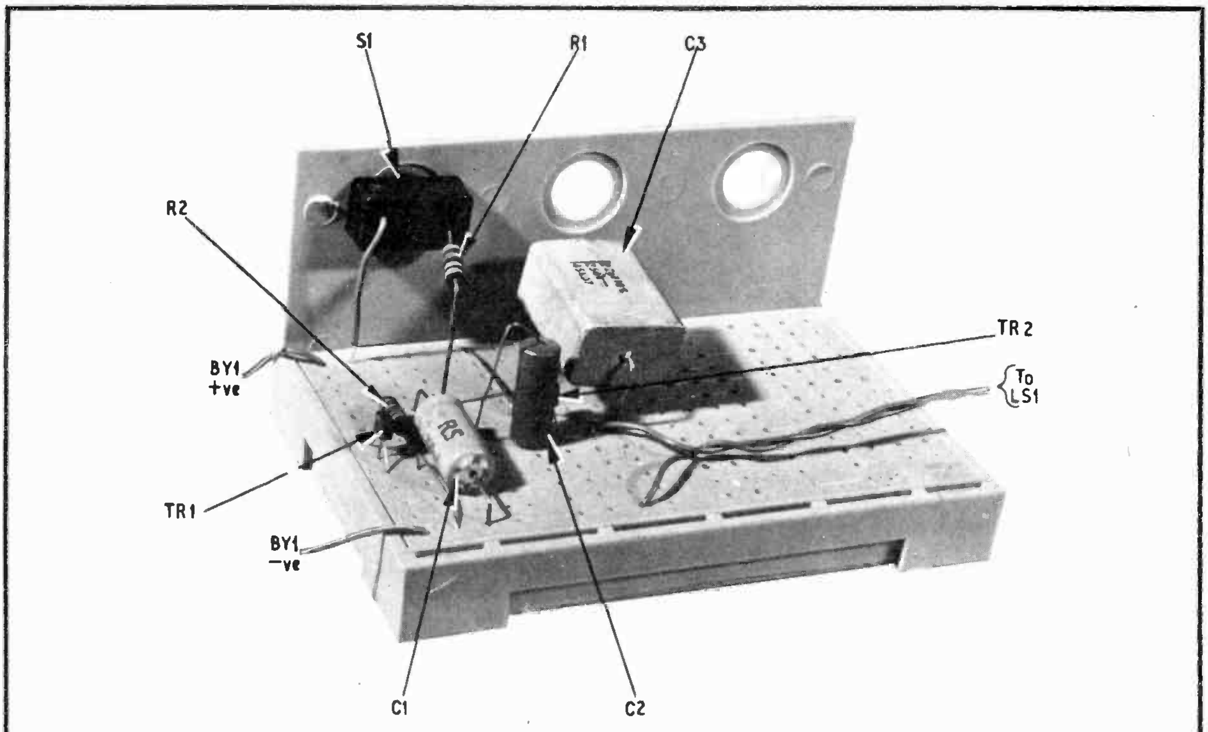


Fig. 2. Pulse shape produced across loudspeaker load. The amplitude remains constant throughout the Siren's frequency changes



Layout of components on T-Dec

The release of S1 causes the frequency to fall. Since C1 is charged to about half the rail volts, the discharge period is reduced by this factor.

INCREASING THE OUTPUT

Without the inclusion of C3 the power available at the output would be negligible. This capacitor has the effect of increasing the pulse width and so raising the mean d.c. level.

It is most important that a capacitor with a low power factor be used here; an electrolytic type just will not do.

To alter the frequency of the siren C2 should be changed. An increase in capacitance will mean a reduction in peak frequency and a decrease will raise it.

ALTERNATIVE CONSTRUCTION

A permanent assembly of this unit can be made on Veroboard. Component mounting can be identical to that given for the T-Dec as the hole matrix for the board is identical.

NEWS BRIEFS

Scouts Communications

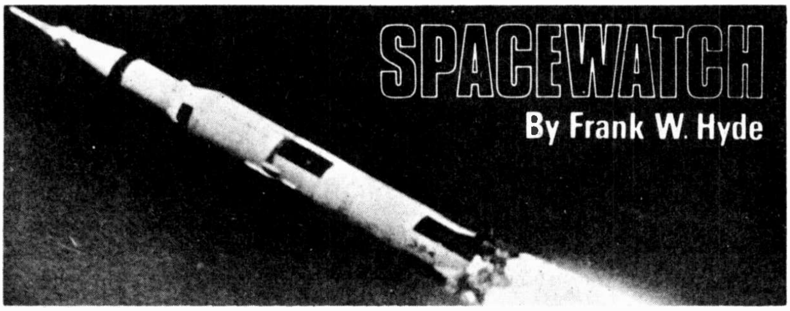
The centre of the 3rd Bracknell Scouts was turned into a complete communications centre for a weekend in October by equipment loans from the nearby Racal Electronics Group. The Racal Amateur Radio Club GB3RAC, also loaned the Scouts equipment and the members assisted operations for day and night watches.

The centre had four complete transmitting/receiving stations, five separate monitoring stations manned by Scouts, a news and weather bureau with all necessary sound and TV monitoring receivers, teleprinter, and Mufax picture receiver.

Pictures of weather charts included one from Khabarovsk in Eastern Siberia. Other weather information was intercepted from weather ships in the Atlantic.

Jamboree contacts were made with numerous Scout Groups throughout the world, including Australia, S. Africa, U.S.A., Middle East and Europe.

Over 200 Scout Leaders and Scouts shared watch duties throughout the weekend and there were over 200 spectators. The photograph left shows part of the communications centre operating.



A DECADE AHEAD

As 1971 opens it is perhaps worthwhile to look at the next decade as planned at this moment. Certain programmes have already been put in hand and these have been covered by previous *Spacewatch* articles. However, in order to take an overall look at the next decade some of the programmes will of necessity be noted again.

One of the most important items in the programme is to find ways of reducing the cost of space operations. For this reason the development of the space shuttle will be a priority venture. The prospect of a re-usable shuttle vehicle which can travel between the Earth and space stations in Earth orbit offers a system that is within the range of present technology. Already the design stage has reached a definitive study. The vehicle in its present form will be launched by a booster from a rocket pad and return to Earth to land like an aircraft.

SPACE TUGS

To this must be added the rather newer proposal for a space tug which would serve for goods and personnel transport from space station to space station. Other operations to be undertaken would be the raising of satellites from lower orbits to higher and synchronous orbits and the firing of automated probes from Earth orbit into orbits that will enable a further investigation of the planets. The tug would ride in the shuttle cargo compartment. Already these programmes envisage international participation in a greatly extended manner.

In the past decade there has been considerable co-operation so far as contractors were concerned, but the new thinking is more in the terms of a cost sharing as well as contracting between the U.S.A., the United Kingdom, Federal Republic of Germany, France, Belgium and Italy. This could mean that the European Nations will provide half of the cost of the space tug (about 1,000 million dollars). The cost of the space programme for the shuttle is estimated at about 4,500 million dollars, and for the 12 man space station upwards of 4,000 million dollars. There is to be a standardisation of technique, and both vehicles should be operative by 1978.

SKYLAB

This will be a large orbiting workshop which will examine the capability of men to live and work in space over long periods. It will use systems already developed for the *Apollo* missions. Later, there will be even more sophisticated vehicles with the exchange of personnel on varying tours of duty.

EARTH RESOURCES SATELLITES

One of the major projects already well under way is that of surveying the earth to assess its potential for the future. This programme will have an unprecedented facility for the study of crops, the location of new sources of water and the prospecting for mineral deposits. There will be the more extended use of space vehicles in the fields of weather forecasting, communications, air traffic control, geodosy map making and navigation. There will also be concentration on the use of television for education particularly directed toward the under-developed countries.

The *Apollo* programme, although curtailed somewhat from the original one, will nevertheless offer an exciting new extension of moon exploration. *Apollo 14* site will be the same as that which was originally scheduled for *Apollo 13*, that is the Fra Mauro rugged region. The site for *Apollo 15* has now been decided; it will land in the lunar plain much further North than any previous mission. There is an area known as the Hadley-Apennine region which has the 8,000 ft. Apennine range on one side and the 60 mille long meandering canyon, 600 ft. deep, known as the Hadley Rille, on the other. It is an important region and will yield a great deal of valuable scientific data.

The astronauts will be able to gather material from the base of the mountains, some of which may date from the old lunar crust, which existed more than 4,000 million years ago. It is thought this may be older than the Mare Imbrium basin which was probably formed by meteoritic impact. There may also be materials, thrown out by this cataclysmic impact, which originated deep within the moon.

On this mission the Lunar Rover vehicle, electrically powered, will be in operation for the first time. The crew will be able to go some miles from the base of operations in order to carry out experiments, and set up scientific instruments. The crew will be David Scott, Alfred Warden and James Irwin. Launch date is likely to be July 1971. The following two *Apollo* missions (16 and 17) are scheduled for January 1972 and June 1972; no sites or crews have been decided at the moment.

MARS PROBES

These have already been noted in some detail in *Spacewatch* for June 1970 and this programme gets under way with the first launches in 1971.

GRAND TOURS

These will take advantage of the position of the planets in the solar system during the next few years. In the case of the first mission the next possible time for this to be done will not come again for 200 years and the second planned mission could not be undertaken for another 100 years. Therefore, these programmes are of great importance, for to achieve the objectives of these missions with our present technology, the gravitational effects of the planets will be needed for an effective gain in momentum for the vehicles as they move from one area to another. These will of course be unmanned. The manned tours will need nuclear or some other source of power for this to be successful. The testing of nuclear powered rockets will be made in 1978 with unmanned craft.

The *Mariner* Venus-Mercury tour will begin the series and for the first time man may be able to see a close-up of the surface of Mercury. The next will begin in 1977 with one or perhaps two unmanned craft launched toward Jupiter.

When the spacecraft arrives in the vicinity of Jupiter it will swing round the planet under the influence of the local gravitational field; four years later it will reach the planet Uranus where again gravity will influence the path to project it toward the end of its journey five years later at the planet Neptune in 1988 after a 3,000 million mile trip.

A further launch will be in 1979. The route will on this mission be more direct to Jupiter and by 1980 will swing round Saturn and will head for Pluto which it should reach five years later. Pluto itself is the most distant planet from the Earth and will at that time be some 3,700 million miles distant.

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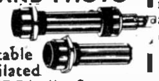

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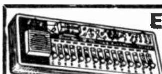

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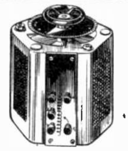

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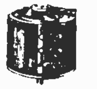

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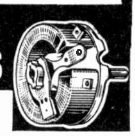

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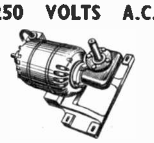

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MAKING THE MOST OF LOGIC IC's

PART SEVEN—By R. W. COLES

TTL FLIP-FLOPS

THE range of bistables, or flip-flops as they are usually termed in i.c. parlance, is more varied in the TTL family than in either DTL or RTL. There is, in fact, a flip-flop to suit every occasion, or for those who dislike using a different component for each specialised application, there is one flip-flop which may be used for any of the normal storage circuits.

Flip-flops are one of the most important elements in a logic system, all types having one feature in common. They provide storage of one binary digit for any length of time which may be necessary, as long as the power is applied.

The differences between the various types occur only in the way that the data to be stored is "written" into them, their outputs always consist of a true and an untrue indication of the digit they contain. By connecting them together in the appropriate fashion, it is possible to build many types of counters or dividers, shift registers, and memories, which may contain a complete binary word.

DATA ENTRY

Data may be entered into a flip-flop either asynchronously, i.e. at any time, regardless of the original contents or the state of the clock pulse, or synchronously, i.e. the data is entered only when a clock pulse "enables" the data inputs.

The flip-flops in the TTL family usually have both synchronous and asynchronous inputs, which makes them most versatile in use. In fact, so many useful features have been packed into such a small package, that the discrete, specialised designs of ten years ago seem primitive in comparison.

Apart from the usual types of data entry mentioned above, TTL synchronous inputs can be further subdivided into either those which employ the positive edge of the clock pulse for gating (edge-triggered), or those which employ both edges of the clock pulse (master/slave).

EDGE TRIGGERED TYPE

With the edge-triggered type, assuming that the data to be entered is waiting at the inputs, as the clock pulse starts to rise this data is entered into the storage latch, and is thus immediately present at the outputs. As soon as the clock pulse has passed the threshold of the input gates, the input data is locked out, and can have no effect on the stored information until the clock rises again.

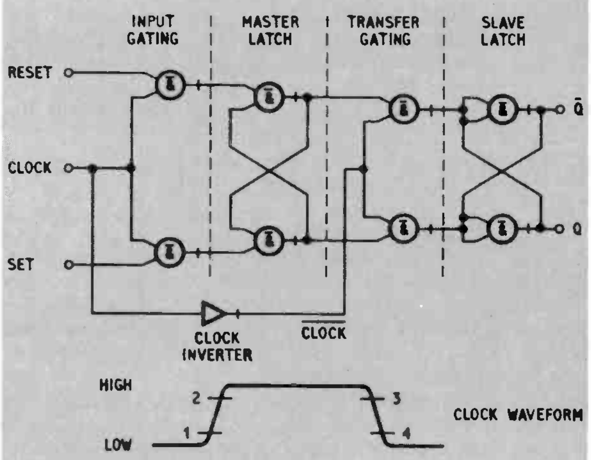
MASTER/SLAVE

The master/slave type is a little more complex in operation, as the individual flip-flops of this type really consist of two interconnected bistable sections, termed the master section and the slave section. Information enters the master section as the clock pulse rises, but this information does not appear at the outputs immediately because of the interposition of the slave section.

The slave bistable is also clocked, but through an inverter. The slave sees a positive clock pulse when the main clock pulse is actually falling, and enters the data present at the output of the master latch, and transfers it immediately to its outputs, which are also the outputs of the flip-flop as a whole.

Ignoring what goes on inside such a flip-flop and looking at it just as a "black box", information enters on the positive excursion of the clock, and appears at the outputs on the negative excursion. A simplified logic diagram of this type is shown in Fig. 7.1, together with a diagram of clock action.

Master/slave JK flip-flops form the backbone of TTL counting circuits, giving maximum versatility at the expense of a slightly higher power dissipation and slightly lower maximum toggle frequency than the edge-triggered type.



1.......ISOLATE SLAVE FROM MASTER
2.......ENTER DATA INTO MASTER
3.......DISABLE DATA INPUTS
4.......TRANSFER DATA FROM MASTER TO SLAVE

Fig. 7.1. Master/slave flip-flop. This is a simplified explanatory arrangement, using the master/slave principle. As it stands, it is a set/reset type, but JK operation is simply achieved by connecting the Q output to the reset input gate, and the $\bar{Q}$ output to the set input gate. No preset or clear inputs are shown

A few examples of the many flip-flops available of both edge-triggered and master/slave type are given with their package outlines in Fig. 7.2. Note that some JK types have several J and K inputs, so that gated inputs for synchronous counters will not require separate gate packages.

Some of the flip-flops have no preset input—only clear. These are useful for counter circuits, where the asynchronous inputs are not needed other than to set up the all zeros condition before a count sequence.

TYPE-D FLIP-FLOP

There is one "odd-ball" which is a little different from the rest—the 7474 type "D" flip-flop. This one is intended specifically for shift-register applications, and belongs to the edge-triggered group.

It embodies full asynchronous input capability, but has only one data input D. The other data input is obtained internally by inverting the information on the D input. This means that only one connection is necessary to transfer data from one stage of a shift register to the next.

Perhaps this is not so obvious an advantage until you consider that many shift registers require inputs from several sources, in which case the external gating is cut by half when using the type D.

Although it is intended only for register use, it may be used in ripple counters by connecting the $\overline{Q}$ output back to the D input, but this is by no means the best choice of flip-flop for such use.

TTL COUNTERS

Having discussed what types of flip-flop are available, it is possible to have a look at some applications. To start, let us examine counting circuits. Simple ripple counters were described in the sections on RTL and DTL, and should help here to understand the principles involved in TTL.

RIPPLE COUNTER

Ripple counters are the simplest type of design using TTL i.c.s; all that is necessary is to connect the Q output of the first flip-flop to the clock input of the second, and so on, the input being connected to the clock of the first flip-flop in the chain.

The maximum number of separate states is given by 2^n, where n is the number of flip-flops so connected. Thus a four-stage counter has sixteen states, and a five-stage counter has thirty-two states.

If a count which is not a binary multiple is required, it is necessary to force the counter to skip some of its usual states. There are several ways to achieve this, the simplest method being to detect the desired final count $+1$ with a NAND gate, and use its output to reset all the flip-flops in the counter to zero.

This method may, however, result in a "race" condition if one of the counter stages resets more readily than the others, causing the NAND gate output to disappear before all stages are reset. For this reason it is not commonly used, although it is possible to include some sort of delay, such as a monostable, in the reset path to ensure that the reset pulse will last long enough to do its job properly.

IMPROVED DIVIDER

A much better method of dividing by a number which is not a binary multiple is to feed the flip-flop outputs which are in the 1 state at the desired final count, along with the counter input, or clock, to a NAND gate, and use the resultant output to set all the counter stages to 1.

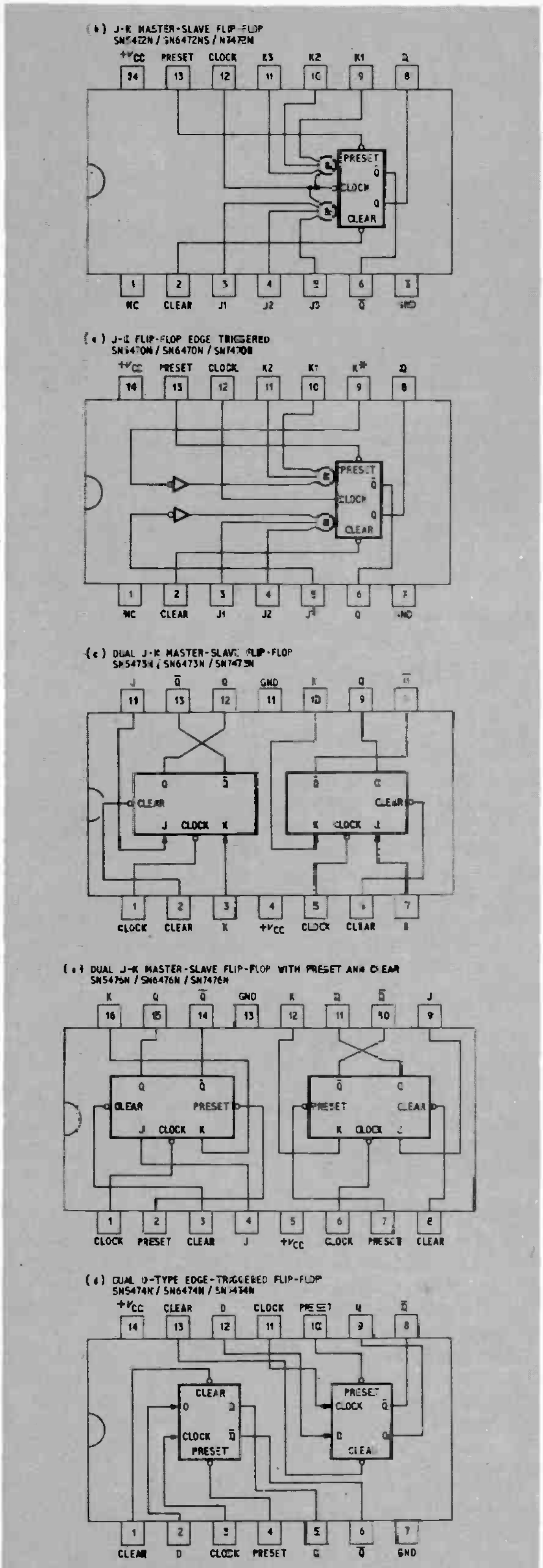


Fig. 7.2 Logic circuits and pin connections of TTL flip-flops

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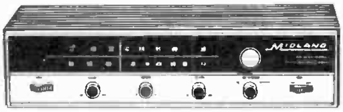

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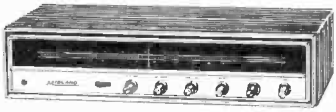

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Frequency Response	50–17,000 Hz	35–20,000 Hz
Power Output	2½ watts rms per channel (8 watts music power)	4 watts rms per channel (18 watts music power)
Inputs	Ceramic phono	Magnetic/Ceramic phono and aux.
Speaker impedance	4–8 ohm	8 ohm
Controls	Power on/off, Volume, tone, balance, tuning, AFC. Stereo indicator	On/off, Volume, bass, treble, balance, tuning, AFC. Stereo indicator
Function	AM, FM, FM Stereo, Phono (Stereo indicator light)	AM, FM, FM Stereo, Ceramic, Magnetic. Aux.
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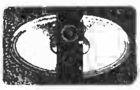

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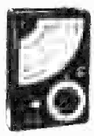

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DT5	5″	1200′	POLYESTER	15/–
LP6	5¾″	1200′	P.V.C.	12/6
DT6	5¾″	1800′	POLYESTER	22/6
TT6	5¾″	2400′	POLYESTER	37/6
SP7	7″	1200′	P.V.C.	12/6
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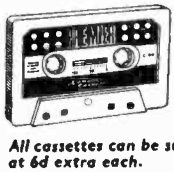

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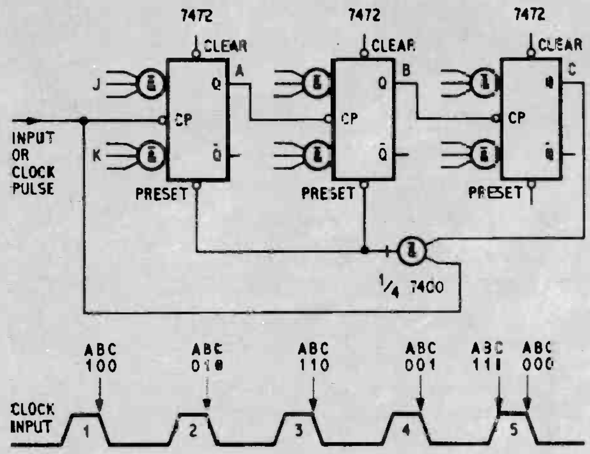
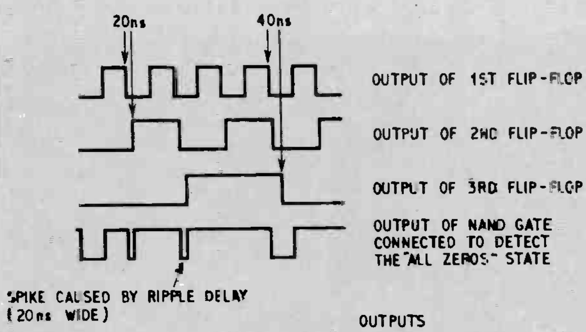


CLOCK PULSE	OUTPUTS A	B	C	
0	0	0	0	← BEFORE ANY CLOCK PULSES
1	1	0	0	
2	0	1	0	
3	1	1	0	
4	0	0	1	← RECOGNISE THIS STATE
5	1	1	1	← PRESET TO THIS STATE
	0	0	0	← COUNTS TO THIS STATE WHEN 5TH CLOCK PULSE FALLS

Fig. 7.3. Improved divider with truth table



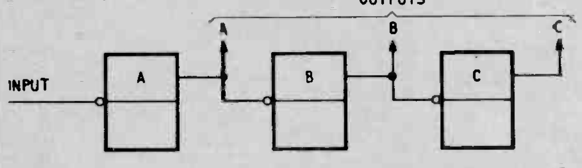


Fig. 7.4 Effect of compounded propagation delay

When the final clock pulse falls (assuming JK master/slave flip-flops), the counter will count to the all zeros state, ready to begin another cycle. The appearance of the all 1 state during the final clock pulse is unlikely to cause a problem, although this depends on the application.

To see this system operating, take as an example a divide-by-five counter using type 7472 JK flip-flops. The nearest power of 2 which is higher than 5 is 2^3, so a three stage counter will be necessary as a basis of the design.

The final counter state will be binary four, 100, because the first state of the counter will be zero, i.e. 000. The only flip-flop which has an output of 1 at this stage is the third one, so we must feed this output together with the clock into a 2-input NAND gate, and connect the output of this gate to the preset inputs of the first two flip-flops.

The final circuit is shown in Fig. 7.3, together with a truth table and the clock pulse action. Note that the J and K inputs are not used in this application, and are therefore left disconnected, simulating a 1 input. They can, in practice, be connected to $+V_{cc}$ to ensure this state.

PROPAGATION DELAY

The counters we have considered so far have all been ripple types, and, as such, they all suffer from a drawback which can be serious in some applications.

If we look closely at such a counter which is in the all 1 state, it will be required to count to the all zeros state on the arrival of the next clock pulse. The final flip-flop in the chain will not be able to do this until all the stages preceding it have already done so; after all, it gets its own clock edge from the flip-flop immediately before it, which in turn gets its clock edge from the stage before it, and so on.

This all sounds quite straightforward, until we consider the propagation delay incurred from each stage, which in the case of the 7472, is 20ns. This seemingly insignificant delay is multiplied by the number of flip-flops there are in the counter, and may reach alarming proportions in a counter working at high speed and with a long cycle length.

Even so, it need not be a problem unless several of the counter outputs are gated together. Spikes appearing at the gate output at the wrong time may cause other circuits connected to the gate output to mistrigger. To illustrate the effect of this ripple delay, Fig. 7.4 shows the output waveforms obtained from a three stage counter, with the error due to the delay magnified.

To overcome this ripple delay error, a different kind of counter called a synchronous counter is used. With this type, the clock input is fed to every stage, not just the first. Input gating is used to determine the conditions when a flip-flop is required to "toggle", or change state.

Next month's article will continue with synchronous counters, shift registers, and ring counters using TTL flip-flops.

WASH-WIPE

An electronic device for intermittent wiping and automatic wiper operation with washers, on cars with 12 volt field coil wiper motors.

A FACILITY not provided as standard on older cars but which proves to be very useful in the British climate is that of intermittent operation of windscreen wipers. Another useful facility is windscreen wiping initiated by operation of the windscreen washer control and continuing for a limited period after its release. Both facilities are provided by the circuit to be described which can be added to the existing circuits in the car without impairing the normal operation of the standard controls.

The circuit takes advantage of the windscreen self-parking mechanism fitted to most cars; reference to back numbers of practical motoring magazines will show that this mechanism can be fitted to almost any vehicle very easily at little cost. The circuit is also basically designed for negative earth connection but a modified version to suit positive earth connection is given. The unit cannot be operated with the latest permanent magnet wiper motors, or in conjunction with 6 volt systems.

CIRCUIT DESCRIPTION

The circuit diagram for negative earth connection is given in Fig. 1 and the mode of operation is as follows. The thyristor SCR1 is connected in parallel with the manual switch controlling the windscreen wipers (S4) and when triggered will initiate wiper action. A small amount of wiper action closes the self parking switch S3, short-circuiting SCR1 and turning it off; the wipers continue under the control of the self parking switch to the end of a single sweep. If SCR1 is not in a triggered state at this time, no further wiping action will take place until SCR1 is again triggered or the wiper switch (S4) is closed.

The function of diode D2 is to bypass the inductive surge current generated when the motor is switched off. The necessary trigger pulses for SCR1 are provided by the unijunction oscillator TR2 at intervals determined by the time constant (VR1 + VR2 + R5)C2. The function of R5 will be described later. VR2 is a preset potentiometer which determines the fastest intermittent rate and VR1 is the rate control which can be omitted if fixed rate operation only is required, in which case VR2 determines the rate. Switch S2 is the on-off control and is incorporated in VR1.

With the component values given, the sweep rate can be adjusted to cover a range from one sweep every 1·5 seconds to one sweep every 15 seconds. Resistor

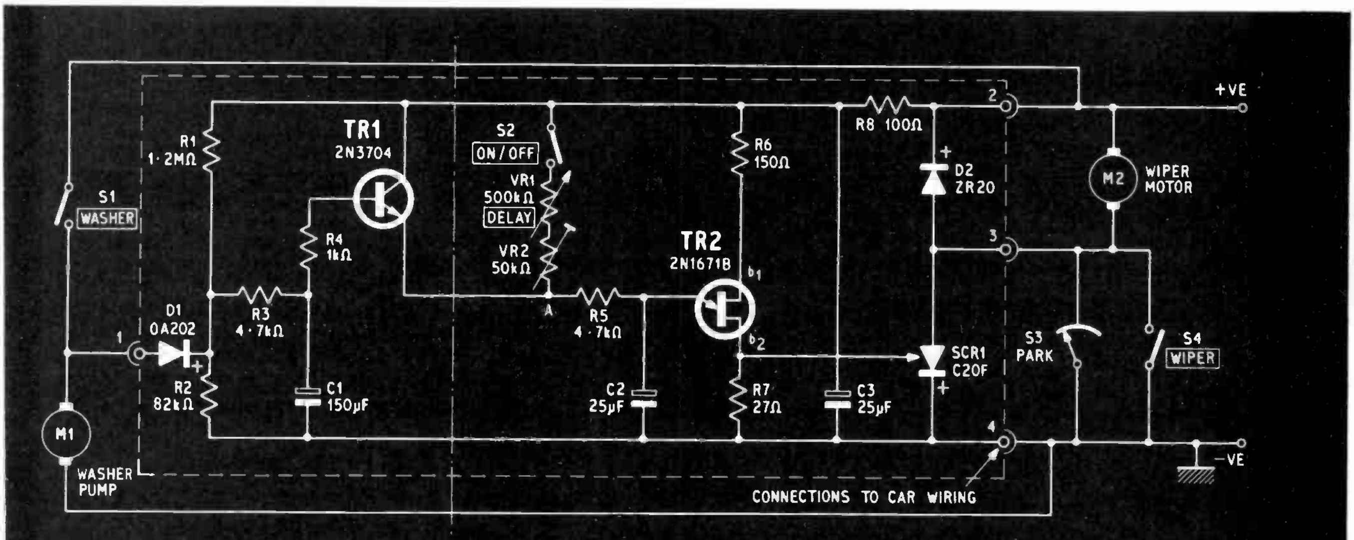


Fig. 1. Circuit diagram of the negative earth wash-and-wipe control

CONTROL

By D. E. VAUGHAN

R8 and capacitor C3 form a filter which prevents voltage disturbances on the battery line from producing false trigger pulses. If R5 is omitted together with that part of the circuit to the left of the chain dotted line (the components on tagboard A), the circuit as described will provide the intermittent sweep facility alone.

LIMITED CONTINUOUS OPERATION

The limited continuous wiper operation is obtained in the following way. In the quiescent state, with S1 open, point A (Fig. 1) is approximately at the same potential as the junction of R1 and R2 and, since this is less than ηV_b, the unijunction oscillator will not function. When S1 is closed C1 is charged rapidly through D1 and R3 and by emitter follower action in TR1 point A is raised above ηV_b, allowing the unijunction oscillator to function at a rate determined by the time constant R_5C_2. (Where ηV_b is the intrinsic stand-off ratio.)

If the resistor R5 has the minimum value consistent with reliable operation, a high repetition rate is obtained so that there is minimal delay at the end of each wiping stroke before SCR1 is re-triggered. When S1 is opened C1 discharges slowly through R3 in series with the parallel combination of R1 and R2 towards a potential $R_2V_{10}/(R_1 + R_2)$ and the potential of point A follows. When this falls below V_b the unijunction oscillator again ceases to function.

The effective time constant of the component values suggested allows three or four sweeps after the opening of S1, depending upon the speed of the windscreen wiper motor. The elaborate charge-discharge circuit is incorporated to prevent an unwanted sweep occuring when power is first applied. It will be noted that the limited continuous wiping facility is obtained irrespective of the state of S2. If the latter is closed, intermittent operation automatically follows the end of the continuous wiping period.

COMPONENTS

The modified circuit for use in vehicles with positive earth connection is shown in Fig. 2. Two additional components are required to provide the necessary improvement in false trigger pulse suppression.

The choice of *npn* transistor TR1 and unijunction transistor TR2 are in no way critical, the particular types listed being those which were at hand. The thyristor SCR1 should have current rating at least equal to the running current of the windscreen wiper motor, typically 3 to 4 amps, although in the interests of reliability the thyristor should be of sufficiently high rating to handle the hot stall current, typically 7 to 8 amps.

Diode D2 should have a forward current rating equal to at least half of the normal running current. Other component values are selected to suit the particular devices used and to provide the desired timing intervals.

CONSTRUCTIONAL DETAILS

The simplicity of the circuit means that any form of construction which is convenient may be used without difficulty. However, details of the form of construction used in the prototype are given here as a guide.

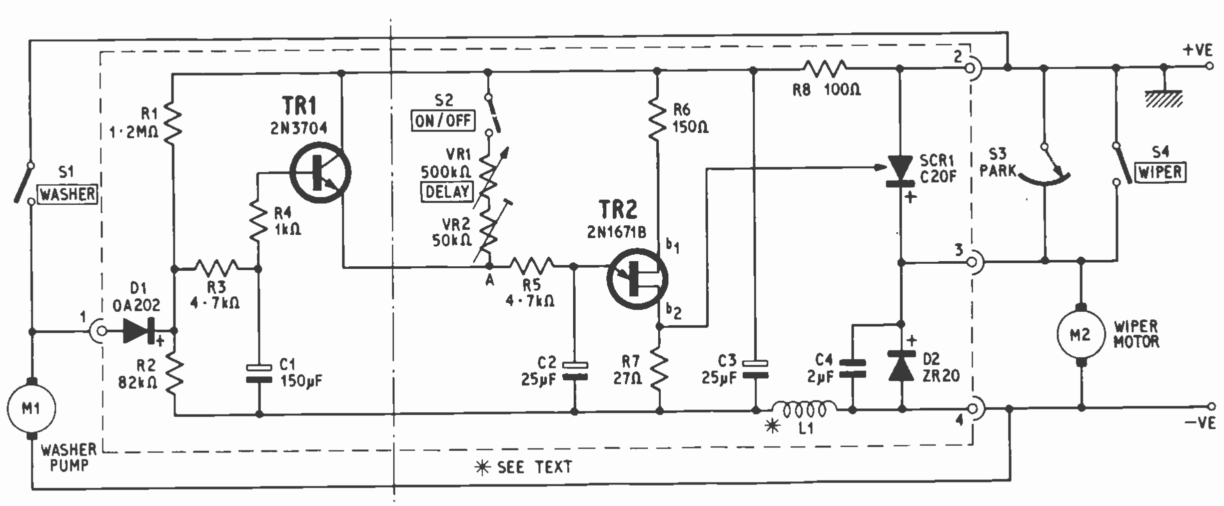


Fig. 2. Circuit diagram of the positive earth wash-and-wipe control

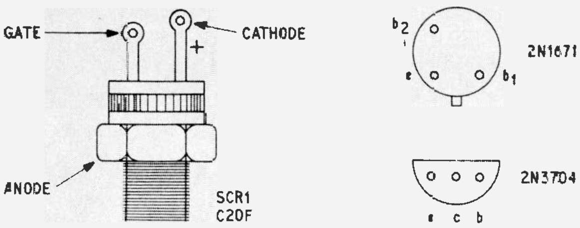


Fig. 3. Semiconductor connections for the components listed

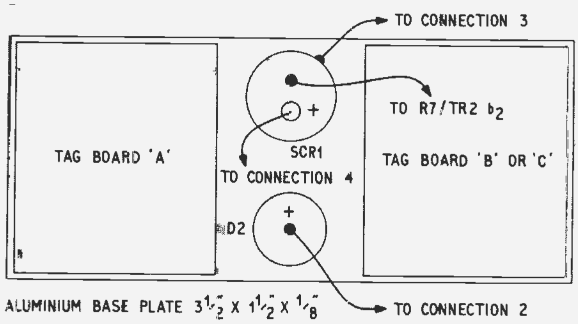


Fig. 4. General layout of the tag boards

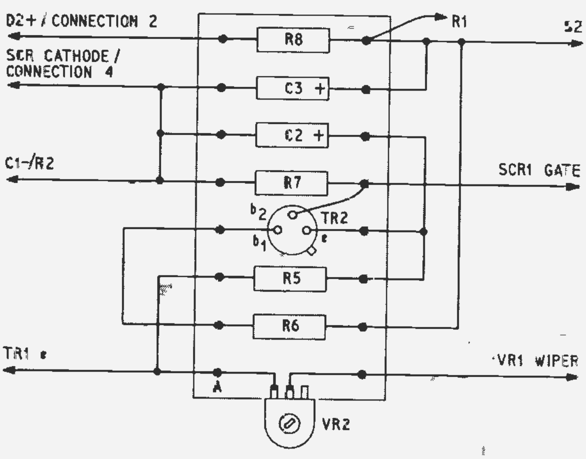


Fig. 5. Tag board B, for negative earth version

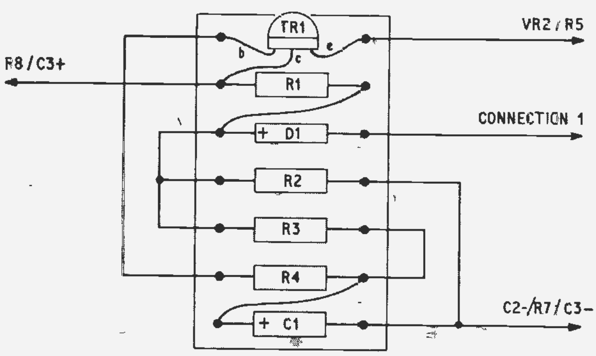


Fig. 6. Tag board A, for both versions

COMPONENTS . . .

Resistors
- R1 1·2MΩ
- R2 82kΩ
- R3 4·7kΩ
- R4 1kΩ
- R5 4·7kΩ
- R6 150Ω
- R7 27Ω
- R8 100Ω

All ¼W, ±10% carbon

Potentiometers
- VR1 500kΩ with single pole on-off switch (S2)
- VR2 50kΩ skeleton preset

Capacitors
- C1 150μF elect. 15V
- C2 25μF elect. 15V
- C3 25μF elect. 15V
- C4 2μF paper (for positive earth version only)

Semiconductors
- D1 OA202
- D2 ZR20
- SCR1 C20F thyristor
- TR1 2N3704
- TR2 2N1671B unijunction

Miscellaneous
- L1 1A T.V. suppressor choke
- Control knob
- Tag boards and aluminium for heat sink
- 6B.A. fixings

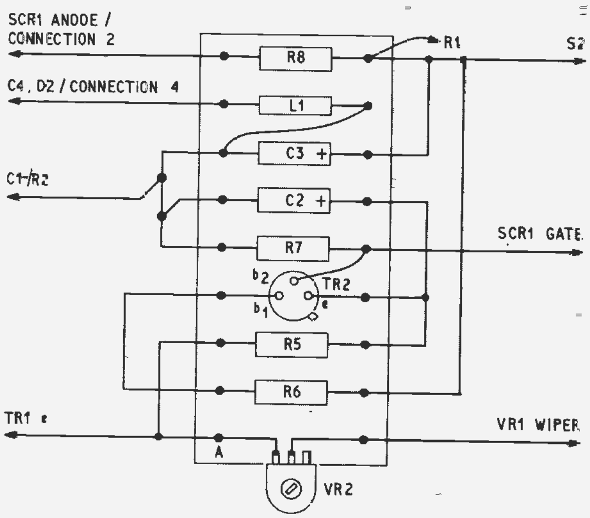


Fig. 7. Tag board C, replaces tag board B for positive earth version

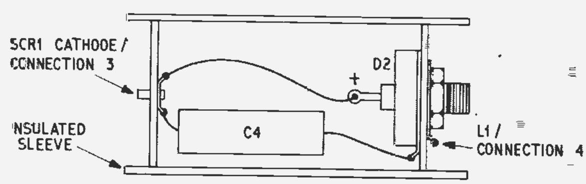


Fig. 8. Sub-assembly for positive earth version

For the benefit of readers who are not familiar with the unijunction transistor and the thyristor, details of the electrical connections are shown in Fig. 3. Although these are typical, should other types be used the relevant manufacturer's information must be followed.

NEGATIVE EARTH VERSION

The general layout for a negative earth system is shown in Fig. 4, SCR1 and D2 being fixed directly to the base plate which acts as a heat sink. Two tag boards are also attached to the base plate. Since the base plate is live to the circuit, it is enclosed in a small plastics box using nylon screws as mounting studs; this box can be fixed at a convenient point behind the car facia panel (the base plate must not be earthed to the car).

Detailed component layouts on the two tag boards are shown in Figs. 5 and 6. Although VR2 is shown on the circuit diagrams as a preset component, once its value has been found it can be replaced by a fixed resistor.

Two groups of leads are taken from the box, one group going to S1, S2 and VR1 mounted on the facia panel and the second passing through the bulkhead to the washer pump, the wiper motor and to the positive and negative battery connections.

POSITIVE EARTH VERSION

Because the stud connections to SCR1 and D2 are not common when a positive earth system is required, a slightly different form of construction has to be adopted. The general layout of the base plate differs from that shown in Fig. 4 in that D2 is omitted and one of the tag boards carries an additional component (L1) —Fig. 7 replacing Fig. 5.

Diode D2, together with the additional capacitor C4, is mounted as a separate assembly in a small insulated tube (see Fig. 8) fixed near the wiper motor. In all other respects the details of construction are similar.

CONNECTION TO WIPER MOTOR

Examination of the electrical connections to a wiper motor already fitted with a self-parking switch will show two live leads and an earth return. Reference to the workshop manual, or a few minutes work with a voltmeter, will establish which of the live leads is connected to the battery and which is the switch lead. The lead from the base plate (i.e. the common connection of the thyristor and diode anodes) is connected to the switch lead terminal. It is stressed that no modification to the wiper motor is required unless the motor does not have the self-parking facility.

In the case of wiper motors not fitted with a self-parking switch, the first step is to make the necessary modifications. When the modifications have been completed the connection can be made as previously described.

WASHER PUMP SWITCH

An electric washer pump switch is sometimes fitted in cars but is normally connected between the pump and earth. If this is so it is a simple matter to reconnect is as shown in the circuit diagram (Fig. 1).

Although the control for manual and vacuum washer pumps is not electrical, it should be possible to fit a microswitch, actuated by the normal control, in place of the washer switch. Other methods of switching may well be possible and no doubt some readers will add this facility to non-electric washers. ★

BIAS IN TAPE RECORDING

By C.W. Smedley C.Eng., M.I.E.E.
Southall College of Technology

TAPE recording has been covered by many text books, and the general principles are well known. The explanations given of bias, however, tend to be vague, and those who would like to pursue the matter are often deterred by the *B*/*H* loop, with its associated mathematics, implied if not stated. This article is intended to be a reasonably valid description avoiding the use of complicated analysis.

The object is to record signals, which can be audio, video, digital, etc. on a tape which is either coated or impregnated with magnetic material, and the system described here will be longitudinal.

THE MAGNETIC CIRCUIT

The recording/playback head consists of a winding on a ferromagnetic core, and current fed to the head will produce a magnetic flux. Fig. 1 shows the relationship between flux, *B*, and the magnetising force *H*, which is proportional to ampere-turns. If the current is increased slowly from zero, the value of flux can be plotted against the value of *H*, and the line OA will be traced.

At some point, A on our diagram, the value of flux will remain constant for any further increase in *H*, and the core is said to be saturated. P represents this maximum value of flux and S shows the corresponding value of *H*. If the current, i.e. *H*, is now reduced to zero, the flux decays along the curve AR, and R is the remanent value of the flux.

The ratio of OR to OP is called the retentivity of the core material. Some ferrites produce a curve in which OR and OP are practically equal; these are called square loop materials and are used in computer stores.

HYSTERESIS LOOP

If the current is now increased in the reverse direction, at some point the flux will have fallen to zero, shown as point C. Further increase will bring the flux to point D, which is reverse saturation, identical in value with point A, but opposite in polarity. Reduction of current, towards zero, will reduce the flux, and the curve DQ will be traced out.

Note that this curve does not pass through point O, but rises, as current is increased in the original direction, through E to A. It can be seen that, for any value of *H*, there are two possible values of *B*, and the perpendicular drawn at the point where *H* equals X cuts the *B*/*H* loop at points Y and Z. When *H* is rising, the value of flux corresponding to Y is less than on the original trace, OA, whereas, when *H* is falling, the value of flux corresponding to Z is higher. This lagging effect is called hysteresis, and the curve ACDEA is called the hysteresis loop.

THE AIRGAP

If the magnetic core formed a complete ring there would be no flux outside the ring, and a tape drawn across it would be unaffected. To produce flux outside the ring it is necessary to break the magnetic circuit, i.e. to have an airgap, and it will be at this point that the moving tape will be brought into contact with it.

The airgap will increase the reluctance of the magnetic circuit, and the flux for any given value of head current will be less than the value without an airgap. Another effect, however, offsets this apparent loss, and Fig. 2 has been drawn to illustrate it.

If we assume that the *B*/*H* loop is very narrow, then let OA represent the loop with no airgap. OA′ shows the loop when a small gap is introduced, OA″ the loop for a bigger gap. The first trace, OA, shows extreme curvature near the ends, and would not, in fact, be linear at any point. OA′ is much more linear, although the slope is less, and OA″ is better still, although the value of *H* necessary is increasing with the size of the airgap. This is not too important, since the amplifier gain can be increased to compensate. For the sake of linearity, therefore, the gap should be as big as possible.

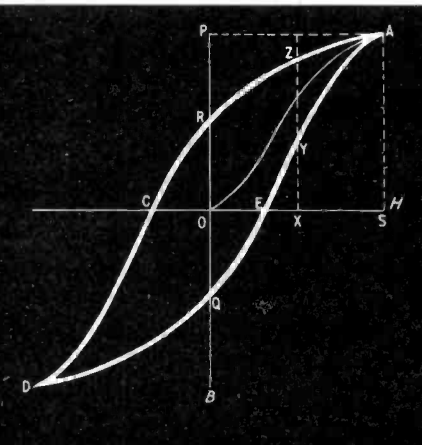


Fig. 1. B H curve or hysteresis loop

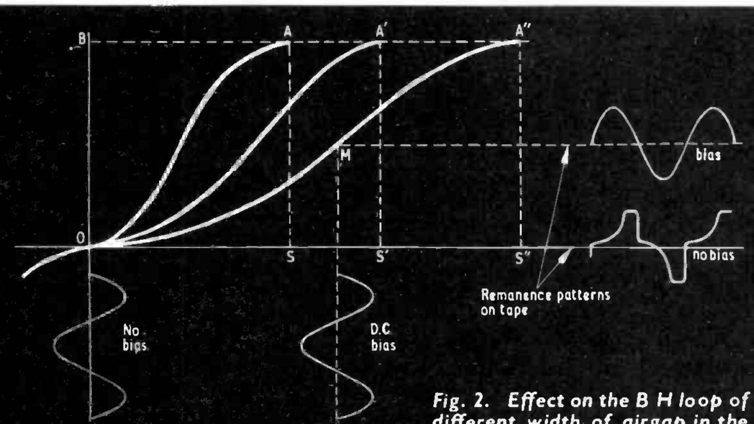


Fig. 2. Effect on the B H loop of different width of airgap in the magnetic core. The larger the gap, the better the linearity

But it can be shown that, for any given tape speed, the bigger the gap the poorer is the high frequency response of the system, and the two fundamental requirements appear to be in conflict. The practical solution is to make the actual recording/playback gap as small as possible, then to insert a second gap diametrically opposite to it.

DIAMAGNETIC GAP

Although the term airgap remains in use, the actual gap must be filled, for two reasons. One, if left open it would collect magnetic material from the tape, to re-form a closed magnetic circuit. Two, the external flux would be low in value. The gap is closed by a material which is both hard, to resist wear, and diamagnetic. Brass is a good example, and is commonly used. The flux now "fringes" out across the gap to make recording more effective.

The actual distribution, however, is not at all like the pattern across the open end of a horseshoe magnet. The brass insert acts as an obstruction to the flux and the tape itself closes the magnetic circuit. The flux can be said to enter and leave the tape at right angles to the surface of it, but all of the flux does not leave the core at the edge of the gap. It is spread each side of the gap to form a fringe which tails off within a short distance, and the electrical gap is therefore greater than the physical gap in the head. It is important to remember this when considering erasure.

THE NEED FOR BIAS

The effect of recording a signal has been shown by superimposing it on the vertical axis of Fig. 2. The recorded pattern on the tape will show the curvature near to point O, and harmonic distortion has been introduced. To prevent this effect the working area should not include the extreme curvatures near zero and saturation.

Direct current bias can be used, for example sufficient current can be passed through the record head so that every tape element is, in the absence of a signal, magnetised in the same direction, to the same degree. Such a current would correspond to a value of H somewhere between S and S′, so that the effective working point is M on the curve OA″. The signal to be recorded is now shifted bodily to the right, so that it becomes symmetrical about the vertical drawn through M.

This bias system closely resembles that used for valves and transistors, where the transfer, or mutual, characteristics exhibit similar curvature at cutoff and bottoming.

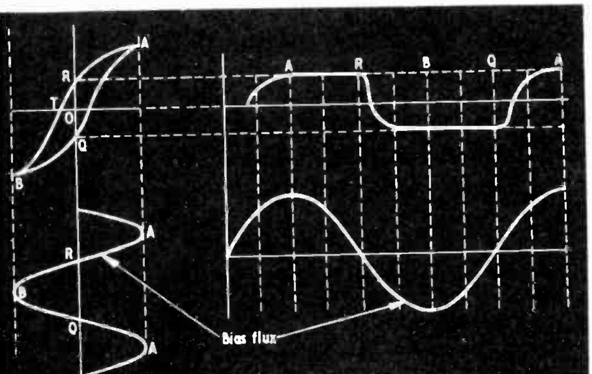


Fig. 3a (left). Applied flux on the H axis of the magnetic loop is transferred to the tape in distorted manner due to remanent magnetism, which is plotted in Fig. 3b (right) and shown against the sine wave producing it

Although this d.c. system is used on cheap tape recorders, there are two major limitations. One, the peak to peak signal amplitude must be only half the value of that when no bias is used. This can be partially overcome by shifting the d.c. bias point, but the benefits are marginal and still include some distortion. Second, every particle on the tape is magnetised and, on playback, will make a contribution to the output voltage in the form of noise, mainly high frequency (hiss). For these reasons supersonic (a.c.) bias is now almost universal.

HIGH FREQUENCY BIAS

The frequency chosen must meet two requirements: it must be high enough to be filtered out on playback without attenuating the wanted signal and, in general, should not be less than three times, preferably five times, the highest frequency to be recorded. At the same time, it must not be too high because the record head is highly inductive. The practical value lies between 50 and 75kHz and a sinewave form is essential to prevent head magnetisation by second harmonic. LC oscillators of the Hartley or Colpitt type are popular, and the stage often "doubles" as audio output on playback.

To understand the full effect of a.c. bias, two points should be kept in mind. One, the gap includes the fringe each side of it, and the actual flux entering the tape from the head is almost perpendicular to the surface. Two, the flux is alternating at bias frequency, and the actual value affecting each tape element will be the instantaneous value as that element leaves the fringe. Each tape element, or particle, is therefore exposed to a flux which can have any value from zero to maximum, of either polarity, but the resultant magnetic pattern on the tape is not sinusoidal.

Fig. 3a will show this more clearly, and the applied flux, H, is shown to have sine wave form. Point A on the sine wave corresponds to saturation, i.e. point A on the B/H curve, and any tape element exposed to this value of flux will have a remanent magnetisation equal to point R when it leaves the fringe. Following elements will be exposed to a flux decaying towards point R but all will have the same remanent value as point A.

REMANENT FLUX

Fig. 3b shows the remanent flux plotted against the sine wave producing it, and it can be seen that the waveform written on to the tape has a flat top from point A to point R. From R to B the applied flux is increasing in the reverse direction, but the remanent flux does not fall to zero until the applied flux has reached a point between T and B. At point B reverse saturation is reached and from B to Q the remanent flux again shows a flat top. In the absence of any other signal the bias continues to write this pattern.

If the tape is now played back at the same speed the pattern will induce small voltage pulses in the head at bias frequency, but since the pulses are symmetrical about zero, simple integration (to be discussed later) will virtually eliminate them. One thing the bias has established is the maximum wavelength of each pattern on the tape. Larger groupings, which would give rise to low frequency noise if exposed to direct current bias, have been restricted to this wavelength.

It should be noted at this stage that, although the terms amplitude and frequency are used for signal and bias currents, they should not be used when referring to the recorded tape. The pattern on the tape has intensity and wavelength.

SATURATION BIAS

If a low frequency signal, for example audio, is now fed to the head at the same time as bias the pattern on the tape will be modified. Fig. 4 shows the effect, in terms of *H* and *B*. The l.f. signal shifts the bias waveform progressively, in this case, to the right. The bias current remains the same in amplitude but now "rides" on the signal. The value of "*H*", in the right hand direction, increases to well beyond saturation, but the remanence pattern cannot increase with it, as it already corresponds to the saturation value.

However, due to the shift, much more than a half period, in terms of bias, is spent at and beyond saturation, and the pattern on the tape covers a greater distance. On the left hand side, not only is "*H*" reduced in value, but less than half a period is spent in this region. The pattern on the tape therefore shows a reduction in intensity and in length. The overall bias wavelength has not changed, but the pattern distribution has, and any pulses produced by playback will not be equal and opposite. Integration will show a progressive change in one direction, the value depending upon signal amplitude and the direction upon signal phase.

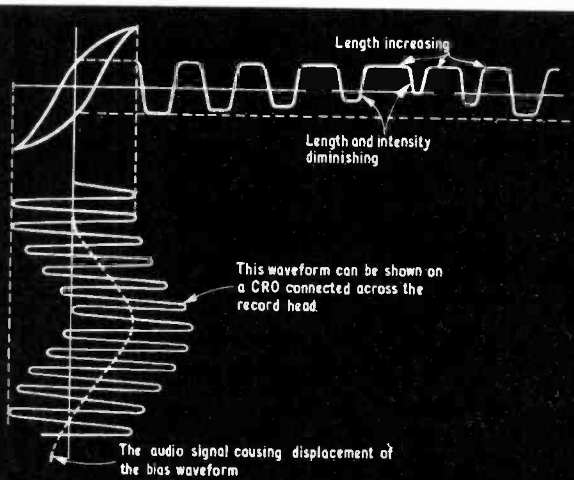


Fig. 4. The effect of applying an audio signal at the same time as the bias signal, producing a saturated magnetisation of tape particles

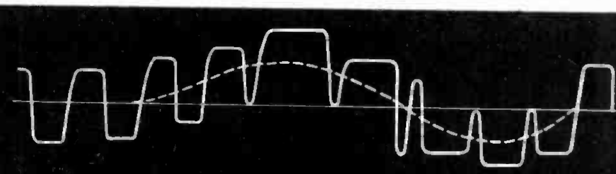


Fig. 5. Correct application of bias magnetises the tape by a series of pulses which are proportional to the applied audio signal

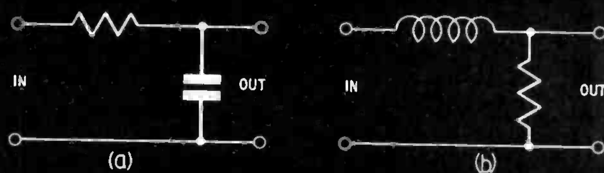


Fig. 6. Filter networks used on playback to eliminate the high frequency bias pulses. A simple CR network is shown in (a) and an LR network using the tape head inductance in (b)

DISADVANTAGES

This system uses saturation bias and has disadvantages. One, the high value of bias tends to demagnetise the pattern recorded, leading to a loss of high frequency response; two, the limiting action described still gives distortion. The optimum value of bias is about half the saturation value, and the remanence pattern on the tape will be lower in intensity. The flat tops will still be present exactly as before, but, when a signal appears, both polarities will be affected, i.e. one half will be increased, the other decreased.

Integration will produce an output whenever the remanence pattern is unbalanced by a signal, but, for any given value of signal, the output will be greater than when using saturation bias because both polarities change in length and intensity.

SCOPE FOR IMPROVEMENT

The system so far described is the typical domestic sound recording, and a few practical details will help to show the scope for improvement. Assuming a bias frequency of 70kHz and a tape speed of 7in/sec the recorded wavelength will be one tenth of a thou (0·0001in) the pattern representing each flat topped pulse will therefore be one tenth of that. Since the process produces a series of "bar magnets" along the length of the tape, the smallest unit will be the dust particle of the coating, and this will be in the region of one micron, which is about one twenty-fifth of a thou.

The flat top cannot be considered as any more than one particle, and it remains flat with or without a signal. If the dust particles were made smaller, and/or the tape speed increased the recorded length of the flat top could cover many particles and any change of signal level during that passage would modify the top. The slope of the signal would then appear superimposed on the flat top.

PLAYBACK

The surface induction (remanence pattern) on the tape has been shown to be a distorted version of the bias waveform. At very short wavelengths there is a strong demagnetising effect, and the actual value measurable would be less than expected. The presence of the bias has, however, made the signal effective over the linear part of the characteristic and this is its true function. Fig. 5 shows the effect of a signal on the pattern, the applied signal represented by the dotted line. Each half cycle of signal now appears as a group of pulses.

When the tape is passed over the gap this pattern will produce voltage pulses in the head circuit and the next process can be considered as filtering. Fig. 6a shows a CR network which will act as a low pass filter, suppressing the high frequency pulses, but producing an output proportional to their amplitude/duration. This action is integration, the pulses producing the charging current for the capacitor, the output signal being the voltage developed across it.

Fig. 6b, although less well known, is also an integrating circuit, having the same effect, but the inductance is that of the playback head, usually 0·5 to 1·0 henries.

ERASURE

The advantage of tape is that it can be used many times, and, to achieve this, some means must be used to remove the recorded signal.

The most common method is to mount an additional head—the erase head— fairly close to, and just ahead of, the record head. A much larger gap is used and the same bias waveform of greater amplitude, is fed to the winding. The current should be sufficient to take each tape element beyond saturation.

This head is usually tuned to bias frequency since it does not handle signal. Although the gap is large, and the erase current high, it is found that the original pattern on the tape, especially that of strong signals, often recovers after erasure. To avoid this effect a double gap is used, the gaps, in this case, being adjacent to each other.

Because the gap is larger, and bias current higher, the flux extends well beyond the physical gap, i.e. the fringe is longer. Each tape element spends much more time in the fringe than it would in that of the recording head, and many loops are traversed in that time. The loops fall off in amplitude as each element moves out of

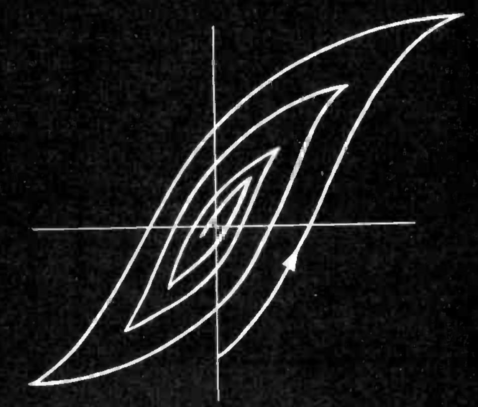


Fig. 7. The series of BH loops through which each tape particle passes, due to large air gap and increase h.f. current for erasure by saturation

the fringe so that the remanent flux is negligible. Fig. 7 shows the series of loops to which each element is exposed as it leaves the erase gap, the actual number of loops being much greater than a clear sketch could show.

CONSTANT CURRENT RECORDING

When a signal is recorded on tape the pattern must represent the amplitude as well as the frequency. The flux and therefore the head current should be independent of frequency. The recording head is highly inductive and its reactance would reduce the current as the frequency became higher, assuming a constant voltage drive.

A resistor is usually connected between the output of the signal amplifier and the head to reduce this effect, which could lead to a fall-off of 6dB per octave. If the resistor value is high, it will swamp the reactance of the head, so that the head current will be the same for all frequencies of the same original amplitude. This is called a constant current system. ★

NEWS BRIEFS

B.A.E.C.

THE British Amateur Electronics Club recently held its annual exhibition at Penarth, Glamorgan, and as a result of this, some of the exhibits were used in a BBC television programme on BBC Wales; the programme—"Heddiw"—was televised in Welsh but the B.A.E.C. were provided with an English translation of the text that they published in their October Newsletter. The games illustrated on television were all constructed by members of the B.A.E.C.

Vidicon Storage Tube

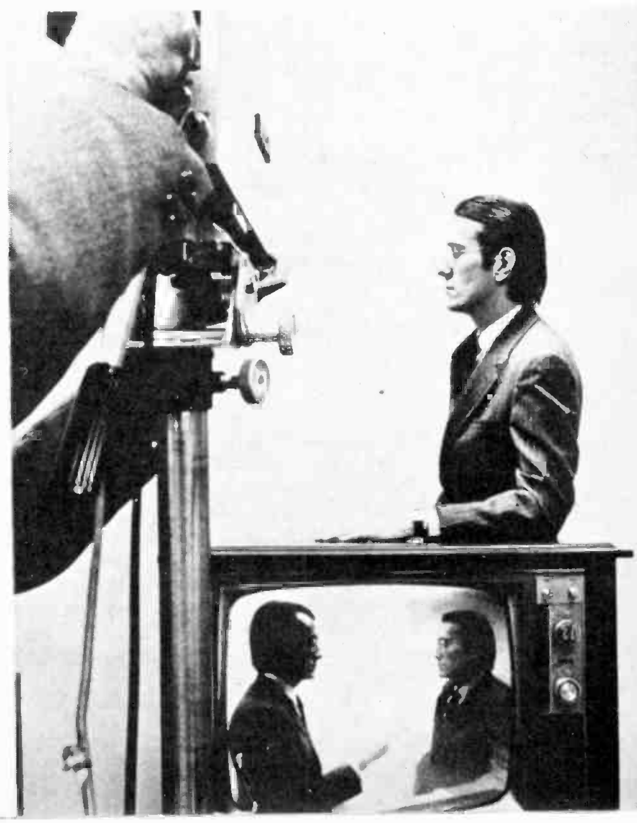
DEVELOPMENT of the first television camera tube to feature built-in stop-action capabilities was reported recently by RCA.

The unit is a small, vidicon-type device that can take—and store for later play-back—single electronic "snap-shots" or "stills" of continuous programmes being transmitted by the tube.

The still picture is electronically stored inside the tube itself thus eliminating the need for an external storage medium such as film or videotape. It can be relayed to a TV monitor immediately, or kept intact within the tube for several days.

The new tube is technically referred to as a silicon storage vidicon and could be used, for example, in a space, satellite to eliminate the bulk and weight of the present video storage devices which relay individual TV pictures to earth by relatively slow communications systems.

The picture below shows the new tube in use. The image on the left of the screen was recorded by the tube a few minutes before, and the one on the right is being transmitted "live", giving the impression that the subject is talking to himself.



PE GEMINI

DUAL PURPOSE STEREO AMPLIFIER

PART THREE

By D. S. GIBBS and I. M. SHAW (FERRANTI LTD)

A HIGH quality pre-amplifier must perform several important functions, it must have an input impedance sufficiently high not to load the signal sources, it must provide frequency equalisation where necessary, it must have filters to remove spurious noise or harsh treble from poor recordings and it must have tone controls to accommodate the preferences of the listener, the deficiencies of the loudspeakers and the acoustics of the listening room. Furthermore it should do all this without any significant increase in either distortion or background noise level over a wide range of input signal levels.

The design evolved meets all these requirements, as the specification published previously shows, and it has several other valuable facilities. A microphone channel is included which can be mixed independently with any other input. This facility is useful to tape recording enthusiasts or can be used as a "home discotheque" for parties etc. Another feature valuable to the tape recorder enthusiast is the recorder output which is taken after the equalisation and filter stages but is unaffected by volume or tone controls. The circuit diagram of the right hand channel of the pre-amplifier is shown in Fig. 24, the left hand channel is identical.

DISC INPUT

The disc input stage comprising T14, T15, T114 and T115, provides frequency equalisation to the RIAA L.P. characteristic with an accuracy of approximately ± 0·5dB between 30Hz and 15kHz as shown in Fig. 25. The circuit has been designed so that the frequency response curve falls below 20Hz. This attenuates low frequency components in the output of the pickup and makes a separate rumble filter unnecessary. The sensitivity is 3mV in the "Lo" position and about 60mV in the "Hi" position so that either magnetic or ceramic pickup cartridges may be used.

The circuit used is a complementary two stage feed-back amplifier, a more detailed circuit of which is shown in Fig. 26. This was chosen in preference to the more popular circuit shown in Fig. 27, because of the greatly improved bias stability and its freedom from the subsonic ringing which the circuit of Fig. 27 tends to produce. This arises through the feed-back provided by R1 becoming positive at certain frequencies due to the phase shifts produced by C1 and C2 (Fig. 27).

The shape of the frequency response curve is defined by the negative feed-back provided by R39, R40 and C19 to 21; the overall gain is defined by R38. The circuit gives an output of 100 mV for an input of

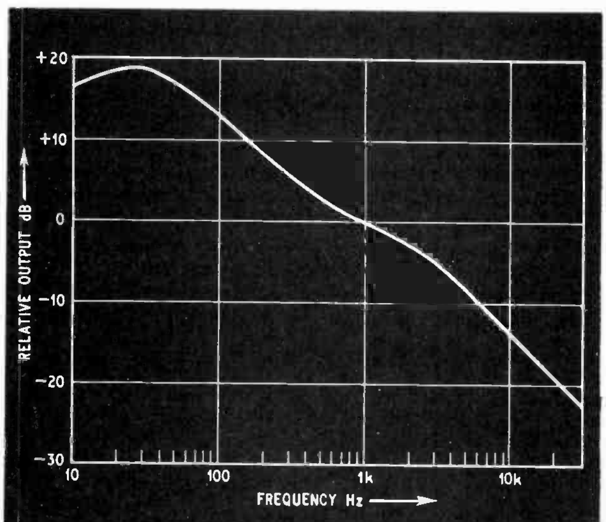


Fig. 25. Frequency response curve of disc input stage

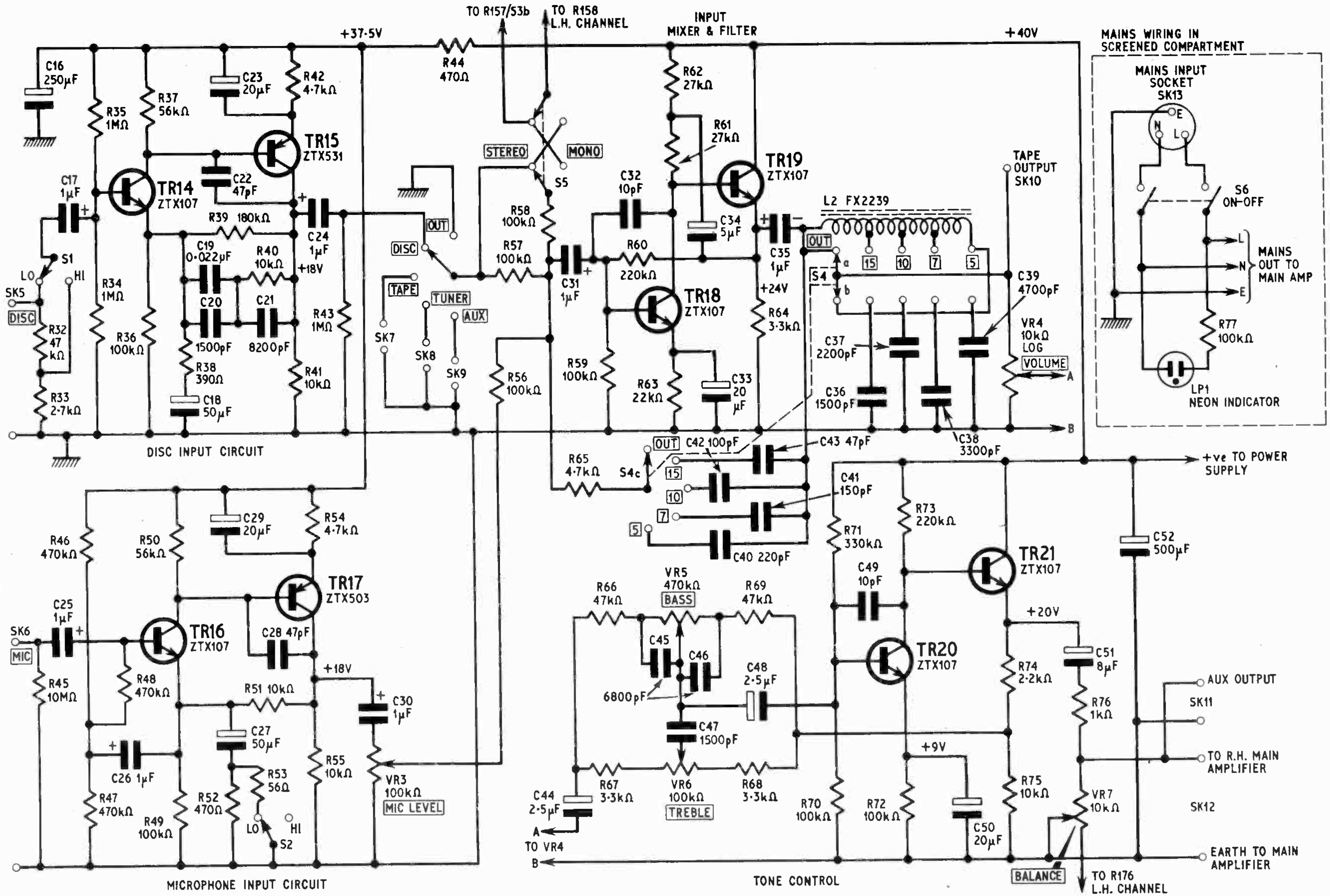
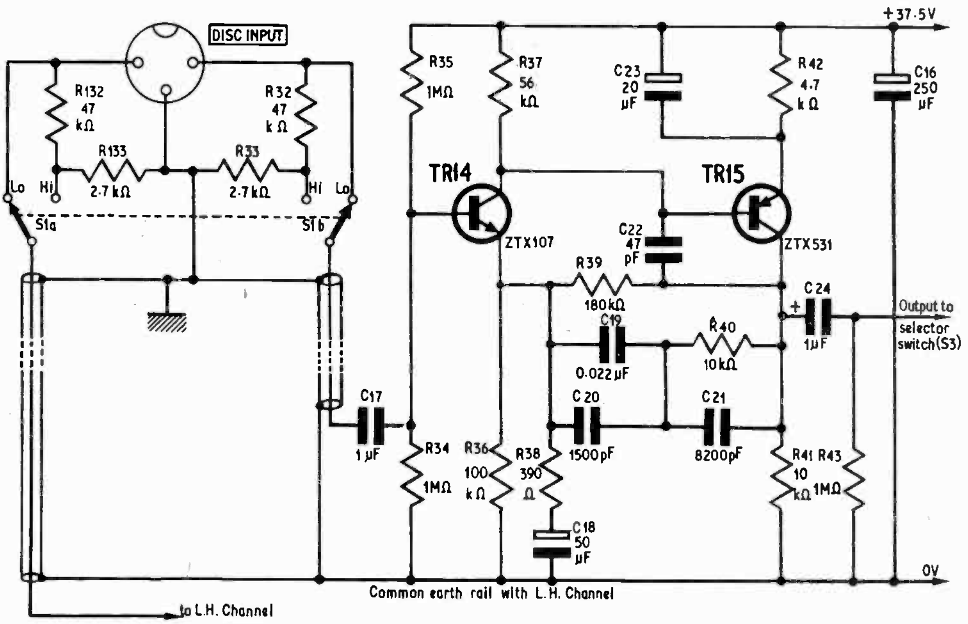


Fig. 24. Circuit diagram of the right-hand channel of the pre-amplifier of the P.E. Gemini. The left-hand channel is identical—component numbers being right-hand channel plus 100, except for the switches and sockets which serve both channels by being double pole types



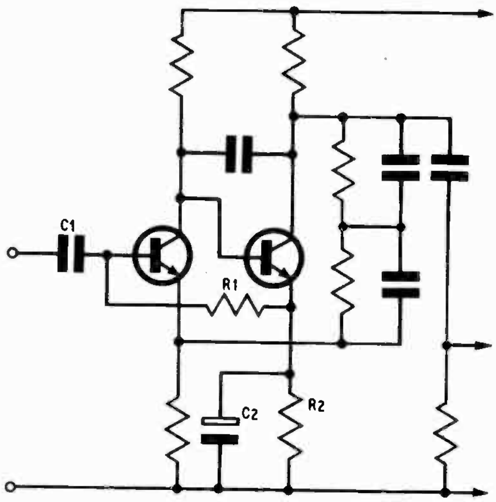
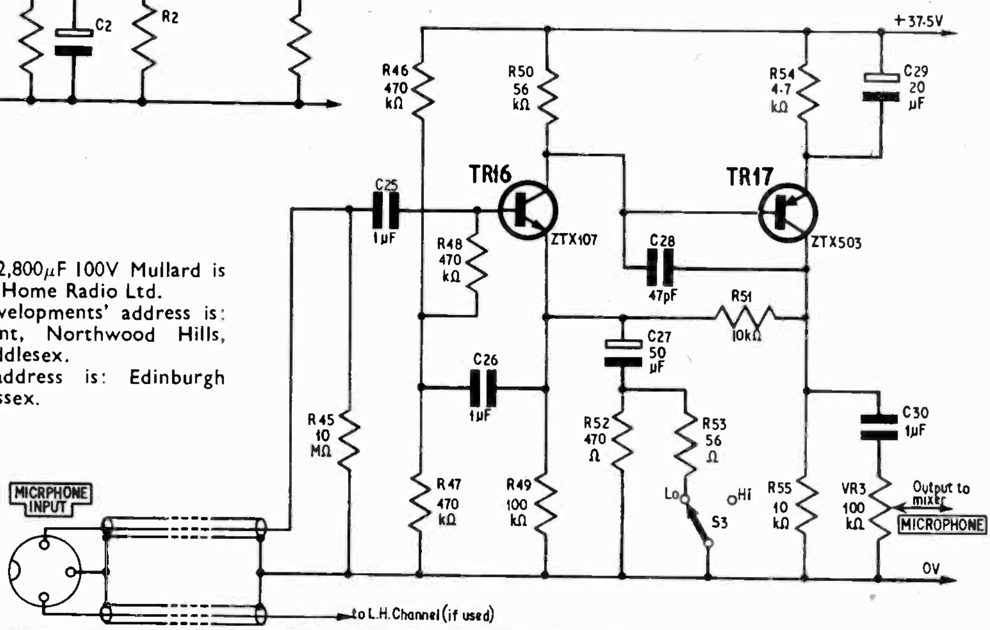


Fig. 26. Disc input circuit—right-hand channel only

Fig. 27. A popular two transistor disc input circuit. This circuit was rejected in favour of the circuit shown in Fig. 26 because of its inferior bias stability and its tendency to subsonic ringing

Fig. 28. Microphone input circuit—right-hand channel only



NOTE:

Capacitor C3—2,800μF 100V Mullard is obtainable from Home Radio Ltd.
West Hyde Developments' address is: Ryfield Crescent, Northwood Hills, Northwood, Middlesex.
Electroniques address is: Edinburgh Way, Harlow, Essex.

3mV at 1kHz. Distortion generated by the input stage is below 0·005 per cent with 3mV input at 1kHz and below 0·05 per cent at 20dB overload. Between 100Hz and 10kHz the distortion does not exceed 0·1 per cent at any level up to 30dB overload.

MICROPHONE INPUT

The circuit of the microphone input stage (Fig. 28) is virtually the same as the disc input except that the feed-back network is replaced by a single resistor to give a flat frequency response and the bias resistors at the input are bootstrapped to increase the input impedance. Two input sensitivities have been provided. In the "Lo" position of S2 the input sensitivity is 1mV with an input impedance of 1 megohm which is suitable for most low and medium impedance dynamic and ribbon microphones. With the switch in the "Hi" position the sensitivity is reduced to 10mV and the input impedance rises to 2 megohms. This sensitivity is suitable for high impedance dynamic or crystal microphones.

Constructors not requiring the microphone input can simply omit all the components associated with this stage, or if only mono microphone operation is required only one microphone input stage need be built and the output can be fed to both mixers via separate 100 kilohm resistors (R56, R156). Potentiometer VR3 in this case need only be single gang.

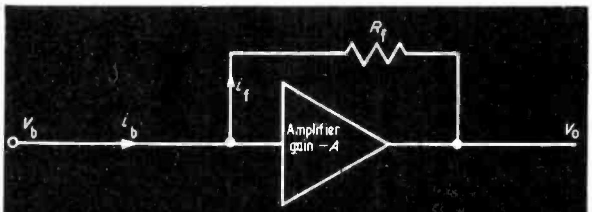
The table below summarises the performance of the microphone input stage:

INPUT MIXER

The input mixer works on the virtual earth principle which is explained in Fig. 29. Because the input impedance at the base of the TR18 is low—only about 100 ohms—it can for all practical purposes be considered as a short circuit to earth, hence the name virtual earth amplifier. The total input current when

Table 1

	"Lo"	"Hi"
Input Sensitivity	1mV	10mV
Input impedance	1MΩ	2MΩ
Distortion	less than 0·005% at 1mV input and less than 0·05% at 20dB overload	less than 0·005% at 10mV and less than 0·02% at 20dB overload
Frequency response	65Hz to 70kHz at −3dB	10Hz to 200kHz at −3dB. With 500pF source (crystal microphone) frequency response is −3dB at 60Hz
Signal to noise ratio at rated sensitivity	−60dB with 100Ω source, −56dB with 1KΩ source, unweighted, 20Hz to 20kHz	−70dB with 1kΩ source, −56dB with 50KΩ source, unweighted, 20Hz to 20kHz



If input voltage $= V_b$

Then output voltage $V_o = -AV_b$

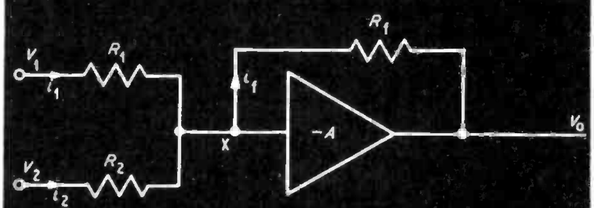
Input impedance $= \frac{V_b}{i_b} = \frac{V_b}{i_f}$ if the input current of the amplifier itself is neglected

But $i_f = \frac{V_b - V_o}{R_f} = \frac{V_b + AV_b}{R_f}$

Therefor input impedance $= \frac{R_f}{1 + A}$

In the actual circuit $R_f = 220k\Omega$ and A is approximately 2000 giving an input impedance of about 100Ω

Fig. 29a. Virtual earth amplifier—functional diagram



Because point X is "virtually" at earth potential the total input current when used as a mixure is

$$i_1 + i_2 = \frac{V_1}{R_1} + \frac{V_2}{R_2} = i_f$$

The output voltage $V_o = i_f R_f = \frac{V_1 R_f}{R_1} + \frac{V_2 R_f}{R_2}$

i.e. the gain from each input is given by the ratio of R_f to the appropriate input resistor and the output is proportional to the sum of the individual input currents

Fig. 29b. Virtual earth amplifier as a mixer

used as a mixer is then just simply the sum of the input currents from each signal source, which enables the microphone input to be mixed with any of the other inputs without interaction.

The input sensitivity at the tape, tuner and aux, inputs is 100mV with an input impedance of 50 kilohms, and the output at the emitter of TR19 is 400mV. Capacitor C34 is a bootstrap capacitor which increases both the gain and the available output voltage swing to give minimum distortion. At 1kHz the distortion produced is below 0·005 per cent at rated sensitivity and below 0·02 per cent at 20dB overload, at 10kHz these figures become 0·01 per cent and 0·1 per cent respectively. The circuit will give an output of 10 volts r.m.s. (28dB overload) before clipping occurs. Signal to noise ratio at rated sensitivity is −80dB (unweighted 20Hz to 20kHz).

To be continued

AUDIO TRENDS

By F. C. JUDD

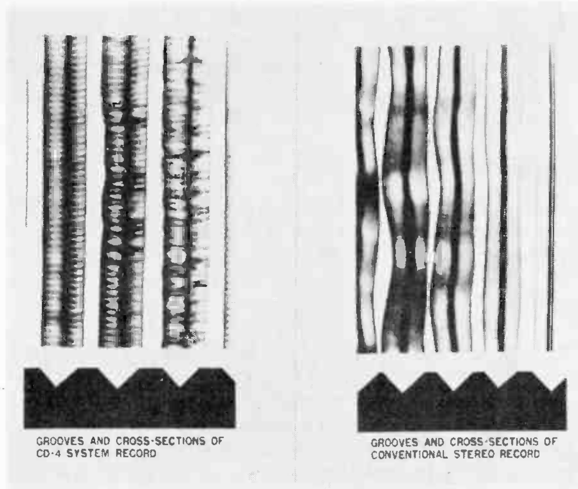
When stereophonic sound reproduction made its debut, only a few years ago, the various manufacturers who exhibited at the annual Audio Fair were quick to take advantage of the "moving sound" illusions that could be created with stereo. These consisted mainly of the sounds of express trains and racing cars, etc. which hurtled across the demonstration rooms at breakneck speed, and of phantom ping-pong games in which you followed the movement of the ball without seeing it. After being subjected to this and other subtle forms of audio brain-washing, you went home either cross-eyed or cross-eared but nevertheless convinced that stereo had something even if it was only two of everything.

Now it seems that stereo is out—two channel stereo that is. The "in thing" is four channel stereo alias quadrasonic, alias CD-4 alias surround sound, call it what you like. At least that's one impression gained at the 1970, 16th International Audio and Music Fair held in October at Olympia. This time, no trains and no ping-pong game. This time they sat you down in the middle with the sound all around and intensified the audio brain-washing with real solid state power.

Practical Electronics went one better. With their demonstration of the "P.E. Gemini" stereo amplifier, visitors were also treated visually with the "P.E. Aurora", an audio controlled light display, which can be adapted by the constructor for domestic settings. (Details of "Aurora" will be published very soon as a constructional project—Ed.)

FOUR CHANNEL—ON DISC

JVC-Nivico (Victor Company of Japan) recently announced their new four channel disc stereo system and its reproducing equipment known as CD-4. This was demonstrated at Olympia and is claimed to be high fidelity and also compatible with existing two channel reproducing equipment, i.e. the CD-4 four channel discs can be played on conventional two channel equipment and two channel discs can be played on CD-4 equipment.



Comparison of CD-4 disc and conventional stereo record

The four channels are cut in one groove and according to the very limited technical information at present available, the system features both frequency and phase modulation which are combined to carry the signals for the extra channels. Reproduction requires four separate amplifier channels and four loudspeakers. Two loudspeakers are positioned in front of the listener and two at the rear. The photographs show the difference between recording on a two channel stereo disc and the new CD-4 disc. The U.K. distributors are Denham and Morley Limited, Denmore House, 453 Caledonian Road, London, N.7.

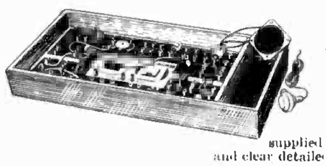
FOUR CHANNEL—ON TAPE

The Audiosonic system, which is four channel stereo on tape, was also demonstrated at Olympia by JVC-Nivico. The system employs four separate tape heads and offers various ambionic arrangements for the listener, i.e. two speakers in front and two at the rear or three in front and one at the rear or all four at the front. The makers claim that the system presents truly "solid music" with complete freedom of movement for the listener. As the two recommended twin channel Nivico amplifiers for this system are each rated for 140W music power (total 280W) the system could present some pretty solid sound as well.

Nivico four channel disc player

ROC ELECTRONICS

50 PROJECT ELECTRONIC KIT Model R.130



King of the Roc Electronic Kits is the Giant R.130 which makes up into no less than 50 separate projects including Radio Receivers, Transmitters, Tachometer, Rain Alarm, Testers, Electronic Switches, Amplifiers and even an Electronic Target Game. As well as carphone, speaker, meter, relay, transformer, solar cell, buzzer, etc., etc., the R.130 is supplied complete with a fitted hardwood case and clear detailed instructions for all 50 projects.

PRICE £7.19.0

20 PROJECT SOLAR ELECTRONIC KIT Mod. R.128

This ultra modern Project Kit is shaped for the space age. Carried inside a transparent domed 4½in capsule the R.128 comes complete with a self-contained solar cell to power any one of 20 projects ranging from a one transistor radio to a morse set complete with key and morse training code. Supplied complete with easy to follow instructions and even the cement to assemble this unique electronic space capsule.

EXCLUSIVE

PRICE £4.10.0

2 OCTAVE ELECTRONIC ORGAN KIT Mod. R.129

Complete with a music book containing 10 easy to play songs the R.129 solid state organ kit covers 2 full octaves. Slotting into a fitted hardwood case the top panel carries the key assemblies and all the components including the loudspeaker. Like all Roc Electronic Kits every item is included down to the last nut and bolt so that the constructor can start assembly within minutes of opening the package.

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10 PROJECT INTEGRATED CIRCUIT KIT Model R.127

Using a robust Solid State Integrated circuit the R.127 kits will build any one of these projects: (1) Germanium Radio. (2) Test Oscillator. (3) Morse Telegraph Training Set. (4) I.C.I. Transistor Radio. (5) Germanium 1 Transistor Radio. (6) Record Player Amp. (7) Continuity Tester. (8) AF Signal Tracer. (9) Radio Transmitter. (10) Water Purity Tester.

PRICE £3.10.0

2 TRANSISTOR SOLAR RADIO KIT Model R.126

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

EXCLUSIVE

PRICE £2.10.0

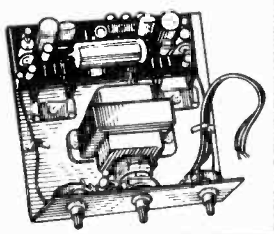
CRYSTAL RADIO KIT Model R.125

This easy to build Radio is based on the same circuit developed by Marconi for the very first radio transmission but uses a modern ferrite aerial for maximum efficiency. A perfect introduction to Radio Theory.

EXCLUSIVE

PRICE £1.10.0

5 WATT STEREO INTEGRATED AMPLIFIER CHASSIS Model R.123



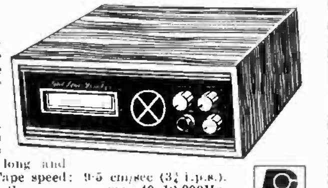
Mounted on a heavy gauge chassis the fully transistorised R.123 stereo amplifier is completely self-contained even down to ganged volume and separate tone controls. For a simple stereo amplifier of excellent quality all you have to provide is the cabinet and control knobs.

SPECIFICATION:
Output: 5W total. 2·5W per channel.
Input sensitivity: 600mV at 2·2Mohms.
AC 240V operation.

PRICE £4.19.0

EXCLUSIVE

5 WATT 8 TRACK CARTRIDGE STEREO AMPLIFIER Model R.133



Just slot in one of the many 8 track cartridge tapes available for a continuous programme of your favourite music. A manual programme override switch enables you to switch from one track to the next at the push of a button at the same time a numbered indicator lights up to show which track is playing. Beautifully finished in an oiled walnut cabinet the R.133 is mechanically engineered to provide long and reliable service. SPECIFICATION—Tape speed: 9·5 cm/sec (3¾ i.p.s.). Wow & flutter: better than 0·3%. Frequency range: 40–12,000Hz. Cross talk: better than 45dB at 1,000Hz. Output: 5W total. 2·5W per channel. Amplifier outputs: 200mV.

EXCLUSIVE

PRICE £36.0.0

STEREO HEADPHONES Model R.328

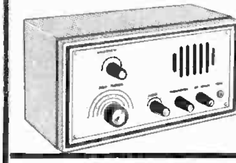
Built up to a standard not down to a price, the R.328 stereo headphones represent a breakthrough in value for money.

A valuable addition to any stereo installation they will provide many hours of listening pleasure.

SPECIFICATION:
Matching impedance: 8–16 ohms.
Frequency range: 30–15,000Hz.

PRICE £2.8.0

FOUR BAND SHORT WAVE RECEIVER KIT Model R.140



This excellent transistorised battery operated kit will not only provide hours of entertainment when made up but also in its construction.

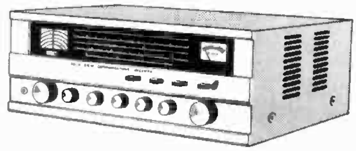
It receives the normal broadcast band 550kHz to 1·6MHz and on short wave 1·5–30MHz in three bands.

The 32-page manual not only shows step by step instructions on how to assemble the kit but also includes a guide on broadcasting stations throughout the world.

PRICE £9.8.0

EXCLUSIVE

PROFESSIONAL SOLID STATE FOUR BAND COMMUNICATION RECEIVER Model R.135

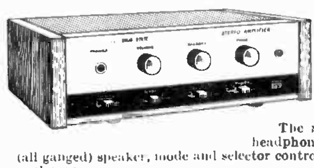


This is the communication receiver that you have long been waiting for. Fully transistorised and continuous coverage from 555kHz to 30MHz in four bands including illuminated electronic bandspread for 160–10 metres. Also incorporated is an internal speaker, automatic noise limiter, SSB/AM/CW Switch, AVC Switch, S Meter, Receive and Standby Switch, external socket for headphone or speaker, bandspread control, BFO control, on/off/AF gain, band selector, antenna trimmer and RF gain. The R.135 will run off of 240V a.c. dry batteries or any 12V d.c. negative ground source.

EXCLUSIVE

PRICE £45.0.0

10 WATT BUDGET STEREO ALL TRANSISTOR AMPLIFIER Model R.136



Ideal as a second stereo system or for the newcomer to Hi-Fi who wishes to upgrade existing equipment the R.136 sounds every bit as good as it looks. As well as inputs for crystal or ceramic cartridge the R.136 has a Stereo Tuner input which accepts the matching R.134 Stereo AM/FM Tuner.

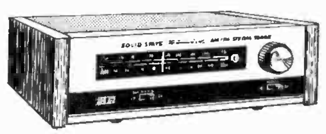
The Satin Finish front panel carries a stereo headphone socket as well as volume, balance, tone, (all ganged) speaker, mode and selector controls. Supplied complete with oiled walnut enclosure.

SPECIFICATION: Output: 10 watts total. 5 watts per channel.
Frequency Range: 35–18,000Hz. Inputs: Phono and Tuner.

EXCLUSIVE

PRICE £13.0.0

AM/FM/MPX STEREO TUNER Model R.134



Perfect Matching Unit to the R.136 Amplifier. The R.134 Stereo Tuner is designed to give years of reliable performance. The Tuning Band covers AM & FM with a separate stereo beacon to indicate when stereo broadcasts are being received.

SPECIFICATION:
FM: frequency range: 88–108mHz. Usable sensitivity: 18μV. Stereo separation: 26dB at 1kHz. Image rejection: 55dB. AM: frequency range: 535–1,605kHz. Usable sensitivity: 280μV.

PRICE £21.0.0

EXCLUSIVE

4 WATT STEREO FM/AM/MPX TUNER AMPLIFIER Model R.124

Another Roc Exclusive offering top value for money performance the R.124 is a Stereo Tuner/Amp with facilities only usually found in much more expensive units. Features like separate bass and treble controls, automatic frequency control switch and stereo headphone socket give the R.124 a price to specification ratio second to none.

Housed in a handsome walnut cabinet the classical low line styling of the R.124 will grace any home. SPECIFICATION: FM: Frequency Range: 88–108MHz. Usable sensitivity: 20μV. Stereo Separation: 26dB at 1kHz, 20dB minimum. Image Rejection: 55dB. AM: Frequency Range: 535–1605kHz. Usable Sensitivity: 300μV. Audio Section: Total Output Power: 4W. Phono Input: 200mV at 1MΩ. Tape Input: 100mV at 100KΩ.

EXCLUSIVE

PRICE £29.19.0

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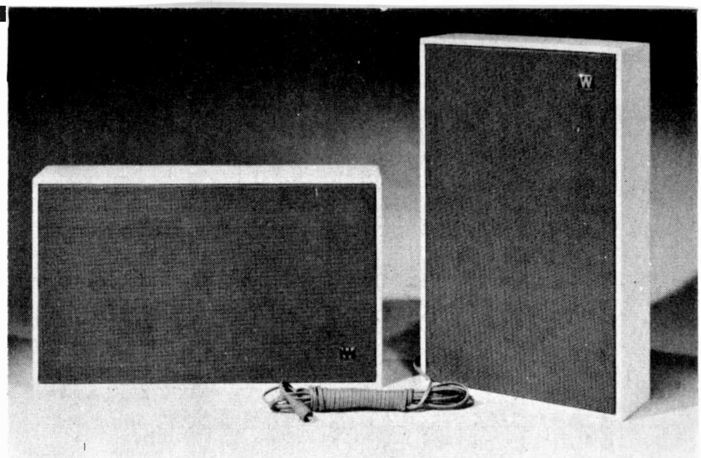
SURROUND STEREO

A cheaper and perhaps equally effective "ambionic" system known as "surround stereo" can be devised using any conventional two channel stereo equipment plus one extra loudspeaker. This system is introduced in a leaflet included with the new EXP-70 LP disc called "This is Stereo".

This record, one of the EXP Technical Series, will by now be available from all record dealers price 39s. It is a combined stereo demonstration and test record containing various recordings that illustrate not only the dynamic and spatial possibilities that stereo offers, but also includes test tracks for adjustment of experimental "surround stereo" systems described in the leaflet and for balance and phasing, etc. of two channel stereo.



Wharfdale Aston, wall mounting loudspeaker

SOME NEW AUDIO PRODUCTS

Although over 80 manufacturers were exhibiting at the 1970 Audio and Music Fair, few completely new products were to be seen. Most manufacturers were showing their current ranges of equipment, a good deal of which has already been publicised in the technical press.

The new Wharfedale Aston wall mounting loudspeaker was one new product and this breaks away from the old hi-fi tradition of dark veneer and rather uninspiring front covering. These speakers are available in glossy white enamelled cabinets and the front is finished with what Wharfedale call their "silver fox" fabric which looks like shiny metal. The Aston speaker system comprises an 8 inch bass unit and 3 inch treble unit and the cabinet measures $19 \times 11\frac{1}{2} \times 4\frac{1}{2}$ inches. Power handling capacity is 18 watts r.m.s. and the input impedance 4 to 8 ohms. These and the new Wharfedale Triton speakers, also released at the same time, are available in matched stereo pairs complete with 15 feet of connecting cables and DIN plugs.

LOUDSPEAKERS FOR THE FUTURE

The loudspeaker has always been the most inefficient link in an audio reproducing system requiring as it does a comparatively large amount of audio power to produce a useful sound output. J. B. Lansing Sound Inc. of America have not only found a way of increasing efficiency but also of producing better sound distribution. Most of their loudspeakers are intended for professional studio use but one known as Aquarius 4 has been designed for domestic use and was introduced at the Audio and Music Fair.

Mounted inside the enclosure is an 8 inch wide range transducer directed upward into a radial horn. This spreads the sound through a 360 degrees horizontal radial defraction slot. The higher frequencies emerge in a 360 degree vertical plane from a 2 inch driver separately loaded by a radial horn mounted at the rear of the enclosure. The result is a much wider distribution of sound than would be obtained with a conventional system.

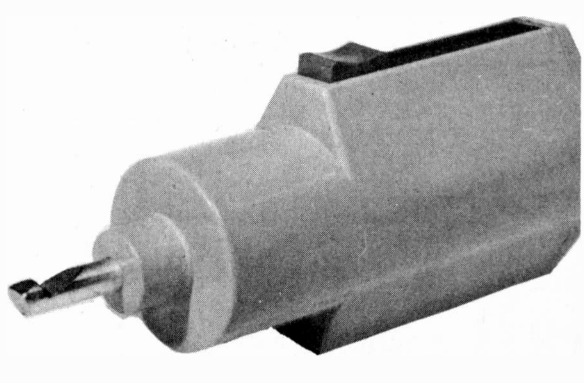
The Aquarius 4 will handle power up to 30 watts r.m.s. but nothing like this power is necessary for life size sound because of the high efficiency. The same company also manufacture a very compact studio monitor speaker for power capacity up to 75 watts. The U.K. distributors are Feldon Recording Limited, 126 Great Portland Street, London, W.1.

LESS NOISE PLEASE

The Dolby noise reduction system has, until recently, been available only for studio use. Kellar Electronics Limited have now introduced two Dolby type B noise reduction units for use with any domestic tape recorder having radio or line inputs and line or external amplifier outputs. The KDB1 unit is switchable from record to replay and is for use with recorders having a combined record/replay head. This retails at £45. The second unit, known as the KDB2, has two separate record and replay channels for use with machines having separate record and replay heads and retails at £75. Both units are supplied complete with stabilised power supplies and VU meters and are for two channel (stereo) operation.

Kellar Electronics have also released a combined cassette recorder/amplifier known as type DTA50, with a built-in Dolby noise reduction system the retail price of which will be £148 4s 8d. It seems likely that a noise reducing system will become an integrated part of all domestic as well as professional tape recorders. Cassette tape recorders are a very obvious choice to begin with as few have a noise performance of better than −40dB.

Tape head magnetisation is one of the most common causes of high noise level on tape recordings. Tape heads should therefore be frequently demagnetised with a defluxing tool. Together with many other new audio accessories that Ferrograph have just released is a new tape head demagnetiser, their Defluxer type D/2 which retails at £4. The outlay is a very worthwhile



Ferrograph tape head demagnetiser

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GP81-1	2/6	7/6
GP91-1	6/6	9/6
GP91-2	6/6	9/6
GP91-3	6/6	9/6
GP91-18c	6/6	9/6
GP91-38c	6/6	9/6
GP93-1	6/6	9/6
GP94-1	6/6	9/6
GP95-1	6/6	9/6
GP96	6/6	9/6
HGP37	2/6	7/6
104	6/6	9/6
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BSR TC8H	2/6	7/6
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BSR ST9	6/6	9/6
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BSR X1M	6/6	9/6
BSR X1H	6/6	9/6
BSR X3M	6/6	9/6
BSR X3H	6/6	9/6
BSR X5H	6/6	9/6
BSR X4H	6/6	9/6
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Collaro-Ronett TX88	2/6	7/6
Collel SK1	2/6	7/6
Dual CDS2/CDS3 (DN2)	6/6	9/6
Dual CDS/320 (DN3)	6/6	9/6
ELAC KST9 (PE10)	6/6	9/6
ELAC KST9 (PE1B)	6/6	9/6
ER5MB	6/6	9/6
ER5MX	2/6	7/6
ER5 SB	6/6	9/6
ER60 Stereo	6/6	9/6
DECCA		
Deram.. diamond only		27/9
GARRARD		
EV26 Stereo	2/6	7/6
GC2	2/6	7/6
GC8	2/6	7/6
GCE12	2/6	7/6
GCS10/1	2/6	7/6
GCS10/2	2/6	7/6
S 1—2—3	6/6	9/6
TS1	6/6	9/6
TS2	6/6	9/6
TS3	6/6	9/6
GOLDRING		
CM50	2/6	7/6
CM60	2/6	7/6
MX1	2/6	7/6
MX2	2/6	7/6
Stereo CS80	2/6	7/6
PERPETUUM ERNER		
PE188	6/6	9/6
PHILIPS		
AG3016	2/6	7/6
AG3063	2/6	7/6
AG3306	6/6	9/6
AG3310/3306	6/6	9/6
AG3400	2/6	7/6
RONETTE BINOFLUID		
BF40	2/6	7/6
DC284	2/6	7/6
SONOTONE		
2T	6/6	9/6
3T	6/6	9/6
8T4A	6/6	9/6
9TA	6/6	9/6
9TA/HC	6/6	9/6
19T	2/6	7/6
20T	2/6	7/6

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2N718	5/-	2N2904A	8/-	2N384A	5/6	2N5365	9/6	ACY22	4/-	BC140	7/6
2N718A	6/-	2N2905	8/-	2N3855	5/6	2N5366	6/6	ACY28	4/-	BC147	3/6
2N726	6/-	2N2905A	9/-	2N3855A	6/-	2N5367	11/6	ACY40	4/-	BC148	3/-
2N727	6/-	2N2906	6/-	2N3856	6/-	2N5457	7/6	ACY41	5/-	BC149	3/6
2N914	3/6	2N2906A	6/6	2N3856A	7/-	28005	15/-	ACY44	8/-	BC152	3/6
2N916	3/6	2N2907	8/-	2N3858	5/-	28020	37/6	AD140	8/-	BC157	4/-
2N918	6/-	2N29023	3/6	2N3858A	6/-	28102	6/6	AD149	11/6	BC158	3/6
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2N1303	3/6	2N3011	6/-	2N3900	7/6	3N128	18/6	AF116	5/-	BC169C	3/-
2N1304	4/6	2N3014	6/6	2N3900A	8/-	3N140	19/6	AF117	5/-	BC170	3/6
2N1305	4/6	2N2053	5/6	2N3901	19/6	3N141	19/6	AF118	12/-	BC171	3/6
2N1306	5/-	2N3054	11/-	2N3903	7/-	3N142	19/6	AF119	4/-	BC172	3/6
2N1307	5/-	2N3055	15/-	2N3904	7/-	3N143	17/6	AF124	4/6	BC175	5/6
2N1308	6/-	2N3133	6/-	2N3905	7/6	3N152	22/6	AF125	4/-	BC182	4/6
2N1309	6/-	2N3134	6/-	2N3906	7/6	R.C.A.:		AF126	4/-	BC183	4/6
2N1507	5/6	2N3135	5/-	2N4058	5/6	40050	13/6	AF127	3/6	BC184	4/6
2N1613	5/-	2N3136	5/-	2N4059	5/-	40250	10/-	AF139	7/6	BC182L	4/-
2N1631	8/6	2N3340	19/6	2N4060	5/-	40251	19/6	AF178	9/-	BC183L	3/6
2N1632	8/6	2N3349	26/-	2N4061	4/6	40309	8/-	AF179	9/-	BC184L	4/-
2N1637	8/6	2N3390	7/6	2N4062	4/6	40310	11/6	AF180	10/6	BC187	5/8
2N1638	7/6	2N3391	4/-	2N4244	9/6	40311	9/6	AF181	8/6	BC212L	4/6
2N1639	7/6	2N3391A	6/-	2N4245	8/6	40312	12/6	AF186	13/4	BC213L	5/4
2N1701	32/6	2N3392	4/-	2N4254	8/6	40314	9/6	AF239	8/6	BCY10	5/6
2N1711	5/-	2N3393	4/-	2N4255	8/6	40315	9/6	AF279	9/6	BCY12	5/6
2N1889	6/6	2N3394	4/-	2N4284	3/6	40316	12/6	AF280	12/6	BCY30	5/6
2N1893	8/6	2N3402	4/6	2N4285	3/6	40317	9/6	AFZ11	6/6	BCY31	5/6
2N2147	14/6	2N3403	4/6	2N4286	3/6	40319	13/6	ASY26	5/-	BCY32	7/6
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2N2217	5/6	2N3417	7/6	2N4292	2/6	40344	7/-	ASY51	6/6	BCY42	3/-
2N2218	6/6	2N3439	26/-	2N5027	10/6	40347	8/6	ASY53	5/-	BCY43	3/-
2N2219	6/6	2N3440	19/6	2N5028	11/6	40348	12/6	ASY54	5/-	BCY54	6/6
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2N2540	4/6	2N3707	4/-	2N5266	55/-	AC127	5/-	BC114	7/6	BD131	19/6

BD132	19/6	BFY30	10/-	D16P4	8/-	NKT238	5/-	OC22	10/-
BDY10	27/6	BFY41	10/-	GET102	6/-	NKT240	5/6	OC23	10/-
BDY11	37/6	BFY43	12/6	GET113	4/-	NKT241	5/6	OC24	11/6
BDY17	37/6	BFY50	4/6	GET114	4/-	NKT242	4/-	OC25	10/-
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BDY19	62/6	BFY52	4/6	GET119	4/-	NKT244	3/6	OC28	12/6
BDY20	30/6	BFY53	4/6	GET120	10/6	NKT245	4/-	OC29	15/-
BDY38	19/6	BFY56A	11/6	GET873	2/6	NKT261	4/-	OC35	8/-
BDY60	36/-	BFY75	6/-	GET880	6/-	NKT264	6/-	OC36	12/6
BDY61	36/-	BFY76	8/6	GET887	4/-	NKT271	4/-	O341	4/6
BDY62	27/6	BFY77	11/6	GET889	4/6	NKT272	4/-	OC42	5/-
BF115	5/-	BFY90	13/6	GET890	4/6	NKT274	4/-	OC44	4/-
BF117	9/6	BFW58	5/6	GET896	4/6	NKT275	4/-	OC45	2/6
BF163	7/-	BFW59	5/-	GET897	4/6	NKT281	4/-	OC46	3/-
BF167	5/-	BFW60	5/-	GET898	4/6	NKT401	17/6	OC70	3/-
BF173	6/6	BPX25	37/-	MAT100	6/-	NKT402	18/-	OC71	2/6
BF177	6/6	BPX29	36/-	MAT101	6/-	NKT403	15/-	OC72	2/6
BF178	7/-	BPY10	29/-	MAT120	6/-	NKT404	12/6	OC74	6/6
BF179	14/6	BSX19	3/6	MAT121	6/-	NKT405	15/-	OC75	4/6
BF180	7/-	BSX20	3/6	MJ400	21/6	NKT406	12/6	OC76	4/6
BF181	6/6	BSX21	7/6	MJ420	22/6	NKT451	12/6	OC77	5/6
BF184	5/-	BSX26	9/-	MJ421	22/6	NKT452	12/6	OC78	5/-
BF185	8/6	BSX27	9/6	MJ430	20/6	NKT453	9/6	OC81	4/-
BF194	4/6	BSX28	6/6	MJ440	19/-	NKT603F	6/6	OC81D	4/-
BF195	5/6	BSX60	16/6	MJ480	19/6	NKT613F	6/6	OC83	5/-
BF196	8/6	BSX61	12/6	MJ481	25/-	NKT674F	6/-	OC84	5/-
BF197	6/4	BSX76	4/6	MJ490	20/-	NKT677F	6/-	OC139	6/6
BF198	8/6	BSX77	5/6	MJ491	27/6	NKT713	5/-	OC140	6/6
BF200	7/4	BSX78	5/6	MJ1800	43/6	NKT717	8/6	OC169	4/8
BF224	6/-	BSY10	5/6	MJE340	12/6	NKT734	5/6	OC170	6/-
BF225	6/-	BSY11	5/6	MJE520	17/6	NKT736	7/-	OC171	6/-
BF237	6/6	BSY24	3/-	MJE521	17/6	NKT773	5/-	OC200	6/6
BF238	6/6	BSY25	3/-	MPF102	8/6	NKT781	6/-	OC201	9/6
BF257	9/6	BSY26	3/6	MPF103	7/6	NKT10339	6/6	OC202	9/6
BF22A	9/6	BSY27	3/6	MPF104	7/6	NKT10419	6/-	OC203	6/6
BFX12	4/6	BSY28	3/6	MPF105	7/6	NKT10439	7/6	OC204	8/6
BFX13	4/6	BSY29	3/6	MPS3638	6/6	NKT10519	6/6	OC205	8/6
BFX29	7/-	BSY32	5/-	NKT0013	9/6	NKT20329	9/6	OC207	12/6
BFX43	7/6	BSY36	5/-	NKT124	8/6	NKT80111	15/6	OCP71	8/6
BFX44	7/6	BSY37	5/-	NKT125	5/6	NKT80112	19/6	P346A	4/6
BFX68	13/6	BSY38	4/6	NKT126	5/6	NKT80113	22/6	T1834	12/6
BFX84	6/-	BSY39	4/6	NKT128	5/6	NKT80211	18/6	T1843	8/-
BFX85	7/-	BSY40	6/6	NKT135	5/6	NKT80212	18/6	T1844	2/6
BFX86	6/-	BSY51	6/6	NKT137	6/6	NKT80213	18/6	T1845	3/6
BFX87	6/-	BSY52	6/6	NKT210	6/-	NKT80214	18/6	T1846	3/6
BFX88	5/-	BSY53	7/6	NKT211	6/-	NKT80215	18/6	T1847	3/6
BFX89	12/6	BSY54	8/-	NKT212	6/-	NKT80216	18/3	T1848	3/6
BFY10	6/6	BSY56	18/-	NKT213	6/-	OC20	15/-	T1849	3/6
BFY11	8/6	BSY78	9/6	NKT214	4/6			T1850	4/6
BFY17	4/6	BSY79	9/-	NKT215	4/6			T1851	3/6
BFY18	6/6	BSY82	10/6	NKT216	7/6			T1852	3/6
BFY19	6/6	BSY90	11/6	NKT217	8/6			T1853	6/-
BFY20	12/6	BSY95A	2/6	NKT219	6/-			T1860	6/-
BFY21	8/6	BSW41	8/6	NKT223	5/6			T1861	6/-
BFY24	9/-	BSW70	5/6	NKT224	5/-			T1P29A	13/6
BFY25	5/-	D16P1	7/6	NKT225	4/6			T1P30A	15/-
BFY26	4/-	D16P2	8/-	NKT229	6/-			T1P31A	16/6
BFY29	10/-	D16P3	7/6	NKT237	7/-				

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safeguard against the high noise level that can be imparted even to pre-recorded tapes if a tape head has become magnetised.

Another new and useful device suitable for all current Ferrograph tape recorders is a signal operated switching unit which starts the recorder on arrival of wanted signals and stops it again automatically when the signals cease. The device operates from a lowest signal level of 400mV and has an adjustable over-run time of 5 to 25 seconds; retail price £30.

MUSIC AT THE FAIR

A few large musical instrument distributors were showing currently available instruments, such as electronic organs, guitars and amplifiers, but nothing that could be described as new could be found.

One of the highlights in the music field, however, was the Moog Synthesiser which is an electronic music composition and performance system. The system is partly keyboard operated but consists mainly of a large number of voltage controlled oscillators and filters

The Moog Synthesiser — this version would cost between £2,250 and £3,000

which can be interconnected to produce the pitch, waveform and envelope for an infinite range of musical sounds and even of "pseudo" human voices. One of the larger versions of the Moog Synthesiser is shown on this page but such devices are hardly for domestic use since the price range is £2,250 to over £3,000. However, a small synthesiser suitable for schools and small studio use will shortly become available at less than £600. The present U.K. distributors for Moog Synthesisers are Feldon Recording Limited, 126 Great Portland Street, London, W.1.

The designer of the Synthesiser, Dr R. A. Moog, who gave a lecture on and a demonstration of the instrument at Olympia, spoke of the possibility of combining the music synthesiser with a conventional electronic organ resulting in a musical instrument with variable voicing and effects that could be chosen at will by the player. There is already some indication of this idea in modern electronic organs.

AUDIO PRESENTATION PROGRAMME

Visitors to the Fair were also able to hear a series of lectures (many with demonstrations) by well-known experts in sound reproduction and music. Among these were Dr R. A. Moog mentioned above, P. J. Baxandall, inventor of the almost universally used Baxandall tone control network, Desmond Briscoe from the BBC Radiophonics Workshop and Sir Arthur Bliss (Master of the Queen's Music). Many well-known audio journalists and designers also gave talks on high fidelity sound reproduction. Other special features included a recording studio where visitors could make a record, a search for a singer contest, a music tuition bookshop and a comprehensive display of musical instruments of all kinds.

A number of films of interest to audio enthusiasts such as "The Timeless Track" and "The Magic Tape" by B.A.S.F. and "Sound on Tape" by Philips Limited, were also shown during the week of the fair. All this, together with the displays and demonstrations of products by over 100 exhibitors made the 1970 Audio and Music Fair a successful and interesting venture for both the exhibitors and the visitors. However, the exhibiting manufacturers of audio equipment still had the problem of accommodating a worthwhile number of people during demonstrations; the demonstration cubicles were just not large enough.

NEW RELEASES

Rola Celestion Limited—a new loudspeaker—the Ditton 120. The 120 was displayed at the Audio Fair; it consists of three units, an HF1300 treble speaker, a long throw mid range and bass speaker and an audio bass resonator (A.B.R.) all housed in a case measuring $17 \times 7\frac{3}{4} \times 8\frac{1}{4}$ inches. Frequency response is 30Hz to 15,000Hz, power handling is 20W DIN, impedance is 4 to 8Ω; the speakers are available in matched pairs and cost £48 per pair.

K.E.F. Electronics Limited—a new range of loudspeakers known as the Cresta, Chorale, Cadenza and Concerto and each has a three speaker system. The Cadenza was released at the Audio and Music Fair and is a completely new system with a passive bass radiator. Frequency range 30 to 30,000Hz. Power handling capacity 25 watts at 8 ohms.

Uher-Bosch Limited—a new tape recorder, the Uher 724, which is a quarter-track stereo machine for $7\frac{1}{2}$ and $3\frac{3}{4}$ i.p.s. Specification is to DIN standards with an output power of 2 watts per channel. The recorder operates in the vertical or horizontal position. Retail price is £103 10s 0d plus £25 11s 5d p.t. Uher have also introduced a new portable cassette recorder for C60, C90 or C120 tapes and which features a reversible drive system to obviate having to turn the tape cassette over. Price not available at time of writing.

B.A.T.R. CONTEST

Prizes were presented at the Audio and Music Fair to winners of the 1970 British Amateur Tape Recording contest. The "Tape of the Year" winner was Mr K. McKenzie for his documentary tape called "Sunderland Hospital Broadcasts". For this he was awarded the Emitape Challenge Cup and also the Philips Shield for the best recording in the documentary class.

The 1971 and 14th British Amateur Tape Recording Contest has already been announced with a closing date of 30th June, 1971. Entry forms are available from the Secretary, B.A.T.R. Contest, 37 Fairlawnes, Maldon Road, Wallington, Surrey. As before there are six categories to choose from including one for schools.

DIGI-CLOCK

By R. W. Coles

Part 2

THE alarm board "B" carries the logic and oscillator circuitry required by the alarm system, and the 5 volt regulator, which provides the highly stable supply required by all the i.c.s used in the clock. The board is physically smaller than the main clock board "A", being a "Dualine" DL109/22, which has positions for nine 14/16 pin DIL packages, and is equipped with a single-sided 22-way edge connector.

Six i.c.s are used in all, but two of these are CA3046 transistor arrays which are 14-pin packages containing five individual transistors. These are not members of the TTL family used to perform all the clock and alarm logic.

ALARM OPERATION

The time at which the alarm is required to sound is entered by means of a bank of thumbwheel switches S2a and S2b mounted adjacent to the display on the front of the clock.

These switches are so constructed that they give a four-bit binary coded decimal output pattern for each number selected. This b.c.d. word is continuously compared with the b.c.d. output from the clock counters in a digital comparator (see Fig. 7). When the switch setting and the display are the same, the output of the comparator falls to a low level and is used to set a simple "latch" bistable in IC18.

The output of the latch enables a gate G5c which allows the alarm tone through to a 40 ohm moving-coil speaker, and thus the alarm is sounded. The alarm will continue indefinitely unless reset by means of the miniature toggle switch S3, also mounted on the front of the clock.

The alarm setting accuracy could be extended to any degree by simply adding more switches and increasing the comparator size. A setting to within 0·1 second is quite possible if required, but with the prototype the system was intended for domestic use, and time setting in ten minute increments was considered adequate.

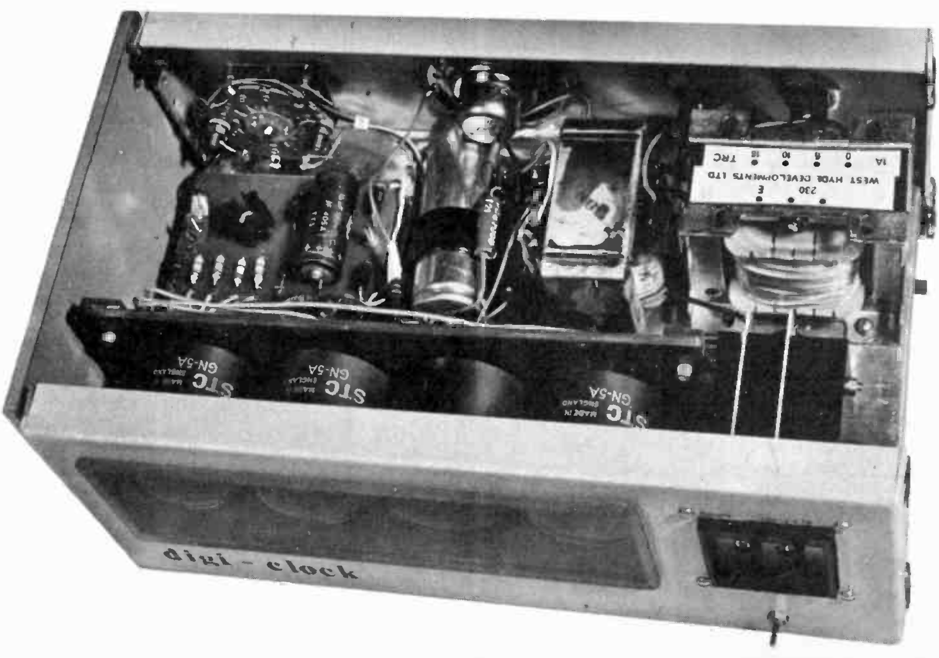
It was also considered unnecessary to include the hours 10.0 to 12.50 in the comparison, thus saving an expensive switch bank which would have been necessary in the "tens-of-hours" position. If this expense is unimportant, or if the aesthetic consequences of using a toggle switch in this role (for this is all that is required in this position) can be tolerated, these times are easily added because the comparator as described has allowance for this extra switch.

There is therefore a considerable amount of flexibility in the alarm circuitry which allows individual constructors to tailor the system to their own requirements.

ALARM CIRCUIT

The circuit of the alarm system is given in Fig. 7, and it can be seen that it is not very complicated at all. Of course, the alarm circuit can be omitted altogether without affecting the remainder of the clock circuit.

The digital comparator is formed from two SN7483 MSI packages, each containing four complete full-adders, with internally connected ripple through carry.



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Precision made as used in record decks and tape recorders. Suitable many other applications. 10/- each. P. & P. 3/-.

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Incorporating two coils. Each coil when energised will produce opposite rotation of output shaft. 120V 60Hz. 1/10 r.p.m. 30/- each. P. & P. 5/-.

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Ideal for instrument chart drives. Extremely quiet, useful in areas where ambient noise levels are low. High starting torque enables relative high inertia loads to be driven up to 6oz/in. Available in the following speeds and ranges: 240V 50Hz, 1½ r.p.m., ¾ r.p.m., ¼ r.p.m., ⅛ r.p.m., 1/10 r.p.m., 1/12 r.p.m., 1/20 r.p.m., 1/45 r.p.m., 1/60 r.p.m., 1/360 r.p.m., 25/- each. P. & P. 5/-.

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With integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz torque at 240V 50Hz, 1/12 r.p.m., ¼ r.p.m., ⅓ r.p.m., ½ r.p.m., 15 r.p.m. 120V 50Hz, 1/12 r.p.m., 1/10 r.p.m., ¼ r.p.m., 5/12 r.p.m., 4/11 r.p.m., 2 r.p.m. 120V 60Hz, ¼ r.p.m., 1 r.p.m. 24V 50Hz, 1/20 r.p.m., 4 r.p.m. 25/- each. P. & P. 5/-.

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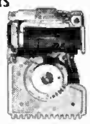
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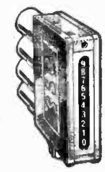
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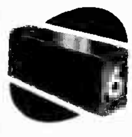
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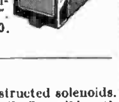
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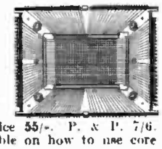
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To understand exactly how these circuits can be used as comparators, consider Fig. 8. Fig. 8a shows the truth table of an "exclusive-OR" gate, which is sometimes called a "non-equivalence" gate because its output is a logic 1 only when its inputs are exactly opposite.

To use such a gate as an equivalence circuit which gives a logic 1 output when its inputs are identical, it is only necessary to invert one of those inputs by means of an inverter gate, or if complementary inputs are available anyway, to compare the true form of one input with the negated form of the other. It follows then that this type of gate could be used to build the complete alarm comparator we require.

As Fig. 8b shows, the truth table of a full-adder is identical to that of the "exclusive-OR" gate, if we ignore the carry output and keep the carry input at 0. In fact, using the SN7483 as four "exclusive-OR" gates suits our comparator design admirably. The inverted form of one of the words to be compared is already available, because the thumbwheel switches give outputs in this form. The fact that we do have a carry input available can be put to good use in correcting the lagging output of the hours counter.

EIGHT DIGIT EQUALITY

So far this article has only considered the comparison of single digits, but all eight digits from the counters should be equal to the switch outputs before the completed comparator registers an equality. To achieve this, the eight sum outputs from the adders (each of which registers equality of one digit) are fed to an SN7430 8-input NAND gate G4 in IC17, the output of which will only fall to a logic 0 when all the individual comparisons are valid.

The output of this gate will remain low for ten minutes, until a further increment in the "tens-of-minutes" count invalidates the comparison. A period of this length would probably be sufficient for alerting the sleeper, but to make absolutely sure that the alarm cannot be ignored, the output of IC17 sets a latch formed from two cross-coupled 2-input NAND gates G5a and G5b in IC18, which ensures that the alarm tone will continue until reset, even if this process takes longer than ten minutes.

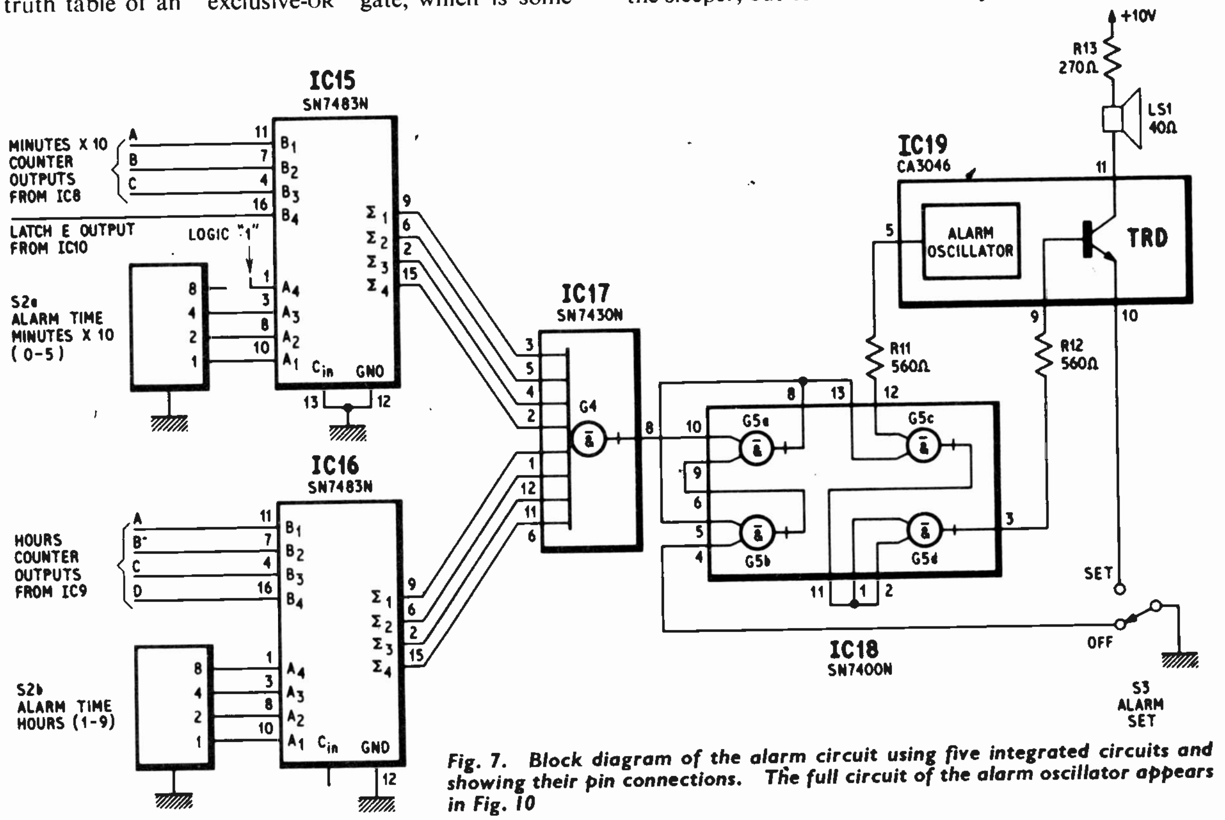


Fig. 7. Block diagram of the alarm circuit using five integrated circuits and showing their pin connections. The full circuit of the alarm oscillator appears in Fig. 10

INPUTS (a)

A	B	OUTPUT
0	0	0
1	0	1
0	1	1
1	1	0

(b)

C_{in}	A	B	Σ	C_n+1
0	0	0	0	0
0	1	0	1	0
0	0	1	1	0
0	1	1	0	1

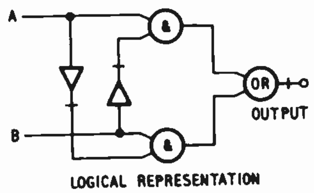


Fig. 8a. Truth table for "exclusive-OR" function

Fig. 8b. Truth table for full adder when $C_{in} = 0$

ALARM TIME SWITCHES

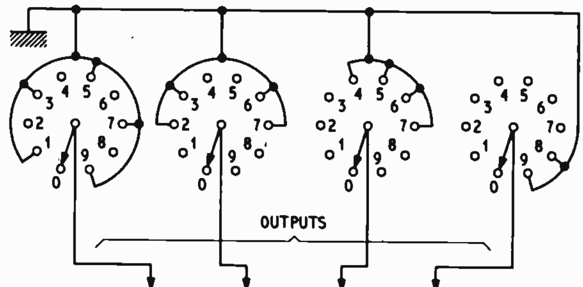
The switches used to set the alarm time were chosen from the Birch-Stolec "standard" range, and both banks are coded S.B.10.N1248. These switches are well suited to this application because they give an output on four lines which conforms to the binary code, a separate pattern being produced for each of the ten positions of the numbered wheel.

Any number of switch banks can be mounted together if the constructor wishes to expand the alarm system, the final assembly being finished off by means of a pair of end cheeks which give a neat appearance and provide the mounting holes.

The principle on which these switches are based is that of a four-track printed, gold plated stator, traversed by four phosphor bronze rotor contacts. The life of this assembly is at least 100,000 operational cycles when switching 24 watts, so in this application the life will be much extended due to the very small current being carried.

To fabricate a similar system using wafer switches, a four pole ten-way switch would be required in each position, with a considerable amount of wiring necessary to programme the required code.

The wafer switch system does provide a useful way of explaining the action however, and a diagram with output logic table conforming to the thumbwheel switch coding is given in Fig. 9. Note that the output is in the complement form (assuming positive logic). A logic 0 is represented by a ground connection, and a logic 1 by an open circuit.



DECIMAL	A (1)	B (2)	C (4)	D (8)
0	1	1	1	1
1	0	1	1	1
2	1	0	1	1
3	0	0	1	1
4	1	1	0	1
5	0	1	0	1
6	1	0	0	1
7	0	0	0	1
8	1	1	1	0
9	0	1	1	0

Fig. 9. Wiring of a 4-pole 10-way switch to give a four-bit binary coded decimal output in complement form. The truth table shows positive logic

DIGITAL COMPARISON

As discussed earlier, this inverted code is just what is required for connection to the comparator. Of course, numbers one to nine only are required as inputs to the hours comparator, and numbers zero to five for the tens-of-minutes circuit. Stops could be fitted to the switches if desired, although this is not really necessary; blanking the undesired numbers with paint would be a simple alternative.

Only six positions are required for the tens-of-minutes switch. It follows, therefore, that the full output of four digits is not needed. In fact, the "8" output from this switch can be ignored in the comparison, leaving a spare comparator section in IC15, which is put to good use as an "inhibit" while the "tens-of-hours latch" E output is high. Remember that the alarm system is not operative during this three-hour period as it stands.

This inhibiting logic is simply achieved by comparing the E line with a permanent "1", thus only permitting a 1 output from this section when the E line is at 0.

As an alternative, it would be possible to ignore this spare comparator section, and feed the $\bar{E}$ output from IC10 (Fig. 2) to the 8-input gate in IC17 which, when using this method, would have an input available. This system was not used in the prototype simply to retain the design simplification of feeding only true outputs from the main clock board.

HOURS COUNT CORRECTION

So far so good, but up to now we have ignored the point made last month that the hours counter outputs do not conform directly to the binary code, 0000 representing decimal 1 instead of 0, and so on up to 1000 representing 9 instead of 8.

The thumbwheel switches, being "off-the-shelf" items, do not allow for this idiosyncrasy. The comparison as previously described would reveal that, when the switch was set to, say, four o'clock, the alarm would sound at five o'clock, and so on, a most unhappy state of affairs.

It is evident, however, that the code output from the hours counter could be corrected by simply adding binary 0001 to it, increasing its binary value by one. This simple conversion could be carried out using a four-bit parallel adder such as the SN7483N. (A four-bit adder is necessary because carries must be allowed for over all four bits.)

A separate SN7483N could be employed to carry out this correction, but as these circuits are used as comparators anyway, this is not necessary. A 1 can be added in by feeding a carry in on the "carry" input to the least significant adder. Admittedly this is all a little difficult to grasp, but it does work, and the best way of proving it is to set an example down as a sum, thus:

Hours display: 7, Switch setting: 7.
Binary 7: 0111
Therefore switch output (inverted): 1000 } add
Hours counter output: 0110 }
= 1110
1 (plus 1 carry)
= 1111 *equal* (alarm sounds)

RISK OF TRANSIENT OPERATION

During the "paper" design of this part of the clock it occurred to the author that, due to the relatively lengthy propagation delay of the SN7483N, and the non-synchronous inputs from the MSI ripple counters, it might be possible for all the adder outputs to be at 1 when the comparison should not show equal, thus giving a transient output from IC17.

As any such transient "low" output longer than a few nanoseconds is likely to set the latch and sound the alarm (at the wrong time), this state of affairs must obviously be avoided. A good deal of thought was

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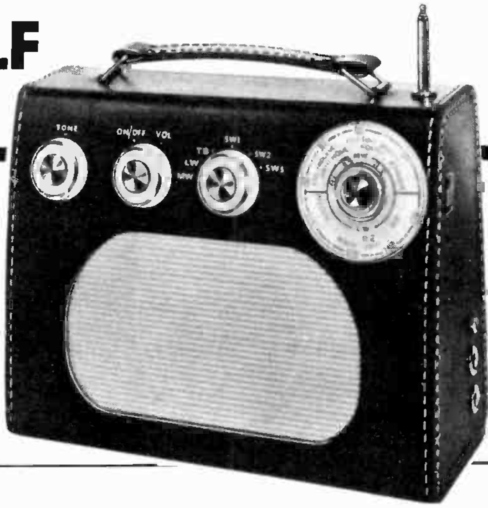

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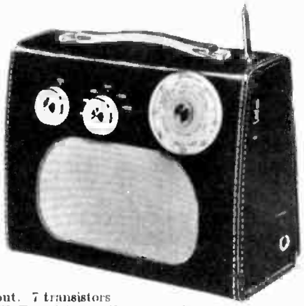

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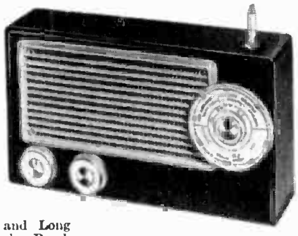

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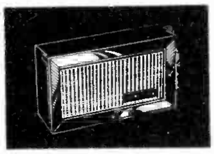

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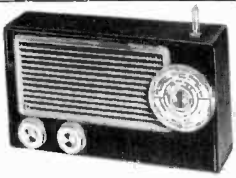

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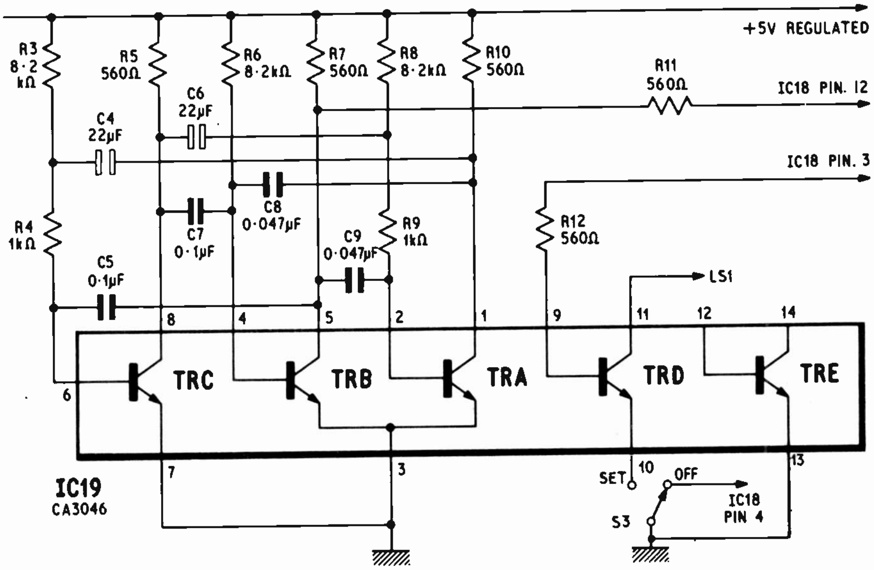


Fig. 10. Alarm oscillator circuit using an integrated package of five transistors. TRE is unused

put in to discover whether this could in fact occur. It was decided that the only way to find out was to "try it and see"!

In the event, it was found impossible to generate this condition in the completed clock, and so all was well, but the point has been made because, with the wrong combination of adders and counters, it was thought to be a possible occurrence.

If any reader should be unlucky enough to experience this phenomenon, the solution is simply to gate the comparison with a clock waveform from one of the divider stages not used in the comparison. In this way the output from IC17 could be strobed only after the hours and tens-of-minutes counters have changed and the SN7483N "carries" have propagated. Obviously some circuit modifications would be necessary to achieve this.

ALARM OSCILLATOR

The alarm oscillator circuit is shown in Fig. 10, which may attract the interest of those who are not otherwise concerned with the clock, because of its obvious applications in many other designs.

The circuit was described by A. B. Blackwell-Jones in a letter to *Wireless World* (August 1967). He called it a "Trivibrator" or "Donkey Simulator", a very apt pair of names indeed. The circuit is based on the usual two transistor astable multivibrator arrangement, to which an extra transistor has been added, so that three separate cross-coupled timing networks result instead of the usual one, as shown in Fig. 11.

Each of the timing networks has a different natural frequency, two being audio tones of about one and two kilohertz respectively, and the other being a low frequency timing circuit giving a 5Hz gating effect. The output is taken from the centre transistor of the two a.f. arms, and consists of alternate bursts of the two tones, each lasting for about 0·2 second, controlled by the l.f. arm. When fed to the speaker this tone gives a very pleasing "space age" warble effect.

If the reader is familiar with the basic multivibrator circuit action, there should be no problem at all in understanding this extension of the idea. It will help to refer to Fig. 11.

CIRCUIT OPERATION

Either transistor TRA or TRC will be saturated at any time. This saturation will last for about 0·1 second, as controlled by the 5Hz timing network coupling them. The saturated transistor is unable to react via its a.f. timing network with TRB during this time, so this tone is not produced. Meanwhile, however, the other transistor (of the pair TRA or TRC) is not saturated by the l.f. arm and is free to interact via its a.f. timing network with TRB, giving an a.f. output of the appropriate frequency. When the 0·1 second period has expired the l.f. arm changes over, saturating the other (TRA or TRC) transistor, and allowing the other a.f. tone to be produced, and so on.

The only unfamiliar parts of the circuitry are the two resistors, R4 and R9, which are necessary in the trivibrator to prevent the very low impedance of the l.f. coupling capacitors shunting the a.f. arms. In effect, the capacitors C4 and C6 coupling this section are taken to taps on the CR timing resistance chain.

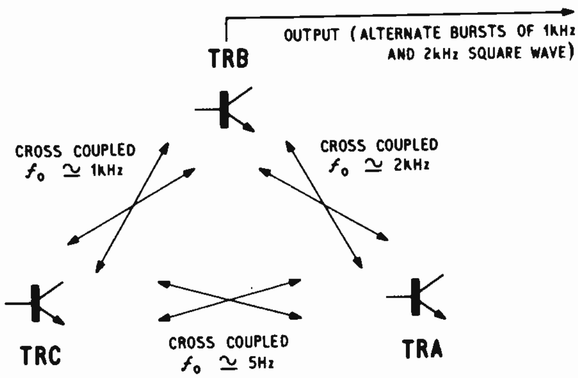


Fig. 11. Principle of operation of the alarm oscillator

The output of the oscillator is taken from TRB via a resistor R11 to gate G5c (Fig. 7), where it is held until allowed through by a logic 1 input from the alarm latch G5a. Note that the alarm oscillator runs continuously, whether the latch is set or not.

When G5c is not enabled, its output will be at a permanent 1, or positive, level. If this output is fed to the simple saturating switch used to drive the speaker directly, although the alarm would not sound, this transistor would be hard on, giving a high power drain and possibly damaging the speaker. To avoid this, G5d is interposed between G5c and the switch TRD to act as an inverter, ensuring that when the alarm circuit is inactive, the output transistor will be off, and no current will flow through the speaker.

The three transistors forming the oscillator, and the transistor used to drive the speaker, are all contained in an integrated package IC19. The other transistor in this array is not used, but it is vital that its emitter (pin 13) should be grounded, as it is connected to the substrate of the device. An open circuit on this pin would jeopardise the isolation between the separate transistors.

The positive supply for the a.f. output stage is taken from the unregulated 10V line, not to gain any power advantage, but to isolate the 5V line powering the logic circuitry from any ripple produced.

The emitter of the output stage is grounded through the combined "alarm-off/reset" switch S3. When this switch is in the "off" position the alarm cannot sound under any conditions, and a 0 is fed to G5b to reset the latch ready for the next alarm setting.

Note that during the ten-minute period that the alarm output from IC17 is active, it is not possible to reset the latch by simply flicking the switch up and down.

This concludes the description of the alarm circuitry; the 5V regulator, which is wired up on the same board, follows next. It is recommended that the 5V regulator be wired up before the alarm circuit as will be realised later in this article.

FIVE VOLT REGULATOR

The 5V regulator uses a total of seven transistors, five being contained in another CA3046 (IC20), one being a discrete 2N706, and the last being a plastic encapsulated power transistor, type MJE521, which is mounted off the board using the chassis as a heat sink.

The regulator features fold-back current limiting, excellent temperature stability, and an output impedance of less than 0·1ohm from d.c. to 100kHz together with line regulation of better than 10mV per volt.

Inputs to the circuit are 10V d.c. (nominal) and 200V d.c. (nominal), provided by conventional power supplies which are described next month. The regulator circuit is shown in Fig. 12.

The 200V line is reduced to provide a 12V biasing supply set by a discrete Zener diode D3, which is bypassed by C1 to suppress any high voltage transient surge when switching on. The 12V is used to power the temperature compensated 7·5V reference supply and the differential amplifier. Using a separate bias supply rather than the unregulated 10V to power these sections gives a great improvement in line and load regulation, and increases ripple rejection.

In the alarm oscillator circuit the advantages conferred by employing a transistor array were those of compactness and convenience, but in this circuit the benefits of the monolithic construction provide a specification which could not be equalled simply by replacing the array with discrete devices. Because each transistor is mounted in close thermal contact with its neighbours, tight temperature tracking is assured, enabling the construction of an accurately compensated reference and a differential amplifier with a negligible input offset voltage temperature coefficient.

As each transistor was made at the same time and experienced the same diffusion process, parameter matching is also assured. The transistors' V_{be} are guaranteed to be within 5mV of each other; all these factors can be put to good use in this type of circuit.

REFERENCE SUPPLY

The reference supply is provided by TRD and TRE, which are not used as transistors in this application, but as a Zener diode and forward diode respectively. The use of a base emitter junction as a Zener is not new, and the transistors in the CA3046 provide a breakdown voltage of about seven volts when used in this way, with a temperature coefficient of plus 2mV/degree C.

A temperature induced variation of this order is not serious in itself, but if it occurs at the same time as other variations, it could take the 5V supply outside the necessary design limits of plus or minus 250mV.

To eliminate this drift, a forward biased diode, formed from another base emitter junction (TRE), is connected in series with TRD. A junction biased in this way exhibits a forward voltage of around 600mV, but it has a negative temperature coefficient of 2mV/degree C, which cancels the plus 2mV/degree C of the TRD "Zener" junction.

A variable potential divider is used to tap off an accurate 5V from the reference line, and is used as an input to the non-inverting input of the differential amplifier (TRA and TRB). A capacitor C11 is used to bypass any noise which may be present on this supply.

Because a 5V reference is used, the differential amplifier can be used in the voltage-follower mode, with the final 5V output being fed back directly to the inverting input without the usual potential divider chain being interposed. This connection gives a maximum value of loop gain for good regulation, and also increases the frequency response of the amplifier, giving good transient response.

DIFFERENTIAL AMPLIFIER

A differential amplifier was used because of its high voltage gain and absence of temperature problems which affect single-ended designs.

The output of the "error" amplifier is taken from the collector of TRA and used to drive the base of TR1 which, with the series pass power transistor TR2, forms a compound emitter follower with a very high current gain, and consequently low output impedance. TR2 has to pass all the current required by the load, which could be as high as 1A, and is therefore a power device bolted to a heat-sink.

FOLDBACK CURRENT LIMITING

The foldback current limiting circuit is provided by TRC with R21, R22, and R23. The following paragraphs describe its operation using Fig. 12.

As many constructors are aware, a short-circuit on the output of a semiconductor regulator can wreak havoc with the regulator devices in a matter of microseconds, and with a project of this complexity a short-circuit is very likely to occur, especially in the early stages of testing. Protection against this sort of disaster

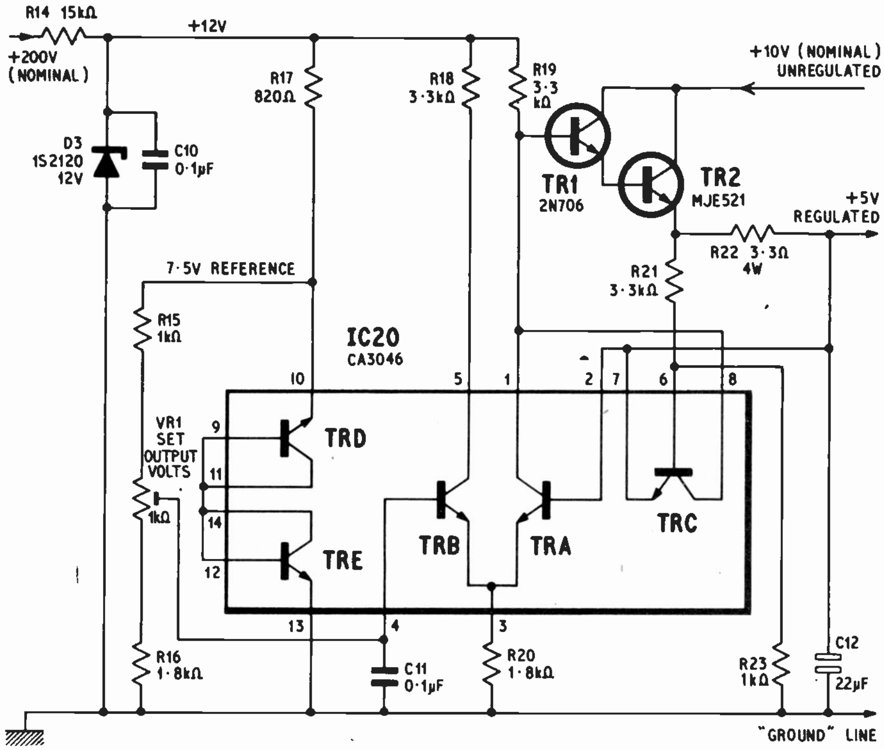
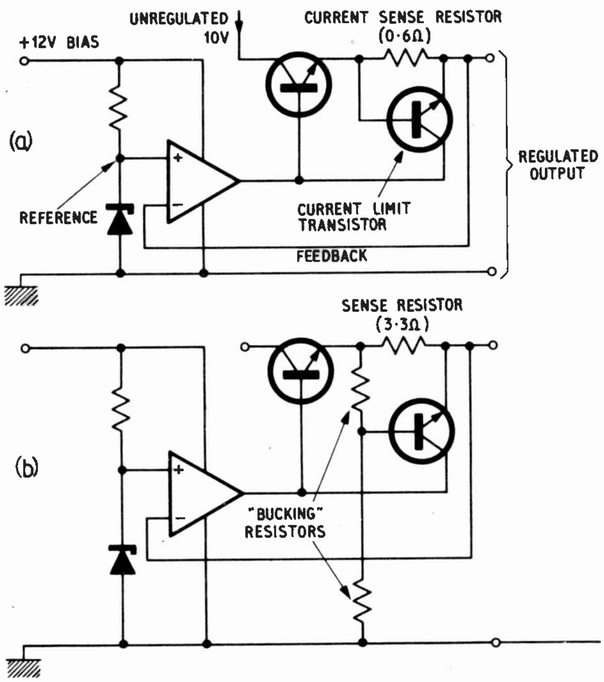


Fig. 12a. Circuit diagram of the 5V regulator circuit including foldback current limiting



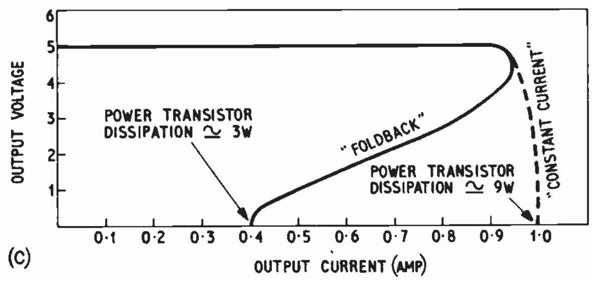


Fig. 12b. Skeleton circuit of a 5V regulator with constant current and foldback current limiting

is easily provided by adding a current limiting circuit, of which there are numerous designs available, the simplest being the one transistor "constant current" arrangement.

A skeleton circuit of the regulator with this kind of limiting is shown in Fig. 12b, along with its limiting characteristic. The operation is quite straightforward; a current sense resistor in series with the 5V supply is used to develop a voltage proportional to the current drawn.

When this voltage approaches the V_{be} of the current limit transistor, it turns it on, diverting some of the base drive to the series pass transistor, and causing the output voltage to fall to maintain the preset current. If the load on the supply is reduced to zero ohms (i.e. a short circuit) the output voltage falls almost to zero allowing only a current preset by the sense resistor value to flow.

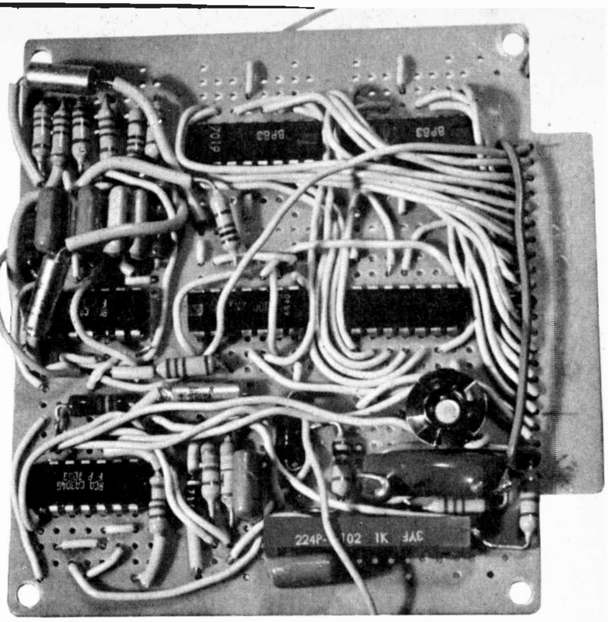
The short-circuit current must be set to greater than the permissible load current. For this particular regulator this would be up to 1A, giving a very high dissipation in the power transistor under short circuit conditions, because most of the unregulated voltage appears across this device.

HANDLING THE HEAVY LOAD

This problem could be overcome by using a heat sink large enough to handle the extra dissipation under fault conditions, but there is a much simpler method that is used in this regulator and requires only the addition of two resistors.

In Fig. 12b these extra resistors have been added, and are used as a potential divider to "buck-out" the voltage developed across the sense resistor, preventing it from turning on the transistor at the previous current level.

With the resistor values used in this regulator, the limit transistor will not be able to turn on until the current drawn approaches 1A, instead of the 250mA level set with constant current limiting and the same sense resistor.



COMPONENTS . . .

ALARM & 5V REGULATOR BOARD

(a) Alarm Oscillator *(b) 5V Regulator*

Resistors

R3 8·2kΩ	R10 560Ω	R14 15kΩ	R21 3·3kΩ
R4 1kΩ	R11 560Ω	R15 1kΩ	R22 3·3Ω 4W
R5 560Ω	R12 560Ω	R16 1·8kΩ	R23 1kΩ
R6 8·2kΩ	R13 270Ω	R17 820Ω	
R7 560Ω		R18 3·3kΩ	
R8 8·2kΩ		R19 3·3kΩ	
R9 1kΩ		R20 1·8kΩ	

Potentiometer

VR1 1kΩ linear helical (Painton Bourns type 224P-1-102)

Capacitors

C4 22μF tantalum 15V	C10 0·1μF met. foil 250V
C5 0·1μF met. foil 250V	C11 0·1μF met. foil 250V
C6 22μF tantalum 15V	C12 22μF tantalum 15V

C7 0·1μF
C8 0·047μF } met. foil 250V (Mullard C281)
C9 0·047μF

Diode

D3 1S2120, 12V 400mW Zener

Transistors

TR1 2N706
TRS MJE521 (with mica washer)

Integrated Circuits

IC15 SN7483N (BP83)
IC16 SN7483N (BP83)
IC17 SN7430N (BP30)
IC18 SN7400N (BP00)
IC19 CA3046 (R.C.A.) IC20 CA3046 (R.C.A.)

Further notes on purchasing i.c.s given in the article "Making the Most of Logic ICs" last month

Miscellaneous

S2 2-bank printed thumbwheel switch 10-way (see text) (Birch-Stolec *or* Radiospares)
S3 Miniature toggle switch, single-pole, changeover
LS1 40Ω or higher miniature
"Dualine" type DL109/22 printed circuit card (Shirehall Electronics Ltd., Station Yard, Borough Green, Sevenoaks, Kent)

When the transistor does turn on, however, the output voltage will drop, removing the effect of the "bucking" voltage and reducing the output current. When the output load becomes a short on the output, the final voltage will have dropped almost to zero, and the output current fallen to less than half the value at which limiting began.

This effect is termed "fold-back" limiting, for obvious reasons, and cuts the dissipation in the power transistor, under short circuit conditions, to about a third of that obtained with "constant current" limiting, operating at the same maximum current—a very worthwhile return for a couple of resistors.

In the prototype the limiter began to operate at about 1A, and with a shorted output the current dropped to 400mA, although resistor tolerances will affect these figures with later versions. The current limiting transistor TRC, is contained within the CA3046, which gives the added advantage that the operating and short-circuit current will decrease as the chip warms up, due to the negative temperature coefficient of the device's V_{be}, giving a degree of thermal feedback.

OUTPUT VOLTAGE CONTROL

The output voltage of the regulator is not affected by the limiting circuitry under normal conditions, because the feedback to the error sensing amplifier is taken from after the current sense resistor R22, the voltage drop across this resistor being automatically allowed for by the amplifier.

The capacitor C12, which should either be a 22μF tantalum type or an aluminium electrolytic in parallel with a 0·1μF paper capacitor, reduces transient spikes on the output and also ensures that the regulator remains stable at all times.

Using a miniature helical preset potentiometer for VR1 allows accurate setting of the output voltage. This type of component also features excellent temperature and long term stability. There is, however, no overriding reason why a single turn rotary control should not be substituted as an economy if a sacrifice of these qualities can be tolerated.

The construction of the regulator should precede that of the alarm circuitry; details of these will be given next month before describing the main power supply.

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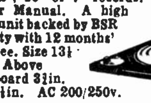

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16/450V	3/-	8+8/450V	3/7	32+32/250V	3/7
32/450V	4/-	8+16/450V	4/-	32+32/450V	6/7
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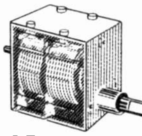

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10 WATT **65/-** CARRIAGE 5/-

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8¾ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE. 16 × 10 × 9 in. Modern Scandinavian fluted front design for Mini-Module. **£5** Post 5/-

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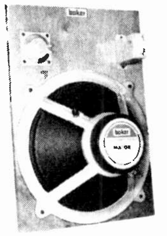
BAKER 12in MAJOR £9



30-14,500 c.p.s., 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c.p.s. Rated 20 watts. State 3 or 8 or 15 ohm. Post Free.

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SPECIAL OFFER! 80 ohm, 2½in, 2¾in. dia.; 35 ohm, 3 in. 25 ohm, 3in. dia.; 6 × 4in; 8 × 5in. 15 ohm, 3½in. dia.; 7 × 4in; 8 × 5in. **18/-** EACH TYPE
8 ohm 6 × 4in; 3 ohm, 2½in, 3in, 5in. 5 × 3in, 7 × 4in.

LOUDSPEAKERS P.M. 3 OHMS. 6½in 22/-; 8 × 5in. 25/-; 8 × 2½in 18/-; 8in 35/-; 10 × 6in 38/-.

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RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in or 10in or 12in, 3 or 15 ohm 39/-.

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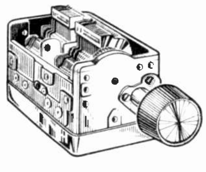
VHF-FM TUNER FRONT END 88-108 Mc/s



Transistor FM tuner oscillator and frequency changer printed circuit. Slow motion tuning gang condenser. Ready wired and tested including two transistors AF124 and AF125. A total of 29 components. Size 2¼ × 2 × 2in. Requires I.F. and Detector stages 10.7 M/cs. 9 Volt. Connection details supplied but we have no further information available.

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BARGAIN FM TUNER as above. Chassis only, less cabinet. **£7.10**

FM STEREO MULTIPLEX ADAPTOR for above or general use. Ready made with 4 transistors, 6 diodes **£5**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **£3.10**

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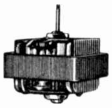

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2N2484	9/6	2N4291	3/-	AF180	18/6	BC214L	5/3	TI843	10/6
2N2646	10/9	2N4292	3/-	AF239	9/9	BCY70	4/-	ZTX300	3/6
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Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below)	100 up
C	1/20W	5%	82Ω–220kΩ	E12	18d	16d	15d
C	⅛W	5%	4·7Ω–330kΩ	E24	2·5d	2d	1·75d
C	¼W	10%	4·7Ω–10MΩ	E12	2·5d	2d	1·75d
C	½W	5%	4·7Ω–10MΩ	E24	3d	2·5d	2·25d
C	1W	10%	4·7Ω–10MΩ	E12	6d	5d	4·5d
MO	½W	2%	10Ω–1MΩ	E24	9d	8d	7d
WW	1W	10% ± 1/20Ω	0·22Ω–3·9Ω	E12	1/6d all quantities		
WW	3W	5%	12Ω–10kΩ	E12	1/6d all quantities		
WW	7W	5%	12Ω–10kΩ	E12	1/9d 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: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of **1d** *on total resistor order.)*

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SINCLAIR IC.10 complete with instruction book giving amplifier circuit details and range of applications. **59/6** nett. Components pack for stereo inc. mains transformer, controls, etc., **£4.15.0** nett.

PLESSEY SL403A. Only **42/6** each nett. 3W into 7·5Ω for 18V supply. Application data **2/-**: free with two or more.

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250V 20%: 0·01, 0·022, 0·033, 0·047, **8d** ea.; 0·068, 0·1, **9d** ea.; 0·15, **11d**; 0·22, **1/-**. 10%: 0·33, **1/5**; 0·47, **1/8**; 0·68, **2/3**; 1μF, **2/9**; 1·5μF, **4/2**; 2·2μF, **4/9**.

MULLARD SUB-MIN ELECTROLYTIC

C426 range axial lead **1/3** each
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, 20/16, 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.

LARGE CAPACITORS

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MEDIUM RANGE ELECTROLYTICS

Axial leads: 50/50 **1/9**; 100/25 **1/9**; 100/50 **2/6**; 250/25 **2/6**; 330/25 **2/6**; 250/50 **3/9**; 500/25 **3/9**; 500/50 **4/6**; 1000/25 **4/-**; 1000/50 **6/-**; 2000/25 **6/-**.

SMALL ELECTROLYTICS

Axial leads: 4·7/10, 4·7/25, 5/50, **1/-** ea. 10/10, 10/25, 10/50, 33/10, 50/10, **1/-** ea. 25/25, 25/50, 47/25, 100/10, 220/10, **1/3** ea.

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PEAK SOUND PRODUCTS ENGLEFIELD AMPLIFIER

12 + 12 watts RMS per channel

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MAINLINE AMPLIFIER KITS

RCA/SGS designed main amplifier kits. Input sensitivity 500–700mV for full output into 8Ω.

Power	Kit price including components	Suitable unreg. power supply kit
12W	168/- nett	92/-
25W	190/- nett	N/A
40W	210/- nett	115/1
70W	252/- nett	138/10

30 WATT BAILEY AMPLIFIER KIT

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Any type with ½A D.P. mains switch, extra **2/3.** Please note: only decades of 10, 22 and 47 are available within ranges quoted.

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10% on orders for components for £5 or more. 15% on orders for components for £15 or more (No discount on nett items).

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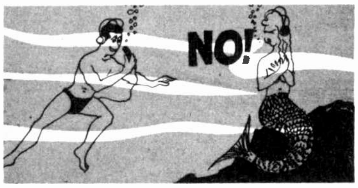
Gerry Brown . . .

ON THE FRINGE



BATH GOSSIP

"Daddy", chorused my two girls the other day, "Mummy says you're trying to talk through your bath-water. Is that true?" Well how can you best answer this sort of question when you have the bath half-full of tepid water and a whole maze of electronics and tangled wires connected to electrodes dipping over the side!

"You look as if you're going to 'lectracoot yourself", they continued, quite unconcerned about the unanswered question, "Can we help?" Since I had no immediate desire to meet an early demise, I thought it prudent to explain just what was going on.

Actually, I had for a long while been toying with the possibility of using one of Marconi's earlier ideas for transmitting through water. His technique, which he later abandoned, was to utilise a pair of conductors on one side of a river connected to a carbon microphone and battery, and another couple of electrodes on the opposite bank hooked up to a pair of headphones. This arrangement essentially amounts to a bridge circuit, which, provided the impedances between the various electrodes are maintained as in Fig. 1, some fair results can be obtained, but only fair. Put a little two stage amplifier in at the transmitter and another in at the receiver and you have something that will "go-out" quite a way. Try it and see.

Two hours and four ounces of liquorice comfits later, and my bath-tub project, still not off-the-ground, saw me leaving this silent epitaph of despair for the more successful reaches of the Basingstoke Canal.

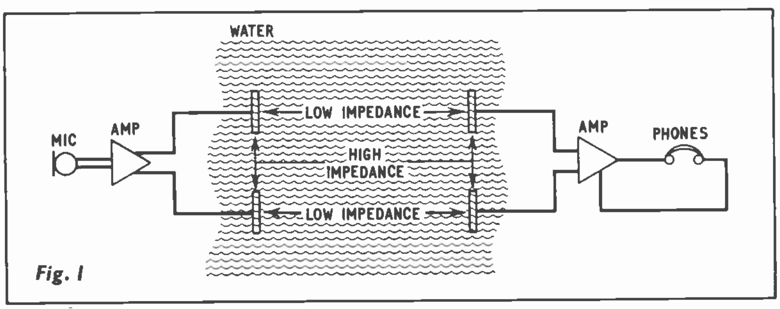


Fig. 1

WALKING MACHINES

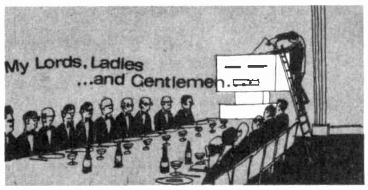
Who, you might well ask, wants a machine that walks! Particularly since there are already such perfectly satisfactory devices as the wheel, and even caterpillar tracks for more difficult terrain. Well, it seems that at least two groups of people are extremely interested in having a viable mechanised walker at the earliest opportunity. One, the Army Tank Automotive Command in Michigan, have already got an experimental "clomper" to play with, and I understand that such a machine is likely to be brought into use where wheels or tracks leave off. This pretty sizeable piece of "ironmongery" is apparently capable of climbing over objects in its path and walking through swamps.

The Army machine weighs 1,400 odd kilogrammes and each of the powerful legs is operated by an hydraulic "muscle" driven by high-pressure oil. Incorporated within the legs are tactile sensors which permit a degree of force-feedback control, so enabling any forces encountered by the machine to be sensed and dealt with accordingly!

Likely to have a more valid interest in walking devices are the gentlemen of the medical profession, who for years have sought the perfect walking prosthesis with precious little success. However, there seems no reason why hope should be completely abandoned because Prof. A. A. Frank of the University of Wisconsin (who has already completed a very successful four-legged creation) is currently engaged in work on a machine having two legs. This set-up, he forecasts, is anticipated to take the place of the conventional wheelchair and, in time, would give amputees more freedom than they currently enjoy.

Coordination of the legs in Frank's device is envisaged to be under the direction of a miniaturised digital computer. This, basically, will consist of a random access core memory which can be addressed by associated read/write registers. Initially, the handicapped person would need to make the rather tedious walking movements via the artificial legs himself, but once a satisfactory gait had been established the data could be written into the memory for subsequent use. From then on, whenever walking was required, the memory would be read in a continuous fashion, rather like a tape-recorder using a loop of tape, so producing cyclic leg action; left, right, left, right, and so on until they were required to stop or maybe perform some other function.

A working prosthesis is expected to be in existence round about 1972; it would be nice to think that such worthwhile devices will be capable of being mass-produced fairly soon. Without a doubt the demand will be high.



CHATTY COMPUTER

For 'umpteen years now, workers in the field of speech research have hankered for a computer that could produce good synthetic speech without the prior need for human translation of input data into "machine-language" before it could "understand". They need hanker no more, for scientists at the Bell Laboratories in New Jersey have recently taught a computer to convert printed English directly into synthetic speech.

During the experiments the computer was programmed with a basic vocabulary of words, together with their categories and definitions plus such related data as the pitch, stress, and timing as used in average normal conversation. In order to achieve the most natural sound, the computer was additionally given mathematical approximations to the changes in shape which occur in the human vocal tract when making speech sounds.

In use, information for conversion to synthetic speech is fed to the computer via a conventional teletype machine. Since the programme incorporates stress data, one must trust that its digestion is not upset too greatly by such word-group similarities as "a noisy noise", and "a noise annoys", or, dare I say it, "a noisy noise annoys". "Burp!"

Readout—
A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

"P.E. Gemini"

Sir—I unfortunately do not know whether Mr D. S. Gibbs or Mr I. M. Shaw was responsible for writing the introductory article for "P.E. Gemini" Stereo Amplifier, but this preamble was one of the most interesting articles which I have read for quite some time. It could easily serve as a general guide to basic amplifier design and pointing out some of the pitfalls of design and, of course, teaching one how to gain more useful information from the various technical data leaflets published by the manufacturers of stereo equipment.

I particularly liked the point about distortion at low levels. I had, up till now, thought only that distortion at the high power levels to be of importance, and how it could be "swept-under-the-carpet" by plotting the graph with a linear scale instead of a logarithmic one.

Of course, my impression of this preamble is purely subjective, not being connected in any way professionally with electronics, only in an amateur capacity, but still nevertheless, possessing a fairly good knowledge of basic valve and transistor theory through spare time reading of your own journal and various other publications. I only hope that next month's article can achieve the same level of interest; and I suspect that with the same author it will probably surpass it. As always, looking forward to next month's issue.

D. J. Whitaker,
Bromley,
Kent.

"GEMINI"

When the name *P.E. Gemini* was adopted for the Practical Electronics Stereo Amplifier, we overlooked the fact that *Gemini* was already associated with products of the Tripletone Manufacturing Co. This company has in fact used the name *Gemini* for a range of low cost amplifiers since 1959. The current version *Tripletone Gemini Mk II* is an all solid state design, previous models being valve designs. The output is 5W per channel and the retail price is £23 10s.

We hope there has been no confusion. In fact the *P.E. Gemini* and the *Tripletone Gemini Mk II* are quite dissimilar, both in specification and physical appearance.—Ed.

Beginning

Sir—I was interested to read Mr Bennett's letter (November 1970) and I appreciate the difficulty he and other beginners experience trying to find suitable books to guide them. Perhaps my own experience will be of interest to anyone finding it difficult to get started.

My interest in electronics began about 11 years ago at the age of 13. At that time transistors were relatively expensive, but I found that old televisions and radios could be acquired for next to nothing, so naturally I began by building valve circuits. I visited my local public library, renounced the children's section forever, and looked instead at the mysterious books on electronics. Nearly all of these books explained how the various electronic components functioned but hardly any of them gave practical advice on making a circuit work.

It was around this time that I discovered that magazines were available describing practical circuits and they proved to be very useful. There was nearly always some simple project that I could build and the more complex designs could be left until later. I quickly found that the practical experience helped to make the theory more meaningful.

After a year or two I was building circuits to my own designs and some of the circuits behaved in the most extraordinary way. There were audio amplifiers which oscillated and audio oscillators which didn't. This was very frustrating at the time, but clearing the faults was a challenge and further knowledge was gained in this way. Progressing from one mistake to another may not sound exciting, but its amazing how much you learn. Touching the tags of a capacitor charged to 300 volts d.c. is a mistake that you learn not to repeat too often!

Transistors and small components bring electronics within the reach of anyone having a table and a few hours to spare. A 9 volt battery makes an excellent (and inexpensive) power supply and a surprising number of projects can be built around just two transistors.

My advice to anyone thinking of taking up electronics is quite simple—have a go! Read as many books and magazines as possible and spend as much time as you can trying out the circuits that are published.

A. M. Rudkin B.Sc.(Eng.),
St. Albans,
Herts.

Second string boost

Sir—Your reader Mr A. D. Jones (Readout, November 1970) refers to my article on guitar pick-up construction (September 1970) and points out that an important point was omitted. He is, of course, quite correct in his comment that the magnets should be mounted with like poles at the same end and I regret that this point was not included in the article.

The phenomenon known as "second string boost" amongst guitar players, has for a long time been believed to be due to the particular character of the material, tension, etc. of the second string and it is supposed that this string vibrates with a slightly wider arc than the rest of the set, so producing a stronger signal than its neighbours.

Mounting magnets with opposite poles adjacent will cause interaction between strings and certainly aggravate any tendency the second string may have to vibrate over a wider arc. Fortunately, modern technology has done much to eliminate this irritating feature and good makes of guitar strings do not usually produce this bugbear.

I have made quite a number of pick-ups in the manner described in the article, assuring that all magnets are the same way up, and all have produced an even response on all strings.

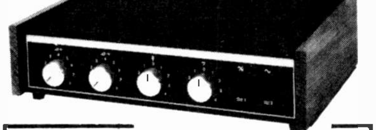
L. F. Dickson,
Salisbury,
Wilts.

MEETINGS . . .

INSTITUTION OF ELECTRICAL ENGINEERS
LONDON
January 11, 5.30 p.m.
Amorphous Semiconductors, R. W. Brander, at Savoy Place, London, WC2R 0BL.

INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS
LONDON
January 13, 6.0 p.m.
Integrated Circuits for Colour Television, J. C. MacKellar, at 9 Bedford Square, London, WC1B 3RG.

HARVERSONIC SUPER SOUND
10 + 10 STEREO AMPLIFIER KIT



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

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ±3dB 15-30,000Hz. Sensitivity better than 80mV into 1M Ω. Full power bandwidth ±3dB 20-14,000Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size—12" wide 8" deep 2¾" high.

Fully detailed 7-page construction manual and parts list free with kit or send 3/6 plus large S.A.E.

PRICES

AMPLIFIER KIT,	£10.10.0.	P. & P. 3/-.
POWER PACK KIT.	£3. 0.0.	P. & P. 5/-.
CABINET,	£3. 0.0.	P. & P. 5/-.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£20.10.0.** Post Free.

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

FANTASTIC 'POLY PLANAR' WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER

Size only 11¾" × 14⅝" × 1⅛" deep. Weight only 19 ozs. Can replace cone speakers in any application and is particularly useful for those with limited space. Extremely rugged and shockproof. Operating temperature −20°F to +175°F. Power handling 10 watts rms (20 watts peak). Impedance 8 ohm only. Response 40 Hz–20 KHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S.A.E. for full details. Only **£5.15.0** each. P. & P. 5/-.

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3in 4 ohm **10/-**, P. & P. 1/6. 5in 3 ohm **16/-**, P. & P. 3/-. 7 × 4in 3 ohm **21/-**, P. & P. 4/-. 10 × 6in 3 or 15 ohm **35/-**, 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/-.

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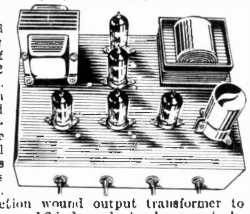

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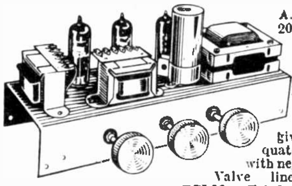

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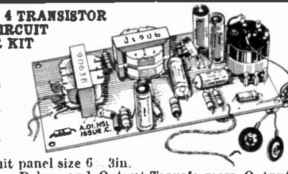
HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



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 49/6.** P. & P. 3/-. Also ready built and tested, **55/-**. P. & P. 3/-.

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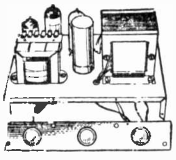

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VCB60	Ic 6A		fT. 1M/cs
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PRICE **6/-** EACH

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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

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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	25 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

PIV	1A (TO-5 case) each	3A (TO-66 case) each	7A (TO-48 case) each	16A (TO-48 case) each	PIV	30A 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/-.

DIACS
FOR USE WITH TRIACS
BR100 .. .. 7/6 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. TI843. 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.

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	IN914	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. 388-7006

BI-PAK

63A High Street WARE Herts.

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

G. F. MILWARD

Mail Orders: DRAYTON BASSETT, TAMWORTH, STAFFS

ELECTRONIC COMPONENTS

Wholesale/Retail : 369 Alum Rock Road, Birmingham B8 3DR. Tel. 021-327 2339

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

WIRE-ENDED TYPES

REF. No.			REF. No.			REF. No.			REF. No.			REF. No.		
G1/11	20/450V	2/-	H1/11	8/6V	6d	G4/13	400/50V	2/-	H7/2	20/15V	1/-	H7/10	60/15V	1/6
G1/13	40/50V	1/-	H2/1	32/150V	1/-	G4/14	500/4V	9d	H7/2A	20/6.4V	9d	H7/11	64/25V	1/6
G2/5	10/6V	9d	H2/2	64/2.5V	9d	H5/3A	500/25V	2/-	H7/3	25/12V	9d	H7/13	75/15V	1/6
G2/6	8/12V (REV)	9d	H2/6A	24/275V	1/-	H5/6A	40/3V	6d	H7/4	25/25V	1/6	H7/14	100/4V	1/-
G3/7	100/25V	2/-	H2/8	32/150V	1/-	H5/7	30/6V	6d	H7/4A	25/20V	1/6	H8/2	2/50V	1/-
G3/14	100/180V	2/-	H2/9A	2/150V	1/-	H5/11	400/6.4V	9d	H7/5	40/15V	1/6	H8/3	3/50V	1/-
G5/9	8/8/450V	3/-	H2/10A	16/32/350V	2/-	H5/12	320/10V	1/-	H7/6	50/3V	6d	H8/6	8/50V	1/-
G6/13A	40/450V	2/-	H2/11A	32/275V	1/6	H5/14	5/6V	6d	H7/6A	26/50V	1/6	H8/7	12/52V	1/6
H1/1	1/6V	6d	H3/7A	500/12V	1/6	H6/1	100/50V	1/6	H7/7	50/12V	1/6	H8/7A	15/15V	1/6
H1/3	4/4V	6d	H3/8	750/12V	1/6	H6/6	200/3V	6d	H7/7A	50/10V	1/-	H8/10	2/275V	1/-
H1/4	6/6V	6d	H3/10A	30/10V	6d	H6/7	200/16V	1/6	H7/8	50/15V	1/6	H8/11A	250/12V	1/6
H1/7	20/6V	6d	H3/12	16/50 (REV)	2/-	H6/13	500/3V	9d	H7/9	60/12V	1/6	H8/13	100/25V	2/-
H1/9	50/6V	6d	H4/1	20/4/275V	1/6	H7/1	10/12V	9d						

CAN TYPES

REF. No.			REF. No.			REF. No.			REF. No.			REF. No.		
G1/1	4,000/100V	7/6	G4/1	300/700/320V	7/6	G5/4A	500/100V	3/-	G6/9	60/200/300V	5/-	H3/4	1,000/50V	6/-
G2/1	6,000/30V	7/6	G4/5A	60/350V	1/-	G5/5	400/275V	3/-	G6/11A	400/300V	3/-	H3/4A	3,000/25V	3/-
G2/5	125/200V (REV)	5/-	G4/6	60/200/275V	2/6	G5/7	100/400/300V	7/6	G6/12A	1,000/12V	3/-	H3/6	2,500/9V	2/6
G2/10	50/50V	1/-	G4/7	40/40/275V	1/6	G5/7A	45,000/12V	15/-	H5/4	325/25V	1/6	H3/6A	5,000/18V	4/-
G2/11	100/350V	2/-	G4/7A	40/40/450V	2/6	G6/1	12,000/15V	15/-	G6/14	400/275V	3/-	H3/9	100/275V	2/-
G3/2	200/200/350V	6/-	G4/11	2,000/25V	3/-	G6/2	2,500/40/60V	7/6	H1/5	2,000/18V	3/-	H3/13	16/16/375V	2/-
G3/2A	200/200/100/350V	7/6	G4/12	150/30V	1/-	G6/2A	2,500/50V	7/6	H1/6	125/200V	2/-	H4/3	500/12V	1/6
G3/4	650/300V	7/6	G4/13	100/200/16/275V	6/-	G6/3	2,000/50V	7/6	H1/12	200/275V	2/-	H4/5	32/32/350V	2/-
G3/9	100/200/250V	6/-	G5/1	8,000/70V	10/-	G6/3A	2,000/15V	3/-	H1/15	100/200/60/275V	5/-	H4/9	500/6V	1/-
G3/10	40/20/10/10/350V	3/-	G5/2	300/300/350V	4/-	G6/5	1,000/1,500/25V	7/6	H2/6	50/275V	1/6	H4/11	75/400/16/275V	7/6
G3/10A	200/350V	2/-	G5/2A	30,000/40V	15/-	G6/5A	1,600/80V	7/6	H2/9	16/16/450V	2/-	H6/10	250/25V	1/6
G3/13A	2,000/30V	5/-	G5/3	35,000/15V	15/-	G6/6	1,000/60V	6/-	H2/10	1,000/100V	7/6	H8/13	6,000/6V	4/-
			G5/4	39,000/10V	10/-	G6/8	200/250V	3/-	H3/2	2,500/100V	7/6			

TAG ENDS

REF. No.			REF. No.			REF. No.			REF. No.			REF. No.		
G1/4	4/150V	1/-	G2/4	40/300V	1/6	G4/9	8/8/350V	2/-	G6/7	100/275V	2/-	H4/2	250/25V	1/6
G1/5	8/275V	1/-	G2/13	100/50V	1/-	G4/10	350/25V	2/-	G6/12	1,000/12V	2/-	H4/7A	32/32/275V	2/6
G1/5A	32/350V	1/6	G4/3A	200/25V	1/6	G6/1A	3,000/15V	3/-	H1/9A	50/150V	1/-	H4/12	500/50V	2/-
G1/7	16/16/275V	2/-	G4/5	16/300V	1/-	G6/4	1,000/50V	6/-	H3/5	250/150V	2/-	H5/6	250/50V	2/-
G1/12	40/450V	2/-												

PRINTED CIRCUIT, CAN TYPE

REF. No.			REF. No.			REF. No.			REF. No.			REF. No.		
G1/6	16/32/450V	2/-	G3/12	100/200/16/16/300V	5/-	G5/14	8/8275V	1/6	H3/9	100/275V	2/-	H5/2	64/32/8/275V	2/-
G1/8A	16/350V	1/-	G3/13	64/275V	2/-	G6/4A	1,000/25V	2/6	H3/10	100/250V	2/-	H5/3	500/25V (REV)	2/6
G1/10	32/275V	1/-	G4/3	250/150V	2/-	G6/11	40/350V	1/-	H3/13A	16/16/275V	1/6	H5/8	32/32/275V	1/6
G1/14	16/275V	1/-	G4/4	50/50/200V	2/-	G6/12	250/25V	2/-	H4/3A	500/50V	1/6	H5/9	100/100/150V	2/-
G2/10	100/100/350V	3/-	G4/8	40/40/450V	2/-	H1/10A	10/10/350V	1/6	H4/4	400/6 (REV)	2/-	H5/13	32/32/8/300V	2/-
G2/12	100/150V	2/-	G5/6	60/100/275V	2/6	H1/12	200/275V	2/-	H4/6	64/275V	2/-	H5/9	50/50/50/350V	3/-
G2/14	20/10/10/450V	2/-	G5/8A	100/65/250V	2/-	H1/13	250/150V	2/-	H4/7	32/32/350V	2/-	H6/4	150/150V	1/6
G3/1	60/100/350V	3/-	G5/10	100/100/50/350V	3/-	H2/4	50/80/300V	2/-	H4/8	8/8/8/275V	2/6	H6/14	1,000/20V	2/-
G3/6	100/250V	2/-	G5/11	100/200/25V	2/-	H2/5	100/100/100/275V	2/6	H4/10	10/10/425V	2/6	H8/11	250/25V	2/-
G3/6A	50/50/350V	2/-	G5/12	100/20/10/350/20/50V	2/6	H2/6	50/275V	1/6	H4/13	400/250V	3/-	H8/12	3,000/6V	3/-
G3/8A	100/25V, 100/12V	2/-	G5/13	40/100/350V	2/6	H2/11	32/32/250V	1/6	H5/1	150/200V	2/-	H8/13A	100/25/200/25V	1/6
G3/11	100/350V	2/6	G5/13A	40/40/40/40/350V	2/6	H2/12	50/50/150V	1/6				H3/11	150/200V	2/-

PRINTED CIRCUIT TYPE, WIRE LEADS

REF. No.			REF. No.			REF. No.			REF. No.			REF. No.		
G1/9	16/275V	1/6	H3/15	350/12V	1/6	H6/10	300/9V	1/-	H7/12	65/15V	1/6	H8/4	5/15V	1/-
H2/7	10/25V	1/-	H5/1	150/30V	1/6	H6/11	300/15V	1/6	H7/15	100/16	1/6	H8/8	20/9	1/-
H2/12A	350/12V	1/-	H5/14A	1,100/10V	2/1	H6/14A	900/15V	2/-	H8/1	1/350V	1/-	H8/9	40/15	1/-
H2/15	12.5/40V	1/6	H6/5	150/25V	1/6									

SPECIAL 10/- PACKS. ORDER 10 PACKS AND WE WILL INCLUDE AN EXTRA ONE FREE ! ! ! !

RESISTORS, ¼/½ watt assorted	100	10/-
Wire-wound 1 to 3 watt	20	10/-
5 to 7 watt	15	10/-
10 watts	10	10/-
Multi-tapped	12	10/-
PAPER CONDENSERS TV types	50	10/-
Miniature	100	10/-
ELECTROLYTIC CONDENSERS Suitable for Mains Radio/TV	10	10/-
Transistor types	20	10/-
Mixed (both types)	15	10/-
POLYSTYRENE CONDENSERS	100	10/-
MULLARD POLYESTER COND.	50	10/-
SILVER MICA	100	10/-
WIRE-WOUND 3-Watt SLIDERS	15	10/-
VOLUME CONTROLS. Assorted	5	10/-
NUTS AND BOLTS. Mixed length/type 8 B.A.	100	10/-
6 B.A.	100	10/-
4 B.A.	100	10/-
2 B.A.	100	10/-
METAL SPEAKER GRILLS 7½in. × 3½in.	6	10/-
EARPIECES, Magnetic No Plug	6	10/-
2.5mm Plug	4	10/-
3·5mm Plug	4	10/-
500 MICRO-AMP LEVEL METERS	1	10/-
VEROBOARD. TRIAL PACK 5 BOARDS + CUTTER		10/-

TRANSISTORS		
P.N.P. Untested but mainly O.K.	50	10/-
N.P.N. Untested but mainly O.K.	50	10/-
OCP 71 equivalent	5	10/-
Light-sensitive Diodes	10	10/-
(These produce up to 1ma from light)		
OC 44 Mullard 1st grade	4	10/-
OC45 Mullard Boxed	4	10/-
2G378 Output, Marked	4	10/-
2G371 Driver, Marked	4	10/-
ASY 22. Marked	5	10/-
BY 127 Rectifiers	4	10/-
IN4007 Rectifiers (1200V peak)	4	10/-
STC 3/4 Rectifiers	6	10/-
DIODES (0A 81 & 0A 91)	40	10/-
WIRE. Solid Core. Insulated	100yds.	10/-
Stranded ditto	50yds.	10/-
SOLAR CELLS. Large Selenium	2	10/-
Small	3	10/-
(6 cells will power a Micromatic radio)		
CO-AXIAL CABLE. Semi Air-spaced	15yds.	10/-
CRYSTAL TAPE RECORDER MIKES	1	10/-
CRYSTAL EARPIECES 3.5mm Plug	2	10/-
TRANSISTORISED Signal Injector	1	10/-
TRANSISTORISED Signal Tracer	1	10/-
TRANSISTORISED CAR REV. COUNTER KIT (Needs 1ma. meter as indicator)	1	10/-

MULLARD 'UNIFLEX' AMPLIFIERS
In our opinion these units are the best value for money ever offered. A complete stereo unit consisting of Control unit. Pre-amplifier, Two Main Amplifiers and Power Pack complete and ready for use—NO extra components to buy—yours for **£15.** (Normal retail price is £16.10s.)

GARRARD SP 25 UNITS also offered at a discount. Our price only **£12.10s.** Postage 9/-.

SINCLAIR AMPLIFIERS AND SPEAKERS. Complete range in stock. All at 10 per cent discount on list.

VEROBOARD

2½in.	× 1in.	× .15	1/3	5in.	× 3¾in.	× .15	5/6	3¾in.	× 3¾in.	× .1	4/9
3¾in.	× 2½in.	× .15	3/3	17in.	× 2½in.	× .15	11/-	5in.	× 2½in.	× .1	4/7
3¾in.	× 3¾in.	× .15	3/11	17in.	× 3¾in.	× .15	14/8	5in.	× 3¾in.	× .1	5/6
5in.	× 2½in.	× .15	3/11	3¾in.	× 2½in.	× .1	4/2				

Spot Face Cutter 7/6. Pin Insert Tool 9/6. Terminal Pins (.1 or .15) 3/6 for 36.
Special offer pack consisting of 5 2½in. × 1in. boards and Spot Face Cutter . . 10/-

TRANSISTOR RADIOS
Once again we have a supply of these excellent radios which offer superb quality sound and excellent sensitivity. They are packed in a colourful presentation box complete with battery, earpiece and carrying case. Each one is guaranteed. You would expect to pay at least £5—but our price due to a bulk purchase is only **37/6.** Many of our customers have made a considerable profit by buying these radios and re-selling them to friends!

RECORD PLAYER CARTRIDGES. Well below normal shop price!
ACOS GP 67/2 **15/-.** (Mono). ACOS GP 91/3 **20/-.** (Compatible) ACOS GP 93/1 **25/-.** (Stereo) ACOS GP 94/– **30/-.** (Stereo, Ceramic). ACOS GP 93/– DIAMOND 32/6. ACOS 94/1 DIAMOND **37/6.**

TRANSISTORISED FLUORESCENT LIGHTS. 12 volt. All with Reverse Polarity protection. 8 watt **59/6.** 15 watt **79/6.** 13 watt **99/6.** Postage 3/- per fitting. These can be sent on approval against full payment. Thousands already sold.

MULLARD POLYESTER CONDENSERS
1,000 pf., 1,200 pf., 1,800 pf., 2,200 pf., 400 volts, **3d.** each. 25 per cent discount 100 any type. .15uf., .22uf., 27uf., 160 volts **6d.** each. 25 per cent discount 100 any one type.

RESISTORS
¼ and ½ watt. Most values in stock. **10/-** per 100 of any one value. **2/-** dozen. **3d.** singles. MAINS DROPPER TYPE. Hundreds on values from .7 ohm upwards. 1 watt to 50 watts. 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.

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS
Large range in stock. 15/- per 100 of any one value. 3/- per dozen. Singles 6d. each.

RECORDING TAPE BARGAIN! The very best British Made low-noise, **high-quality Tape!** 5in. Standard, **7/6.** Long-play **9/-.** Long-play **12/-.** 7in. Standard **12/-.** Long-play **16/3.** We are getting a fantastic number of repeat orders for this tape. Might we suggest that you order now whilst we still have a good stock available?

£5 WORTH OF COMPONENTS FREE! ! ! !
Thinkingoflearning another language? If so, apply to us for details of Linguaphone courses. We will GIVE you £5 worth of components of your selection when you purchase a language course" ! ! ! !

G. F. MILWARD, Drayton Bassett, Tamworth, Staffs. Postage (minimum) per order 2/-.

BRAND NEW! BANG UP-TO-DATE!

RUSSIAN WORLD BEATER!

WE COULDN'T EVEN MAKE THEM FOR THIS FANTASTIC PRICE!

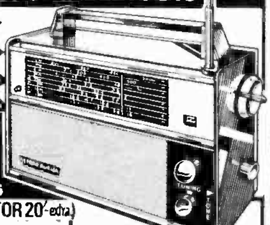
NOT JUST A RADIO—BUT TECHNOLOGICAL MAGIC!

BATTERY/MAINS!

8 WAVEBAND 10 TRANSISTOR PLUS 2 DIODES PORTABLE RADIO

WORLD WIDE RECEPTION

THOUSANDS OF TRANSMISSIONS, AND STATIONS THE WORLD OVER!



BATTERY MODEL £13·19·6

BOX POST ETC. 8/6

(OR WITH MAINS/BATTERY ELIMINATOR 20/- extra)

***COMPARE IT'S PERFORMANCE with 39½ Gns. RADIOS!**

This fantastic brand new Astrad Auriga Russian 8 waveband portable radio, designed for world wide reception will probably make your present radio seem like a "crystal set"*! It's far better than any other 8 wave radio that **even they** have produced before! Complete with optional battery eliminator for **both** battery **and** mains use! We're almost **giving** them away at only **£13.19.6 a mere fraction of even today's Russian miracle price!** In fact, we challenge you to compare the performance and value with that of 39½-gn. radios! ★ You just can't lose, we'll refund your money instantly if you are not astounded! **Purer and sweeter tone than ever! Wider band spread for absolute "pin-point" station selection!** Yes, the Russians have **really surpassed themselves this time,** proving once again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of space communications. YOU GET THIS AMAZING SET FROM US AT A PRICE THAT BEARS NO RELATION TO ITS TRUE VALUE! **Yes, 8 separate wavebands, including Standard Long, Medium and Short Waves to cover the world! Unique side control waveband selection unit gives incredible ease of station tuning! Thousands of different transmissions and stations at your fingertips 24 hours a day,** including ships at sea and messages from all over the world—**truly nothing is secret! You must hear it to believe it! Superb, sweet tone**—controlled from a whisper to a roar that will fill a hall! Genuine push-pull output! Separate ON/OFF volume and Treble-Bass tone controls! **Press-button dial illumination! Take it anywhere**—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240V a.c. mains supply. Internal ferrite rod aerial plus built-in telescopic aerial extending to full 31in length. **It's also a fabulous CAR RADIO—any speed, requires no additional aerial. UNIQUE!** Elegant Black & Chrome finish case. **SIZE 11in × 9in × 3¾in overall approx.** Made to give **years of perfect service.** Complete, with WRITTEN GUARANTEE, manual with simple operating instructions and circuit diagram. **ONLY £13.19.6 (mains/battery eliminator 20/- extra). POST, ETC. 8/6. Standard batteries 5/- extra. Can also be used through extension amplifier, tape-recorder, public address. Send today or call. But HURRY! It's the chance of a lifetime!**

Sensational News from Russia! for Every Lover of HI-FI!

SUPERB COMPLETE DE-LUXE STEREO RADIOGRAM System

Comprising 4 magnificent UNITS!

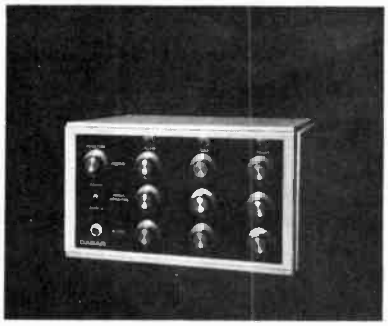
GUARANTEED £140 PERFORMANCE!

LISTED IN U.K. Sept '69 AT £79— AND THAT WAS A RUSSIAN MIRACLE!

NOW FROM US FANTASTIC! ONLY 49½ GNS. COMPLETE CARR. ETC 2 GNS

Comparable with specifications costing around £140, to be sold by others in U.K. **at £79** as recently as Sept., '69. **NOW**—unbelievable but true—**We are able to** offer 500 only. **BRAND SPANKING NEW with written 12 months guarantee, for only 49½ gns., carriage, etc., 2 gns. You'll never appreciate the wonderful reproduction possible from your old stereo or mono records until you listen to them on this superb Hi-Fi Audio Unit.** It's a **breath-taking** experience! But wait. With the 6 Waveband Radio you can **get** thousands of transmissions from all over the world including ham radio, ships at sea, continental and international stations. Amazing clarity of tone and incredible station selection. Just read the magnificent specification of this compact fully transistorised, high quality sound reproduction equipment in matching unit form: **Four-speed single Record Player deck,** lightweight arm with "turnover" sapphire stylus and transparent deck cover, etc. (15½in × 12in × 6¾in approx.). **Two speaker Cabinets** (each 18¾in × 9½in × 8in approx.), each containing 8in high efficiency unit and 3in cone tweeter. **Fully transistorised Tuner/Amplifier** (26 transistors, 11 diodes) (18½in × 9½in × 8in approx.) incorporating VHF/FM, Long, Medium and 3 Short wavebands. **All instantaneous Press Button top panel** controls! Push-pull output stage. Frontally controlled rotatable ferrite rod aerial, internal FM aerial, meter type tuning indicator, stereo balance control, separate variable bass and treble controls give superb balance and tone. Plus all usual extension sockets. **110, 127, 220, 240V a.c.** All cabinets very strongly constructed—with beautiful high gloss walnut polyester finish. **Long negotiations and a final purchase for cash made this incredible offer possible! Please don't ask questions—just hurry! Only 500 will be lucky! SPARES AND UK SERVICE CONSTANTLY AVAILABLE. Only 49½ gns. plus carriage, crating, handling, etc., 2 gns., and test on 7 days appro. No more to pay!** ★U.K. Trade distributors claim that British models comparing with this specification could cost you £140! **We guarantee to refund your money if YOU don't agree!**

SHOPERTUNITIES LTD. S|L **Dpt. PE/1, 164 UXBRIDGE RD., (facing Shepherd's Bush Green), London W12 8AQ. (Thurs. 1, Fri. 7). Also 37 High Holborn, London, WC1 (opp. Chancery Lane). (Wed. 1, Thurs. 7). Both stores open Mon.-Sat. from 9 a.m. until 6 p.m.**



KINETIC LIGHTING EFFECTS

The DABAR range of Kinetic Lighting Effects encompass a wide range of sophisticated colour pulsing and blending units, designed for discotheques, dance halls, restaurants, shop-window displays, etc.
Basically 3 facilities are available: A sound to light Psychodelic lighting unit or colour organ. This unit connects directly into an amplifier output or across loudspeakers (with negligible loading effect) and converts the audio frequency signals into a 3-colour light display; the colour depending on the frequency of the signal and the intensity of the light on the loudness of the audio source. Secondly a background control providing a variable minimum ambient lighting level if required and thirdly a colour blender providing a continuously and completely random slowly changing pattern of lights. This is fully automatic requiring no audio input and is controlled by 3 speed-control potentiometers.
Units are available providing loading of either 1kW of lighting per channel (3kW max per unit) or 3kW per channel (9kW max per unit). Latest full-wave Triac circuitry is used and radio-frequency interference filters are fitted in all units.
Case size: 13in × 7in × 9in.

Audio Activated Colour organ incorporating background controls.

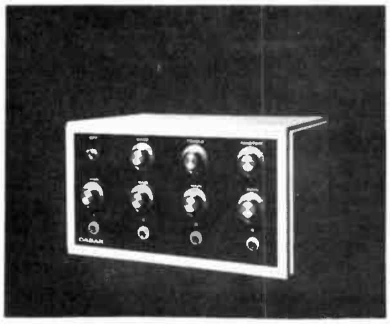
1kW per channel **£50**	3kW per channel **£88**

Colour blender:

1kW per channel **£40**	3kW per channel **£78**

Audio activated colour organ with background controls and colour blender:

1kW per channel **£60**	3kW per channel **£98**



100 WATT AMPLIFIER

The latest addition to the DABAR range of equipment is a 4 channel integrated Preamplifier and Power amplifier, delivering a full 100W r.m.s. into a 4 ohm load. The amplifier has 4 inputs, each with their own gain control and a further master gain control, treble and bass control. A unique feature of this amplifier is in it's versatility of uses. It has been designed to accept plug-in pre-amp cards for each channel thus covering a wide range of applications. The basic unit is supplied with 4 input modules of your choice, but further modules may be purchased at moderate cost, thus enabling, with the minimum of time, effort and outlay the conversion of any one or all channels to accept an entirely different input.
Modules available include: P/U cartridges—crystal, ceramic, and magnetic (equalised R.I.A.A.); Microphones—30–60 Ω, 300–600 Ω and 50k Ω types. Guitar and two modules for high impedance outputs from tape, tuner, etc., 100mV f.e.t. and 1V input.
Case size: 13in × 7in × 9in.
Price complete with 4 modules **£109.0.0**
Extra modules **£5.0.0** each.

Please send 1/- in stamps for full descriptive literature.

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BCY31	5/6
BCY32	7/6
BCY33	4/-
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BCY39	10/6
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BCY42	3/-
BCY43	3/-
BCY54	6/6
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BCY60	19/6
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BSX77	5/6
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BSY28	3/6
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BSY32	5/-
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GET896	4/6
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OC42	5/-
OC44	4/-
OC45	2/6
OC46	3/-
OC70	3/-
OC71	2/6
OC72	2/6
OC74	6/6
OC75	4/6
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OC77	6/-
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OC81D	4/6
OC83	5/-
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OC201	9/6
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TIS44	2/6
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TIS49	2/6
TIS50	3/6
TIS51	2/6
TIS52	2/6
TIS53	4/6
TIS60	4/6
TIS61	5/-
TIS62	5/6
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ZTX108	3/6
ZTX109	3/6
ZTX300	3/6
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ZTX500	4/6
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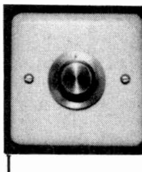

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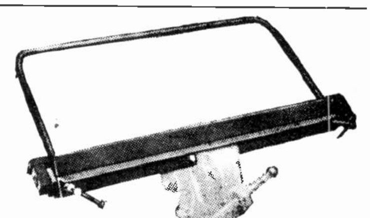

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